Cayman Islands Energy Policy Background Advisory Document

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

EXECUTIVE SUMMARY

The Cayman Islands, like many Small Island Developing States (SIDS), are primarily dependent on fossil fuels for their energy needs. Water, electricity and transport are all reliant on imported oil, as are the two sectors of the islands economy, i.e. tourism and offshore finance. Both these sectors require affordable sources of energy in order to remain competitive.

Due to the Cayman's dependency on imported oil, it has seen dramatic increases in the cost of electricity as the price per barrel of petroleum went as high as $147 during the summer of 2008. The geopolitical risk of a conflict or terrorist attack half the world away could result in an interruption of shipments of oil to the Cayman Islands, which would result in significant damage to the Cayman's economy as well as to the drinking water supply, as the majority of the drinking water is produced utilizing an electrically powered reverse osmosis equipment, which runs on imported oil. Also changes in global petroleum production and distribution present serious supply and demand issues for the Cayman Islands.

Many stakeholders see the lack of an energy policy as an impediment to energy security. The reliance on a single source of energy (i.e. diesel fuel), from a source over which the Cayman Islands has no control, was recognized as being non-sustainable. It was pointed out on more than one occasion that high energy prices would have a negative effect in both economic sectors of the country.

For the Cayman Islands a transition from energy dependency to energy security requires an economically, environmentally and socially sustainable energy policy.

The objective of this report is to provide the Cayman Islands with a comprehensive up-to-date background document and literature review on energy policy, which then leads to a set of recommendations to develop an economically, environmentally and socially sustainable energy policy for the Cayman Islands.

The recommendations were built up from lessons learnt on the development of energy policies worldwide. Those were compiled in a roadmap to a successful policy framework with three main underlying objectives:

- The Supply Objective: To ensure the provision of adequate, secure, and cost-effective energy supplies by promoting the development of both renewable and non-renewable resources using least cost options and diversification of supply sources;
- The Utilization Objective: To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and
- The Environmental Objective: To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

The roadmap includes recommendations with regards to:

- Defining the rationale and expected long-term outcome of the policy;
- Assessing the technical and economic potential;
- Quantify short, medium and long-term targets;
- Identify barriers and challenges, and provision of according solutions and incentives;
- Preparation, design & implementation of the system, as well as monitoring of the system performance and continuous improvement when experience grows.
- It also provides guiding suggestions on the development of incentives as well as some specific remarks on Energy Efficiency and Transport.

1. INTRODUCTION

The Cayman Islands, like many Small Island Developing States (SIDS) are primarily dependent on fossil fuels for their energy needs. Water, electricity and transport are all reliant on imported oil, as are the two sectors of the islands economy, tourism and offshore finance. Both these sectors require affordable sources of energy in order to remain competitive.

For the Cayman Islands a transition from energy dependency to energy security requires an economically, environmentally and socially sustainable energy policy. The Cayman Islands' dependency on imported oil has seen dramatic increases in the cost of electricity as the price per barrel of petroleum went as high as $147 during the summer of 2008. The International Energy Agency states:"*Current global trends in energy supply and consumption are patently unsustainable – environmentally, economically, and socially. But that can – and must – be altered; there's still time to change the road we are on. It is not an exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two central energy challenges facing us today: securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of an energy revolution*".

The geopolitical risk of a conflict or terrorist attack half the world away could result in an interruption of shipments of oil to the Cayman Islands. Such an interruption would only have to be for a few weeks to create enormous damage to Cayman's economy. The situation with gas shipments from Russia to the European Union last year is an indicator of what could happen regionally. Global demand for energy is increasing and carbon dioxide emissions associated with the use of fossil fuels are expected to rise 60% worldwide by the year 2030. Future changes in global petroleum production and distribution represent serious supply and demand issues to the Caymans. The cost of imported fuels has pushed Cayman's electricity rates among the highest in the world.

From the perspective of human security, the Cayman Islands are in a precarious position vis-à-vis potable water. The majority of the island's drinking water is produced using electrically powered reverse osmosis equipment. A shortage of petroleum or a steep escalation in price could severely affect the availability or affordability of this vital commodity. The government does extract water from aquifers for public consumption, but the reality that many of the main supply lines, by necessity, follow major road corridors, which are situated on the coast plain, only reinforces the vulnerability of the water supply.

The other half of the equation, having examined the economic implications of oil dependency is the advent of peak oil. As was stated by the IEA in the forward to its World Energy Outlook 2008 "*Out of the turmoil of the energy markets of the last 12 months and our evaluation of future influences on the sector has emerged a new underlying price assumption for the World Energy Outlook - an oil price through 2030 which nudges twice the level in WEO-2007. The era of cheap oil is over. This alone should be enough to make policy makers sit up. On the present trends, just to replace oil reserves [which] will be exhausted and to meet the growth in demand, between now and 2030 we will need 64 million barrels per day of new production capacity, six times the size of Saudi Arabia's capacity today.*"

A reliable energy supply has been a major component of the Cayman Islands' development. As such, meeting the islands' energy needs, in the face of current and future energy and energy security challenges, must be made a priority for the future. Securing energy supplies and speeding up the transition to a low-carbon energy system both call for radical action by governments, at national and local levels, and through participation in co-coordinated international mechanisms. Households, businesses and motorists will have to change the way they use energy, while energy suppliers will need to invest in developing and commercializing low-carbon technologies. To make this happen, governments have to put in place appropriate financial incentives and regulatory frameworks that support both energy-security and climate policy goals in an integrated way. (WEO 2008)

Currently, the only renewable energy scheme in existence is the Consumer Owned Renewable Energy (CORE) Program agreed between the Electricity Regulatory Authority (ERA) and Caribbean Utilities Company (CUC) in January 2009. This program runs until end of 2010, after which it will be reviewed. The CORE Program allows customers on Grand Cayman to connect their small-scale solar systems or wind turbines to CUC's distribution system and receive credit for the self-generated renewable energy. This program is complemented by the recent duty exemption on renewable energy equipment granted by the Cayman Islands Government. Effective since 1 December 2008, the waiver allows a full exemption from import duty on renewable energy equipment for residential homeowners. Waivers on similar equipment imported for commercial use will be reviewed on a case-by-case basis by the ERA. Cayman Brac and Little Cayman already have duty exemption for building supplies, which could include renewable equipment (solar panels, solar water heaters etc). The reaction to date to the CORE program has been mixed, partly due to the absence of net metering. The CORE program may also discourage large commercial enterprises wanting to generate energy for their own use in an area a long distance away from where it will be utilized, which under net metering would be traceable and thus could be used for incentives such as promotional tariffs etc.

Distributed generating is arguably a positive step for the Cayman Islands and all Small Islands Developing States (SIDS) that are exposed to hurricanes and cyclones. The experience in the Cayman Islands post hurricane Ivan highlighted the vulnerability of the above ground electrical transmission and distribution system. Sections of the island were without electricity for many weeks post-disaster. Many large office buildings installed large backup generators for a post-disaster usage. In future, with an energy policy that supports the island's energy security and independence, it is hoped such fossil fuel-based generating systems will be replaced with solar photovoltaics and wind turbines.

Some large hotel properties do have both energy and sustainability programs. These properties have made 'Greening of the Hotel' a priority, and consequently have realized financial savings in the mid six-figure region. The use of compact fluorescent bulbs, bulk purchasing of supplies without individual packaging, monitoring of energy and water usage are energy efficiency measures that can be easily implemented throughout the Cayman Islands.

Many stakeholders see the lack of an energy policy as an impediment to energy security. The reliance on a single source of energy (i.e. diesel fuel) from a source over which the Cayman Islands has no control, was recognized as being non-sustainable. It was pointed out on more than one occasion that high energy prices would have a negative effect in both sectors of the country's economy, tourism and finance.

The business community speaks of the necessity of working towards energy efficiency in buildings (such as in HVAC systems and higher 'R' values in building insulation) and has suggested import-duty rebates on high efficiency equipment. This would encourage the adoption and utilization of energy efficient, low carbon appliances and equipment. Further mention was made of the need for an off-peak electricity rate structure. Energy cannot effectively be managed if it cannot be measured. Smart metering technology offers easy to access, real-time electricity use data. Smart meter trials in other jurisdictions have shown up to a 15% reduction in electricity use as a result of consumers changing their consumption patterns based on the information provided by the smart meters. The Cayman Islands Government is investigating the implementation of international building codes that will raise standards for energy efficiency.

In the field of bio-fuels the Cayman Islands have one producer manufacturing bio-diesel who is producing approximately 70,000 gallons per year. Production is however limited by the availability of used vegetable oil in the Cayman Islands.

The Cayman Islands are in a position to become a world leader in the transition to a sustainable society reliant on green energy sources. However, breaking our dependence on carbon emitting fossil fuels is vital and the first step in the process is an energy policy. The objective of this report is to provide to the Cayman Islands with a comprehensive up-to-date background document and literature review on energy policy.

The review followed up a bottom-up approach, listing and assessing the current situation in terms of energy policy and its outputs at the international, regional (Small islands Development States) and local (Latin America and the Caribbean) levels.

Based on the lessons learned from energy policies worldwide this document will finally come up with a number of recommendations and steps to take in order to develop a tailored policy framework for the Cayman situation.

2. GLOBAL ENERGY TRENDS

2.1 The Stern Review and the Global Deal on Climate Change

The Stern Review, conducted by Sir Nicholas Stern and published in 2005, was the first rigorous economic analysis of the cost to the global economy of action versus inaction on climate change. This Review has become the most influential piece of economic policy work in the climate change field worldwide (Stern, Stern Review, 2006).

In 2008 Lord Stern developed a coherent set of proposals for a global treaty to address climate change. The recommendations are built around the scenario in which a peak in greenhouse gas emissions is reached by 2023 and new emissions by 2050 are reduced to half of the 1990's level (Stern, 2008).

The key elements of the Stern Review and on the Global Deal on Climate Change Report are here in presented.

Key Elements of the Stern Review (2005)

The review has assessed a wide range of evidence on impacts of climate change and on economic costs, as it has utilised a number of different techniques to assess costs and risks. From all evidence gathered by the review, it has shown that the benefits of strong and early action far outweigh the economic costs of not acting.

Within this review the costs of climate change were estimated as equivalent to 5% of global GDP per year for eternity. If a wider range of risks and impacts were accounted (e.g. environmental and health) the estimates of damage would rise to 20%.

On the other hand, the costs of action by reducing the greenhouse gas emissions to avoid the worst impacts on climate change can be limited around 1% of global GDP each year. For that there is a strong need for emissions - after having peaked in the next 10-20 years - to fall by 1 to 3% annually thereafter, implying the emission intensity of GDP to be around a quarter of today's levels by 2050.

The Stern Review (2005) shows there is a need for policy responses that integrate action for mitigating GHG emissions and adapting to climate change, and demonstrates a need for international cooperation to implement those actions.

Mitigation of GHG emissions is essential to combat climate change. The review shows that the risks of the worst impacts of climate change can be substantially reduced if the GHG levels in the atmosphere are stabilised between 450 and 550 parts per million (ppm) CO_2-equivalent, which means that the GHG levels should be at least 25% below the current level of 430ppm (which is rising at more than 2ppm per year) in 2050, and that stabilization after 2050 will require annual emissions to be brought down at least 80% below current levels. These data are shown in further detail in Figure 1 and Table 1.

As greenhouse emissions are an externality for producers, incentives to drive low-carbon choices are necessary:

- A global carbon price, through carbon taxes and emission trading, as well as measures to ensure that dangerous investment decisions are not made during the cross-over period;
- Close collaboration between governments and industry is essential to drive technology and research and development (R&D). For the development of a diverse portfolio of technologies global public energy R&D should double to about US$20 billion a year.

- Education, labelling, efficiency standards and direct incentives are key for encouraging behaviour change.

According to the review these initiatives would foster reducing the demand for high-emission goods and services; switching to low-carbon technologies for power, heat and transport; and ensuring widespread uptake of energy efficiency measures.

Stern estimates that the excess of benefits over the costs associated with stabilising CO_2 at a level of 500-550ppm would yield a net present value of US$2.5 trillion. These cost can be lower if there are major gains in efficiency or if strong co-benefits are measured (such as the reduction of air pollution), or can be higher if innovation in low-carbon technologies is slower than expected or if policy makers fail to make the support instruments sufficiently cost-effective, i.e. allowing emissions to be reduced whenever, wherever and however it is cheapest to do so.

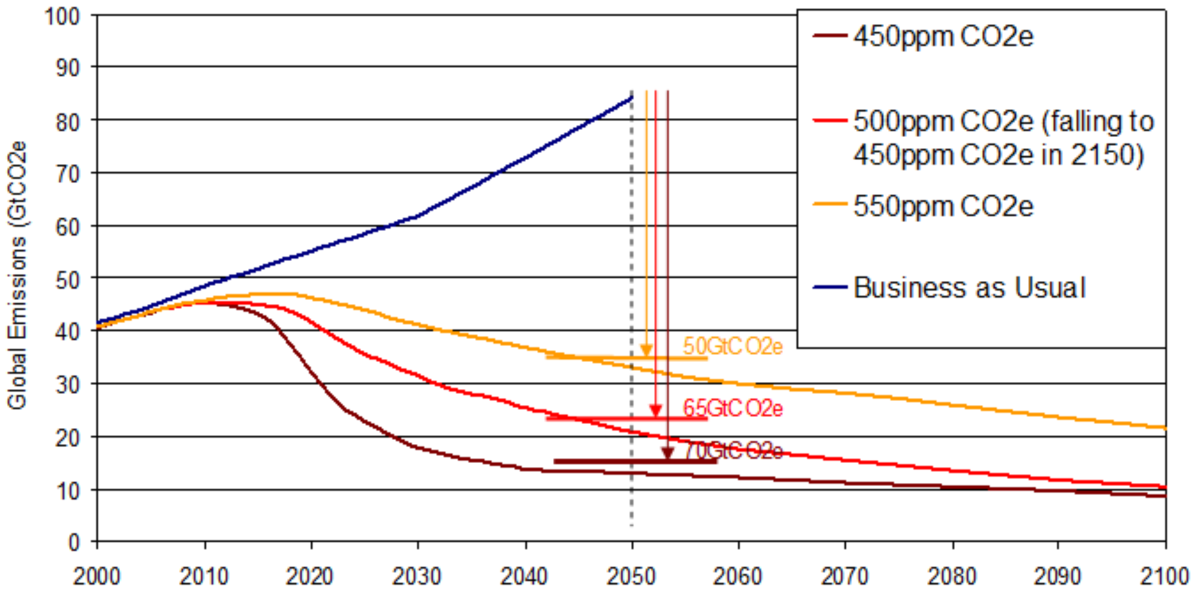


Figure 1: Mitigation effort (Stern, Stern Review, 2006)

Table 1: Stabilization paths (Stern, Stern Review, 2006)

Stabilisation Level (CO_2e)	Date of peak global emissions	Global emissions reduction rate (% per year)	Percentage reduction in emissions below 2005* values 2050	Percentage reduction in emissions below 2005* values 2100
450 ppm	2010	7.0	70	75
	2020	-	-	-
500 ppm (falling to 450 ppm in 2150)	2010	3.0	50	75
	2020	4.0 - 6.0	60 - 70	75
	2030	*5.0[1] – 5.5 [2]*	*50 - 60*	*75 – 80*
	2040	-	-	-
550 ppm	2015	1.0	25	50
	2020	1.5 – 2.5	25 – 30	50 – 55
	2030	2.5 – 4.0	25 – 30	50 – 55
	2040	3.0 – *4.5 [3]*	5 – 15	50 – *60*

In addition to stabilization of GHG in the atmosphere, since climate change is real, it is also important that society adapts to the impacts that will occur. Within this review Stern identifies four key policies for governments:

- Provision for high quality climate information services – for better prediction of extreme events;
- Introduction of regulations for building, land use and infrastructure that take into account climate change predictions;
- Long-term planning for climate-sensitive public goods;
- Creation of a financial safety net for the vulnerable – especially for the poorest populations that will suffer the impacts of climate change the most.

As climate change is a global problem that requires international collective action, international cooperation is essential to tackle this problem. Stern advocates:

- Agreement on a framework for global emission reductions;
- Utilising the EU's emission trading scheme as the global carbon market hub, linking prices for carbon and reporting frameworks;
- Cooperation on driving technological cooperation and diffusion;
- Scaling up capital flows to help developing countries adapt to climate change;
- Cooperation in curbing deforestation.

Key Elements of the Global Deal on Climate Change

This framework states that emission levels should stabilise at one tonne per capita per year on a global level, representing an 80% reduction in real emissions of developed countries in the period to 2050. In 2050 it is estimated that the developing world will be responsible for the greater part of global emissions. Due to this all nations need to be involved in the emission reduction process.

To achieve a reduction of half the 1990 levels by 2050, most of the world's electricity production requires to be decarbonised and the emissions from buildings, industry, transport and land use need to be cut sharply. This will need a major global investment in R&D and globally coordinated action.

This report states that the global policy framework should be designed to satisfy three key principles. It must be:

(1) Effective – it should involve action that can affordably keep risks from climate change at acceptable levels;

(2) Efficient – mitigation should be taken where it is cheapest, with carbon market and prices playing a central role in determining type and origin of mitigation;

(3) Equitable – as climate change is a shared problem with differentiated responsibilities, commitments must be perceived as equitable which requires rich countries to take the lead. The countries most vulnerable to climate change are often the ones were the emissions have been the lowest and this requires early support for adaptation. Delayed policies and badly implemented ones can inflate the cost of action by overlooking cost-effective emission reductions and creating additional market distortions and perverse incentives.

This review advocates the following lines of action:

- As the carbon market is the most effective, efficient and equitable way to reduce emissions, an international carbon market should be established;

- There must be coordinated global support for carbon capture and storage technology;
- To share risk efficiently new public-private partnerships need to be established;
- Developed countries until 2020 should focus on delivering emission reductions without threatening economic growth and should design mechanism for low carbon technology transfer for the developing world. From 2020 onwards, developing countries should take responsibility for setting their own emission reduction national targets;
- Middle-income developing countries should take immediate action to stabilise and reverse emissions growth;
- Reduction of deforestation and land degradation should be pursued as a highly cost-effective method for emission growth compensation;
- A global price for carbon: tax and regulation or trading should be instruments utilised to regulate the price and the response to the price. In addition a regime of globally coordinated energy efficiency targets should be developed for all economic sectors;
- Emission reductions should be taken wherever they are cheapest, which is often in developing countries. To facilitate this sector-specific efficiency targets and decarbonisation plans should be developed;
- Global support for adaptation should be implemented in those countries that will face emission impacts for which they are not responsible;
- The Copenhagen 2009 Climate Change Negotiations must institute a credible global institutional structure to manage the international framework that this review outlines.

This report reinforces the idea that the cost of action is lower than the cost of inaction. Climate change is a far-reaching, comprehensive and global challenge but it is manageable. Although the cost of technological transformation and flows of funds required across countries and sectors will be large, and the institutional and implementation challenges are significant, the costs of action are affordable and consistent with sustainable growth and development. By contrast the alternative of inaction or delay is not.

2.2 World Energy Outlook Policy Scenarios

Current global trends in energy supply and consumption are environmentally, economically and socially unsustainable (OECD/IEA, World Energy Outlook 2008, 2008). Although energy use is growing more slowly towards 2030 than projected in the World Energy Outlook 2007 (WEO 2007) the overall trends are broadly unchanged; fossil fuels (oil, energy and coal) will continue to dominate the energy mix, there will be a rising share of emerging economies in global energy consumption, the consuming countries' reliance on imports of oil and gas will continue to grow and the global CO_2 emissions will continue to rise, pushing up average global temperature by as much as 6°C in the long term.

According to the World Energy Outlook 2008 (WEO 2008) reference scenario, which assumes that no new government policies will be implemented beyond those already adopted until mid-2008, the world's primary energy demand is expected to expand 45% between 2006 and 2030, with a 1.6%/year average rate of increase (see Figure 2). Within this scenario fossil fuels will be responsible for 80% of the worlds' energy primary mix in 2030, oil being the dominant fuel. Renewable energy sources that have been growing in the last years will continue to grow rapidly, overtaking gas soon after 2010 to become the second largest source of electricity behind coal.

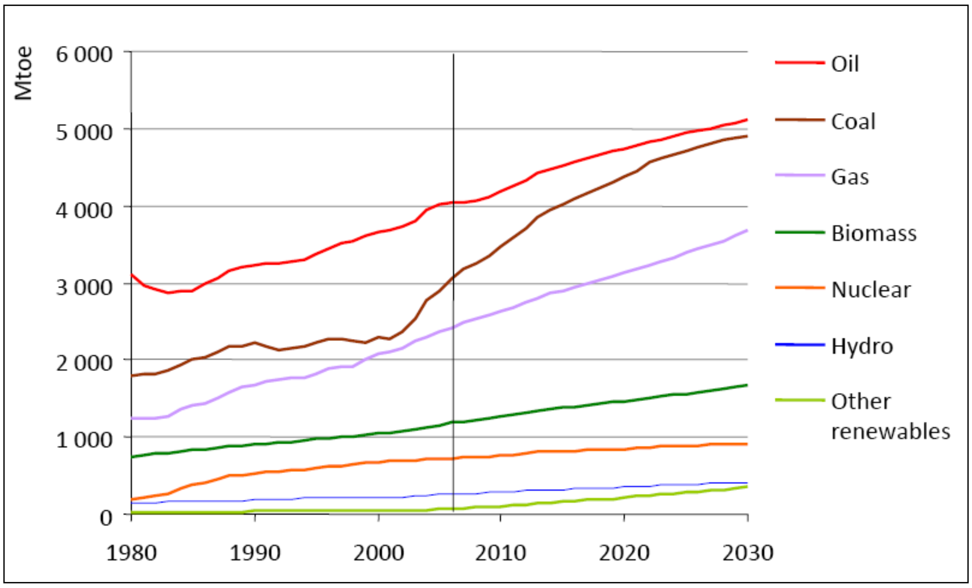


Figure 2: World primary energy demand in WEO 2008 reference scenario (OECD/IEA, WEO 2008: Key Graphs, 2008)

Figure 3 shows the expected rapid growth of the share of renewable energy sources in electricity generation in the WEO 2008 reference scenario. The main drivers of this rapid growth are the falling costs of renewable energy technologies, the higher fossil-fuel prices and the strong policy support that has provided an opportunity to the renewable energy industry. As can be seen, hydro is and will be the most exploited renewable energy source in the world, however the other renewable energy sources (such as wind, solar, geothermal, tide and wave energy) will be responsible for the rapid growth of the share of renewables in the electricity consumption, which is predicted to grow at an average rate of 7.2% per year over the projected period. In OECD countries the expected growth rate of renewable energy-based power generation exceeds the expected growth of fossil-fuel based and nuclear power generation combined.

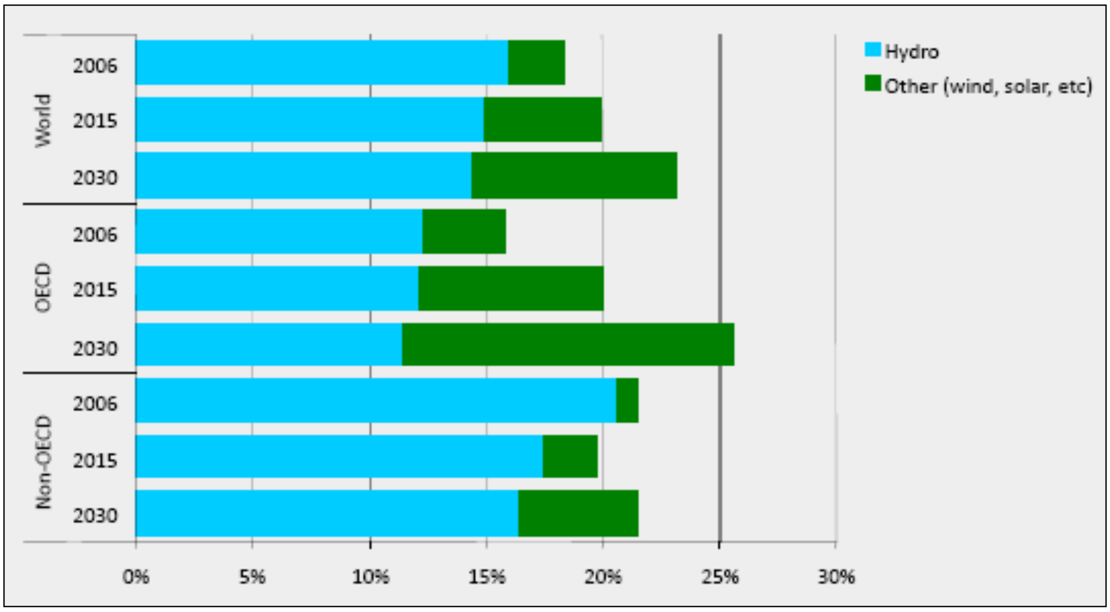


Figure 3: Share of renewables in electricity generation in WEO 2008 reference scenario (OECD/IEA, World Energy Outlook 2008. London Press Conference, 2008)

More than two thirds of the growth in world energy use will come from the developing countries, where economic and population growth are highest. Non-OECD countries account for more than 80% of the increase energy demand in 2030, as it can be seen in Figure 4, with China and India being responsible for more than half of the incremental energy demand in 2030. Also the Middle East emerges as a major new demand centre, contributing further with an 11% increase in energy demand.

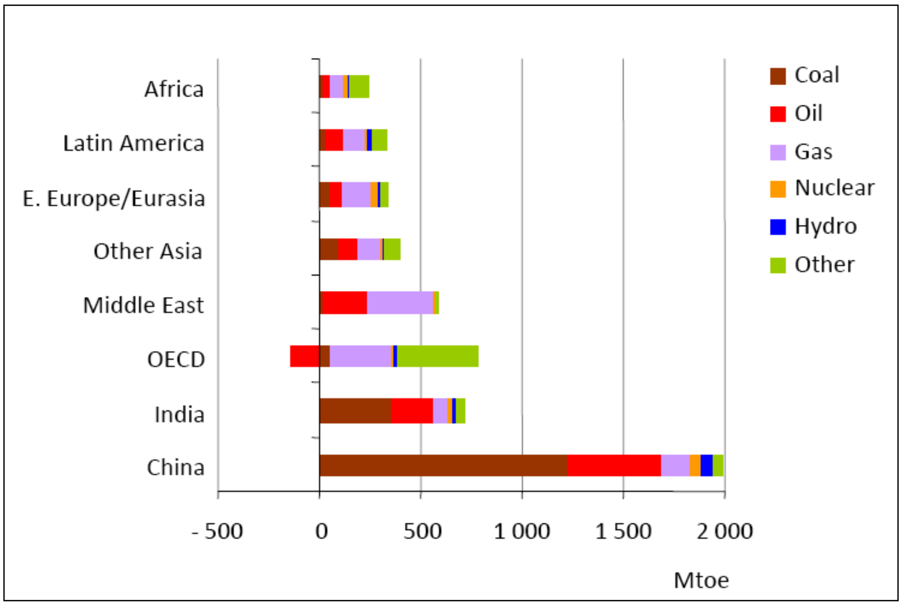


Figure 4: Incremental primary energy demand 2006-2030 in WEO 2008 reference scenario (OECD/IEA, WEO 2008: Key Graphs, 2008)

Also non-OECD countries are responsible for the growth in oil demand (see Figure 5), with China contributing with 43%, the Middle East with 20% and the other Asian emerging economies with most of the rest. Moreover non-OECD countries will be responsible for most of the increase in energy production to 2030 which substantially increases the reliance on imported oil and gas of the main consuming regions, i.e. OECD and Asian economies.

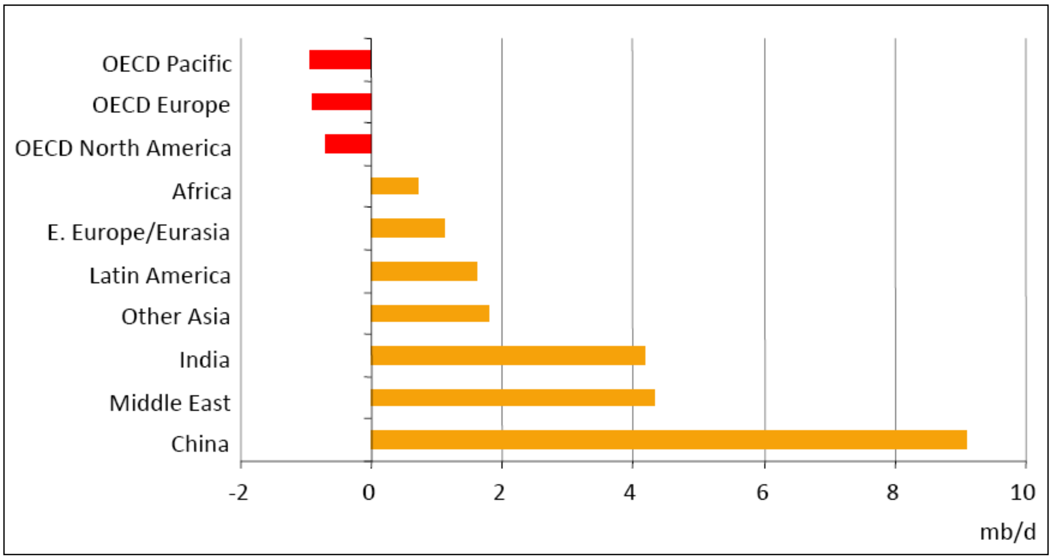


Figure 5: Change in oil demand by region 2007-2030 in WEO 2008 reference scenario (OECD/IEA, WEO 2008: Key Graphs, 2008)

According to the WEO, the world's energy resources are adequate to meet the projected growth in energy demand in the reference scenario; global oil reserves today exceed the cumulative projected production between 2006 and 2030. According to WEO 2008, 1.2 to 1.3 trillion barrels are the estimated remaining proven oil reserves and natural gas liquids (NGLs), which is enough to supply oil for over 40 years at current consumption rates. Besides the referred reserves, there is still a potential of 9 trillion barrels of oil, which include remaining recoverable oil which is thought to lie in the Middle East, Russia and the Caspian region; oil sands and extra-heavy oil that may be ultimately economically recovered (geographically concentrated in Canada and Venezuela); a long-term potentially recoverable oil resource including extra-heavy oil, oil sands and oil shales; and coal-to-liquids and gas-to-liquid. Still, more reserves will need to be "proved up" in order to avoid a peak in oil production before the end of the projection period (Birol, 2007). Indeed, although the oil reserves seem to be enough there are uncertainties related to what can be exploited quickly enough to meet the level of demand projected in the WEO reference scenario.

Although there is an uncertainty related to the exact cost of finding and exploiting energy resources over the coming decades, these costs will certainly be substantial. Cumulative investment needs in energy supply infrastructure are estimated at about $26.3 trillion over the 2007-2030 period, divided as shown in the following figure. More than 50% of the investment will go to the power sector while the rest will be spit over the oil and gas sectors, mainly being for exploration and development in non-OECD countries. More than half of this projected global energy investment will be used to maintain the current supply capacity level.

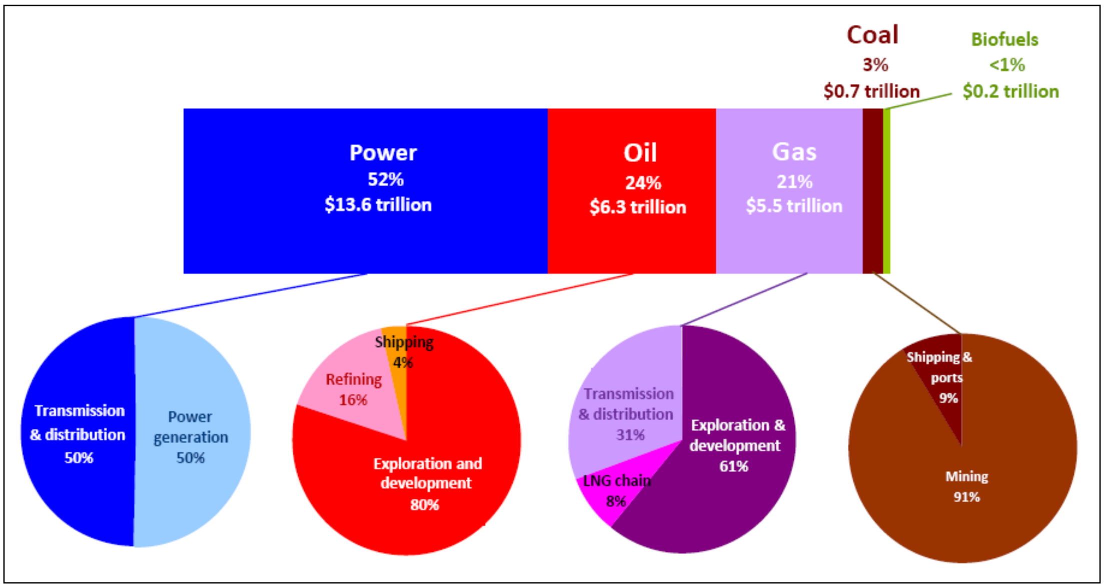


Figure 6: Energy investments in WEO 2008 reference scenario (OECD/IEA, WEO 2008: Key Graphs, 2008)

The rise of the global consumption of fossil fuels is intrinsically related to the rise of greenhouse gas (GHG) emissions and consequently to global temperatures. According to the WEO 2008, GHG concentrations will double to around 1000ppm of CO_2-equivalent (CO_2eq) by the end of this century, and consequently the global temperature will increase up to 6ºC, under the reference scenario in which no change in government policies is assumed. Under this scenario CO_2 emissions related to global energy are estimated to increase 13Gt from 2006 until 2030, corresponding to a 45% increase (see Figure 7). In case non-energy CO_2 and other gases are included, GHG projected emissions will increase 35%, from 44Gt CO_2eq in 2005 to 60Gt CO_2eq in 2030.

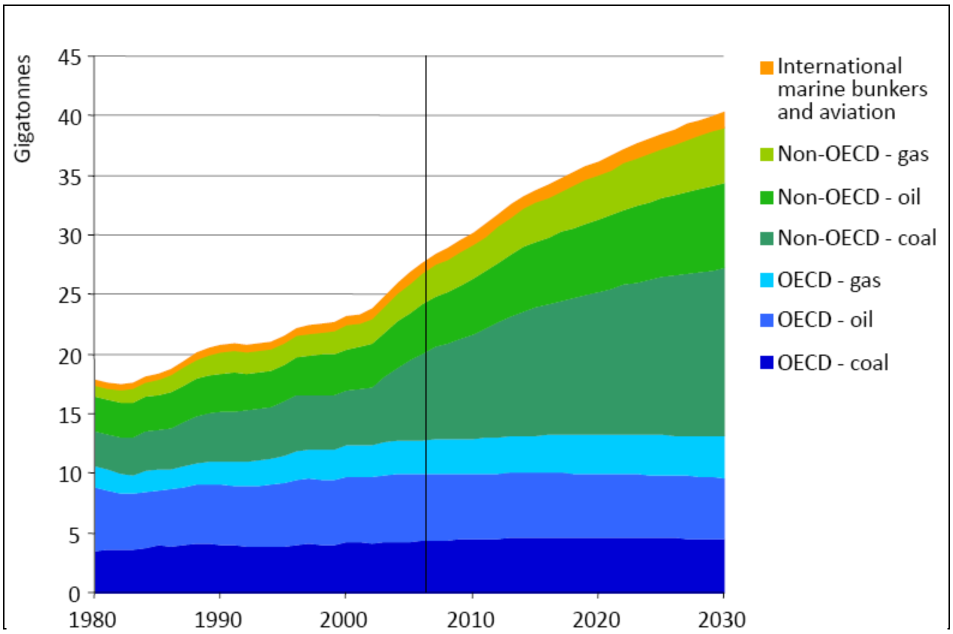


Figure 7: Energy related CO2 emissions in WEO 2008 reference scenario (OECD/IEA, WEO 2008: Key Graphs, 2008)

Non-OECD countries are expected to be responsible for 97% of the increase of CO_2 energy related emissions (in the reference scenario), with China, India and the Middle East being responsible for three quarters of the increase. OECD countries emissions are expected to peak up shortly after 2020 and then decline. The emissions from Europe and Japan are expected to be lower in 2030 than what they are today. The largest part of the increase in CO_2 emissions is expected to come from cities, with their share expected to increase at 5% per year between 2006 and 2030 (the cities in 2006 being responsible for 71% of the CO_2 emissions). The power generation and transport sectors are expected to contribute 70% to the projected world energy related CO_2 emissions to 2030.

Power stations that are already built and operating today will be responsible for more than three quarters of the projected electricity output in 2020, and more than half of the output in 2030 (under the reference scenario). The power sector rate of capital-stock turnover is particularly slow. Power stations generally have large up-front costs and are projected and built for operating over a long period, which means that the ones already built and in operation will continue to be active in the medium to long term. Consequently, even if carbon-free power plants are built from now onwards, the CO_2 emissions from the power sector would be (only) 25% (4Gt) lower in 2020 relative to the levels projected in the reference scenario of the WEO 2008.

Action is needed to stop GHG growth as expected in the reference scenario. Indeed, several actions are being taken to decrease the build-up rate of GHG in the atmosphere on a global scale. The post-2012 global climate change policy regime which is expected to be established in Copenhagen in December 2009 at the UN Conference on Climate Change is hoped to provide the international framework. Once the energy sector is responsible for the majority of global GHG emissions (61%), it will be the heart of the discussion in terms of the concentration level to aim for and how this will be achieved. Thus the global energy system will have to be transformed accordingly to the long-term GHG stabilisation target.

Taking into account the proximity of the establishment of the post-2012 global climate change policy, the WEO 2008 analysed the implications for the energy sector if the world is set on a low carbon trajectory. This is simulated by means of two policy scenarios towards 2030:

1. The "550 Policy Scenario", in which GHG concentration is stabilised at 550ppm CO_2eq and temperatures will rise 3ºC;
2. The "450 Policy Scenario", in which GHG concentration is stabilised at 450ppm CO_2eq and temperatures will increase 2ºC.

Figure 8 shows the reductions in CO_2 energy related emissions in the climate-policy scenarios. As it can be seen the emissions trajectory after the adoption of any of the policy scenarios as stated above, will follow a totally different trajectory than the one considered with no policy adoption (reference scenario) which strengthens the need for action and the positive results that will be achieved through it. The emissions trajectory in the two climate policy scenarios only differ from each other after 2020, after which emissions fall more sharply in the 450 Policy scenario than in the 550 Policy Scenario. Until 2020 the emissions in both scenarios follow the same path. Both climate-policy scenarios assume a mixed-policy approach, with a combination of cap-and-trade systems, sectoral agreements and national measures. Figure 9 shows the world GHG emissions for the reference scenario and the 550 and 450 Climate-Policy Scenarios.

With the adoption of the 550 Policy Scenario CO_2 energy emissions will rise from 27Gt to 33Gt, from 2006 to 2030, which is 19% lower than estimated under the reference scenario. Within this scenario, the share of low-carbon energy (hydropower, nuclear, biomass, renewables and fossil-fuel power plants with carbon capture and storage) in the world primary energy mix increase from 19% in 2006 to 25% in 2030. Once more low-carbon energy is produced oil and gas demand in OECD countries is reduced (imports are estimated to be 15% lower than in the reference scenario) and international oil prices are also reduced by 18%. For this shift to happen much more investment in energy-related infrastructure than outlined in the reference scenario is needed. In fact, an extra global energy investment of $4.1 trillion is needed in the 2010-2030 period compared to the reference scenario in order to keep up with the 550 Policy Scenario. This extra spending is on the demand side (on more efficient cars, appliances and buildings), on power plants and on energy efficiency improvements.

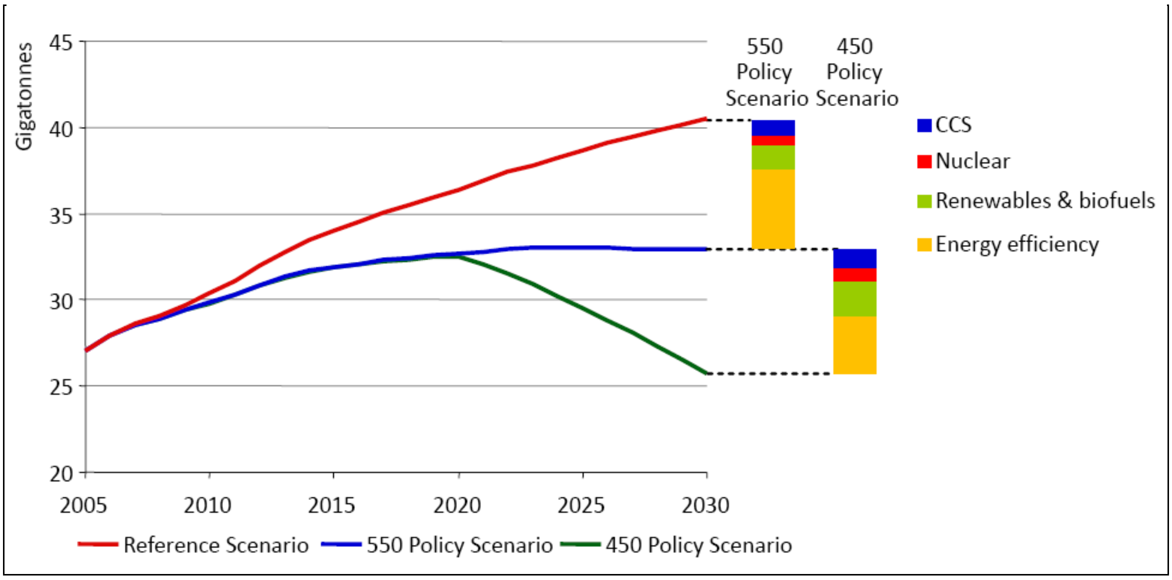


Figure 8: Reduction in energy related CO2 emissions in the climate policy scenarios (OECD/IEA, WEO 2008: Key Graphs, 2008)

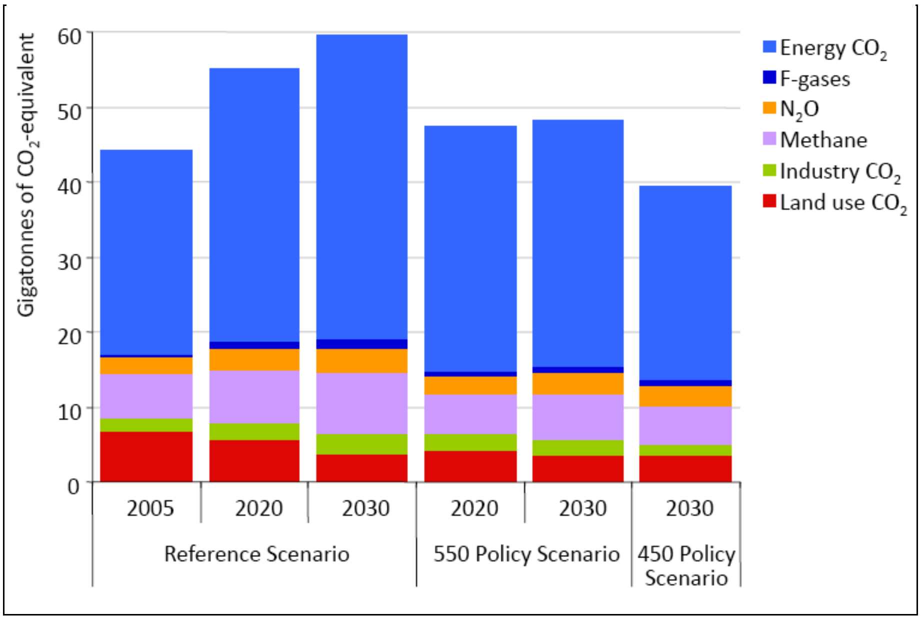


Figure 9: Worlds GHG emissions (OECD/IEA, WEO 2008: Key Graphs, 2008)

The adoption of the 450 Policy Scenario will imply an even bigger challenge, so that world energy-related emissions drop faster from 2020 onwards, i.e. from 27Gt in 2006 to 25.7Gt in 2030 (lower value than the one registered in 2006 and lower than the level of projected emissions for non-OECD countries alone in the reference scenario). In this scenario the participation of non-OECD countries is crucial, i.e. OECD countries alone cannot put the world towards the 450ppm trajectory, even if their emissions were reduced to zero. The 450ppm outcome can only be achieved if even bigger efforts in the rapid growth of the use of renewable energy are put forward, as in this scenario renewables account for 40% of the power generated in 2030. In terms of investment, to achieve the goals under this policy a global energy investment $9.3 trillion higher than the one considered in the reference scenario is needed.

3. ENERGY POLICIES IMPLEMENTED WORLDWIDE

3.1 Europe

Presently Europe imports half of its energy and it is previewed that if no action is taken, Europe will still import half of its energy in 2030. The potential effects of this dependence are serious (Piebalgs, 2008). Oscillations of oil prices which have reached values of $100/barrel as well as fuel supply security are posing problems to both European citizens and economic sectors. Europe is vulnerable to price shocks and dependent on major oil and gas producers which need to invest massively in order to meet the rising global demand, which according to the IEA is "particularly uncertain" (OECD/IEA, World Energy Outlook 2008, 2008). Therefore the diversification of the energy supply base is an absolute priority for Europe.

This along with the impacts which an increase in GHG can have in Europe (such as submergement of parts of Barcelona, Amsterdam, London, Venice etc., and shortages in water supply in southern EU etc) have lead to strong policy development and implementation aiming for energy supply to meet environmental, social and economic goals.

The EU's ambitions in terms of climate change are: to limit climate change at the international level to a 2ºC temperature rise compared with pre-industrial levels and at the domestic level to meet EU's Kyoto Commitments and to fit EU into the 21st century. The 2ºC limit was chosen because it is the increase in temperature after which problems of food scarcity, severe weather events and threats to unique ecosystems will certainly increase (see Figure 10).

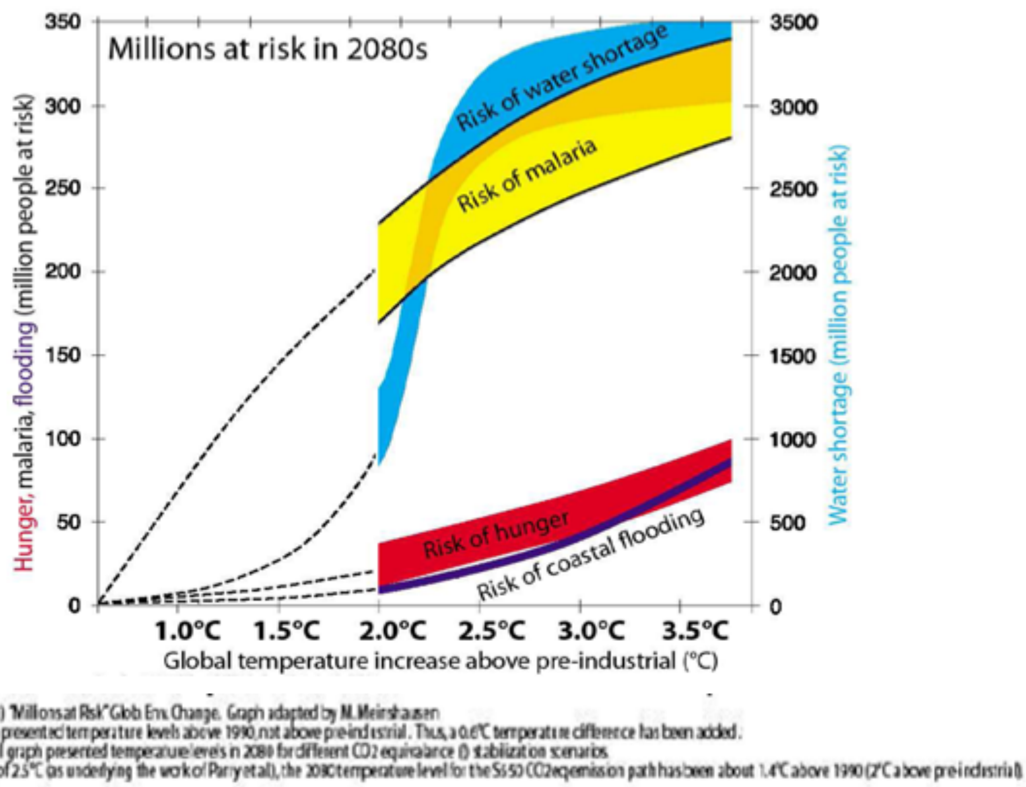


Figure 10: Consequences of global temperature increase above pre-industrial levels (Müller, 2007)

Towards addressing climate change and the 2ºC goal, the European Commission has taken several initiatives since 1991 to limit CO_2 emissions into the atmosphere (such as commitments under the Kyoto Protocol, directives to promote electricity production by utilising renewable energy sources, voluntary commitments by car makers to reduce CO_2 emissions by 25% and proposals on taxation of energy products) and felt the duty to set an example through robust policy making.

3.1.1 European Climate Change Programme (ECCP)

A package of comprehensive measures to reduce GHG emissions was initiated through the European Climate Change Programme (ECCP). The first programme was launched in 2000 by the European Commission with the goal to identify and develop the necessary elements of an EU strategy to implement the Kyoto Protocol, and was in place until 2004. It required EU-15 (i.e. the 15 countries that were EU members before 2004) to reduce their combined emissions to 8% below 1990 level by 2012. The ECCP involved all relevant stakeholder groups working together with representatives of the Commission, the Member States, environmental groups and industry. One of the most important initiatives of the program is the EU-Emission Trading Scheme (EU ETS), which covers CO_2 emissions from heavy emitters in the power generation and manufacturing sectors.

In October 2005, the second European Climate Change Programme (ECCPII) was launched, with the aim to explore further cost-effective options for GHG emission reduction (covering carbon geological storage and carbon capture, CO_2 emissions from light-duly vehicles, aviation emissions and adaptation to climate change effects) in synergy with the EU's Lisbon Strategy in order to increase economic growth and job creation.

3.1.2 Directive on Electricity Production from Renewable Energy Sources and the new Renewable Energy Directive

In 2001 the European Union adopted the so-called Renewables Directive (Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market, 2001) which set an EU-wide target of 21% of the share of renewables in electricity production by 2010. This Directive – which set national indicative targets for the share of green electricity – urged each Member State to take action in promoting electricity production from renewable energy sources, resulting in the emergence of a range of support mechanisms throughout Europe. Since then green electricity production has seen a remarkable and continuous increase, with especially wind power capacity expanding by 28% annually, most notably in Germany and Spain. Figure 11 below presents an overview of the proportion of each resource for 2004 and 2005 (excluding large scale hydro as hydraulic power). To a large extent this trend can be attributed to policy and financial support regimes.

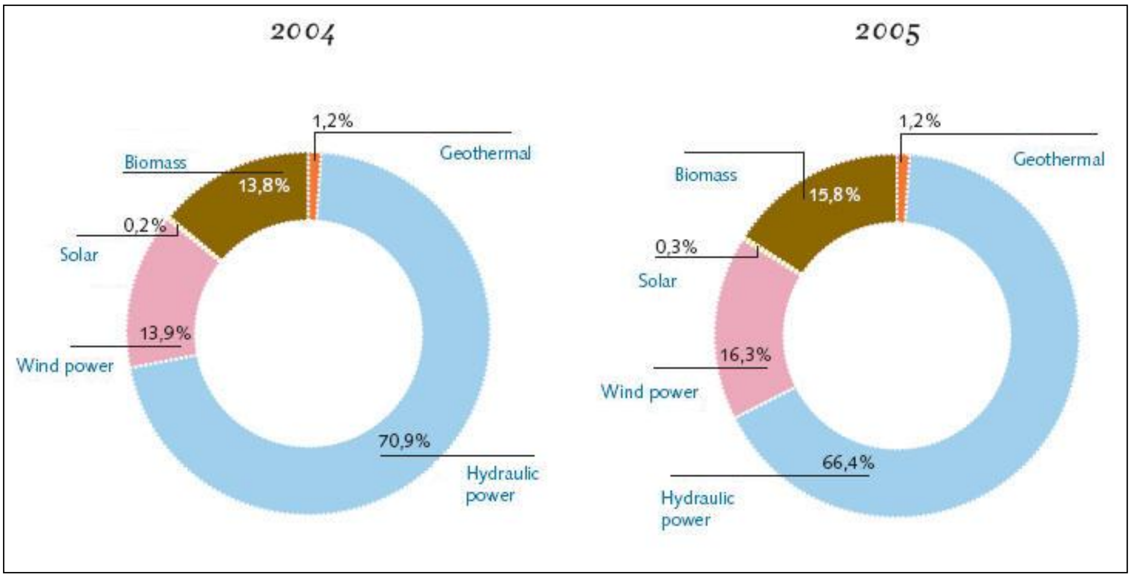


Figure 11: Share of each resource in renewable electricity generation - Source DG TREN

A proposed new Renewable Energy Directive (RED) was presented during the Spring Council in 2007 within the climate change and energy policy package (which is further explained in the following section) to replace the existing measures adopted in 2001. It aims to establish an overall binding target of a 20% share of renewable energy sources in energy consumption and a 10% binding minimum target for biofuels in transport to be achieved by each member state, as well as binding national targets by 2020 in line with the overall EU target of 20%. The RED was officially available in 23 January 2008 with the differentiated targets for each member state based on the per capita GDP of each country. These long-term mandatory targets are aiming for stability in the policy framework, and confidence among investors and market actors. EU governments and the European Parliament reached a broad agreement on the proposal on 9 December 2008, which was then adopted by the Parliament in a plenary vote on 17 December. The political process of trilateral negotiations on a final version of the proposed Directive is still ongoing at the time of writing (February 09). The references to the proposed Directive refer to the version as it was presented in January 2008. A final agreement on a new Directive is hoped for by the summer of 2009.

According to the RED, to achieve the proposed targets, every nation in the 27-EU countries is required to increase its share of renewables by 5.5% from 2005 levels, with the remaining increase calculated on the basis of per capita gross domestic product (GDP). Table 2 shows the share of renewable energy in 2005 and the target towards 2020 for selected countries.

Table 2: National overall targets in selected EU MS for the share of energy from renewable sources in 2020 (European Commission E. , 2008)

Member State	Share of renewables in 2005	Share required by 2020
Austria	23.3%	34%
Belgium	2.2%	13%
Bulgaria	9.4%	16%
Cyprus	2.9%	13%
Czech Republic	6.1%	13%
Denmark	17%	30%
Estonia	18%	25%
Finland	28.5%	38%
France	10.3%	23%
Germany	5.8%	18%

Member State	Share of renewables in 2005	Share required by 2020
Greece	6.9%	18%
Hungary	4.3%	13%
Ireland	3.1%	16%
Italy	5.2%	17%
Latvia	32.6%	40%
Lithuania	15%	23%
Luxembourg	0.9%	11%
Malta	0%	10%
The Netherlands	2.4%	14%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovak Republic	6.7%	14%
Slovenia	16%	25%
Spain	8.7%	20%
Sweden	39.8%	49%
United Kingdom	1.3%	15%

In order to ensure a steady progress to achieve the 2020 targets, the commission proposed the following interim targets:

- 25% average between 2011 and 2012;
- 35% average between 2013 and 2014;
- 45% average between 2015 and 2016, and;
- 65% average between 2017 and 2018.

This proposed Directive is expected to significantly reshape the renewable energy markets and sectors, with most notably the targets on renewable heating and cooling and biofuels presenting both a major challenge and an interesting opportunity. The major new features include:

- Mandatory national target setting for renewable energy (RE) shares, including 10% biofuels share, in 2020 (Articles 3 and 5)
- The 20% target for RE by 2020 in the proposed directive is now an overall target (covering renewable electricity and heating and cooling) apart from biofuels, for which the mandatory target of 10% remains set as a sectoral target;
- This should allow for an increased flexibility in target compliance across sectors; i.e. member states will be able to choose to either focus more on renewable electricity or RE heating and cooling, depending on existing potential and policy priorities;
- An action plan (defined along three sectors: electricity, heating and cooling, and transport) with an indicative trajectory to meet the target (NAP) is required to be submitted to the European Commission by the member states by 30 June 2010 (Article 4), followed by progress reports every two years;
- An online 'Transparency Platform' will be created to allow member states to access and exchange information on the directive and on achieving the targets, their NAPs, statistical transfers and joint projects. Also the Platform should facilitate and promote cooperation between Member States;
- Guarantees of Origin (GO, certifying the renewable origin of electricity or heat) are to be issued for renewable electricity, heating and cooling, at least for installations with a capacity above 5 MW. GO will have the sole function of proving to a customer that

a given quantity of energy was produced from renewable sources and each one will have a standard size of 1 MWh;

- GO (Article 13A) are to be used to demonstrate the amount of renewable energy in a supplier's fuel mix, these can be traded between suppliers across countries but only affect suppliers' fuel mixes. They do not (unlike previous drafts) affect the country's achievement towards its targets, this remains the role of statistical transfer and joint schemes.
- No harmonised support scheme is put forward, national support schemes can continue to exist – although the door is open to some form of trade as mentioned above;
- In terms of support for financing RE the European Commission will publish in 2009 an analysis and plan focusing on how to use EU structural funds and framework programmes for energy from renewable sources, funds from the European Investment bank and other public finance institutions; better access to risk capital and an improved coordination of Community and national funding in accordance with the objectives pursued by the Strategic Energy Technology Plan. The Cayman Islands being a UK colony can benefit from these supporting mechanisms and funds for developing programs for renewable energy.
- Reduction of administrative and regulatory barriers (Article 12), improvements in provision of information and training (Article 13) and increased access for renewables to the electricity grid (Article 14). Qualification / certification schemes shall be available for installers of small scale systems (not defined in terms of size) by 31 December 2012;
- A sustainability regime for biofuels is created (Articles 15-18). Furthermore, it introduced a new Regulation setting performance standards for new passenger cars.

In relation to this the Internal Market Directive[1] is also under revision, with the Commission's proposal for revision (COM (2007) 528) also going through in co-decision procedure. No changes with regards to the disclosure regulations are foreseen, but disclosure statements should be standardised and enhanced in terms of their information content, i.e. indicating the:

- Share of high-efficiency of energy from Combined Heat and Power (CHP);
- Share of green electricity differentiated between supported green electricity generation; not supported ("new") green electricity generation; other green electricity generation;
- CO_2 emissions and nuclear waste of the technologies used.

3.1.3 Energy and Climate Change Package / Green-Energy Package

In March 2006, the European energy situation was evaluated by the European Commission and the conclusions were far from reassuring. As a response to this evaluation the European Commission published a Green Paper, called *A European Strategy for Sustainable, Competitive and Secure Energy* (European Commision, Green Paper: A European strategy for sustainable, competitive and secure energy, 2006) which referred to the goals which Europe had agreed on in terms of its energy policy, i.e. "that it should be environmentally sustainable, help Europe to be competitive and secure, both for internal supply as far as

[1] Directive 2003/54/EC of 26 June 2003 concerning common rules for the internal market in electricity

imports are concerned". This document was an important milestone towards a common energy policy as it regrouped the energy policies of all member states into a common strategy for Europe. Also the Green paper's recommendations were used as a basis for the new European Energy Policy, such as "the EU should try to work more closely together: to save energy, use more renewable energy, invest in the energy supplies and energy technologies of the future and speak with a common voice in international energy negotiations" (European Commission E. , Memo: An Energy Policy for Europe, 2007).

On 10 January 2007, the EU presented the "Energy and Climate Change Package" including a Strategic Energy review focusing on both external and internal aspects of EU energy policy. This package was proposed with the objective of being the first step towards a low-energy economy, making energy more secure, competitive and sustainable. The *Energy Policy for Europe* (European Commission E. , An Energy Policy for Europe, 2007), developed within this package (i) stressed how Europe was failing to address its energy challenges under the existing policies, (ii) proposed a strategic objective/goal which should be the target for future energy policies and set out an action plan to achieve the new goal. The *Energy Policy for Europe* set out the goal for reducing EU-27 GHG emissions by at least 20% by 2020 compared to 1990. The reasons for setting up a GHG emission target as the main goal of the European energy policy are: *"(i) CO_2 emissions from energy make up 80 % of EU GHG emissions, reducing emissions means using less energy and using more clean, locally produced energy, (ii) limiting the EU's growing exposure to increased volatility and prices for oil and gas, and (iii) potentially bringing about a more competitive EU energy market, stimulating innovation technology and jobs"* (European Commission E. , An Energy Policy for Europe, 2007).

The European Commission set out proposals and options for an ambitious global agreement as part of an Integrated Climate Change and Energy Policy, with the Communication *"Limiting Global Climate Change to 2 degrees Celsius: The Way ahead for 2020 and beyond"*, which in March 2007 was endorsed by all EU leaders. Within this the EU committed to cut GHG emissions by 2020, on 30% of 1990 levels provided that other developed countries commit to make similar reductions under a global agreement, and by 20% independently of a global agreement (which was endorsed by the European Energy Policy).

Indeed, by targeting emissions from the energy sector, Europe will address the economic, social and environmental challenges of climate change, while it improves its energy efficiency, the use of low-emission energy forms and renewable energy and promote clean energy development. Also by achieving this goal the EU will be less exposed to the volatile oil and gas prices and possible future uncertainties over oil and gas market development, becoming a more competitive energy market that stimulates technology development and job creation. Indeed, it will transform Europe into a very efficient and low-carbon economy, ready to face future energy challenges.

The aims of the policy are supported by market-based tools (mainly taxes, subsidies and the emissions trading scheme), by developing energy technologies (especially technologies for energy efficiency and renewable or low-carbon energy) and by Community financial instruments. The fundamental building blocks of the European Energy Policy are presented in Annex I.

Within the summit of in March 2008, an action plan to be implemented between 2007 and 2009 was endorsed, including the following main elements[2]:

- Completing the internal market for electricity and gas;
- A binding target to raise the EU's share of renewables to 20% by 2020;

[2] The action plan is explained in more detail in Annex II

- An obligation for each member state to have 10% biofuels in their transport fuel mix by 2020;
- Boosting energy efficiency with a target to save 20% of the EU's total primary energy consumption by 2020. New initiatives here include proposals for an international agreement on energy-efficiency standards for consumer appliances;
- Aiming towards "a low CO_2 fossil fuel future" with support for 'clean coal' technology, using carbon capture and storage;
- Developing a common external energy policy to "actively pursue Europe's interests" on the international scene with major supplier, consumer and transit countries, including Russia;
- Developing a European Strategic Energy Technology Plan to focus R&D efforts on low carbon technologies, and;
- On nuclear, leaving the decision up to member states.

Since 2007, the European Commission has put forward the following legislative packages in respect to the action plan:

- The third "package" of proposals to liberalise the EU's energy market;
- The "climate and energy package" which integrates:
    - The legislative proposals on CO_2 burden sharing and on the post 2012 period of carbon trading under the EU-ETS;
    - Revised EU state aid rules;
    - A communication on carbon capture and storage (CCS);
    - And a proposed directive on renewable energies, including biofuels.

The liberalisation of the EU's Energy Market package was put forward in 19 September 2007 and in 10 October 2008 the European energy ministers agreed to compromise under the Commission's proposal to open the EU gas and electricity markets. Member states decided to grant former state monopolies the right to retain ownership of their gas and electricity grids, on the condition that they are supervised by an independent body. Nevertheless, a clause was inserted to prevent energy producers from buying up the transmission businesses of energy companies in European countries where full unbundling has been introduced. This package still has to be approved by MEPs.

In 23 January 2008, the European Commission has put forward the integrated climate change and energy policy package, including new measures covering the main economic EU sectors. It included:

i) Improvement of the emissions trading scheme (ETS);

ii) Emission reduction targets from 2005 levels by 2020: 10% reduction for industries not covered by the EU ETS (such as agriculture, waste, buildings, transport, etc) with differentiated targets per member state according to current and projected levels of GDP/capita; and 21% reduction for emissions already covered by the EU ETS;

iii) Enforcement of targets for renewable energy production in the energy mix; and

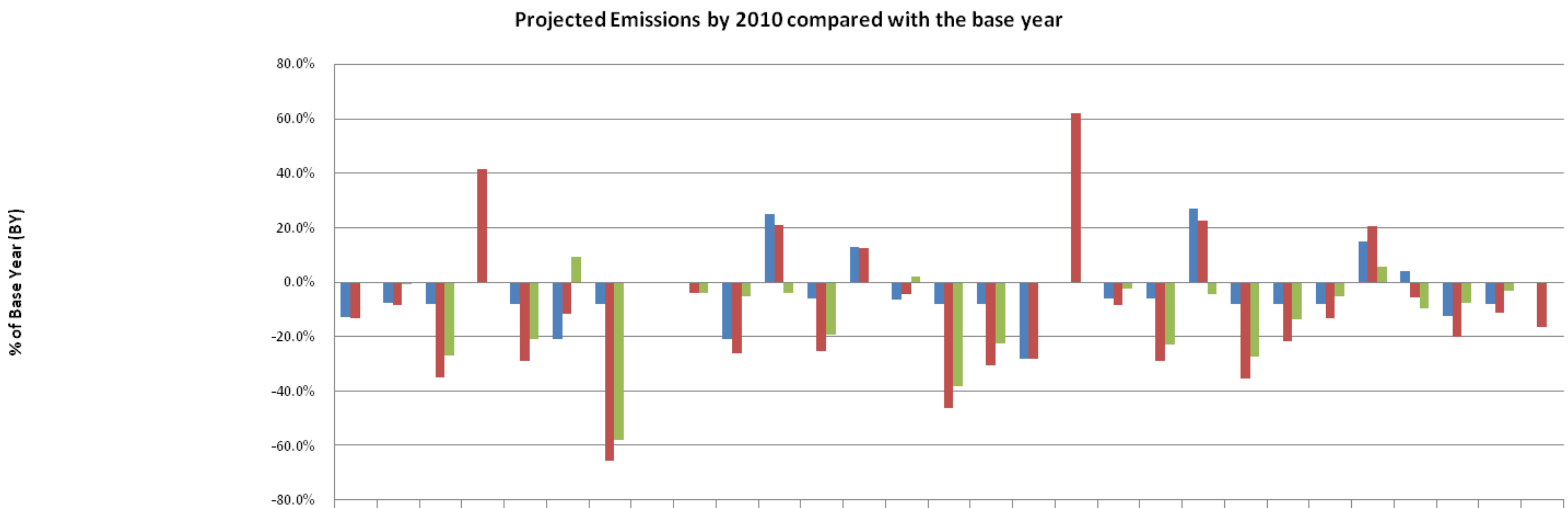
iv) New rules for carbon capture and storage and on environmental subsidies.

This package was approved in December 2008 and will come into effect in 2011 the latest and the EU ETS will move to its next phase on the 1st of January 2013. The following table summarises the targets of the package (including all European Energy Policy targets), the benefits and the reasons why EU has to take action.

Table 3: Targets, benefits of the climate and energy package and reasons for EU to take action (Commission, EU Climate and Energy Package: Citizen's Summary, 2008)

Targets, actions and measures? (approved in December 2008)	• For power plants and energy-intensive industries - emissions to be cut to 21% below 2005 levels by 2020. How? By granting fewer emission allowances under the EU ETS (covering some 40% of total EU emissions). • For sectors not covered by the ETS (e.g. transport (except aviation, which will join ETS in 2012), farming, waste and households) - emissions to be cut to 10% below 2005 levels by 2020. How? Through binding national targets (with higher reductions for richer countries and limited *increases* for the poorest ones). • Renewables will produce 20% of all the EU's energy by 2020. How? Through binding national targets (from 10% for Malta to 49% for Sweden). At least 10% of transport fuel in each country must be renewable (biofuels, hydrogen, 'green' electricity, etc.). Biofuels must meet agreed sustainability criteria. • Promotion of safe use of carbon capture and geological storage (CCS) technologies which could eventually
Benefits	• Big step to combating climate change • example to rest of the world that can help to shape a new global climate agreement • more secure energy supplies • €50bn a year less on oil and gas imports by 2020 • ± 1m jobs in European renewables industry by 2020 (300 000 today) • competitive advantage through significant innovation in the European energy sector • more jobs in environment-related industries • less air pollution - significant health benefits and less money spent on control measures.
Why EU has to take action	• Individual countries have a responsibility to limit emissions as far as possible, but joint EU or international action is more effective. Joint action can: - maximise the effectiveness of measures taken - create economies of scale so measures cost less and don't disrupt trade in Europe's single market. • Together the 27 EU countries can influence the global fight against climate change much more than they could individually.

According to monitoring data from 16 October 2008 (European Commission E. , Changement climatique: au vu des projections, l'Union européenne est sur la bonne voie pour atteindre ses objectifs de réduction des émissions au titre du protocole de Kyoto, 2008) the 15 countries that were EU members at the time EU ratified the Kyoto Protocol (2002) will reach their commitments for cutting GHG emissions. The 8% reduction target will be achieved through a combination of already implemented policies and measures, including the emissions credits purchased from developing countries and forestry activities that act as carbon sinks. Moreover the measures now under discussion will bring a further 3.3% reduction, which will enable the EU15 to reduce its emissions even further, going beyond the Kyoto Protocol commitment. Although there is no collective target for the EU-27, most of the EU member states that joined the European Union in 2004 and 2007 (except Cyprus and Malta which do not have any targets) have individual commitments under the protocol to reduce their emissions to 6% or 8% below the base year in the 2008-2012 period. Figure 12 shows the projected emissions by 2010 for all EU27 countries.



	Austria	Belgium	Bulgaria	Cyprus	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	Sweden	United Kingdom	EU-15	EU 27
Kyoto Targets (% of BY)	-13.0	-7.5%	-8.0%	0.0%	-8.0%	-21.0	-8.0%	0.0%	0.0%	-21.0	25.0%	-6.0%	13.0%	-6.5%	-8.0%	-8.0%	-28.0	0.0%	-6.0%	-6.0%	27.0%	-8.0%	-8.0%	-8.0%	15.0%	4.0%	-12.5	-8.0%	0.0%
Projections for 2010 (% of BY)	-13.3	-8.5%	-34.9	41.4%	-28.8	-11.6	-65.7	-0.6%	-4.2%	-26.2	20.8%	-25.4	12.4%	-4.6%	-46.1	-30.4	-28.0	61.8%	-8.4%	-29.0	22.7%	-35.3	-21.6	-13.2	20.5%	-5.7%	-20.0	-11.3	-16.3
Gap between projections and target (% of BY)	-0.3%	-1.0%	-26.9	0.0%	-20.8	9.4%	-57.7	-0.6%	-4.2%	-5.2%	-4.2%	-19.4	-0.6%	1.9%	-38.1	-22.4	0.0%	0.0%	-2.4%	-23.0	-4.3%	-27.3	-13.6	-5.2%	5.5%	-9.7%	-7.5%	-3.3%	0.0%

Figure 12: Projected Emissions by 2010 compared with the base year, with data extracted from (European Commission E. , Changement climatique: au vu des projections, l'Union européenne est sur la bonne voie pour atteindre ses objectifs de réduction des émissions au titre du protocole de Kyoto, 2008)

The following figure illustrates the gap between the 2020 member states projection and the EU target goal requiring the EU to get onto a steeper emissions path after 2012 than the one that has been followed since 1990 and also strengthening the importance of the new legislation implementation.

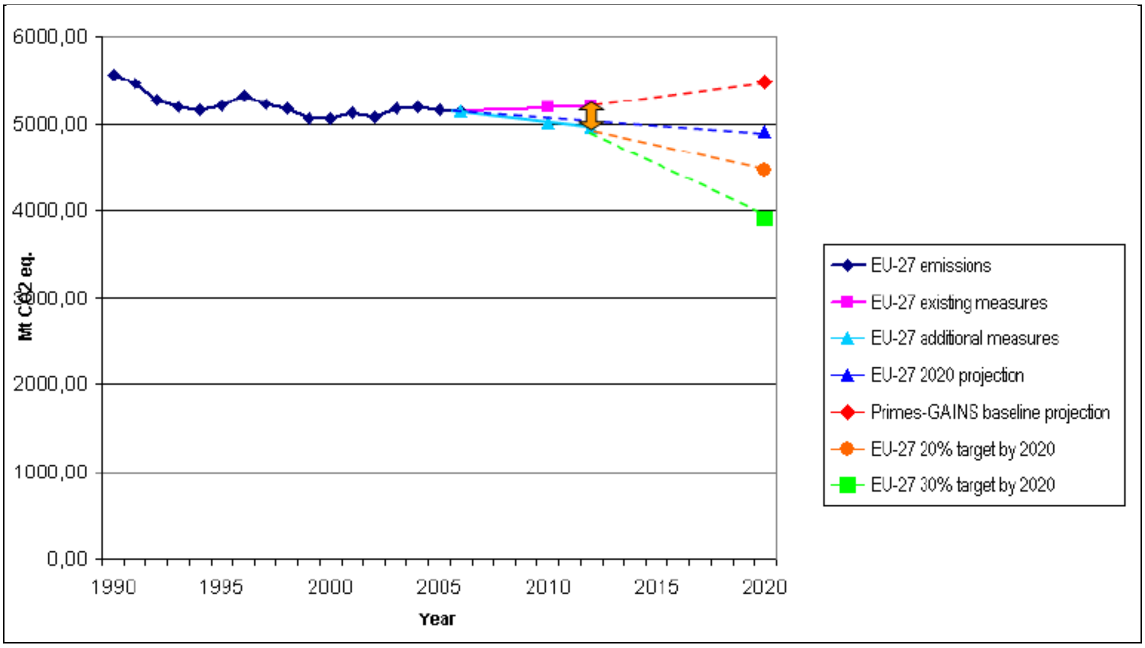


Figure 13: Actual and projected emissions for EU 27 (European Commission E. , Progress Towards Achieving The Kyoto Objectives, 2008)

Also, for the period after 2012, international negotiations are under way to conclude a global agreement at the UN climate change conference in Copenhagen (December 2009), and the conclusions of these negotiations are a key priority for the EU. In fact, in 28 of January 2009, the European Commission has set out a proposal for the new global agreement to tackle climate change and how it will be financed (Communication "Towards a comprehensive climate change agreement in Copenhagen") addressing three key challenges:

- Targets for developed countries and appropriate action for developing countries;
- Need to address the financing of developing countries actions both to GHG emissions and adaptation to climate change; and
- Need to build an effective global market: "*OECD-wide carbon market by 2015 and of innovative international funding sources based on countries' emissions and ability to pay*" (European Commission E. , EC Communication: Towards a comprehensive climate change agreement in Copenhagen , 2009)

The following section will outline the types and current experiences of support instruments for green electricity in Europe.

3.1.4 Green Energy Support Instruments in Europe: current, potential and trends

The main regulatory instruments implemented in Europe member states for the promotion of renewable electricity generation are either price-based (e.g. feed-in tariffs) or quantity-based (e.g. quota obligations) Mechanisms.

Feed-in tariff systems, investment subsidies and tax incentives are so called price-based mechanisms (i.e. the mechanism primarily aims to influence the cost/price for RE), whereas quota systems and tender schemes are quantity-based measures (the mechanism primarily aims to achieve a given amount of RE). In reality the major support instrument usually is either a feed-in or quota system, with investment subsidies and tax incentives acting to complement the major support instrument or to focus investment towards specific sectors or technologies.

In December 2005 the Commission published its first report on the experience gained concerning the application and coexistence of the different support schemes in the different MS. This report aimed to evaluate the success (including the cost-effectiveness ratio) of the two main support schemes for the promotion of green electricity, i.e. feed-in tariffs and quota systems. Based on the short experience the report could not draw final conclusions on which support system might prove better than the other, despite acknowledging that especially the spectacular growth in electricity generation from on-shore wind energy to a large extent was due to the feed-in schemes in Germany, Spain and Denmark.

The key features and experiences of the major two[3] support mechanisms will be described below.

Feed-in Schemes

Feed-in schemes currently are the most widespread support mechanism for green electricity in Europe. A feed-in tariff either sets a minimum price or a premium on top of the market price per unit of electricity generated.

Systems vary in different MS but the common basic features of feed-in tariffs schemes include:

- A minimum guaranteed price per kWh, or a premium on the market price per kWh;
- Guaranteed for a certain period (e.g. 10 years) depending on the RE technology;
- An obligation to give access to the grid;
- A purchase obligation by utilities or system operators for green electricity;
- Differentiation per RE technology;
- The costs are covered by a levy per kWh (consumers - taxpayers)

The level and the guaranteed period of the tariff are chosen per technology and aimed to cover the costs and foresee sufficient return on investment for green electricity producers (relating to the effectiveness of the support instrument), whilst at the same time avoiding the tariff to be too high and over subsidise certain technologies (relating to the cost-efficiency of the support instrument).

The institutional set-up of the mechanism, i.e. with regard to system governing procedures to commission generation plants, grid access, which party is obliged to buy the electricity and which pays for the extra costs, the way in which the extra costs are equalised between different parts of the system and the mechanism for the tracking of the electricity.

The major strength of a feed-in scheme is the guaranteed price over a fixed period of time, gives certainty and confidence to investors and project developers to invest in renewable electricity generation projects (provided the feed-in tariff is set at an appropriate level to guarantee an income stream which provides an incentive for investors and project developers).

[3] A third regulatory option is the tender system. This approach was tried out by countries like France and Ireland but despite some merits of tender systems they tend to hamper the development of a solid renewable energy sector. As they are no longer in use and are not expected to play a role in the European context they will not be given further attention in this report.

A possible weakness is the need for detailed monitoring by government and regulatory institutions to avoid over subsidization through periodical updates of the tariff in line with changing market conditions and technological improvements.

Most notable examples include Austria, Denmark, Germany, and Spain.

Quota systems

Renewable Energy Quota Obligation Schemes first emerged in the late 1990's in the United States, Australia, Japan and several European countries. In Europe countries like Denmark and the Netherlands were much in favour of a European wide quota system supported by a system of Tradable Renewable Energy Certificates (TRECs). The rationale behind this was that with such a system the renewable energy targets would be met in the most cost-efficient manner, i.e. by investing in renewable energy projects where these are most profitable throughout Europe. This approach and system design is much the same as the current European Emissions Trading Scheme (EU ETS). When the Renewable Electricity Directive was approved in 2001, the emphasis was on the development of national support instruments rather than a European wide system, and finally Denmark and the Netherlands adopted a feed-in scheme.

A quota system sets a legally binding minimum amount or share of electricity supply to be produced from renewable energy sources. It is a mandatory regulatory framework instituted and managed by the government and regulatory authorities.

The common basic features of quota systems include:

- Obligation for x% RE; penalty for non-compliance
- RE technologies selected by market players
- Supported by tradable green certificates

The quota obligation and the according penalty for non-compliance provide a significant incentive for established utilities to consider renewable energy projects and to integrate them in their technology portfolio. The TREC market is separate from the sale of physical electricity and TRECs generally can be traded, banked or consumed like any other commodity, thus providing flexibility in achieving compliance by different suppliers.

The quota obligation is usually formulated as a gradually increasing percentage of electricity supplies, and the (long term) target together with the according penalty for non-compliance (i.e. x€/MWh) are defined in such a way as to foresee sufficient return on investment for green electricity producers (relating to the effectiveness of the support instrument), whilst at the same time avoiding the quota and penalty to be too high which would lead to wind fall profits for certain technologies (relating to the cost-efficiency of the support instrument).

The results with quota systems have been variable; the expected advantage of quota systems enabling market players to achieve the target in the most cost-efficient manner was not proved thus far. The main reason for this is the lack of guarantees about prices on the medium and longer term which proved an important barrier to raise investor's interest, particularly if there is uncertainty about how long the obligation will persist. When implementing a quota scheme it is therefore highly recommended to foresee a stable policy framework including a long term target and provide minimum price guarantees to project developers and investors. MS having implemented quota systems include Belgium, Italy, Poland, Sweden and United Kingdom.

3.2 United States of America

The energy policy of the United States addresses issues of energy production, distribution and consumption, such as building codes and gas mileage standards, and is determined by federal, state and local public entities. It includes legislation, international treaties, subsidies and incentives to investment, guidelines for energy conservation, taxation and other techniques of public policy. In relation to the oil import policy, there is no comprehensive long-term energy policy. Since 1992, three Energy Policy Acts have been passed (1992, 2005 and 2007) which include provisions for conservation (such as the Energy Star program) and energy development, with tax incentives and grants for both renewable and non-renewable energy. Within the USA there are state specific energy efficiency incentive programs which play a significant role in the overall USA energy policy. USA did not ratify the Kyoto Protocol and preferred to let the market drive CO_2 emissions to mitigate global warming. The new USA presidency has a comprehensive plan towards energy independence and emissions reductions through investment in alternative renewable energy and cap-and-trade programs, consequently addressing climate crises and creating millions of new jobs (House).

In Annex III a table with a summary of all US energy related statutes is provided.

In 2007, 86% of all types of energy used in the USA was derived from fossil fuels; petroleum was the largest source of fuel (40%), followed by natural gas (24%) and coal (23%). The other 15% was derived from nuclear power, hydroelectric dams and various renewable energy sources (Figure 14).

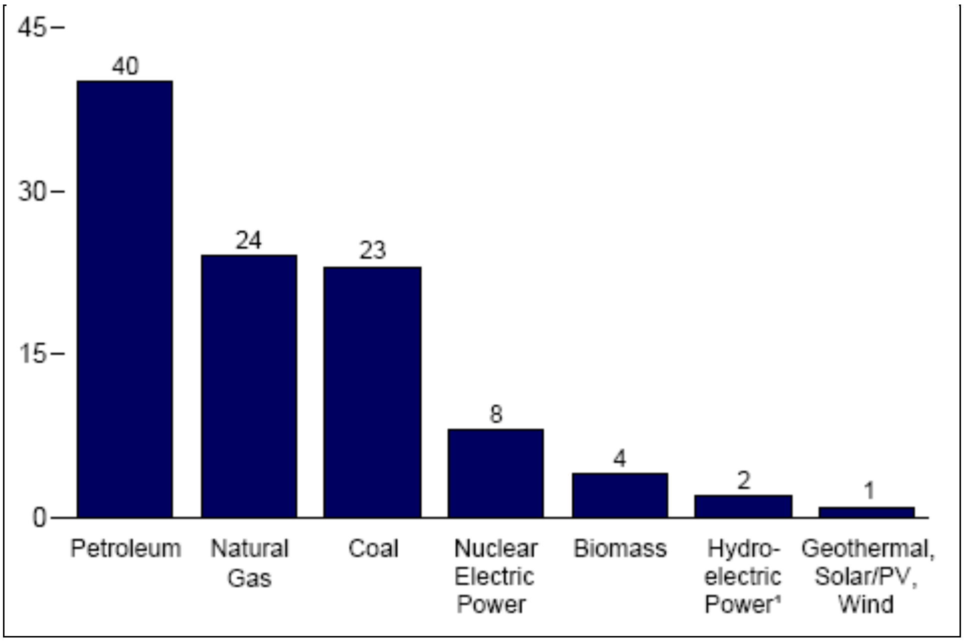


Figure 14: Energy consumption by source in 2007 (US, 2008)

In the first half of 2008, renewable energy accounted for more than 10% of the domestic-produced energy, with the major contribution coming from hydroelectric plants. The wind power industry is growing at an accentuated rate; at the end of 2008, US wind power capacity was of 25,170 MW (enough to supply 7 million households) correspondent to a 45% growth of this industry from 2007 to 2008 (AWEA, 2009). Solar energy is by far the greatest potential energy source in the US although there is still few capacity installed. The US is the world leader in terms of geothermal energy with 2,957 MW capacity installed (30% of the world) and, as of August 2008, has a number of projects underway which are expected to supply up to 3979 MW of power once developed.

Over the past decade there has been a huge progress in renewable energy policy especially at state levels. As it can be seen from the following figure, currently there are 28 states with mandatory renewable portfolio standards (RPS, similar to quota schemes in Europe) and another 5 with non-binding renewable energy goals. It is projected that RPS policies will require the development of over 60 GW of renewable sources by 2025, however this will only account for 15% of projected electricity demand growth in that year (Wilson Rickerson, Florian Bennhold and James Bradbury, 2008).

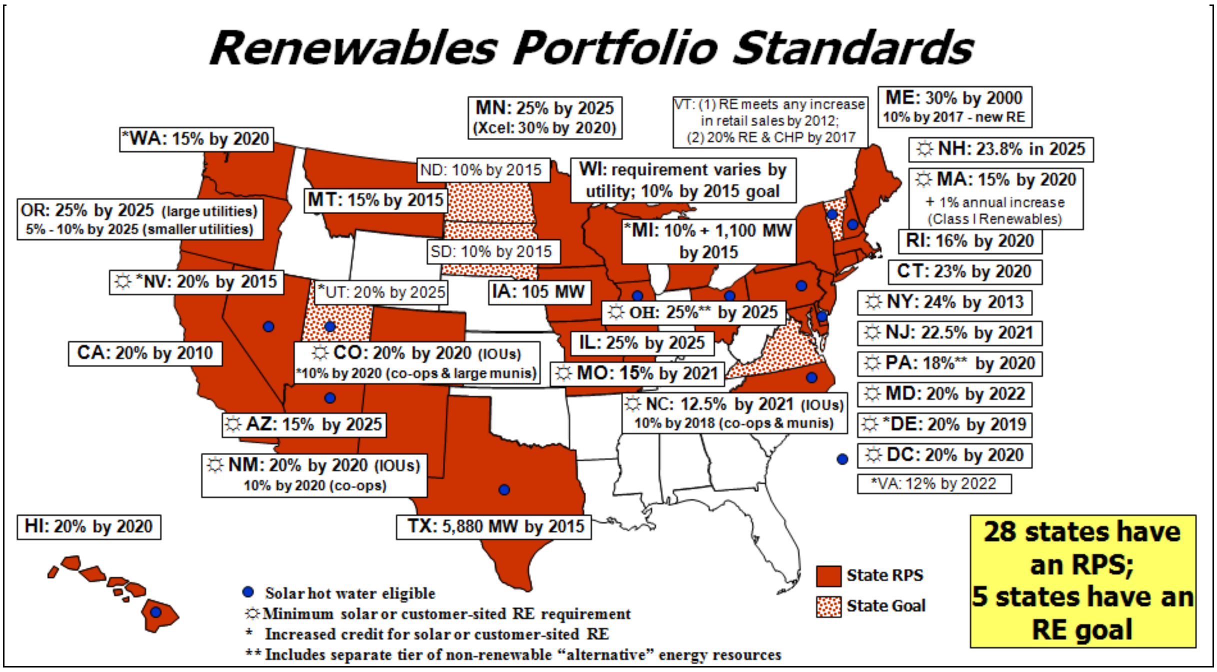


Figure 15: Renewable Portfolio Standards as of February 2009 (DSIRE, 2009)

Interest in biofuels (bioethanol and biodiesel) in the US has been increasing recently. Most cars in the US can use blends up to 10% ethanol and vehicle manufacturers already produced vehicles which can run on much higher ethanol percentages. The Energy Information Administration predicted in the Annual Energy Outlook that ethanol consumption will reach 11.2 billion gallons in 2012, reaching and even over passing the 7.5 billion gallons required by the Renewable Fuel Standard enacted as part of the Energy Policy Act 2005.

In terms of energy efficiency several measures and innovations have already been put forward in the US. These include efficient water heaters, improved refrigerators and freezers, advanced building control technologies and advances in heating, ventilation, and cooling (HVAC), smart windows that adapt to maintain a comfortable interior environment, a steady stream of new building codes to reduce needless energy use, and compact fluorescent lights. Several states have deployed energy efficiency innovations, such as California, New York, Rhode Island and Wisconsin and the state planners officials, industry and citizens have found these to be very cost-effective.

Transmission lines are the link between electricity generation and consumers. In the US the transmission grid infrastructure is owned and operated by approximately 3000 distribution utilities and 500 transmission owners. At the moment a solution for the transmission grid that meets the needs of all parties is needed to face the existent challenges in transmission planning, siting, cost allocation, grid operation and technical innovation, financing and construction. Moreover the existent grid also faces challenges related to growing demand for electricity, aging and congested delivery infrastructure and a growing interest in Smart Grid technologies as well as challenges in terms of integration of renewable energy sources. The grid must meet the needs of the wholesale markets that have evolved since the passage of the Energy Policy Act of 1992, while it should also be capable to integrate renewable energy generation in a reliable and efficient way sources. Within this it is essential that national policy guide programs aiming to maximise cost-effective energy savings, reduce energy use during peak periods, reduce environmental impacts of electric delivery infrastructure utilisation (including end-use infrastructure), coordinate with Smart Grid initiatives and enhance the overall reliability of the electric grid (EAC E. A., 2009).

An electricity grid is not a single entity, it aggregates multiple networks and multiple power generation companies with multiple operators employing varying levels of communication and coordination, most of which is manually controlled. Smart grid technologies can offer a solution, as they allow the grid to better adapt to the dynamics of renewable energy and distributed generation, enabling utilities and consumers to easily access these resources and reap the benefits. Furthermore, smart grids capabilities will make it easier to control bi-directional power flows and monitor, control, and support distributed resources (EAC, Smart Grid: Enabler of the New Energy Economy, 2008). President Barack Obama asked the United States Congress to pass legislation that included doubling alternative energy production in the next three years and building a new electricity smart grid (FNS, 2009). In April 2009 George W. Arnold was named the first National Coordinator for Smart Grid Interoperability and NIST Announced Three-Phase Plan for Smart Grid Standards (NIST, 2009). See appendices for more information on Smart Grids and Energy Storage.

3.2.1 Energy Efficiency Action Plan for States

In 2005 the National Action Plan for Energy Efficiency began, directed by a leadership group of electric and gas utilities, state agencies and other organisations, providing guidance to the states in order to help electric and natural gas ratepayers increase energy efficiency while saving money. In 2006 the Group has presented 5 policy recommendations for fully developing the cost-effective energy efficiency resources in the US, building upon experiences in particular in states and regions:

- *"Recognize energy efficiency as a high-priority energy resource;*
- *Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource;*
- *Broadly communicate the benefits of and opportunities for energy efficiency;*
- *Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective;*
- *Modify policies to align utility incentives with the delivery of cost-effective energy efficiency, and modify rate making practices to promote energy efficiency investments*" (EPA, National Action Plan for Energy Effi ciency Vision for 2025: A Framework for Change, 2008).

In November 2008 EPA and DOE released an updated version of the Plan, called *National Action Plan Vision for 2025: A Framework for Change* (EPA, National Action Plan for Energy Effi ciency Vision for 2025: A Framework for Change, 2008) which lays out a proposed energy efficiency action plan for state policy makers. The report reviewed the 2006/2007 key state policies implemented showing that:

- More than 120 organizations (states, utilities, and other organizations) have endorsed the original recommendations of the action plan and are currently spending about $2 billion per year on energy efficiency programs, which has saved energy customers nearly $6 billion annually;
- In terms of policy, about half of the states have established energy efficiency programs for key classes of customers and have reviewed and updated their building codes and about one-third of states have established energy savings targets and addressed utility disincentives for energy efficiency (Annex IV presents some key areas developed by state policy-makers, including utility commissions, state legislators and governors' offices).

This report also reviewed the approaches for measuring progress towards all cost-effective energy efficiency measures by 2025 and provided approaches for measurement of the 10 implementation goals (shown in Annex IV Table 11) across a set of quantitative measurements. This action plan encourages low-cost efficiency programmes and shows state progress towards their goals. Also two documents, one on cost-effectiveness tests for energy efficiency programs (EPA, Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers, 2008) and the other on best practices for providing data to businesses (EPA, Utility Best Practices Guidance for Providing Business Customers with Energy Use and Cost Data., 2008) go along with this Plan.

If all states implement the plan, energy demand across the country can decrease 50%, more than $500 billion can be saved (net savings) over the next 20 years and GHG emissions can be reduced each year equivalent to 90 million vehicles.

3.2.2 US Energy Policy Incentives

In the US most of energy policy initiatives are financial incentives such as tax breaks, tax reductions, tax exemptions, rebates, loans and specific funding. Most of these incentives have been created through the US energy policy, examples being the Energy Policy Act 2005, the Energy Independence and Security Act of 2007 and the Emergency Economic Stabilization Act of 2008 (all of which promote energy efficiency improvements and encourage the development of specific energy sources).

Biofuel subsidies have the objective to promote energy independence, reduction of GHG emissions, improve rural development related to biofuel plants and farm income support.

Consumer subsidies (ENERGYSTAR.gov, 2008):

- Tax credit for efficient cars:
    - From the beginning of 2009 there is a new tax credit for Plug-in hybrid electric vehicles, starting at $2,500 and capped at $7,500 for cars and trucks (the credit is based on the capacity of the battery system). This tax follows the same principle of the hybrid vehicle tax credit: the first 250000 vehicles receive the full tax credit and then it phases out.
    - There are tax credits for consumer that buys an hybrid gasoline-electric, diesel, battery-electric, alternative fuel, and fuel cell vehicles. The tax credit, ranging from several hundred dollars to a few thousand, is dependent on the type of vehicle and the difference in fuel economy;
- Tax credit provided to homeowners for energy efficiency products such as insulation, doors, windows as well as heating and cooling equipment and biomass stoves. This tax credit can go up to $500 for improvements placed in service starting in January 1st 2009 through the end of the year.
- Tax credit for solar energy systems: homeowners installing quality solar water heating and photovoltaic systems can receive a tax credit of 30% of the cost of the system, up to $2,000, for systems in service from 1st January 2006 until December 2016. After 31 December 2008 this $2,000 cap was removed for photovoltaic systems (but not solar water heaters). This credit is completely separate from the energy efficiency tax credit.
- Tax credit for small wind energy systems: homeowners who install residential small wind turbine systems in service from 1 January 2008 until 31 December 2016 are entitled to tax credit for 30% of the cost of the system, up to $500 for each half kilowatt of capacity with an overall maximum of $4,000.

- Geothermal heat pumps also qualify for tax credits up to $2,000.
- Tax credit on fuel cells: this tax credit is of up to 30% of the cost (up to $1,500 per 0.5 kW of capacity maximum) for consumers who install qualified fuel cells or micro turbine systems. These credits are available for systems in service from 1 January 2006 through 31 December 2016.

Besides tax credits for consumers, there are also tax credits for home builders and tax deductions for commercial buildings.

Recent energy policy incentives have been provided for nuclear power, fossil fuel production, clean technologies, renewable electricity production, and conservation and efficiency improvements.

At the state level, there are a series of policy mechanisms and initiatives supporting the implementation of renewable energy technologies and energy efficiency programs. The Solar America Initiative (SAI), Programmatic Environmental Impact Statement (PEIS) and California Solar Initiative are just some of the examples.

The SAI is part of the Federal Advanced Energy Initiative which aims to accelerate the development of photovoltaic materials with the goal of making this technology cost-competitive with other forms of renewable energy by 2015. SAI goals will be achieved through the U.S Department of Energy Solar Energy Technology Program (SEYP) by focussing on four main areas:

1. Activities that address market place barriers and offer the opportunity for expansion of the market – Market Transformation;
2. Research and development activities that address new devices or processes with both potential significant performance and cost advantages;
3. Research and development activities for developing PV prototype components and systems produced at pilot scale to demonstrate reliability, performance and cost advantages;
4. Industry and universities collaborative research and development activities to develop and improve solar technologies.

PEIS will assess the environmental, economic and social impacts of solar energy projects in six western states of the US (Arizona, California, Colorado, Nevada, New Mexico, and Utah) as well as evaluate alternative management strategies to determine the best management approach for agencies to adopt in terms of facilitating solar energy development and mitigation of potential impacts. The measures that will result from PEIS will provide consistency and certainty for developing solar energy and speed up environmental analysis of future solar energy development sites.

The California Solar Initiative is a comprehensive $2.8 billion program part of the Governor Arnold Schwarzenegger's Million Solar Roofs Program that has the goal to create 3000 MW of new solar-produced electricity by 2017. This initiative offers cash incentives for the deployment of PV solar systems up to $2.50 a watt. Together with federal tax incentives, the California Solar Initiative incentive can cover up to 50% of the total cost of a solar panel system.

Also the US policy makers are looking into the introduction of feed-in-tariffs in the US as a policy mechanism to accelerate the growth of the renewable energy sector. Indeed, although feed-in-tariffs go against energy policy implemented in the US, some states have implemented feed-in-tariffs.

3.2.3 Obama's-Biden Comprehensive New Energy Plan for America

The New Energy Plan for America will:

- Create millions of jobs by investing $150 billion strategically to catalyze private efforts to build a clean energy future over the next 10 years;
- Ensure that 10% of US electricity is produced from renewable energy sources by 2012 and 25% by 2025;
- Implement an economy-wide cap-and-trade program to reduce in 80% the GHG emissions by 2050;
- Save more oil over the next 10 year than what the US imports from Middle East and Venezuela, and consequently reduce the its oil import dependency;
- Bet on the increase of the Plug-In hybrid-car market by putting 1 million Plug–In hybrids in circulation by 2015

In order to eliminate over the next 10 years the current US oil imports from the Middle East and Venezuela, the energy plan will increase the Fuel Economy Standards, put 1 million Plug-In Hybrid cars circulating by 2015, create a new $7000 Tax Credit for Purchasing Advanced Vehicles, establish a National Low carbon Fuel Standard, use a "Use it or Lose It" approach to existing gas and oil leases and promote the Responsible Domestic Production of Oil and Natural Gas.

Millions of green jobs will be created in order to achieve the 10% of US electricity from renewable energy sources by 2012 and 25% by 2025 (there will be a strong investment on this sector), and for that a Renewable Portfolio Standard (RPS) will be proposed. Along with the exploration of renewable energy sources Obama's government will strongly bet on Energy Efficiency (deploy the Cheapest, Cleanest, Fastest Energy Source), Weatherize One Million Homes annually, will develop and deploy Clean Coal Technology and make the construction of the Alaska Natural Gas Pipeline a government priority.

One of the big ambitions of this government is to make the US a leader on climate change, by reducing the GHG emissions by 80% in 2050 through betting on alternative renewable energy sources, energy efficiency measures but also through the implementation of an economy-wide cap-and-trade program.

With the US president Obama's goal of doubling the renewable energy production over the next three years, the president will ask the Congress to act quickly in passing legislation to achieve this goal.

3.3 Developing Countries

There are big differences among developing countries energy needs, energy policy development and implementation. For example the most rapidly developing economies, such as China, India and Brazil, have already energy policies implemented that address energy access, security of supply and climate change issues. On the other hand the poorest developing regions lack a long-term sustainable energy policy which addresses the following challenges: low/deficient energy generation, transformation and transportation capacity, low access to and supply of modern energy, lack of adequate tools for effective energy planning and policy formulation and a weak energy demand base.

In many developing countries access to electricity is still a vital problem. For example, in Sub-Saharan Africa average rural electrification rate is below 10%, electricity supply in cities is often unstable, inefficient and expensive and fossil fuels represent a heavy burden for developing countries budgets.

According to the "*Report Energy Planning in sub-Saharan Africa – facing the challenges of equitable access, secure supply and climate change"* developing countries lack adequate energy planning frameworks leading to ad-hoc and short term decision making in the energy sector.

Currently 1.6 billion people in developing countries lack access to electricity, 2.5 billion rely on biomass that is burned in inefficient polluting stoves, which means that the ones having access to some energy sources also use it on an unsustainable way. Access to energy is one of the main problems of developing countries and also one of the main requirements for these countries to develop. Also in order for these countries to achieve the Millennium Development Goals (MDG) the population and more specifically, poor people, need to have access to energy services.

In terms of energy security, there are big differences among developing countries. Attention is being paid to the developing economies which have an impact on a global level but not on the poor oil importing ones that have little or no access to energy and for these last ones special attention must be paid and framed differently. For poor oil importing countries with little or no access to energy, energy security response measures exist at local, national and regional levels and for example pass by increasing efficiency, recurring to indigenous resources and to supply diversification.

Emissions from developing countries are predicted to overtake the ones from developed ones. However within the developing countries the majority of the emissions come from the rapidly developing countries and not from the poor developing countries. In fact sub-Saharan Africa is responsible for only 3.5% of the current global emissions and is projected to be responsible for less than 4% by 2030 while rapid developing economies such as China are expected to be responsible for 25% of the global emissions. Also an active carbon market has been developed through Clean Development mechanism (CDM) in developing countries such as India and China, but Africa is responsible for less than 3% of the total number of registered projects (in fact as of 2 of February 2009, Africa was responsible for 2,11% of the total registered projects, corresponding to a total of 24 projects (UNFCCC, 2009)). Although Africa is a minor contributor to GHG emissions it is one of the most vulnerable countries to climate change impacts, due to its dependence on natural resources and exposure to extreme weather events.

Africa still has a huge energy resource potential to be exploited, including fossil and renewable sources. The *Report Sustainable Energy in sub-Saharan Africa* (ICSU, 2007) states:

- About 9.5%, 5.6%, and 8% of the world's proven global economic recoverable reserves of oil, coal and natural gas, are located in Africa;
- There is a significant geothermal resource potential in the continent estimated in 2.5-2.6GW, but at present only 129 MW is being exploited in Kenya;
- There is an exploitable hydropower capacity estimated in 1917 TWh/year, to be exploited in both large and small scale hydropower systems;
- Africa has the world's best solar resources, and some of the African countries are already exploiting those for water heating, crop drying and medical applications among other things;
- 10600 TWh/year of estimated wind potential;
- A biomass resource which is already widely used in Africa but in an inefficient way;
- Potential for biodiesel.

Barriers such as the low/deficient energy generation, transformation and transportation capacity, low access to and supply of modern energy, lack of adequate tools for effective energy planning and policy formulation and a weak energy demand base can be overcome through organised R&D activities to facilitate informed energy decision making. In the past several capacity building and R&D projects were developed in Africa, particularly after the oil crisis. Although capacity building and R&D activities on renewable have been carried out in the African sub-Saharan region largely, not many results have been seen as these projects were uncoordinated in nature and did not have any economic and policy links (ICSU, 2007).

The developing world's key drivers for transformation are: poverty eradication, risk avoidance and protection of the natural life supporting systems. Developing countries enjoy unique opportunities of using the increasing global awareness and the Kyoto protocol flexible mechanisms to implement their own agendas of development and security of supply.

A high priority in the developing world is the reduction of poverty and unemployment. Within this the renewable energy market development can have a fundamental and triggering role to play. With the adoption of renewable energy for electricity production in developing countries sustainable jobs can be created and electricity can be generated through renewable sources. In fact in South Africa, to achieve its target of 15% of its total electricity coming from renewable energy in 2020, 36400 direct jobs could be created (Dieter Holm, D. Arch).

The Mauritius cogeneration experience in Africa is a success history for cogeneration. The country's sugar industry is self-sufficient in electricity and sells the excess of power to the national grid. In 1998, 25% of the country's electricity was generated using bagasse and by 2002 the share raised to 40%. The Mauritius Government was supportive and highly involved in the development of the cogeneration project: the Sugar Sector Package Deal Act (1985) was enacted to promote the production of bagasse for the generation of electricity while the Sugar Industry Efficiency Act (1988) provided the tax incentives for investment in electricity generation and encouraged small planters to provide the bagasse for that activity. In 1991 the Bagasse Energy Development Programme was initiated. These measures together with the abolishment of the sugar export duty and the removal of the foreign exchange controls, resulted in the steady growth of the bagasse-based electricity within the country.

3.4 Small Islands Development States (SIDS)

Although the 51 Small Island Developing Stats (SIDS) and territories contribute less than 0,002% to the growth of GHG emissions they are among the most vulnerable in terms of impact of climate change (Roper, The IPCC Report and its implications for the Pacific, 2007). They already have problems in dealing with existing environmental problems such as pollution, coastal and coral degradation and explosive population growth, and climate change is even threatening the very existence of some of them (such as the Maldives, Tuvalu and Kiribati which are a few meters above sea levels).

SIDS have high population density and growth rates (in some islands the population growth rate exceeds the rate of economic growth), are small and are remote and disperse. These islands are vulnerable economies with a low level of economic activity, limited financial and physical reserves, and inadequate infrastructures and are dependent on international trade.

In terms of energy SIDS are very dependent on imported petroleum products, creating expensive import energy budgets, largely for transport and electricity generation and short electricity supply in rural areas (70% of the Pacific Islanders still do not have access to electricity (Roper, The Global Sustainable Energy Island Initiative)). The large share of primary energy consumption in many SIDS is biomass, which is utilised for heating and cooking. However it is used in a traditional way which is inefficient and poses risks in term of health, indoor pollution and depletion of forest resources. Also due to its intense use fuel-wood and charcoal prices are high and have become a burden for lower income groups. Renewable energy resources of SIDS vary greatly and are abundant. All have substantial solar resources, wind, hydro, biomass, geothermal and ocean are also available (GTZ, 2004).

Many of SIDS problems can be addressed by an increase use of the renewable energies and a more efficient and rational use of energy. With measures acting on those two fronts, SIDS can reduce their dependency on fuel imports for energy consumption and stimulate a more sustainable social economic development, with reduced GHG emissions.

The United Nations Programme of Action on the Sustainable Development of SIDS, popularly known as Barbados Program of Action (BPOA), adopted in 1994 in the Conference on the Sustainable Development of Small Island Developing States in Barbados, is a policy document that addresses economic, environmental and social development vulnerabilities which SIDS face and outlines a strategy that seeks to mitigate those vulnerabilities (UN, BPOA 1994, 1994). It was the first programme addressing the challenge of translating Agenda 21 into a program of action for a group of countries. It remains the only internationally approved SIDS specific program which has been collectively and unanimously endorsed by SIDS in 1994. BPOA has been revised through the years, the last revision being undertaken in 2005 at a meeting held in Mauritius. The conclusions of the BPOA 2005 revision concluded that the BPOA implementation was largely unsuccessful, the program was significantly revised and the Mauritius Declaration and Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of SIDS was adopted in that meeting (UN, Mauritius Declaration and Strategy, 2005).

In August 2007, the report *"Follow-up to and implementation of the Mauritius strategy for the further implementation of the programme of action for sustainable development of Small Island Developing States: Report of the Secretary-General"* (UN, Follow Up in the Application of the Mauritius Strategy, 2007) was adopted by the UN Assembly. The conclusions of this report strengthened the needs for awareness raising among stakeholders, regional and international organizations of the Mauritius Strategy for Implementation as a comprehensive sustainable development strategy for SIDS, for work in the design of the framework and monitoring of its implementation as well as its integration with other development plans including the MDGs, and for mainstreaming the Mauritius Strategy for Implementation, to improve coherence in the delivery of assistance to SIDS from the United Nations system and the donor community.

The Global Sustainable Island Initiative (GSEII), which is a consortium of multinational institutions and international NGOs, has been working with the Alliance Of Small States (AOSIS) to mitigate barriers and transform their energy systems from fossil-fuel based to sustainable energy systems. The consortium supports SIDS and potential private investors and donors by bringing renewable energy and energy efficiency projects, models and concepts together into national sustainable energy plans (Roper, The Global Sustainable Energy Island Initiative). In 2004, United Nations Industrial Development Organization joined forces with GSEII to carry out feasibility studies and capacity building activities to help implement SIDS energy plans. Funding for this activities come from United Nations Foundation, Government of Italy, Rockefeller Brothers Fund, US Agency for International Development and the Renewable Energy and Energy Efficiency Partnership (REEEP) (UN Headquarters, 2006).

Beside GSEII which has been very active in some developing projects in SIDS (see section 3.4.1 The Global Sustainable Island Initiative (GSEII)) other programmes are also being developed in SIDS region, such as the Hawaii's Lead By Example Initiative; the Hawaii's Clean Energy Initiative; the CARICOM Sustainable Energy Programme and Caribbean

Renewable Energy Development Programme (CREDP) which targets island of the Caribbean (these two programmes are further explained in Section 4).

3.4.1 The Global Sustainable Island Initiative (GSEII)

GSEII seeks to accelerate the transformation of up to 20 AOSIS member nations towards a sustainable use of energy. The specific objectives of the Consortium include:

- Reduce dependence on fossil fuels and eliminate related trade deficits, securing energy independence;
- Reduce negative impacts on local environments;
- Reduce GHG emissions;
- Encourage private investment and trade;
- Enhance socio-economic development;
- Increase awareness of potential renewable energy and energy efficiency in the SIDS;
- Present the island nations' experiences as an example for larger countries to follow toward a sustainable energy path;
- Demonstrate that SIDS can set examples for bigger and more polluting countries by reducing its GHG emissions.

The strength of GSEII is the ability to develop strategic frameworks for sustainable energy development in the island working at the national level. These include development of necessary regulatory and policy frameworks, institutional capacity, outreach and awareness and project support.

Activities conducted by GSEII include the development of sustainable energy plans (SEPS) in five SIDS, conduct stakeholders meetings to finalize the SEPS, work with the AOSIS governments in policy formulation and implementation, identification of renewable energy projects and its technical, economic and financial analysis, facilitation of project investment financing, public awareness and technical assistance during project implementation. Phase I GSEII interventions (included the development of projects and programs to address barriers for renewable energy development), have proven successful in catalyzing this transition in the Caribbean, particularly in the island states of St. Lucia, Grenada and Dominica ,with support from Rockefeller Brothers Fund, US Agency for International Development, US Department of Energy and the Organization of American States. Table 4 summarises GSEII country activities and Table 5 GSEII projects by area.

Table 4: GSEII countries and activities

Activities	**Dominicana**	**Grenada**	**Saint Kitts and Nevis**	**Saint Lucia**	**Fiji**	**The Maldives**	**The Marshal Islands**
SEP Development	X	X	X	X		X	
Awareness Raising		XEE	XRE	XEE			
Capacity Building			X	XEE			
Technical Assistance	XEE		X		XRE		XRE

Activities	Dominicana	Grenada	Saint Kitts and Nevis	Saint Lucia	Fiji	The Maldives	The Marshal Islands
Financing		XRE		XRE			

Table 5: GSEII Developed projects by area (GSEII)

(Nasir Khattak; Marco Matteini, 2007), (Lambrides, Eastern Caribbean Geothermal Development Project (Geo-Caraïbes)), (Roper, GSEII Newsletter: Energy Efficiency Challenges, 2007), (Lambridges, 2008)

SIDS	GSEII Projects	Progress
Wind	LUCELEC Point de Caille 4.25 MW Wind Farm	St. Lucia, Point de Caille, is undergoing analysis to assess the pre-feasibility aspects of a potential wind farm in the area. LUCELEC intends to apply for planning permission to operate a wind farm at this site.
	Grenada Wind Farm	GSEII supported a 900 kW wind project in Grenada
	Saint Kitts and Nevis Wind Farms Development	The Federation Government of St. Kitts & Nevis is committed to the development of one or more wind farms. There have been recent discussions regarding the potential for the development of 10 MW of installed wind capacity on the island of St. Kitts. On Nevis, a private wind developer has been negotiating with the NIA the details of a PPA for the development of a proposed 1,100 kW Wind Park.
Geothermal	Eastern Caribbean Geothermal Development Project - “Geo-Caraïbes”	Applied in St. Lucia, Grenada, Dominica and Saint Kitts and Nevis. Led by the Organization of American States (OAS). The Project seeks to catalyze the development of one or more geothermal power plants that might export electricity to several islands of the region, including Guadeloupe and/or Martinique. It is expected that a large quantity of geothermal energy capacity (60-120MW) will be developed, and that the resulting power will offer the host countries a low-cost power solution while generating substantial income as an export to Martinique and/or Guadeloupe, via submarine electricity transmission cables. In 2007, the Nevis Island Administration (NIA) entered into a Memorandum of Understanding (MOU) with a private developer, West Indies Power Ltd. The MOU provides the developer with the exclusive rights and responsibilities for geothermal exploration and development. West Indies Power Ltd. has incorporated the surface based analysis that was conducted by the Geo-Caraïbes project into its understanding of the resource and, as of 2008, is conducting exploratory well drilling in Nevis. Preliminary results indicate that there is at least 35 MW of near-term potential available for the first set of possible geothermal

SIDS	GSEII Projects	Progress
		sites. On April 11, 2008 Dominica's Minister for Energy, Honorary Charles Savarin, signed an agreement on the commencement of activities under an EU funded geothermal energy exploration project. It is estimated that 1,390 MWe can be harnessed from Dominica's geothermal sources. Considering that the actual energy peak load demand on the island is only 14 MWe, Dominica has a significant export potential.
Solar	Caribbean Solar Financing Project	The Caribbean Solar Finance Program (CSFP) is designed to measurably reduce the constraints on, and increase the capacity for, financing of SHWS in the three islands while at the same time helping build awareness among the middle income segments of the population on the benefits of SHWS. St. Lucia Solar Hot Water Heating Financing Program: launched this initiative in May of 2005. In September 2005, the UNIDO-GSEII team held a training course for representatives of St. Lucia's credit unions. Grenada Credit Union Solar Hot Water was launched in 2006.
	Marshal Islands Solar project	GSEII will be working with the Marshall Islands to expand the use of photovoltaic technology, thus improving the quality of life for the Marshallese while helping the Marshall Islands to reduce carbon emissions.
	First Grid-Connected Solar System in the	Project located in Tuvalu. The 40 MW solar power project undertaken by the e8, a non-profit international organization composed of nine leading electricity companies from the G8 countries, and the Pacific Power Association (PPA) was commissioned in February 2008. Kansai Electric Power of Japan took the lead in this project.
	Utility Engineers Solar Power Training Program	The Climate Institute regularly arranges educational sessions at the annual PPA (Pacific Power Association) CEO's meeting and Engineers bi-annual workshops in the Pacific. The Institute and E8 are working with the PPA to expand technical knowledge and capacity by organizing intensive workshops for engineers. A thorough 10-day workshop was proposed for 2008 to be carried out in the Marshall Island and Fiji and would consist of at least one week dedicated to stand alone systems and the balance to grid connections.
Waste to Energy	St. Lucia Ciceron Landfill Gas to Energy Project	St. Lucia solid waste management authorities are interested in exploiting the electricity generation potential of the site at Ciceron (landfill closed in 2003), in order to generate electricity that could be fed to the electricity grid, assisting sustainable energy development on the island. The Ciceron Project will be using methane generated in the Ciceron Landfill in order to generate up to 400 KW of power to be integrated in the electricity grid of St. Lucia. The project aims at recognition

SIDS	GSEII Projects	Progress
		through the marketing of certified emission reductions under the Clean Development Mechanism (8,713.6 tons CO2 equivalent/average year) as part of the Kyoto Protocol for mitigation of greenhouse gas emissions. The UNIDO-GSEII team successfully completed the pre-feasibility study for this project in the spring of 2005. Further planning is currently being undertaken for the development of the Landfill Gas to Energy Project in St. Lucia.
	Poultry Litter to Energy Project	The project is to be hosted by Fresh Eggs, Ltd., a local producer of eggs, located in the Laborie area of southern St. Lucia. The production facility at Laborie houses 11,000 laying hens, producing year round, housed at a single building where production takes place. The project considers the use of poultry litter to generate captive power that will substitute grid electricity in the facility. A feasibility analysis completed in March 2005 proved that this project would not be economically viable.
	Grenada Nutmeg Shell to Energy Project	The project looks at a 50 KW capacity plant using nutmeg shells and steam cycle technology for the generation of electricity, and perhaps process heat as a combined heat and power (CHP) plant to be used in conjunction with an upgrade to the existing nutmeg refinery already installed in northern Grenada. That project has now been cancelled (due to the damage that an hurricane made on the nutmeg trees) , and a new program focusing on sustainable reconstruction is being prepared for Grenada
Energy Efficiency	Energy Efficient Lighting Project	The Climate Institute arranged, with the help of Climate Care of the United Kingdom, for the distribution of 6,000 energy efficient bulbs by the St. Lucian Ministry of Planning. The compact fluorescents are an energy-efficient 15 watts, versus the typical 60-100W bulbs used. The installation of energy efficient lighting mitigates the demand for fossil-fuelled energy, thus saving St. Lucians on their energy bills, as well as lessening burden on the climate. Completed. In the Marshall Island MEC along with the Climate Institute and Climate Care, a UK-based group specializing in the sale of carbon emissions offsets, have begun installing 10,000 compact fluorescent light bulbs (CFLs) this May 2008. Already over 1,000 CFLs have replaced energy inefficient incandescent light bulbs in homes and other buildings on the Marshall Islands.
	Energy Efficiency and Renewables Awareness Campaign Energy Week	The second event of the same type carried out in St Lucia. This week was an important step in St. Lucia's progress toward achieving an economy dependent on clean and green fuel alternatives. It helped facilitate development of a solid energy policy for St. Lucia and was also instrumental in projecting St. Lucia as a country with a bright future in the field of alternative

SIDS	GSEII Projects	Progress
	2004	fuel technologies.
	Energy Audits Workshop	Series of training workshops and audits (carried out in February 2004) in energy management for the Hospitality sector was conducted in the Castries and Rodney Bay areas in St. Lucia. This training was part of a project being undertaken by Lewis Engineering Inc., Marbek Resource Consultants, Inc., and the St. Lucia Ministry of Physical Development, Environment, and Housing, to reduce greenhouse gas emissions through enhancing energy efficiency in the hospitality sector. This project was made possible due to the support of the Climate Change Development Fund of the Canadian International Development Agency.
	Energy Efficiency in Water Utilities	Proposed for St. Kitts & Nevis and St. Lucia in 2008. To assess current energy performance, identify main causes of energy losses and define possible efficiency improvement and conservation measures. To deliver training on pump systems optimization and energy management best-practices in water utilities.
	DOMLEC Reduction Loss Study - Dominicana	Objectives: Improvement of efficiency and reliability in the provision of electricity; Reducing GHG emissions per unit of electricity delivered; and Reducing electricity price to consumers. At the end of 2005, Annual Fuel Cost of Losses were of 2,470,690 USD. 2006 outputs: Study's recommendations were incorporated in DOMLEC's: Loss Reduction Plan for 2006-2009; and there were reduced electricity losses and an improvement on system reliability. Energy Savings: 1,474 MWh; Fuel Cost Savings: 347,980 USD Projection for 2007: Energy Savings: 2,090 MWh; Fuel Cost Savings: 601,000 USD.
Other	Bio-fuel/Copra:	Utilises coconut kernels, as a substitute for diesel, the Marshalls Energy Company aims to develop small generators from 5 kWh to 50 kWh that run on this bio-fuel to work synergistically with solar-powered systems, providing electricity for high load appliances not requiring 24-hour power generation such as freezers and washers. This will grant even greater flexibility for the rural Marshallese.
	Coconut Bio-diesel, 30 MW Power Plant	The GSEII consortium is working on a pre-feasibility study for a bio-diesel facility using coconuts as the feedstock, whereby Caterpillar will provide a 30 MW power plant and the Government of Fiji will supply the fuel.

SIDS	GSEII Projects	Progress
	St Kitts Biomass-to-energy system	In 2005/06 the Organization of American States (OAS) as part of a GSEII-UNIDO program, conducted a pre-feasibility study focusing on finding alternatives for the abandoned sugarcane lands on the island of St. Kitts. In 2007 a comprehensive land use mapping and assessment conducted concluded that some alternative uses of the remaining agricultural lands (about 4,500 acres) for energy and other by-products were financially feasible. Since the Spring 2008, negotiations are being held between the Government of St. Kitts and Nevis and a private developer for a 10 MW Pyrolysis System that can convert a wide range of crops and waste into syngas (to generate electricity in gas turbines), bio-oil and charcoal

According to the GSEII Newsletter (Lambridges, 2008) the 2020 targets for the pacific are:

- Generating 25% renewable energy;
- Improving existing generation and transmission efficiency by 20%;
- Reducing consumption in public building by 10-15% immediately;
- Reducing oil use for transportation by 20%;
- Setting efficiency targets for motors, air conditioning, appliances, and lighting;
- Doubling village and outer island access to electricity.

3.4.2 Hawaii's Lead by Example Initiative and Hawaii's Clean Energy Initiative (HCEI)

Hawaii's energy system is strongly dependent on imported petroleum – over 36 years petroleum consumption remained at 87% (Capitol, 2008). On the other hand Hawaii has a huge renewable energy potential to exploit, around 15% of which is exploited at the moment. In fact, in 2004 Hawaii's Renewable Portfolio Standards included 6% renewable, which would increase only incrementally if no action was taken. In 2006, the Lead by Example Initiative action started and legislation was passed to change the path that was followed until then. Legislation was articulated so that Hawaii could transit from a fossil fuel economy dependent on petroleum imports to an independent clean energy economy. During 2007, the State of Hawaii agencies made progress in energy efficiency, renewable energy, transportation, and environmental policy. The following table shows the major components of the Lead by Example Initiative and the examples of Hawaii's progress in its implementation.

Table 6: Progress of the Lead by Example Initiative (Hawaii, 2008)

Area	Programs	Examples of the Progress achieved in 2007
Energy Efficiency	Lead By Efficiency Program Energy Star LEED Silver	Four state buildings have received ENERGY STAR® awards, acknowledging that they rank in the top 25% of similar buildings nationwide. The Department of Accounting and General Services (DAGS) constructed their first Leadership in Energy and Environmental Design (LEED™) Certified facility, the

Area	Programs	Examples of the Progress achieved in 2007
	Alternative Fueled State Vehicles Dept of Education Energy Efficiency Coordinator	Waipahu Intermediate School Cafeteria, which the Department of Education (DOE) now operates. DAGS has also completed preliminary energy audits for a number of its buildings and initiated the retro commissioning of five buildings: the State Capitol, the Keelikolani Building, and the state office buildings in Lihue, Hilo and Wailuku. DOE initiated a share-the-savings pilot project at 15 schools during the second semester of the 2006-07 school year. The public library system was fully funded for energy efficiency measures at all 51 of its libraries state wide and is working with DAGS to initiate the improvements promptly. The Department of Transportation (DOT) Airports Division is considering a cold ocean-water air conditioning system (similar to the utilized at NELHA for years which was audited and confirmed efficient) for the enclosed areas of Kona International Airport. DOT-Airports has made efficiency improvements in taxiway lights and airfield lighted signs at the Honolulu, Hilo and Kalaeloa airports, and replaced the chiller plant at Kahului airport with more efficient equipment. State agencies have received more than $4 million in efficiency rebates from the Hawaiian Electric Company (HECO), with cumulative dollar savings totaling $69.4 million. State efficiency rebates have thus far saved 354,557 megawatt-hours of electricity; the annual savings is approximately enough to service 6,634 Hawaii homes. Over the life of the efficient equipment, the electricity savings are expected to grow to 812,010 megawatt-hours, enough to serve over 99,000 homes.
Renewable Energy	Renewable Portfolio Standard (RPS)– 20% by 2020 Public Benefits Fund for Demand Side Management	Eight public schools will receive PV installations during FY07, utilizing $5 million appropriated by the 2006 Legislature. DAGS is considering power purchase agreements for photovoltaic (PV) installations on buildings it manages. UH-Hilo has already installed 10 kW of photovoltaics on portable buildings, and a 30 kW array for the new science and technology building is out to bid. A request for proposal (RFP) is being prepared to solicit PV installations on airports and other facilities managed by DOT, as well as DBEDT's Foreign Trade Zone An integrated wind system for an electrical vault is planned for construction by DOT-Airports in 2008. Solar water heating is being promoted where

Area	Programs	Examples of the Progress achieved in 2007
		appropriate. DOE plans to install solar water heaters in cooperation with energy savings companies in FY08.
Transportation	Alternative Fuel Standard – 20% by 2020	State vehicles are utilizing E-10 Unleaded gasoline which contains 10% ethanol; state law requires its sale. Many state vehicles are also flexible-fuel capable, and could use higher percentages of ethanol if they became available. The state offers a pricing preference for biodiesel, and several agencies are prepared to use it.

Since it was initiated in a meeting of all cabinet members, convened by DBEDT, on 11 May 2006, the Lead by Example Initiative frameworks for planning, implementing and reporting energy efficiency activities have been developed, state agency personnel has been trained and received technical assistance as needed. The agencies have set energy-savings targets and are developing tools which will enable their goals to be reached.

Within this scenario, the Hawaii's Clean Energy Initiative was launched on 28 January 2008 with the signing of a Memorandum of Understanding between the State of Hawaii and the US Department of Energy (DOE). HCEI is a broad-based initiative with the main goal of this system being to accelerate Hawaii's energy market transformation towards a more clean, sustainable and independent market, i.e. in detail:

- Achieve a 70% clean energy economy for Hawaii within a generation (by 2030), doubling the rate of progress of the Current State target levels (20% of electricity from renewable);
- Increase Hawaii's energy security;
- Capture economic benefits of clean energy for all levels of society;
- Foster and demonstrate innovation, by becoming one of the first countries independent of fossil fuels;
- Build the workforce of the future;
- Serve as a model for the US and the world.

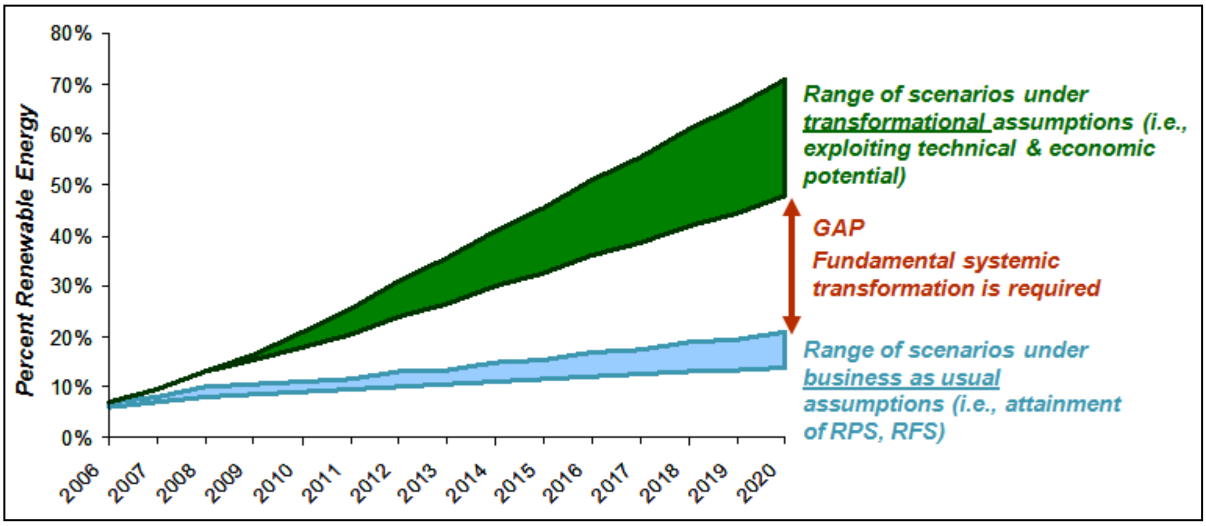


Figure 16: Hawaii's energy market transformation, in terms of RE (Capitol, 2008).

To achieve HCEI goals and objectives DOE provides to Hawaii: technological leadership; coordinate contributions from key federal agencies; and identify and implement opportunities in renewable energy, energy efficiency and electricity delivery programs to fund and support strategic, integrated projects that contribute to achieve HCEI objectives. Hawaii supports regulatory, legislative and outreach initiatives needed to achieve HCEI vision. Within the HCEI, the State, the Consumer Advocate and HECO[4] have reached a series of agreements for Hawaii's energy future.

HCEI assessed through the development of studies in 2008 strategic changes needed in Hawaii's policy, regulatory, financial & technology structures. The technical working groups established under this Initiative identified barriers, made projects and recommendations for regulatory & legislative actions and built key partnerships. After the study of several scenarios to achieve the 70% clean energy in 2030, a transformation strategy based on renewable energy, energy efficiency and transport was developed under HCEI under a State/HECO voluntary agreement:

Table 7: HCEI transformation strategy (Capitol, 2008)

Goals	**RPS (Renewable Portfolio Standard):** – Increase the existing RPS to 25% by 2020 and 40% by 2030 – Limit the amount of biofuels that will count toward the utility obligation; until 2015, the utility can only meet 30% of its obligation by simply substituting biofuels for oil in its existing power plants – The PUC will set financial penalties for utility non-compliance **Energy Scenario Planning:** replace Integrated Resource Planning (IRP), once to reach the RPS electricity system requires integrated clean energy planning.
Assets	**Add RE to the grid** – Addresses the core of implementation by identifying wind, ocean, biomass & other projects that the utility pledges to connect to the grid – Net metering: eliminates system wide cap – PV host program: utility can install solar on rooftops while preserving market competition **Power plant retirements** – The utility commits to retiring a number of oil-fired generating units to transit away from fossil fuels
Pricing	**Feed-in Tariff (FiT)** (which provides certainty to developers and fair prices to consumers) – Very successful in Europe – Standard prices for Power Purchase Agreements – Rather than the utility negotiating each contract, the PUC will set prices for each technology, i.e. wind, solar, ocean, geothermal **Rate pricing** – Time of use rates: let consumers benefit from using electricity at off-peak times – Clean energy infrastructure surcharge: to help fund grid upgrades – ECAC: For now, the utility will be allowed to keep passing on fuel costs via Energy

[4] HECCO – Hawaii's Electricity Company

	Cost Adjustment Clause to maintain a financially sound utility **Decoupling** – Decoupling weakens the utility bias for selling its own power before IPP power – It also decouples the utility's revenue from the number of kilowatt-hours sold
Grid	**Undersea Cable** – HECO commits to working with private developers and the state to buy power from a big wind project from Maui County, and integrating that power onto Oahu's grid via an inter-island cable **Grid Management** – The utility will be responsible for demand response, storage, and other system upgrades to help incorporate and manage renewable energy on the grid – The utility will do a big build-out of advanced metering infrastructure, which they can put into their rate base

Within this the 2009 legislative package for Hawaii was developed. This package is being integrated in the Hawaii: *Bill for and Act*, aligns Hawaii's policy rules with the State's energy goals (Hawai, January 2009). With this package 35% of the clean energy will come from renewable energy in the next few years, and 15% from energy efficiency measures of the electricity mix of Hawaii. To achieve the renewable energy targets PUC will develop rules for feed-in-tariffs, electricity decoupling, etc, and will be responsible for its implementation. In terms of energy efficiency measures, the state will be aggressive in establishing and implementing energy efficiency programs for public and commercial buildings and on the design of a zero net energy building code by 2015. The 2009 package is designed to catalyze the transportation market — e.g., create infrastructure for Alternative Fuel Vehicles — so the legislative package starts the process to deliver the transformation needed to hit 70%. In 2010 the state will propose policies to ensure adequate supplies of biofuels, critical to using AFVs; also clean energy options for aviation/marine transportation will be analysed.

On 20 October 2008, the Governor of Hawaii, the Department of Business Economic Development and Tourism, the Division of Consumer Advocacy of the Department of Consumer Affairs, and the HECO signed an agreement to implement a feed-in-tariff policy by mid-summer 2009 (July), which should be designed to cover "renewable energy production costs plus a reasonable profit". This agreement binds HECO to implement feed-in-tariffs aiming to accelerate the addition of renewable energies and commits Hawaii to complete regulatory review by March 2009 (Gipe, 2009).

4. REGIONAL ENERGY POLICIES: LATIN AMERICA AND THE CARIBBEAN (LAC) SITUATION

4.1 Current Situation

Electricity generation in the Caribbean comes from imported oil and diesel. In Latin America electricity is primarily generated through large hydro, natural gas and fossil fuels (oil and diesel). For the LAC region, between 2002 and 2003, primary energy consumption increased 3.11% and it is estimated that for this decade alone LAC will be required to double its installed capacity (Department of Sustainable Development Organization of American States and Energy and Security Group, 2007). Another problem of the LAC region is the percentage of population without access to electricity, i.e. 13% of the population corresponding to 50 million people.

Electricity markets in Latin America are competitive and there is a general separation between generation, transmission and distribution. They engage independent power producers (IPPs) with power purchase agreements (PPAs) and bulk market agreements. In the Caribbean the electricity markets are vertical monopolies with policies which ensure a set rate of return for electric companies. They have existence licences of 20 to 50 years and regulatory procedures which apart from a few exceptions are not public. Very few tariffs are incentive-based, most utilities have a guaranteed rate of return on capital, and virtually all tariffs have full cost recovery clauses and only few have targets for transmission losses and heat rate targets. Benchmarks generally are not used and very few have voluntary customer service standards imposed by their licences (Sutherland, 2003).

Figure 17 shows the total primary energy supply in LAC countries. There is a big difference between Latin American Countries and the Caribbean in terms of the use of renewable energy. A big share of the electricity in Latin America comes from renewable energy (especially from Central America), mainly from hydro, while the Caribbean countries are more dependent on fossil fuel imports (more than 80% of the regions energy consumption is based on oil products). Although only about 2% of the renewable energy potential is used they have a large renewable energy potential, mainly wind power, hydropower and solar-thermal energy.

According to data from 2006, renewable energy sources generate 24,5% of LAC's electricity and studies indicate that it can generate up to 47% in 2030. Among the renewable energy sources hydro is the most commonly used in LAC. Biomass and biological wastes are another important renewable energy source in the region and it is estimated that Central America and the Caribbean can replace 10% and 50% respectively of their gasoline consumption through the use and production of ethanol (in which Brazil has been a pioneer). Solar energy has also become an attractive means (now that its cost has been reduced from $200/W to $3/W) of bringing electricity to isolated areas within LAC. For example, with the Peru-Sustainable Rural Electrification Installation 12,500 PV systems were installed for rural households and with the Chile-Rural Electrification Program nearly 1000 on-house PV systems were installed in isolated rural dwellings. In terms of geothermal energy, Costa Rica generated 98% of its energy through renewable sources, and Mexico is the third world largest producer of geothermal energy. Also within the Caribbean countries the geothermal potential is being studied for exploitation. In terms of wind there were good experiences in the LAC region with pilot projects and wind capacity is growing every year.

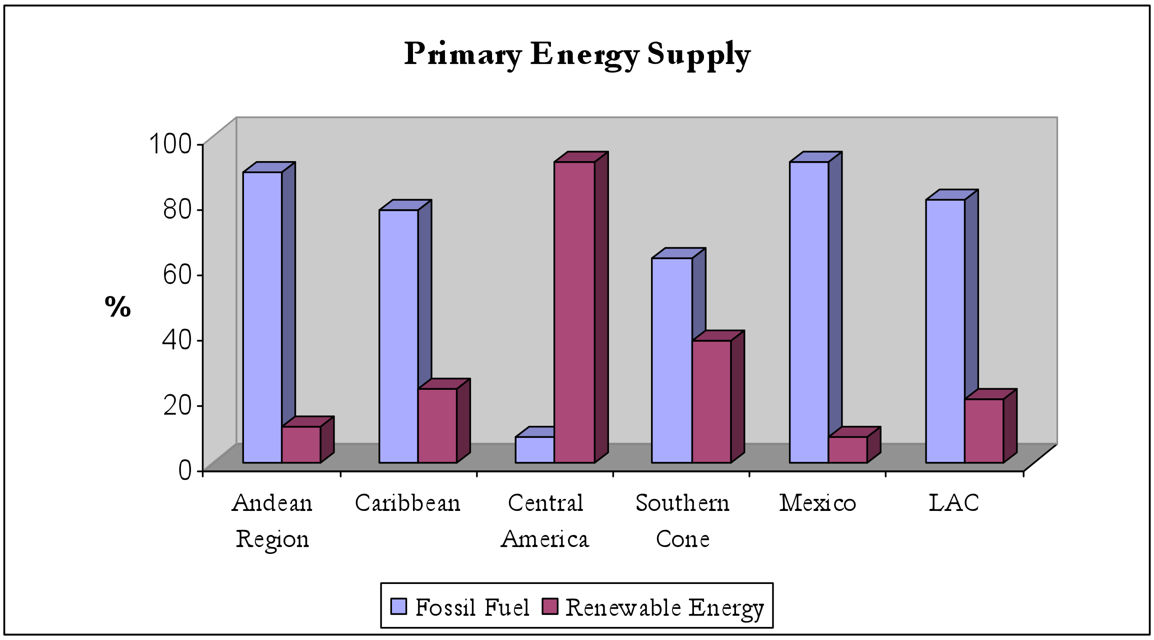


Figure 17: LAC primary energy supply (Inter-American, 2008).

LAC countries' key market drivers for renewable energy and energy efficiency development are energy security, economic sustainable development and climate change. Interconnection and cooperation measures, energy efficiency programs and diversification of the energy sources can guide the market and address energy concerns.

There is a series of interconnection and cooperation measures among LAC countries such as the Electricity Interconnection System for Central American Countries (SIEPAC) and fuel supply interconnections including gas pipelines (e.g. spanning Argentina, Bolivia and Brazil and PetroCaribe's virtual fuel interconnection). However to ensure success in the expansion of these interconnections, cooperation and harmonization of policies, regulations, norms and standards are essential.

Also, there is a need for the implementation of energy efficiency strategies at the demand side, commercial side and in the transport sector. There are some programs already implemented in LAC, such as the Mexico's energy demand side management and efficiency programs, led by the Electric Power Saving Trust Fund (FIDE) and the National Energy Efficiency Commission (CONAE); and the Caribbean Hotels Association's Efficiency Program, which is a good example of a commercial efficiency program.

The diversification of the energy resource, by expanding the fuel and electricity supply resources to include renewable energy is another strategy to address energy concerns. Renewable energy options include biomass, geothermal, hydropower, solar, and wind energy and in the transport sector, diversification options include biofuels and hybrid vehicles.

In the LAC region several programs and initiatives to increase renewable energy use and energy efficiency have been undertaken:

- Latin America and Caribbean Initiative for Sustainable Development (ILAC) – which has set the goal of a minimum participation of 10% of renewable energy in LAC's primary energy supply by 2020. This initiative was approved in the Latin American and Caribbean Forum for Ministers for the Environment, Johannesburg, August 2002. Other objectives of the ILAC include developed countries to comply with their commitment to destine 0.7% of their GDP to development aid, the development of South-South cooperation plans, etc. ILAC defined 38 reference indicators within six priority themes and 25 guiding goals and indicative objectives (UNEP/LAC-SMIG.I/2, 2002);

- Brasilia Platform for Renewable Energy – which was the result of the regional meeting organized in October 2003 in Brasilia. This meeting had the purpose of creating a convergence of initiatives and to discuss problems and opportunities for renewable energy in order to define a common position for Bonn 2004. This platform was the result of that meeting, to coordinate and homogenize the different focus and interests of Latin American countries;
- Latin American Parliament Declaration – also known as the Chile Declaration was a result of the agreements reached by 10 countries in the XVII Meeting of the Energy and Mining Commission of the Latin American Parliament framework, held in Chile in April 2004. The Chile declarations treaties were oriented towards greater penetration of renewable energy and sustainable management of natural resources through the adoption of political, economic and legal policies;
- On 12 May 2006, when the Fourth EU-LAC Summit was held in Vienna, both regions Latin America and the Caribbean agreed on the Summit's purpose: "Strengthening of the strategic association between the two regions" and have established priorities with the objective to coordinate actions in policy, regional integration, multilateralism and social cohesion. Also in this Summit the need to create a safe investment environment were identified as topics to be addressed in the near future;
- Declaration by the Iberoamerican Ministers and Government Representatives – which was signed in the XVI Iberoamerican Summit in Montevideo, Uruguay, 4 and 5 November 2006. This declaration emphasizes the importance of the regional integration of energy in order to increase renewable energy supply and rationalize energy use as well as to promote technological research and development in the field. This declaration also appealed for the development of the Regional Renewable Energy Observatory for LAC (explained in Section 4.1.1 Renewable Energy Observatory for Latin America and the Caribbean).

In the Caribbean the key energy policy pursued in recent years has been the privatization of formerly state-owned electricity utilities. This has been carried out due to budget pressures; need to improve efficiency; and the desire to attract private capital. Privatization has brought restructuring and cost reduction as well as reduced government subsidies to the energy sector. Along with those effects it was also expected to increase competition (Sutherland, 2003).

The privatization status varies from country to country within the Caribbean, from being an integrated department of the ministry (the case of Saint Kitts) to the government being a minority shareholder. Each country has its own sales and privatization rules, but in general the full costs of the generation are covered by the electrical tariffs, which range from $15cents/kWh (Barbados, Jamaica and Guyana) to $30cents/kWh (Antigua). Trinidad & Tobago thanks to its own resources enjoys the lowest electrical rate (United Nations, ECLAC, GTZ, 2004).

In Grenada, Stª Lucia and Dominica, where electrical utilities have been privatized, the governments agreed on a guaranteed fixed return on the utility's assets, as a basis of its operation. Also, on the Caribbean countries governments have allowed a regulation granting sole rights to generate and distribute electricity to the utility, which is very comfortable for the utility. For example, the St.ª Lucia utility enjoys a minimum 15% return on assets guaranteed by the government until 2045, through tariff adjustments, and in Guyana the government guarantees to the company managing the utility payment of the utility debts as well as a 23% guarantee return on assets.

CARICOM Energy Programme for the period 2009 – 2010: In the Second Project Steering Committee Meeting of the Caribbean Renewable Energy Development Programme (CREDP) the Secretariat said that they had developed an energy programme for the period 2009 – 2010. This program has the objective to increase regional cooperation in energy and address a number of critical issues, particularly energy security and the transformation of the region towards a more sustainable energy path. Also the Secretariat indicated the program is structured to build the foundations that can lead the region to provide its people with available, affordable, reliable and sustainable energy sources based on its indigenous resources.

In many countries of Latin America and the Caribbean there is a great expectation for Clean Development Mechanism (CDM, one of the Kyoto Protocol's flexible mechanisms) projects for the valorization of international climate change treaties. With their great potential in renewable resources for energy generation, Latin America and Caribbean are in a good position to implement CDM projects and therefore have a great potential for the generation of Certified Emission Reductions (CERs). CDM offers the opportunity to attract investment and to transfer technologies which can strengthen national development plans.

Several CDM projects have been developed in LAC; however few of them come from the Caribbean countries. To promote CDM projects in the Caribbean the CDM Mechanism Project in the Caribbean was developed and included a baseline study of the power sector as well as capacity building actions. The baseline study of the power sector aimed to simplify the CDM process review and to reduce transaction costs, attract investment to the region and contribute to the project development by providing support for the necessary infrastructures. Within this project three regional workshops were held in St. Lucia, Grenada and Barbados to train people for baseline analysis and benchmarking.

Other programs and initiatives have been implemented and are under implementation in the LAC region, such as the Energy Observatory for LAC, the Global Sustainable Island Initiative (see Section 3.4.1 The Global Sustainable Island Initiative (GSEII)), the CREDP programme (currently in its second phase of implementation) and the Caribbean Sustainable Energy Programme. These last two programs are further explained in the following sections.

4.1.1 Renewable Energy Observatory for Latin America and the Caribbean

This is a multi-institutional and multidisciplinary mechanism that promotes specific actions and projects in the field of renewable energy (productive and industrial application) with the intention of promoting poverty alleviation and the sustainable development of LAC. The Observatory will facilitate the sharing and dissemination of information and replication of renewable energy technologies according to the priority needs and possibilities in Latin America and the Caribbean and offer regional technical assistance for renewable energy initiatives and its legal, technological, managerial and cultural dimensions.

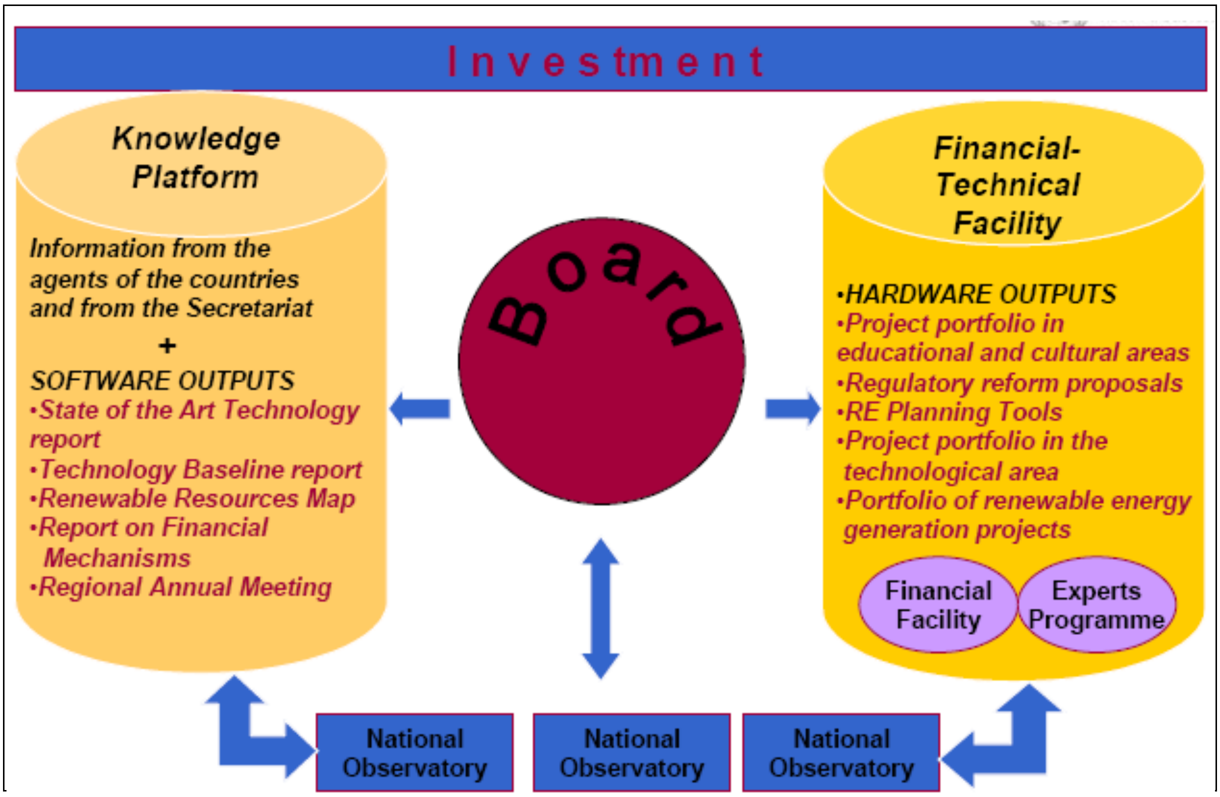


Figure 18: Renewable Energy Observatory for LAC (UNIDO, 2007)

This mechanism aims to increase the investment to facilitate access to stable, modern and environmental sustainable energy services for all inhabitants living in the most disadvantaged areas of the region. This mechanism will, by promoting the supply of sustainable energy, strengthen the capacity of the poorest LAC countries.

The observatory aims to increase access of different players and agents related to the energy sector and will pursue substantial increase in investment in renewable energy. This Initiative has a total budget of € 21,125,500 (€ 538,000 UNIDO + € 20,587,500 co-financing) calculated on the basis of carrying out its activities in 23 countries.

4.1.2 Caribbean Renewable Energy Development Program (CREDP)

CREDP is an initiative of CARICOM region Energy Ministers, established to remove the policy, financial, information and human capacity barriers to increase the use of renewable energy in the region. The project is funded by the UNDP/GEF (US$4.426 million); Co-Financing by: GTZ (US$2.20 million), UNDP Trac (US$80,000) with contribution from OAS, and Regional Governments and Institutions (Secretariat C. C.).

The program was established in 1998 when 16 Caribbean countries decided to work towards renewable energy development and implementation. At the moment 13 Caribbean counties are participating in the project: Bahamas, Barbados, Belize, Cuba, Dominica, Grenada, Guyana, Jamaica, St. Kittis & Nevis, Saint Lucia, St. Vincent & the Grenadines, Suriname and Trinidad & Tobago. The main objectives of the program are:

- To reduce GHG emissions by removing barriers to renewable energy development;
- Establish the foundation for developing a sustainable energy industry;
- Create a framework to support regional and national renewable energy projects.

From 1998 to 2000 studies were carried out to identify barriers for renewable energy development, and this was the first part of the program. In 2002 the second part of the program started, which focused on the development of financial mechanisms to promote renewable energy project investment and on the development of a pipeline of projects to be supported by CREDP. In 2004, the actual implementation of the program started.

Currently renewable energy provides less than 2% of the Caribbean region's commercial electricity. Through CREDP and its planned barrier removal activities the share of renewable energy can reach 5% in 2015, corresponding to annual reductions of CO_2 emissions by some 680,000 tons (Fevrier).

CREDP's main objective being to remove barriers to the use of renewable energy and to foster its development and commercialisation, activities on policy, regulatory, legislative, capacity building, information and financing were performed, as summarised in the table below.

Table 8: CREDP Initiatives and activities development

(Clarke, 2008)**,** www.caricom.org**,** (Scheutzlich, 2008)

	Initiatives	**Activities Development**
Policy	CREDP Initiatives • National Energy Policy Framework • OECS Renewable Energy Policy Framework • 1st Experts and Stakeholder Meeting on the Harmonisation of the legislation for the Electric Sector, Dominica • 2nd Experts and Stakeholder Meeting, Barbados • Coordination of CARICOM Task Force on • Regional Energy Policy • Contributions to draft CARICOM Policy in RE and • Electric Utilities	CREDP assisted policy reform in: • Jamaica (information system and stakeholders consultation) • Barbados – Draft Energy Policy comments • Belize – Stakeholders and GoB-Minister consultation • Grenada – Consultation with GoG • St. Kitts and Nevis – Consultation with GoSKN • CREDP/GTZ assisted policy reform in: • Dominica – Energy Policy Draft • St. Lucia – Green Paper comments, Finalizing draft energy policy (2008, ongoing). • St Vincent and the Grenadines – Draft Policy Statement (2005); follow, update of the policy and newly created Energy Unit at OPM (2007/2008) • Analysis of policy option for 5 countries
	Member States Initiatives World Bank	 Dominica – Reform of the electric sector – development of the new electricity supply act and foundation of the Independent Regulatory Commission (IRC). Supported by

	Initiatives	Activities Development
	GSEII Jamaica	the World Bank. Activity completed. Dominica, Grenada, St. Lucia and St. Kitts and Nevis – development under GSEII of the Sustainable energy plans and implementation of renewable energy and energy efficiency projects (see Section 3.4.1 The Global Sustainable Island Initiative (GSEII)) Jamaica – International efforts with some assistance from CREDP.
Capacity Building and Training	Several seminars on renewable energy technologies, software for technology installation were developed. Caribbean technical and Vocation Qualification (TVET) for Installation and Maintenance of Solar Hot Water Heaters (SHW) is currently being developed. CREDP/GTZ	Seminars: • Wind (4) – Technology, resource, measurement and Integration to small grids, RETScreen • Hydro (1) – Technology, resource measurement, RETScreen • CHP (1) – Sugar Cane Bagasse, Avoided Costs, PPA's • RETScreen (2) • Solar Water Heating (1) – Technology • Solar Water Heating (2) - Market penetration to Belize TVET for installation of SHW is being developed to standardize competences across CARICOM and to facilitate the movement of skills under the CSME RE workshops and policy seminars with CARILEC, Conferences, Study tours to Europe, Specific seminars in Germany (TERNA/WIND)
Information	Creation of a website for dissemination of information and projects as well as information materials CREDP/GTZ	DVDs with information on renewable energy that were sent to the Governments Information Services (GIS) and CREDP focal points; 2 brochures Annual energy week in St. Lucia; PDF/EU EI Initiative: joint wind project development, study tour and regional meetings (CAWEI) and RE exhibitions in 2008 (SLU, Guyana, Barbados, Trinidad)
Finance	Project Screening	23 RE projects in CREDP project pipeline were screened using RETScreen and in Suriname, CREDP conducted and initial assessment of potential wind energy sites

	Initiatives	Activities Development
		RE feasibility studies have been conducted by CREDP/GTZ in Dominica (hydro rehabilitation), St. Lucia (wind), St. Vincent and the Grenadines (wind and hydro).
	Caribbean Wind Energy Initiative	This initiative was organised by CREDP/GTZ and CARILEC and has the objective of collectively purchasing Wind Turbines.
	Creation of the Caribbean Renewable Energy Technical Assistance Facility (with $1.6 million of GEF contribution)	It was designed as an contingency recoverable loan to be used for example if a project did not receive equity or debt financing. CRETAF assists developers with project preparation from the initial through the final stages of bankable project documents. This includes: Pre feasibility studies, Full feasibility studies, Grid stability studies, Resource Assessment and Environmental Impact Assessment. Funds are provided as grants for financing eligible RE projects from CREDP participating countries. All activities financed under CRETAF must be completed prior to 26 May 2009. After 17 October 2008, eligible projects will be funded on a first come first served basis subject to the availability of funds.
	Caribbean Renewable Energy Fund (CREF)	Provides equity and debt financing to renewable energy projects. CREF will co-invest with regional financial institutions (FI's).

CREDP finished its 1st phase in April 2008 and is now implementing its 2nd phase (goes from April 2008 until March 2012). The second phase of the CREDP program was launched at CREDP/GTZ Launch Phase II and Operations Planning, St. Lucia, October 7-8, 2008.

The revision of the first phase of the CREDP program, presented at the October workshop, revealed general and specific challenges and for investment in renewable energy and energy efficiency projects (Scheutzlich, 2008).

The general challenges are due to:

- The lack of consistent energy policies;
- The utilities monopolies;
- The lack of international (bank) rating of benefiting country;
- The high debt burden of benefiting country (debt to GDP ratio) that makes Government guarantees difficult;
- The high dept service of potential borrower/developer;
- Lack of banks and financial institutions knowledge and confidence on renewable/energy efficiency technologies;
- Lack of in-house bank capacities for renewable/energy efficiency projects.

The specific challenges are related with land issues (in St. Lucia, Jamaica and Grenada), wind power acceptance (in Barbados); high debt burden (in SVG); low bank rating of borrowers and bank hesitance in taking risks in renewable/energy efficiency projects.

The revision highlighted needs for action ate the government, electric utilities, banks and consumers levels to outcome the referred challenges.

With the challenges and the needs for action retrieved from the evaluation of the 1st phase of the CREDP a four years second phase of the program was design, which will continue the on-going activities of the 1st phase, will expand the program to further countries and will include new energy efficiency projects (such as household project and Caribbean Hotel Energy Efficiency Action Program -CHENACT - $1 million IDB grant). The second phase will have a financing volume of €4.5Mio and ADA additional financing of €0,7Mio still under negotiation (Scheutzlich, 2008).

4.1.3 Caribbean Sustainable Energy Program (CSEP)

The CSEP program was launched in October 9 2008 in a meeting in St. Lucia together with the second phase of CREDP (Secretariat O. G., 2008). The actions of this program will accelerate the transition towards cleaner, more sustainable energy in seven countries of the Caribbean: Antigua & Barbuda, Bahamas, Dominica, Grenada, St. Lucia, St. Kitts & Nevis, St. Vincent & the Grenadines. This program is lead by Organization of American States (OAS) in partnership with CARICOM, CARILEC and REEP.

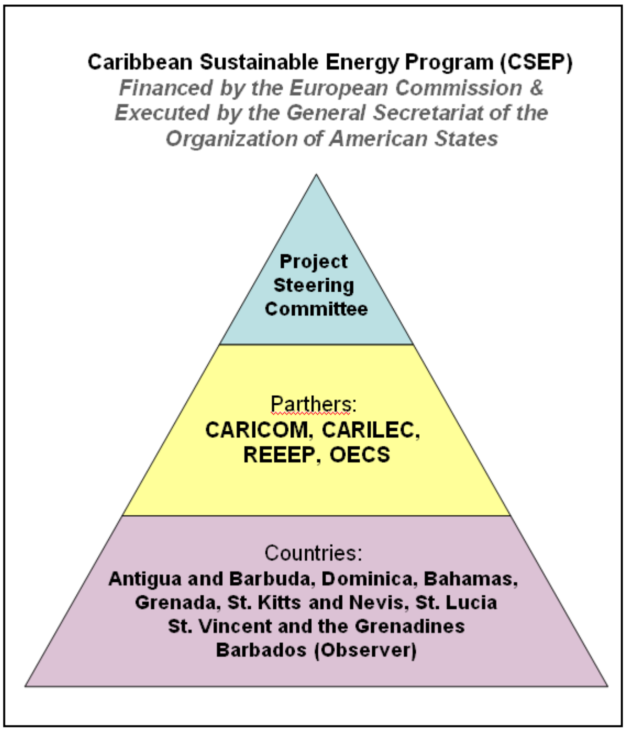


Figure 19: CSEP Structure (Secretariat O. G., 2008)

It will address market conditions for renewable energy and energy efficiency systems by mitigating barriers to its implementation and utilisation. CSEP actions focus on improving energy governance and management in the target countries. The main actions of the program are: adoption of Sustainable Energy Plans (SEPs) (establishment of national energy goals/target) and target support for SEPs activities. Also CSEP will look at previous developed SEPs in St. Lucia, SKN, Dominica and Grenada (Lambrides, Caribbean Sustainable Energy Program (CSEP): Improved Governance and Management, 2008).

In the first phase of the program SEPs will be developed for three countries (Antigua and Barbuda, St. Vincent and the Grenadines, and the Bahamas) once St. Lucia, St. Kitts and Nevis, Dominica and Grenada have already prepared a version of SEPs and support will provided to all seven in further development and adoption of SEPs. The SEPs developed will be essentially national policies targeting only the renewable energy technologies instead of the full energy issues, such as transmission lines, roads, fossil fuels, etc). The developed SEPs will include, renewable energy targets, solutions to overcome obstacles and challenges and a timetable for achieving SEPs goals.

CSEP will help on its own and in partnership with CREDP/GTZ forums for information dissemination, and the two programmes will work in cooperation in related matters, once both projects intervene in overlapping countries: CREDP/GTZ program has helped SVG in the preparation of a policy and action plan for this region and the same program will continue to support policy development and planning processes in those countries although its activities need to be coordinated closely with CSEP.

The next steps of this program suggested ate the conference are:

1. Development of SEPs.

- Preparation of a general template (based on past SEPs and in consultation and per experience of GTZ, CARICOM, others).
- Schedule consultations for countries where there have yet to be interventions on this matter (Antigua and Barbuda, Bahamas, and St. Vincent and the Grenadines).
- Discussion (as needed) will occur in countries where previous SEPs exist.

2. Meeting to discuss first year progress.

- It was suggested that a possible occasion for the next steering committee meeting will be at the proposed Caribbean Renewable Energy Forum (Jamaica, May 2009).

4.2 Main Drivers and Barriers in Renewable Energy Policy Development and Implementation

The main drivers for policy development are: energy supply, energy security and climate change, i.e. the integration of renewable energy in the energy mix, especially in regions with abundant renewable energy sources, as well as energy efficiency measures at these three levels.

There are several barriers in terms of exploration of renewable energy. These barriers are normally associated to institutional and legal frameworks of the countries, underlying financial mechanisms and technological, technical and cultural aspects.

The institutional barriers are associated with the lack of effective legal frameworks that promote the development of renewable energy, the lack of coordination and homogeneity at the regional level, lack of political measures for renewable energy promotion and the lack of government specific goals. Energy authorities often are not sufficiently aware of the benefits of renewable energy projects and tend to give priority to grid extension instead of considering decentralised energy solutions.

Financial barriers are associated with the high transaction costs inherent to renewable energy project development and the insufficient financing instruments to promote investments in renewable energy.

Technical obstacles for renewable energy development are often related to inadequate information on the renewable energy resources (normally there is a lack of data in general and scarcity of renewable energy data operations over large time series that make them statistically reliable) leading to uncertainty on the availability and quality of the resources and consequently increases the financial risk of such projects. Also there are no capacity payments for wind projects once capacity generated by wind farms is subject to wind speed fluctuations; there are difficulties in building transmission grids to connect renewables to consumption centres; in terms of off-grid systems there are problems related to inadequate servicing (e.g. lack of spares and a training network, limited technical capacity for project design and development ultimately resulting in an increase of the cost of the project); there are some specific problems for biomass utilisation due to the low efficiency of boilers and the seasonality of the resource.

The technological barriers have to do with the lack of a country-level baseline detailing both renewable energy resources and new technologies, insufficient technological demand that fosters research and development in the renewable energy field and the lack of capacity in countries for selecting, adapting and validating new technologies.

The cultural barriers are associated with traditional patterns of consumption, i.e. the use of traditional energy sources instead of renewable ones, the lack of awareness with regard to the available renewable energy resources, its potential and convenience to satisfy local needs as well as the lack of resources to create and consolidate capacities in the sector at different levels.

Most of the programs and initiatives in LAC try to overcome some or all of these barriers, by working on the identification of the renewable energy and energy efficiency potential, by providing financial mechanisms to perform those tasks, by identifying together with stakeholders needs for action and to try and develop regional and local policies that can be adopted by those countries.

Within the energy sector privatization process in the Caribbean, several difficulties arise related to: the limited knowledge of the regions' regulators and misunderstandings from the utility commissioners who instead of paying attention to reasonable requirements of investors saw themselves as defenders of the consumer's interests. This made the process very time consuming and resulted in a considerable regulatory lag. The results were not great: tariffs were kept at levels significantly below the marginal cost of supply, there was significant under-investment in the power sector and consequently capacity shortages, and since there was no assurance of return on investment, private investors were unwilling to invest. Governments invested in enterprises which did not yield positive returns and utilities operated on requirements needs conducting unreliable supply with deteriorated efficiency.

5. LESSONS LEARNED FROM ENERGY POLICY DEVELOPMENT AND IMPLEMENTATION

Based on the examples as described in the previous sections the key lessons learned can be summarised as follows:

- Long term commitments, targets and consistency are needed – renewable energy transition takes time until mean full results start to appear, results do not appear soon after policy formulation. There are several case studies both in the developed and developing world that illustrate the negative consequences of on and off renewable energy policies:
    - In the US since the Production Tax Credit has been allowed to expire several times it has created cycles of boom and bust for renewable, which impacts workers and increases uncertainties for potential investors;
    - In India renewable energy development was delayed due to conflicting and inconsistent state policies;
    - Germany, through its consistent policy development, on the other hand, has seen its renewable energy market develop: consistent policies fostered a domestic industry and job growth and national economy development.
- Another requirement, apart from the development of appropriate laws and regulations, is the consistently enforcement of these laws; renewable energy laws should be easy to understand and to implement otherwise they will not generate the desired effect;
- Predictable and reliable market conditions should be developed. Countries like Brazil, Germany, Denmark, Japan and Spain demonstrate that the key for steady renewable energy price reductions lies in the creation of a predictable and reliable market. Within this type of market medium and small size enterprises can afford to enter into the market, and these enterprises normally provide the core of the employment and invest in R&D activities;
- Renewable energy feed-in systems have thus far proved the most successful in the development of renewable energy. These systems have achieved the greatest market penetration of renewable energy, produced the most cost-efficient renewable energy projects, built domestic markets, created local industries, created workplaces, attracted bankers as well as big and small private investors. On the other hand, quota systems have been more volatile, tending to boom and boost markets, and will need large markets in which the advantage of flexibility and trading can be fully exploited;
- It is challenging for an existent grid to accept input from many distributed energy sources, because existing grids are designed to move power centralized supply sources to fixed, predictable loads. Moreover the RE resources, such as solar and wind, are intermittent the grid will require integrated monitoring and control, as well as integration with substation automation, to control differing energy flows and plan for standby capacity to supplement intermittent generation, which is also challenging to implement on an existing grid. Smart grids technologies, are a solution, as they allow the grid to better adapt to the dynamics of renewable energy and distributed generation, enabling utilities and consumers more easily access these resources and reap the benefits. Furthermore, smart grids capabilities will make it easier to control bi-directional power flows and monitor, control, and support these distributed

resources (EAC, Smart Grid: Enabler of the New Energy Economy, 2008) (for more information on smart grids see Appendix);

- Optimisation of grid system to include storage of energy, to utilise energy that is produced in off-peak demand times to face peak demand. The shift form electricity produced from fossil fuels to RE calls for this type of solutions, as RE electricity production is variable and intermittent in time (for example, wind power, in particular, is often strongest at times when electric demand is far from peak). Energy storage applications may offer potential benefits to the transmission and distribution (T&D) system because of the ability of modern power electronics, and some electrochemistries, to change from full discharge to full charge, or vice versa, These characteristics enable energy storage to be considered as a means of improving transmission grid reliability or increasing effective transmission capacity. At the distribution level, energy storage can be used in substation applications to improve system power factors and economics and can also be used as a reliability enhancement tool and a way to defer capital expansion by accommodating peak load conditions. Also it be used to alleviate diurnal or other congestion patterns and, in effect, store energy until the transmission system is capable of delivering the energy to the location where it is needed. For renewables energy storage technologies allow the energy produced to be used more efficiently, and provide ancillary transmission benefits (EAC, 2008) (see the document on Bottling Electricity: Storage as a Strategic Tool for Managing Variability and Capacity Concerns in the Modern Grid in Appendix).

Several lessons can be learned from the process of liberalization of the electric utilities in the Caribbean (Sutherland, 2003):

- Intruding competition when possible by liberalization of the market is an important factor, however it is not a reliable tool to reduce costs;
- When competition is not practical or possible, governments should pass and implement regulations to protect utilities by allowing them to anticipate a sustainable return on investment (for example by determine standby connection tariffs and transmission access for self generators) and to protect consumers by attempting to use the regulations to approximate market value of a reliable service;
- Within the process of designing and implementing regulations, utilities need to be regarded as public/private partners rather than purely private enterprises, once if they not succeed consumers investors and governments also lose;
- Policy makers should introduce effective, strong and transparent regulatory frameworks with clear guidelines as to what utilities are supposed to do and what incentives they will be allowed for the pursuit of social objectives (such as providing electricity to the poor rural areas that lack the service) and those should be aligned with the government expectations for the sector;
- For the success of developing renewable energy governments and regulators should ensure that the electricity rates reflect the true cost of power and that incentive based tariffs are introduced and that renewable energy integration is a cost plus. Also, over the long term, the policy framework should take into account environmental externalities;
- To encourage the development of renewable energy projects, governments and regulators could consider allowing utilities a margin of preference for power that was generated or that is purchased by Independent Power Producers, e.g. for the Caribbean region this would imply the utility would pay a premium for electricity generated from renewable energy compared to the average price paid for fossil fuel

generated electricity. The utility would be allowed to recover these costs in the tariffs. This will serve as an incentive for renewable energy to be part of the energy mix.

Lessons learned from the implementation of several renewable energy initiatives in SIDS and the Caribbean:

- Energy policy should be seen in the context of national sustainable development – it should be seen as a parcel of a long-term socio-economic policy. National energy policies ensure adequate and available supplies are reasonable priced to support sustainable, national economic development objectives. The policy statement is therefore guided by three principal energy objectives that are instrumental in the future development of the energy sector. They are:
    - **The Supply Objective:** To ensure the provision of adequate, secure, and cost-effective energy supplies by promoting the development of both renewable and non-renewable resources using least cost options and diversification of supply sources.
    - **The Utilization Objective:** To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and
    - **The Environmental Objective:** To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.
- It is important to have a deep knowledge of the renewable energy sources potential within a region so that policy makers and governments can set up regional and local energy policy goals that are realistically achievable;
- Awareness raising among government, utilities and consumers of the potential and benefits for renewable energy integration on the counties energy mix is needed, as are ways to unlock the potentials (such as primary resources that can be explored, financial mechanisms that can be utilised etc). Results that will be yielded and expected benefits (savings) of implementing energy efficiency measures are important to make the case of renewable energy and energy efficiency policy development;
- Energy policy must seek to strike a balance between government goals (security of supply, innovation, social, environmental, etc.) and utilities goals (financial sustainability, long-term viability etc.);
- Policy instruments can encourage and discourage certain types of energy projects in line with the overall policy goals. This can be done through indirect incentives such as: direct action instruments (such as providing finance for the development of rural electrification projects), taxes or subsidies affecting energy prices for given types of energy (e.g. fossil fuel taxes and subsidies for the promotion of renewable energy and energy efficiency);
- It is important that policies developed to attain certain goals include operational measures and specific timeframes to monitor and achieve these goals. There should be a strict follow up on policy implementation to check if the measures outlined within the policy are being attained. Wherever needed changes and improvements should be incorporated based on the results achieved so that the goals of the policy are attained within the set timeframe;
- Consistency between energy policies must exist so that the set of measures as a whole work towards the same end;

- In regions with special spatial conditions such as the Islands, it is important to ensure cooperation and maximise the differing renewable energy potential between them;
- For isolated populations with no access to electricity, renewable energy stand-alone systems should be considered to satisfy population needs;
- Awareness raising of bank and financial institutions is a key factor to increase financial flows towards renewable/energy efficiency projects;
- In developing countries CDM can be used as a financial mechanism to facilitate the implementation of renewable energy projects. Since the Cayman Islands are a UK colony (and thus seen as an Annex I country - those listed in Annex I of the Kyoto protocol) CDM in the first instance seems not possible. In principle Joint Implementation (JI) is the flexible mechanism which can be used between Annex I countries to reduce emissions cost effectively through cooperative efforts, but the UK currently does not host JI projects.

6. ROADMAP TO A SUCCESSFUL POLICY FRAMEWORK

National energy policies ensure adequate and available supplies are reasonable priced to support sustainable, national economic development objectives. The policy statement is therefore guided by three principal energy objectives that are instrumental in the future development of the energy sector. They are:

- **The Supply Objective:** To ensure the provision of adequate, secure, and cost-effective energy supplies by promoting the development of both renewable and non-renewable resources using least cost options and diversification of supply sources.
- **The Utilization Objective:** To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and
- **The Environmental Objective:** To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

The experience gained and lessons learned from examples around the world as described in previous sessions, will be crystallised in a number of sequential steps defining a typical roadmap to the development, implementation and follow-up of a policy and regulatory framework. This roadmap will provide guidance for the development of a tailored and balanced set of policy and regulatory measures for the Cayman Energy Policy. The steps and recommendations relate back to (at least) one of the three principal energy objectives as described above.

Step 1: Define the rationale and expected long-term outcome of the policy

Such goals and rationale could include

- Increased security of supply:
  - Higher share of renewable energy in energy mix
  - Identify the share of non-renewable energy needed for Cayman Islands
  - Less dependence of fuel import
    - ❑ Look into energy storage technologies as a strategic source that allows optimum use of existent and new resources of all kind.
- Efficiency goals:
  - Optimisation of the power grid:
    - ❑ Maximize Supply Side Management;
    - ❑ Minimize transmission and distribution losses;
    - ❑ Look into smart grids as a transmission option.
  - Maximize Demand Side Management (including incentives for energy efficiency in different sectors e.g. industry, tertiary, households)
- Environmental goals:
  - Reduction of Greenhouse Gas emissions;
  - Reduction of NO_x, SO_2 emissions;
  - Reduction of waste

- Innovation and sector development
  - New economic sector;
  - Build-up of technical expertise and businesses
  - Create export opportunities
- Social goals:
  - Create job opportunities
  - Local empowerment
  - Rural electrification
- Link with other sectors:
  - Water / Health / Education#

Step 2:

Assess the technical and economic potential

Quantify short, medium and long term targets

Identify barriers and challenges

- What and where is potential: Identify the renewable energy and energy efficiency potential per sector (electricity, heating and cooling, transport, building sector)
- Identify opportunities, barriers and challenges for the implementation of smart grids in Cayman Islands (see Appendix for information on smart grids)
- Identify the technologies that are practical, commercially viable and suited to the culture and economy of Cayman Islands:
  - Spread of resources (resource maps per technology)
  - Technical assessment (based on resource maps)
  - Economical assessment (financial viability based on technology costs and incentives)
- Quantify targets (e.g. x% by 2015, x GWh of green electricity, x people electrified)
  - The goals need to be set according to the analysis of the renewable energy potential and the energy efficiency potential that exist in the Cayman Islands. For that studies of different scenarios of renewable energy development should be carried out in order to see which goals set can be set for a given timeframe.
  - The goals should be set at a regional level and at the local level. The goals should be realistic and achievable.
  - Develop a pathway to the target (yearly or interim targets)
- Assess policies and regulations already in place: identify barriers and challenges for their (lack of) performance thus far. Integrate/build on the useful parts in the new strategy; use Bilateral and multilateral cooperation programs as a means of harnessing existing experience;
- Link the local and national policy goals into the regional strategy where relevant;
- Review existing legislation and policy in light of Energy Policy i.e. Traffic, Building Codes.

Step 3:

Prepare, design & implement system

Provide solutions and incentives

- Draft and implement energy legislation that take into account renewable energy and energy efficiency goals:
  - Within the policy definition, actions and measures should be defined and put in place within an action program to achieve the goals. The program should be practical and realistic. Monitoring measures to check the application of the program of action should also be defined as well as a timeline for revision, evaluation of its application;
  - The policy should identify instruments and incentives for the promotion and utilisation of renewable energy and encourage private sector investment.
- The draft policy should ensure that renewable energy and energy efficiency technologies are utilised in an economically, environmentally and culturally sustainable way;
- Identify stakeholders and their participatory position in the process of energy policy making. The policy should take into consideration the position of the energy, private and financial sector, and consumer, environmental and socio-economic organisations;
- Investigate the knowledge of the different stakeholders in relation to renewable energy development, technologies, benefits as well as their knowledge in terms of energy efficiency measures. Also an analysis of the importance of these issues for the different stakeholders will be important for the definition of capacity building programmes;
- Different support systems (feed-in tariffs, quota systems, tender schemes, emission trading schemes) have specific advantages and potential side effects. Whatever system chosen:
  - Maximise the benefit
  - Minimise side effects
- The major support system is generally complemented with (technology specific) secondary measures (e.g. tax benefits, investment subsidies);
- The mix/combination of different systems should provide “sufficient” incentive;
- To guarantee that new energy projects are sustainable from the design to the decommissioning phase, Environmental Impact Assessments of new energy projects should be mandatory;
- Take into account historical context & specificity of national electricity sectors, e.g. specifically for the Cayman situation it may be worth considering the development of feed-in agreements between utilities and small IPP’s using renewable energy sources such as small micro generators or solar panels, and promote its implementation;
- Address the non-economical barriers (e.g. general awareness in energy, financial and public sector, administrative barriers, grid connection, capacity building)

- Design and implement capacity building programs to raise awareness on renewable energy and energy efficiency throughout all levels of the education system.
- Promote consumer educational programmes towards energy conservation and encouraging the adoption of demand side management strategies. The educational programs should also promote the use of energy efficient equipment technologies such as energy efficiency lights fittings as well as the adoption of solar hot water heaters.
- Build capacity locally to install, manage and maintain standardized equipment necessary for sustainable energy production.
- Promote renewable energy technology research and development for continuous innovation;
- Mandate demand side management efficiencies.

Step 4:

Monitoring of system performance

Continuous improvement when experience grows

- Monitor progress against the pathway and targets
- Calculate effectiveness (i.e. the success of the support measure(s) in generating the effect over a given period in time) and efficiency (i.e. the cost-efficiency of the support measure(s)) of the support systems in place
- Refine and improve the policy and regulatory framework wherever appropriate

A number of guiding suggestions on the development of incentives is provided in Box 1, and some specific remarks on Energy Efficiency and Transport in Box 2 and Box 3.

Box 1 List of suggested incentives

In terms of financing mechanisms for deployment of renewable energy and energy efficiency measures the government should consider the following options:

- In general: consider the use of international financing resources.

- For commercially proven and viable energy technologies: Commercial bank financing, capital market debt financing or private and/or public equity financing

- For research & development and pilot project testing of renewable and alternative energy technologies and systems: venture capital financing, public grant financing from governments, bilateral and international agencies, private foundations (and other entities)

- For renewable energy ventures: Tax rebates and drawbacks by the Government

- For consumers and businesses investing in energy saving and renewable energy solutions to meet their energy needs: commercial bank financing at special rates and tax concessions

Box 2 Remarks on Energy Efficiency

- Energy efficiency should also be considered in buildings. Study the implementation of a Energy Code for Buildings which addresses energy efficiency, similar to the ones under implementation in Europe. Within this code the new building should meet or exceed a minimum standard that will provide a cost effective degree of energy efficiency (the code should cover lighting, ventilating, air-conditioning systems, water heating systems, and electrical power requirements).

- Introduce energy audits as regular and standard practice in all commercial and industrial and residential structures. Also provide training to locals to undertake these audits.

- The Government should promote best practice energy efficient building designs that utilize natural ventilation, day-lighting, extensive natural shading and other sustainable design techniques.

- Government should create incentives for the promotion of energy efficient lighting and new high-efficiency appliances through tax measures, including lesser import duties and loan programs through local lenders and disincentives for the use of incandescent bulbs, inefficient refrigerators, air conditioners, etc.

- Study measures to be adopted to improve the efficiency of the existent electric utilities, and adopt a plan for those measures to be implemented. Monitor the utilities increase in operational efficiency and compare it with other Caribbean electricity utilities benchmarks.

- With the results of the study, encourage the adoption of the best affordably available technologies and materials to promote higher energy efficiency to reduce losses in transmission and distribution of energy in the utility networks, including supply side efficiencies.

- Identify, develop and promote alternative or renewable energy resources, technologies and systems for supplementing current diesel power generations.

- Within utilities that continue to utilise fossil fuels, promote the deployment of high-efficiency, low-pollutant power technologies (such as low-emission diesel generation) and monitor further technological developments for future implementation.

- Investigate periodically the technology for carbon sequestration of exhaust gasses.

- Study the incorporation of renewable biofuels to be blended with fossil fuel for energy production, and if that is a technically and economically feasible solution encourage its implementation.

Box 3 Remarks on Transport

To lower the level of fossil fuels in transport and reduce the CO_2 emissions from transport, within the energy policy, a policy towards the transport sector should be studied design and implemented. This policy should consider:

- Import duty on vehicles depending of the size of the engines: bigger engines higher level of import duty, lower sizes lower level of import duty;

- Create incentives for population to change from old heavy polluter vehicle for less polluter one;

- Create taxation policies that provide strong incentives for the importation and use of more efficient vehicles;

- Create incentives for the adoption of hybrid, flexi (bio-fuel based) and electric vehicles though (discriminatory tax regime)

- Enforce vehicle emission standards, along with tax incentives for energy efficient, low-emission vehicles;

- Improve the public transportation system and use high efficiency transportation fleet

NB - Note

Appended to this document are the following papers; The New Zealand Energy Policy, The (Draft) Anguilla Energy Policy, the Bermuda Energy Green Paper, the Hawaiian Clean Energy Initiative and the United States Nuclear Regulatory Commission's publication on New Nuclear Plant Designs (including the Toshiba 4S Nuclear Battery). These are supplied to provide further information and background reading for policy makers.

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ANNEX I: FUNDAMENTAL BRICKS OF THE EUROPEAN ENERGY POLICY

The following table summarise the fundamental bricks of the European Energy policy.

Table 9: Fundamental bricks of the European Energy policy

A Policy for Europe	• An Energy Policy for Europe:"energy" package (European Commission E. , An Energy Policy for Europe, 2007) • Green Paper: A European strategy for sustainable, competitive and secure energy (European Commision, Green Paper: A European strategy for sustainable, competitive and secure energy, 2006)
Factors contributing to the development of energy policy	• Strategy on climate change: control measures through until 2020 and beyond (Commission, Strategy on climate change: the way ahead for 2020 and beyond, 2007) • Strategy for sustainable development • Integrating the environment into Community energy policy (European Commission E. , Integrating the environment into Community energy policy, 1998) • European Energy and Transport Forum (European Commision, European Energy and Transport Forum, 2001) • Information regarding investment projects in the petroleum, natural gas and electricity sectors (Commission, Information regarding investment projects, 1996)
Market-Based Instruments	• Green Paper on the use of market-based instruments (European Commission E. , Market-based instruments for the environment, 2007) • Greenhouse gas emission allowance trading scheme (European Commission E. , Greenhouse gas emission allowance trading scheme, 2003) • Energy taxation (European Commission E. , Community framework for the taxation of energy products and electricity, 2003)
Research and Innovation	• Strategic Energy Technology Plan (SET Plan) (European Commission E. , Strategic Energy Technology Plan (SET Plan), 2007) • European Strategic Energy Technology Plan (European Strategic Energy Technology Plan, http://eur-lex.europa.eu) • Sustainable power generation from fossil fuels (European Commission E. , Sustainable power generation from fossil fuels, 2007)
Financial Instruments	• "Intelligent Energy - Europe": framework programme for innovation and competitiveness (2007-2013) (European Commission E. , Competitiveness and Innovation Framework Programme (CIP) (2007-2013), 2006) • 7th Framework Programme for Research and Development (2007-2013) (European Commission E. , Seventh Framework Programme (2007 to 2013): Building the Europe of Knowledge, 2006)

ANNEX II: FUNDAMENTAL BRICKS OF THE EUROPEAN ENERGY POLICY

To achieve the *Energy Policy for Europe* goals a set of measures were compiled in a 10 Step Action Plan which was endorsed in March 2007:

1. Make a better use of the new internal energy. Within this measure the European Commission wants to oblige Member States and National bodies to take measures in order handle sources of energy fairly, which include actions: to establish a EU level regulatory mechanism; to tackle potential discrimination against new entrants; and to make sure individual consumers get listened to and that they get the best service.
2. Increase the solidarity between Member States in case of an energy crisis arises.
3. Improve the EU Emission Trading Scheme to turn it into the real catalyst for CO2 reduction and clean energy investment (which is point of consideration in the report "*Limiting Climate Change to 2° - Policy Options for the EU and the world for 2020 and beyond*" (European Commission E. , Limiting Climate Change to 2° - Policy Options for the EU and the world for 2020 and beyond, 2007)).
4. Create a program with energy efficiency measures to be applied on community, national, local and international level. Energy Efficiency is the most immediate element in the European Energy Policy for EU citizens; the most decisive contribution to achieve sustainability, competitiveness and supply security is through energy efficiency improvement. In 19 October 2006 the Commission adopted the Energy Efficiency Action Plan with a set of measures to put the EU on the path to achieve by 2020 the 20% energy efficiency target.
5. Increase Renewable Energy use (wind, solar, photovoltaic, biomass and biofuels, geothermal and heat pumps). With this policy the European Commission has developed a Renewable Energy Road Map (European Commission E. , Renewable Energy Road Map, 2007) with a binding target of increasing the level of renewable energy in the EU's overall mix from less than 7% in the year the policy was drawn to 20% by 2020 and a mandatory minimum target of 10% for biofuels. It also proposes creating a new legislative framework to enhance the promotion and use of renewable energy. For this, and to achieve the 20% common RE EU target within Europe there is a differentiation of targets between countries and flexibility in target setting within a country between sectors.
6. European Strategic Energy Technology Plan: technology has a fundamental part in driving Europe towards a low carbon economy that is sustainable and less dependent of energy supply. Europe has two key objectives for energy technology: to lower the cost of clean energy and to put EU industry at the forefront of the rapidly growing low carbon technology sector. The plan was set in 22 November 2007 (European Commission E. , Strategic Energy Technology Plan (SET Plan), 2007).
7. Sustainable power generation from fossil fuels. Even with the incorporation of RE and EE measures, energy supply will still be dependent on fossil fuels (oil, gas and coal). Thus to reduce GHG emissions EU has to put forward technology to reduce CO2 emissions from coal and gas burning, such as carbon capture and storage technologies. It is consider in this policy the development of 12 large scale CCS demonstration plants by 2015; aiming at near-zero emissions on new plants by 2020.
8. Nuclear power: on average one third of the EU energy comes from nuclear power. Although the decision of considering the use of nuclear power was still not taken when the European Energy Policy was formulated, as a EU decision (the decision is up to the Member States), the EU wants to achieve the highest standard of safety,

security and non-proliferation in the nuclear sector and to continue to ensure that such high standards are observed internationally.

9. International Energy Policy that actively pursues Europe's interests: Agree to an international energy policy with common objectives, and for all Member States to pursue with a common voice. The priorities to be pursued by an effective external EU Energy Policy during 2007-2010 (three year period) are: be a key driver in the design of international agreements, including the future of the Energy Charter Treaty and the post-2012 climate regime; aim to build up a wide network of countries around the EU, acting on the basis of shared rules or principles derived from the EU energy policy; enhance relations with our external energy suppliers, further developing comprehensive partnerships based on mutual interest, transparency, predictability and reciprocity; continue to develop closer energy relations with other major consumers, in particular through IEA and G8 or through intensified bilateral cooperation; make use of financial instruments, via enhanced co-operation with the EIB and EBRD and the establishment of a Neighbourhood Investment Fund, to enhance the EU’s energy security; improve the conditions for investments in international projects, working for example to secure a clearly defined and transparent legal framework and appointing European coordinators to represent EU interests in key international projects; and promote non proliferation, nuclear safety and security, in particular through a reinforced cooperation with the International Atomic Energy Agency (European Commission E. , An Energy Policy for Europe, 2007).
10. Improve the understanding of what is happening in energy supply and demand in Europe. For that the Commission would provide a new service to study energy trends and investment, needs for EU as a whole, etc – Energy Observatory.

ANNEX III: US ENERGY RELATED STATUTES

Table 10: Summary of US energy statutes

Year	Title	Short Summary
1920	Federal Water Power Act	Created a Federal Power Commission to coordinate federal hydroelectric projects
1935	Federal Power Act	Put electricity sale/transportation regulation under Federal Power Commission
1935	Public Utility Holding Company Act	Regulated size of electric utilities, limiting each to a specific geographic area
1936	Rural Electrification Act	Funded electric cooperatives to bring electricity to underserved rural areas
1938	Natural Gas Act	Gas pipelines regulated under Federal Power Commission
1946	Atomic Energy Act	Put development of nuclear weapons/power under civilian control (instead of military)
1954	Atomic Energy Act	Opened way for civilian nuclear power program
1975	Energy Policy and Conservation Act	Created Strategic Petroleum Reserve, established first automobile fuel economy standards
1977	Department of Energy Organization Act	Created federal Department of Energy
1978	National Energy Act - National Energy Conservation Policy Act - Power Plant and Industrial Fuel Use Act - Public Utilities Regulatory Policies Act - Energy Tax Act - Natural Gas Policy Act	Encouraged conservation efforts in homes, schools, and other public buildings Restricted new power plants using oil or natural gas. Repealed in 1987. Opened electric markets to alternate power producers Taxed gas-guzzlers, gave income tax credits for alternate fuel use Phased deregulation of gas wellhead prices
1980	Energy Security Act -U.S. Synthetic Fuels Corporation Act -Biomass Energy and Alcohol Fuels Act -Renewable Energy Resources Act -Solar Energy and Energy Conservation Act -Geothermal Energy Act -Ocean Thermal Energy Conversion Act	Created Synthetic Fuels Corporation to market fossil fuel alternatives Provided loan guarantees for biomass and alcohol fuels projects
1982	Nuclear Waste Policy Act	First comprehensive nuclear waste legislation
1992	Energy Policy Act	Required alternative fuel vehicle use in some private/government fleets
2005	Energy Policy Act	Provided tax incentives for conservation and use of alternative fuels
2007	Energy Independence and	Increased fuel economy requirements, phased out

Year	Title	Short Summary
	Security Act -America COMPETES Act	incandescent light bulbs, encouraged biofuel development
2008	The Energy and Tax Extenders Act of 2008 -Food, Conservation, and Energy Act of 2008 -Strategic Petroleum Reserve Fill Suspension and Consumer Protection Act -America COMPETES Act -Energy Improvement and Extension Act of 2008	

ANNEX IV: US ENERGY EFFICIENCY PLAN

Table 11: Goals of the Energy Efficiency Plan (EPA, National Action Plan for Energy Efficiency Vision for 2025: A Framework for Change, 2008)

Goals of the Energy Efficiency	
Goal One: Establishing Cost-Effective Energy Efficiency as a High-Priority Resource	Utilities and applicable agencies are encouraged to: • Create a process, such as a state or regional collaborative, to explore the energy efficiency potential in the state and commit to its full development. • Regularly identify cost-effective achievable energy efficiency potential in conjunction with ratemaking bodies. • Set energy savings goals or targets consistent with the cost-effective potential. • Integrate energy efficiency into energy resource plans at the utility, state, and regional levels, and include provisions for regular updates.
Goal Two: Developing Processes to Align Utility and Other Program Administrator Incentives Such That Efficiency and Supply Resources Are on a Level Playing Field	Applicable agencies are encouraged to: • Explore establishing revenue mechanisms to promote utility and other program administrator indifference to supplying energy savings, as compared to energy generation options. • Consider how to remove utility and other program administrator disincentives to energy efficiency, such as by removing the utility throughput disincentive and exploring other ratemaking ideas. • Ensure timely cost recovery in place for parties that administer energy efficiency programs.
Goal Three: Establishing Cost-Effectiveness Tests	Applicable agencies along with key stakeholders are encouraged to: • Establish a process to examine how to define cost-effective energy efficiency practices that capture the long-term resource value of energy efficiency. • Incorporate cost-effectiveness tests into ratemaking procedures going forward.
Goal Four: Establishing Evaluation, Measurement, and Verification Mechanisms	Ratemaking bodies are encouraged to: • Work with stakeholders to adopt effective, transparent practices for the evaluation, measurement, and verification (EM&V) of energy efficiency savings. Program administrators are encouraged to: • Conduct EM&V consistent with these practices.
Goal Five: Establishing Effective Energy Efficiency Delivery Mechanisms	Applicable agencies are encouraged to: • Clearly establish who will administer energy efficiency programs. • Review programs, funding, customer coverage, and goals for efficiency programs; ensure proper administration and cost recovery of programs, as well as ensuring that goals are met. • Establish goals and funding on a multi-year basis to be measured by evaluation of programs established. • Create strong public education programs for energy efficiency. • Ensure that the program administrator shares best practice information regionally and nationally.
Goal Six: Developing State Policies to Ensure Robust Energy Efficiency Practices	Applicable agencies are encouraged to: • Have a mechanism to review and update building codes. • Establish enforcement and monitoring mechanisms of energy codes. • Adopt and implement state-level appliance standards for those appliances not addressed by the federal government. • Develop and implement lead-by-example energy efficiency programs at

	the state and local levels.
Goal Seven: Aligning Customer Pricing and Incentives to Encourage Investment in Energy Efficiency	Utilities and ratemaking bodies are encouraged to: • Examine, propose, and modify rates considering impact on customer incentives to pursue energy efficiency. • Create mechanisms to reduce customer disincentives for energy efficiency (e.g., financing mechanisms).
Goal Eight: Establishing State of the Art Billing Systems	Utilities are encouraged to: • Work with customers to develop methods of supplying consistent energy use and cost information across states, service territories, and the nation.
Goal Nine: Implementing State of the Art Efficiency Information Sharing and Delivery Systems	Utilities and other program administrators are encouraged to: • In conjunction with their regulatory bodies, explore the development and implementation of state of the art energy delivery information, including smart grid infrastructures, data analysis, two-way communication programs, etc. • Explore methods of integrating advanced technologies to help curb demand peaks and monitor efficiency upgrades to prevent equipment degradation, etc. • Coordinate demand response and energy efficiency programs to maximize value to customers. • Support development of an energy efficiency services and program delivery channel (e.g., quality trained technicians), with specific attention to residential programs.
Goal Ten: Implementing Advanced Technologies	Applicable agencies and utilities are encouraged to: • Review policies to ensure that barriers to advanced technologies, such as combined heat and power (CHP), are removed; ensure inclusion into the broader resource plans. • Work collectively to review advanced technologies and determine rapid integration timelines.

Key policy areas developed state policy-makers, including utility commissions, state legislators and governors' offices

• The **California** Public Utilities Commission adopted the Energy Efficiency Strategic Plan, which considers energy efficiency to be the highest priority resource and is the state's first integrated framework of energy efficiency goals and strategies that covers government, utility and private sector initiatives. The plan was developed through a comprehensive stakeholder process built around the four "Big Bold Strategies" for energy efficiency.

• The EmPOWER **Maryland** Energy Efficiency Act of 2008 established a statewide goal of achieving a 15 percent reduction in per capita electricity use, relative to 2007 levels, by the end of 2015. Savings are to be met by a combination of electric utilities and Maryland Energy Administration efficiency efforts.

• In **Massachusetts**, a Department of Public Utilities order (96 pp., 347K) this summer sets forth a plan for establishing a new base rate adjustment mechanism, or decoupling, to be adopted by electric and natural gas utilities. Also in Massachusetts this summer, Governor Deval Patrick signed into law the Green Communities Act (98 pp., 328K) which establishes long-term plans for the reduction of energy consumption, focusing on energy efficiency as a first step in meeting future energy demand before traditional supply-side options are pursued.

• **Michigan's** Clean, Renewable, and Efficient Energy Act of 2008 established annual electricity savings targets for the state, requiring electricity providers energy savings to rise from 0.3 percent of retail sales in 2009 to 1.0 percent of retail sales in 2012 and each year thereafter. Natural gas providers are required to ramp up annual energy savings from 0.1 percent of retail sales in 2009 to 0.75 percent of retail sales in 2012 and each year thereafter.

• The **New Jersey** Energy Master Plan has been finalized to advance the Governor's directive to achieve a 20 percent reduction in electricity usage by 2020.

• **New Mexico's** amended Efficient Use of Energy Act (14 pp., 48K) requires electric utilities to achieve at least 5 percent energy efficiency savings from 2005 electricity sales by 2014 and 10 percent by 2020.

Under its Energy Efficiency Portfolio Standard proceeding (49 pp., 90K), the **New York** State Public Service Commission increased its energy efficiency funding and goals. In addition, $27 million in utility incentives were allocated to encourage utilities to develop cost effective energy efficiency programs. Separately, the commission approved "Fast Track" energy efficiency programs (103 pp., 571K) to be administered by the New York State Energy Research and Development Authority.

• In **Ohio**, investor-owned utilities are now directed to achieve energy savings of 22.5 percent through energy efficiency programs by the end of 2025 as part of legislation that also authorizes the Public Utilities Commission of Ohio (PUCO) to develop rules for electric utility decoupling.

• Wisconsin is considering a number of energy efficiency policies, consistent with the Governor's Task Force on Global Warming recommendations. Proposed energy savings goals include an annual 2.0 percent reduction in electric load and an annual 1.0 percent reduction to the natural gas load by 2015 after a ramp-up period.

ANNEX V: EAC REPORTS

In this annex the following EAC reports are integrated:

- Keeping the Lights On in a New World
- Smart Grid: Enabler of the New Energy Economy

  Bottling Electricity: Storage as a Strategic Tool for Managing Variability and Capacity Concerns in the Modern Grid.

ANNEX VI: ELECTRIC UTILITY SUPPLY-SIDE EFFICIENCY

Within the electric utility, fundamental rules for supply-side and demand-side efficiency have generally been in place since 1990 and much earlier in some jurisdictions. Due to low cost and rapid growth of the industry, even with energy efficiency (EE) rules in place, there were few real incentives for the electric utility to implement EE policies and programs. Consequently, funding for EE was very low or non-existence and utilities had no idea of how much money was needed to fund such programs.

Early supply-side management programs were the traditional "regulator driven" operational and maintenance and capital budget cap constraints. If the regulator or rules were tight, then the utility exercised restraint and rates increases were lower or less frequent. This was a form of supply-side efficiency by the utility management responding to regulatory controls. Coupled with the traditional O&M and budget controls, the utility could (anytime) advertise their efficient management constraints and cost savings to the customers. After 1990, strong growth, economic adversities, and social shifts and environmental overhauls in the industrialized and modern countries put pressure on the utilities to restructure and either control the rate-of-increase or to delay/defer rate increase or just lower rates.

During the 1990's and forward, things began to change and energy efficiency policies and programs started showing up and eventually became a regular part of the utility budget and lobbying. Some of the types of EE policies and programs put in place included:

- A multitude of cash incentives for the customer or company "promises" for services or "we'll pay you dollars".
- Integrated resource planning to eliminate overlap or gaps or duplications.
- Demand-side management to get customer participation for load shedding.
- Lobbying of the regulator for funding approval to implement EE programs and pass some of the cost to the customers (who were the beneficiary).
- Lobbying the government for new legislation and laws to require and enforce EE policy. This bypassed the regulator for the new rules and forced the regulator to fund programs. The result of this lobbying was strengthened requirements for EE programs, clarification of the cost-effectiveness and financial-effectiveness criteria, ensured cost-recovery, and provided mechanisms for financial incentives.
- Development of energy efficiency resource standards.
- Decoupling – It was not until the 2000's that decoupling of the utilities started showing up and it was not originally looked at as a type of supply-side efficiency.
- Environmental and conservation issues and concerns and constraints have pushed many changes in the electric utility industry, some of which may have caused efficiency improvements, but most caused more financial burden on the utility and its customers.

Before 1990 or thereabouts, there was no formal or directed budgeting for supply-side efficiency programs other than the standard regulatory requirements for O&M. By 2002 this non-funding of EE had changed and a fractional percentage of all utility budgets were funding some type of an EE program. By 2009, this funding had increased by 1800 percent.

Some impairment to EE policy and programs include the following:

- Old infrastructure losses on T&D and Production systems.
- Having systems that are not self-sustaining.

- Constantly rising environmental cost
- Lack of good laws and regulation (not in tune with the times)
- Rapid growth
- Lack of choices (especially for generation fuel sources)
- Local economic constraints (poor region, poor governments)
- Just unable to meet demand requirements (usually a result of social and economic constraints)

The current practice in the electric utility includes funding and research into ways and means to improve supply-side efficiency and customer-side efficiency. There are sufficient ways the customer can initiate their own savings and this has caused the utility to re-evaluate their policies and programs to re-attract the customers to them. The electric utility industry cannot remain status quo any longer.

New Zealand Energy Efficiency and Conservation Strategy

Making It Happen

Action plan to maximise energy efficiency and renewable energy

October 2007

New Zealand Government

sustainability

Statutory declaration

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) has been written in accordance with section 10(2) of the Energy Efficiency and Conservation Act 2000 (the Act). It replaces the National Energy Efficiency and Conservation Strategy (2001). A draft version of this strategy was published in December 2006 in accordance with the Act. The final version has been prepared with consideration of stakeholder feedback on the 2006 draft. A summary of the recommendations and the Minister of Energy's decisions on the recommendations has been provided to submitters in accordance with section 17(2)(a) of the Act.

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Contents

Contents (continued)

List of Figures

Foreword by Jeanette Fitzsimons, Government Spokesperson on Energy Efficiency and Conservation

This is the second five-year strategy under the Energy Efficiency and Conservation Act 2000. Since the first was written in 2001, oil prices have tripled and climate change has accelerated. How we deal with these two defining issues of our time will have a significant impact on our economy, environment and way of life.

Energy efficiency uses smarter technology to deliver the same outcomes. Energy conservation uses smarter behaviour to meet our needs and save us money. They are the fastest, cheapest and most environmentally friendly ways to respond to the challenges of peak oil and climate change.

As well as that, we have now done the analysis to show that renewable energy, at least for electricity, will be cheaper for at least the next 20 years than fossil fuels.

We have consulted widely for three months on the December draft, and I want to thank all of you who have contributed. The final strategy is stronger, with more targets, based on better data and it is clearer who is responsible for delivering it.

This strategy focuses on actions. This means changing what we do and how we invest our time and resources as individuals and as businesses. Together, we can transform our society and economy – saving us money, energy and emissions, while enjoying a better quality of life and creating a more resilient and innovative economy.

Better insulated homes are cheaper to heat and healthier to live in. Businesses that embrace energy efficiency and engage their workers in cutting energy costs are more competitive. Farmers that use modern heat recovery systems and advanced vacuum systems in the dairy shed are more profitable, and vineyards and tourism operators that can demonstrate their commitment to environmental sustainability and going carbon neutral, have an edge in overseas markets.

It’s time to really clean up our act in the transport sector. There is no reason why New Zealand should continue to be a dumping ground for thirsty and dirty vehicles. Kiwi families are spending much more than they need to on fuel, our carbon tyre-print is steadily growing and our cars are contributing to hundreds of premature deaths each year.

We have set challenging targets: to clean up the fleet with more efficient vehicles, biofuels and new technologies; and to reduce the number of one-person car trips, with better public transport, safer walking and cycling, and better planned cities.

Government is ready to take the lead by reducing its own energy use in travel, buildings and purchasing policy. Local Government is keen to set an example with its own energy use, and the way it plans for its communities.

It has been a privilege to lead the development of this second strategy under the legislation I introduced as a private member’s bill in my first term here. The strategy will succeed if it empowers all our companies, communities and citizens to take action too. I hope you will join with us to make all our lives more sustainable.

Jeanette Fitzsimons

Government Spokesperson

Energy Efficiency and Conservation

Foreword by Hon David Parker, Minister of Energy

The government has a bold agenda for New Zealand to become truly sustainable and carbon neutral.

To do so we need to cut our emissions and make our economy more efficient and competitive. Increasing the uptake of energy efficiency and conservation measures and renewable energy is an excellent way to do this.

Doing so should also leave families better off in terms of having healthier, more comfortable homes that are better to live in; make businesses more competitive; let our transport system be less dependent on oil imports, be cleaner and more efficient; use our electricity systems more efficiently with more of our stationary energy needs being met from renewable sources.

The cost-benefit analysis carried out by the Electricity Commission, the Energy Efficiency and Conservation Authority and the Ministry of Economic Development lies behind this strategy; it is a step up on prior efforts and further shows how these measures make good sense.

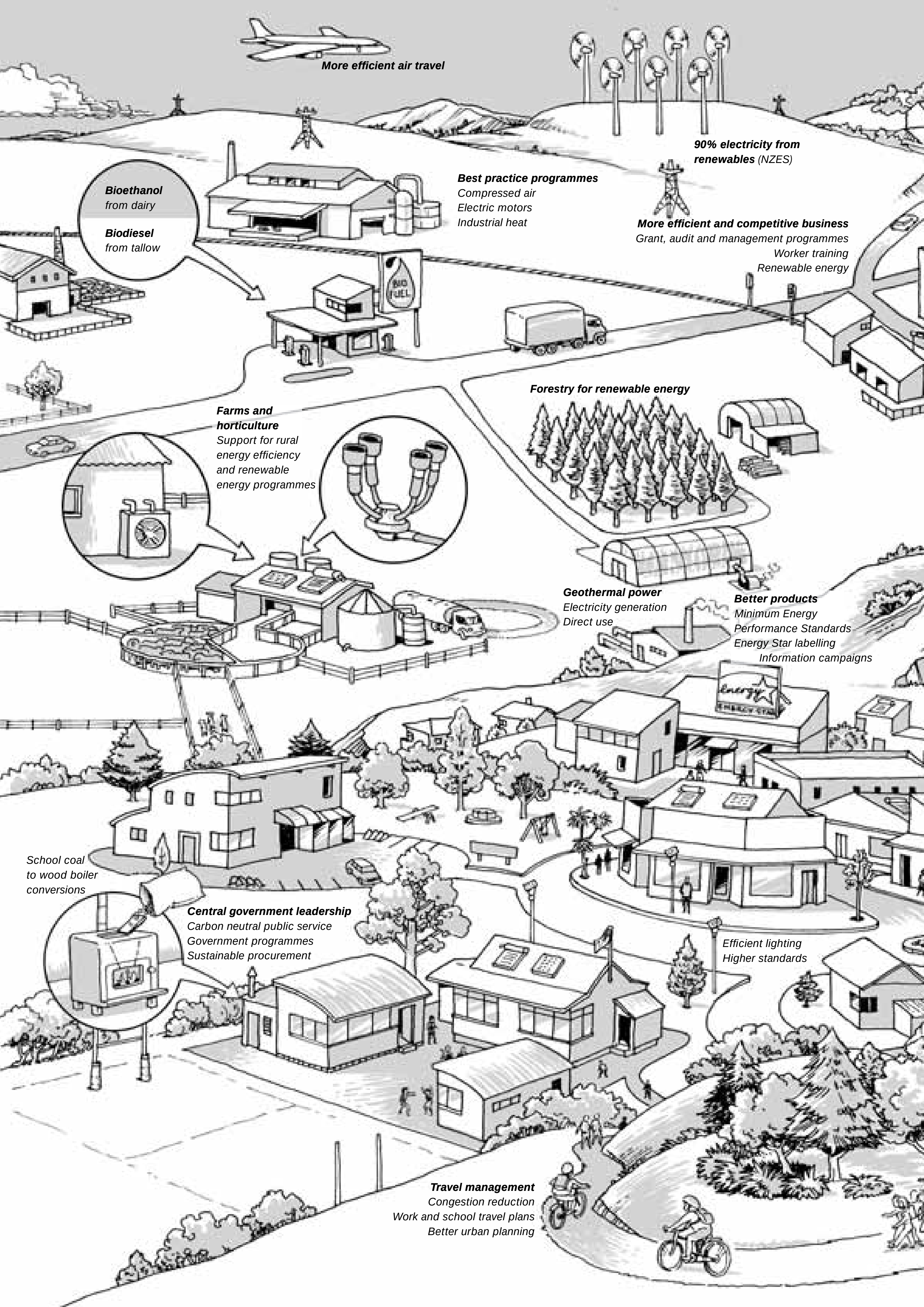
I am grateful to the many submitters who contributed to the development of this strategy, and to the officials for pulling it together. I'd like to thank Jeanette Fitzsimons for her leadership and dedication to improving social, economic and environmental outcomes through driving the uptake of energy efficiency and conservation measures and renewable energy.

Hon David Parker

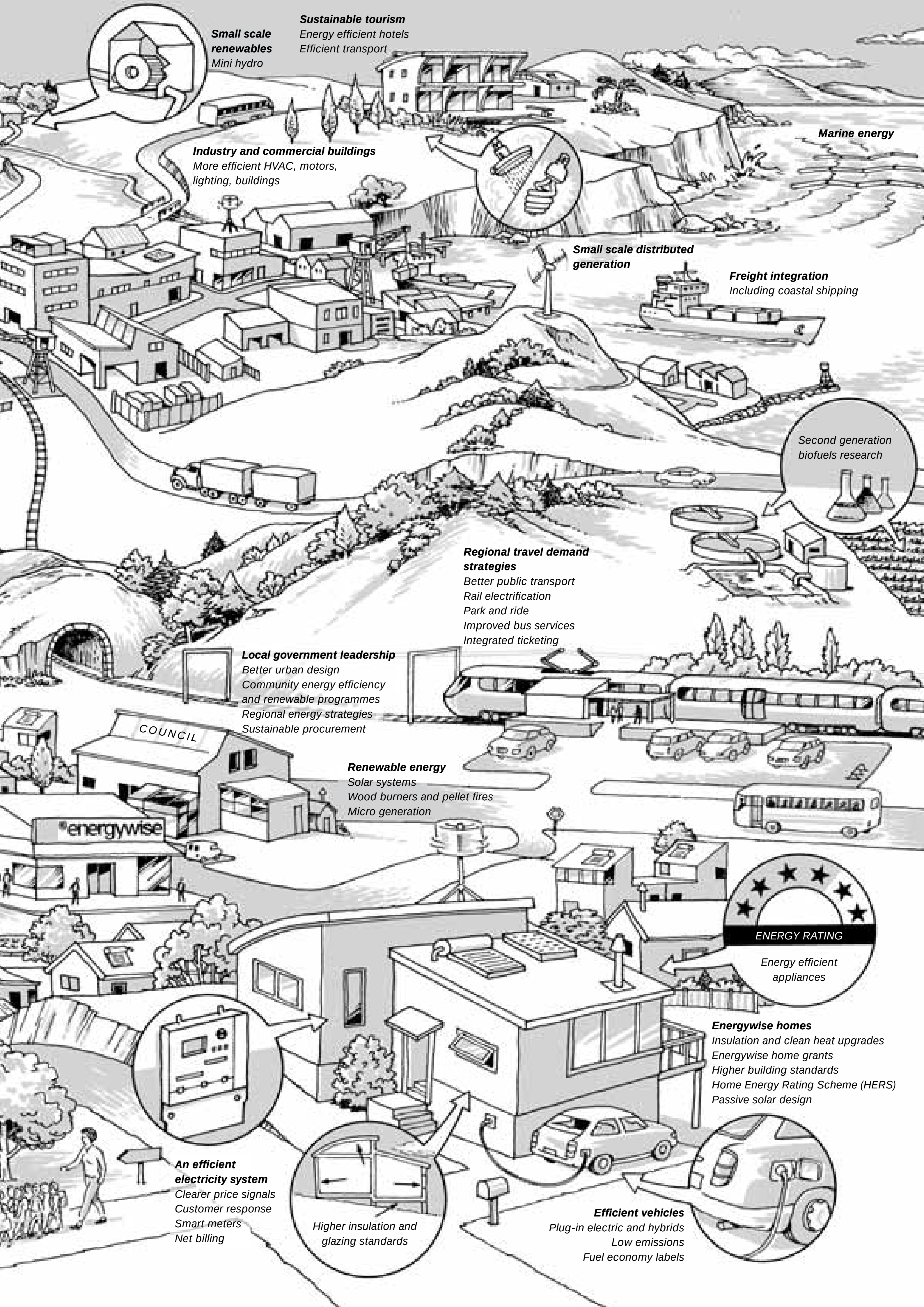
Minister of Energy

Strategy at a glance

The diagram on the following two pages is a pictorial representation of the main areas of action covered by the New Zealand Energy Efficiency and Conservation Strategy. It has not been drawn to scale and elements within it have been drawn for illustrative purposes only.



More efficient air travel
90% electricity from renewables (NZES)
Best practice programmes
Compressed air
Electric motors
Industrial heat
Bioethanol from dairy
Biodiesel from tallow
More efficient and competitive business
Grant, audit and management programmes
Worker training
Renewable energy
BIO FUEL
Forestry for renewable energy
Farms and horticulture
Support for rural energy efficiency and renewable energy programmes
Geothermal power
Electricity generation
Direct use
Better products
Minimum Energy Performance Standards
Energy Star labelling
Information campaigns
School coal to wood boiler conversions
Central government leadership
Carbon neutral public service
Government programmes
Sustainable procurement
Efficient lighting
Higher standards
Travel management
Congestion reduction
Work and school travel plans
Better urban planning


Small scale renewables
Mini hydro
Sustainable tourism
Energy efficient hotels
Efficient transport
Marine energy
Industry and commercial buildings
More efficient HVAC, motors, lighting, buildings
Small scale distributed generation
Freight integration
Including coastal shipping
Second generation biofuels research
Regional travel demand strategies
Better public transport
Rail electrification
Park and ride
Improved bus services
Integrated ticketing
Local government leadership
Better urban design
Community energy efficiency and renewable programmes
Regional energy strategies
Sustainable procurement
COUNCIL
Renewable energy
Solar systems
Wood burners and pellet fires
Micro generation
energywise
ENERGY RATING
Energy efficient appliances
Energywise homes
Insulation and clean heat upgrades
Energywise home grants
Higher building standards
Home Energy Rating Scheme (HERS)
Passive solar design
An efficient electricity system
Clearer price signals
Customer response
Smart meters
Net billing
Higher insulation and glazing standards
Efficient vehicles
Plug-in electric and hybrids
Low emissions
Fuel economy labels

1. Introduction

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) is a key part of the government's response to meeting its energy, climate change, sustainability and economic transformation goals. It has been written as a companion document to, and will give effect to a number of the objectives set out in, the New Zealand Energy Strategy (NZES).

The NZES provides government leadership for the energy sector to respond to long term challenges of energy security and climate change. It sets out the government's vision for a reliable and resilient system delivering New Zealand sustainable, low emissions energy services. It also provides the high-level strategic direction, goals and a market-operating environment to support the greater uptake of energy efficiency and renewable energy.

The NZEECS is a detailed action plan for increasing the uptake of energy efficiency, conservation and renewable energy programmes across the economy and to make doing so part of the normal behaviour of New Zealanders. It demonstrates the government's commitment to addressing climate change concerns and progressing broader sustainability objectives. It complements a number of other government strategies including the Sustainability Package announced by the Prime Minister in February 2006 and the New Zealand Transport Strategy.

1.1 Lessons from the first strategy

This 2007 version of the strategy builds on the experience and achievements of its 2001 predecessor. Experience has helped build better understanding of the barriers that prevent the uptake of cost effective energy efficiency and renewable energy investments and practices.

A review of the 2001 strategy identified that the strategy was necessary but not sufficient.[1] It was necessary as it increased the profile of energy efficiency and renewable energy. It also acted as a driver for strategic policy change in this area. However its ambition to draw improved energy efficiency from across the economy was not realised.

The review also identified that some programmes were performing exceptionally well, for example the Products programme and Energywise homes grants. Progress towards the original renewable energy target has also been strong.

As a result the 2007 NZEECS has:

- a clearer focus on consumer (demand-side) action
- sector-based actions and targets and clear accountabilities for delivery
- improved resources
- new programmes for specific sectors such as primary production and tourism.

[1] *NEECS Situation Assessment Report 2006 –* refer www.eeca.govt.nz/eeca-library/eeca-reports/report/situation-assessment-report-neecs-06.pdf

1.2 Addressing barriers

Barriers that prevent individuals and businesses from taking up energy efficiency and renewable energy in the wider economy include:

Lack of information – Consumers are often unaware of the benefits of energy efficiency, conservation and renewable energy and how to realise them. Education and awareness-raising programmes, including labelling schemes, are designed to help overcome this.

Weak price signals – Energy pricing does not yet fully reflect the environmental and economic cost of energy production and consumption. Decisions around cost-reflective pricing and incentive programmes can help overcome this barrier.

Access to capital – Some consumers struggle to meet the initial costs of energy efficiency and renewable energy measures even though they are cost effective over time. Incentive programmes such as discounted products, and grants and loans can help overcome this.

Split incentives – Landlords who are responsible for paying for building improvements may not directly get the benefits, such as lower energy bills or increased comfort. Likewise, tenants may not want to invest in improving homes or buildings that they don’t own or may not occupy for long periods. Incentive programmes, such as assistance to landlords to insulate properties and the setting of minimum standards, can help overcome this.

1.3 Accountabilities

Clear accountabilities for the delivery of this strategy have been established.

The Ministry of Economic Development (MED) is responsible for the overall monitoring of the strategy and reporting on progress. Responsible agencies have been assigned to each programme with other agencies contributing to policy and programme design and implementation.

However, in order for the strategy to be effective, all sectors of the economy must act. This means everyone has a role to play in taking action to develop a sustainable energy future. This is a strategy for all New Zealanders, not just the government.

1.4 Improving information to help the government make policy decisions

The government has undertaken a thorough programme of cost-benefit analysis studies to inform the design of this strategy. This has incorporated studies conducted by EECA, the Electricity Commission and MED.[2] The combined output of these studies provides a broad picture of the potential to make cost effective energy efficiency gains. The results are robust and underpin the development of programmes in this strategy and the projected outcomes.

Such a programme is to be expanded under the proposed New Zealand Energy Domain Plan. This will inform the ongoing development of programmes and how they might best be changed and expanded to take advantage of emerging opportunities, and to make further cost effective gains.

[2] *Sustainable Energy Value Project – Evaluation of Options for Intervention in Stationary Energy Efficiency*, COVEC February 2007; and *KEMA New Zealand Efficiency Potential Study* (draft) Vol 1 2007.

1.5 Targets

Programmes in this strategy will support the attainment of the following high-level targets. Each chapter contains additional targets.

Energywise Homes Warm dry healthy homes, improved air quality and reduced energy costs	70,000 interest free loans for insulation, energy efficiency or clean heat loans by 2015 65,000 insulation retrofits for low income families by 2012 4,000 clean heating upgrades for low income families in areas of poor air quality by 2012 15,000 – 20,000 solar water heating systems by 2010 Minimum Energy Performance Standards (MEPS) on 17 additional product categories, and Energy Star labels on an additional 15, by 2012
Energywise Business More energy efficient and competitive businesses using more renewable energy and emitting less carbon dioxide	To expand the successful Improve and Energy Intensive Businesses programmes by the end of 2008 To implement an energy efficiency training programme for workers by the end of 2009 Up to an additional 9.5 PJ per year of energy from woody biomass or direct use geothermal by 2025[3] To have plans in place to measure the potential for energy efficiency improvements and to roll out an efficiency programme in the rural sector by the end of 2008 To have a plan in place by the end of 2008 to increase the uptake of energy efficiency measures in the tourism sector
Energywise Transport To reduce the overall energy use and greenhouse gas emissions from New Zealand's transport system	Reduce per capita transport greenhouse gas emissions by half by 2040 For New Zealand to be one of the first countries in the world to widely deploy electric vehicles To have an average emissions performance of 170g/km of CO_2 (approximately 7 l/100km) for light vehicles entering the fleet by 2015 Cut kilometres travelled by single occupancy vehicles in major urban areas on weekdays, by 10 per cent per capita by 2015 (compared to 2007) For 80 per cent of the vehicles to be capable of using 10 per cent biofuel blends or to be electric powered by 2015 Investigate options for improving the efficiency of the North Island main trunk line, including electrification, by 2010
New Zealand's efficient and renewable electricity system	To have 90 per cent of electricity generated from renewable sources by 2025
Government leading the way	Six lead core public service agencies to be carbon neutral by 2012 with the remaining 28 agencies to be on the path to carbon neutrality by then Cut core public service average vehicle fleet emissions by 25 per cent by 2012 A 10 per cent reduction in energy use per employee in core public service buildings by 2012[4] To have plans in place to cut workplace travel by core public service departments by 15 per cent by 2010 Cut use of energy intensive consumables, like paper, by core public service departments by 10 per cent by 2010 Support local government in delivering NZES and NZECS programmes

[3] Covers industrial, commercial and residential sectors. Does not include wood processing residues.

[4] Off a 2006/07 base.

1.6 Potential impacts

The following savings are expected to be delivered as a result of the programmes outlined in the strategy:

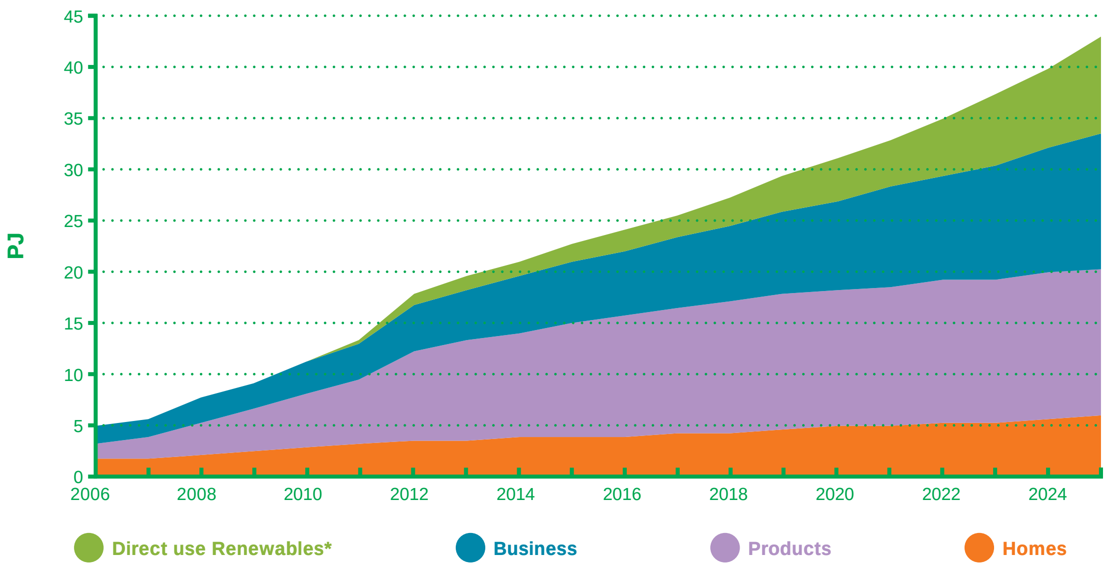
- 30 PJ of savings in non-transport energy per year by 2025
- 9.5 PJ of additional direct use renewable energy per year by 2025
- 20 PJ of energy savings in the transport sector by 2015.

To reach the targets outlined in this strategy, New Zealand will need to lift its rate of improvement in energy efficiency by 40 per cent, moving the rate of improvement from 0.5 per cent per year at present to the OECD average of 0.7 per cent per year by 2012.[5]

Figure 1 outlines how the key aspects of the NZEECS (excluding transport) will contribute to energy savings to 2025. NZES and NZEECS objectives will inform the high-level targets to be developed under the final *Implementing the New Zealand Transport Strategy* (INZTS).

The NZES has set a target for 90 per cent of electricity to be generated from renewable sources by 2025. The outcomes projected in Figure 1 will help to achieve this target by keeping the rate of growth in electricity demand in check.

Figure 1: NZEECS non-transport consumer energy improvements 2006–2025



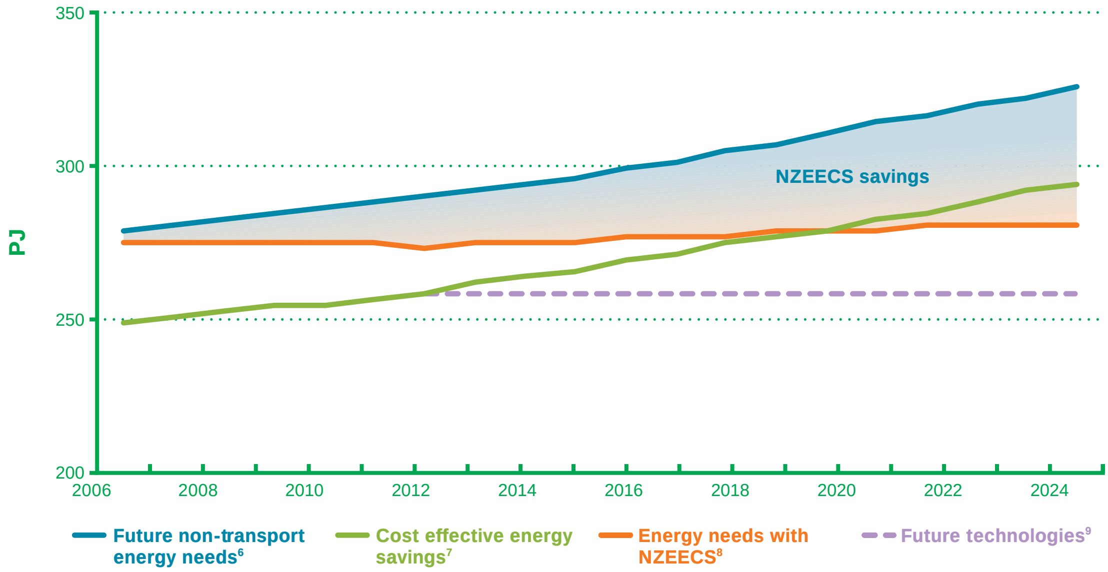
***** Direct-use renewables include meeting new demand and fuel switching from fossil fuels and electricity
Source: EECA

The combined impact of the NZEECS actions in the stationary energy sector (excluding transport) is forecast to be 30 PJ of energy savings and 9.5 PJ of additional direct use of renewable energy leading to 5–6 megatonnes (Mt) CO_2 emissions reductions per year in 2025.

[5] Assumptions: the previous NEECS rate of 0.5% per year for the non-transport energy components of the economy; the NZEECS rate of 0.7% is projected for the non-transport energy components of the economy; the OECD rate 0.7% per year is the average rate for economy-wide change for OECD 11.

Figure 2 shows the forecast impact of the actions in this strategy in the non-transport energy sector (energy needs with NZEECS). This is shown against forecast demand growth if no further action is taken (future non-transport energy needs) and the potential for cost effective savings (cost effective energy savings). The cost effective savings line shows a second track from 2012 (future technologies) that takes into account the likelihood of new technologies becoming available that will offer increased potential for savings from then. The shaded area denotes energy saved as a result of NZEECS programmes.

Figure 2: NZEECS non-transport energy use 2006–2025



Source: EECA

The potential to make cost effective savings is not static. The Energy Domain Plan and the annual reviews of this strategy will identify further opportunities to make improvements. Technology will continue to advance and the potential for cost effective improvements will increase. For instance, the International Energy Agency published an alternative policy scenario in its 2006 World Energy Outlook. This highlights emerging technologies such as: ocean energy, solar photovoltaic, hot rock geothermal, plug-in hybrid vehicles, biomass refineries, and zero energy buildings. These technologies are on a path to commercialisation and could make a significant contribution in the medium term.

The majority of Energywise transport measures are of an enabling nature. Rather than each one producing quantifiable energy savings, in combination they represent opportunities for future energy savings. The NZES envisages a resilient, low-carbon transport future, while the government has agreed in principle to reducing per capita greenhouse gas emissions from transport to half of 2007 levels by 2040.

Targets and actions in this strategy will play a part in achieving these goals. Targets set in this strategy for reducing single occupancy vehicle trips and improving the fuel economy of vehicles entering the light vehicle fleet could, depending on future policy decisions, result in cumulative savings of approximately 20 PJ of energy and approximately 1.3 Mt CO_2 emissions by 2015.[10] Estimated savings to 2025 from the latter target are 175 PJ and 11.8 Mt of CO_2 emissions.

[6] The forecast need for non-transport energy in New Zealand derived from MED outlook.

[7] Forecast non-transport energy needs if the possible cost effective energy efficiency improvements are realised.

[8] Forecast non-transport energy needs in New Zealand with the NZEECS objectives being achieved.

[9] Assumes future technological advances in energy efficiency.

[10] Data supplied by Ministry of Transport, 2007.

A longer-term target has been set to reduce per capita emissions from the transport sector by 50 per cent by 2040. One of the key strategies to achieve this target is to position New Zealand to be one of the first countries, if not the first, to widely deploy electric vehicles.

1.7 Calculating the CO_2 savings resulting from electricity efficiency actions

Emissions reductions attributed to NZEECS programmes are calculated using the marginal emissions factor in the Ministry of Economic Development's model.[11] [12]

1.8 Costing and funding the strategy

Actions in the NZEECS will be funded from a range of sources including the government (including the Electricity Commission appropriation), the private sector, the voluntary sector and individuals.

The government has already agreed to $184 million in funding for a number of programmes in this strategy through previous budget rounds. Other programmes are yet to be funded and are identified in the summary action tables that lead each section. In addition, the government announced $650 million for rail infrastructure improvements in Auckland and Wellington, as well as for national rail improvements.

A principle of the NZES is that investments should be made in energy efficiency measures that are cheaper than the long term costs (including environmental costs) of building additional generation.

Government also considers it appropriate to take into account the value of long term environmental and social benefits associated with energy efficiency, conservation and renewable energy programmes. As such, it will use a 5 per cent real discount rate when analysing the costs and benefits of programmes, where appropriate.

Any regulatory programmes will require Regulatory Impact Statements and be subject to a cost-benefit analysis plus the usual legislative processes, public consultation and government scrutiny before they are introduced.

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[11] MED *Benefit Cost Analysis of the New Zealand Energy Strategy* 11 May 2007, pp 2–3 uses 0.698 t CO_2 per MWh.

[12] A future price on carbon may change the marginal generation source and hence the estimates of future emissions reductions.

2. Energywise homes

Objective:

Warm, dry healthy homes, improved air quality and reduced energy costs

The Beckham Family of Wainuiomata.
Photo courtesy of the Ministry for the Environment.

Energywise homes – Summary of actions

Action	Outcome	Delivery
2.1 Improving the performance of existing homes		
Energywise interest-free loans 70,000 insulation and clean heat installations	0.67 PJ 0.13 Mt CO_2 $22m energy and $73m health savings pa in 2025	EECA (Funded)
Energywise home grants 12,000 insulation retrofits pa to 2012 800 clean heat retrofits pa to 2012	0.62 PJ 0.12 Mt CO_2 $29m energy and $18m health savings pa in 2025	EECA (Funded)
State housing energy efficiency upgrades 7,200 retrofits by the end of 2010	0.07 PJ 0.01 Mt CO_2 $3.2m energy and $1.6m health savings pa in 2025	HNZC (Funded)
Expand HNZC retrofit programme (assumes 20,000 retrofits)	0.19 PJ 0.04 Mt CO_2 $9.1m energy and $4.4m health savings pa in 2025	HNZC (Partially funded)
Investigate Minimum Energy Performance Standards (MEPS) for existing homes – especially rentals	Report with recommendations by the end of 2009	DBH (Under consideration)
Totals	**162,000 homes** **1.55 PJ** **0.3 Mt CO_2** **$63.3m energy and** **$97m health savings pa in 2025**	

Action	Outcome	Delivery
2.2 Better products		
MEPS – 17 new product classes and update stringency levels for seven existing product classes by the end of 2012	12 PJ 2.33 Mt CO_2 and $179m energy savings pa in 2025	EECA (Funded)
Appliance retirement 450,000 fridges over 20 years	1.8 PJ 0.35 Mt CO_2 $43m energy savings pa by 2025	EECA (Funded)
Efficient Lighting Strategy to accelerate the uptake of better lighting technology	0.01 PJ 2,000 tonnes CO_2 $5m energy savings pa by 2012	EC (Funded)
Subsidise an additional 5.7 million compact fluorescent lamps by the end of 2009	0.6 PJ 0.12 Mt CO_2 $3m energy savings pa by 2012	EC (Funded)
Energy Star – expand programme	15 additional product categories by the end of 2012	EECA (Under consideration from 2008)
Totals	**14.5 PJ** **2.81 Mt CO_2** **$230m energy savings pa in 2025**	

Action	Outcome	Delivery
2.3 Improving the performance of new homes		
Building Code amendments for thermal performance and hot water systems by the end of 2008	1.9 PJ 0.37 Mt CO_2 $47m energy savings pa by 2012	DBH (Funded)
Investigate incorporating carbon life cycle analysis into the Building Code	Recommendations by the end of 2010	DBH (Under consideration)
Investigate Home Energy Rating Scheme (HERS) as a tool for the Building Code	Recommendations by the end of 2009	DBH/EECA (Funded)
Support for local councils to implement energy-related changes to the Building Code	Improved information	DBH/MfE (Funded)
Totals	**1.9 PJ** **0.37 Mt CO_2** **$47m energy savings pa in 2012**	
2.4 Better information		
Introduce a national Home Energy Rating Scheme (HERS) Decide on making disclosure of ratings mandatory by the end of 2008	Improved consumer information	EECA (Funded)
Consider expansion of Eco-design advisor scheme	Decision by the end of 2008	EECA (Under consideration)
Energy efficient technology research through to 2012	Improved product assurance for consumers	EECA (Funded)
Sector development and capacity building	Develop implementation plan by the end of 2008	EECA (Funded)
Energywise information campaign	Build awareness	EECA (Funded)
2.5 Increasing the uptake of household renewable energy		
Information, accreditation and financial assistance for solar water heating	15,000–20,000 solar water heating systems by the end of 2010 0.13 PJ 0.02 Mt CO_2 pa in 2010	EECA (Funded)
Support for the Solar Industries Association's advocacy role	Ongoing support	EECA (Funded)
Totals	**0.13 PJ** **0.01 Mt CO_2 pa in 2010**	

Households consume 63 PJ (13 per cent)[13] of energy per year including 44 PJ (33 per cent)[14] of electricity, and are responsible for 3.4 Mt, or 10 per cent,[15] of New Zealand's annual greenhouse gas emissions from the energy sector.

Our homes are central to the quality of life and health of all Kiwi families. They should be warm, dry, healthy places to live in, with affordable energy costs.

Inadequate insulation and poor-quality heating makes many homes cold, damp and expensive to heat. This contributes towards ill health and lost work and school days. These issues apply to many New Zealand families across both urban and rural communities.

Breathing easier

Asthma costs New Zealand around $825 million per year in terms of medical expenses and days off work.[16] It is the most common cause of hospital admissions and is responsible for 500,000 lost school days each year.

Improving household energy efficiency can make reaching minimum temperatures for good health more affordable. Studies[17] have shown that retrofitted insulation in the homes of people suffering from respiratory illnesses, such as the flu or asthma, was effective in improving their health, and reducing the number of days they took off work and school. In retrofitted homes, visits to the doctor by family members dropped by 19 per cent, admissions to hospital due to respiratory conditions dropped by 43 per cent, days off school reduced by 23 per cent and days off work by 39 per cent.[18]

Image courtesy of He Kainga Oranga/Housing and Health Research Programme.

The way energy is used in households is shown in Figure 3. It is affected by the appliances used, householder behaviours and building design. The programmes outlined here will target all three to ensure energy is used more efficiently and to provide the substantial health, comfort and wellbeing benefits associated with smarter energy choices.

13 *New Zealand Energy Data File* MED, 2007.

14 Ibid.

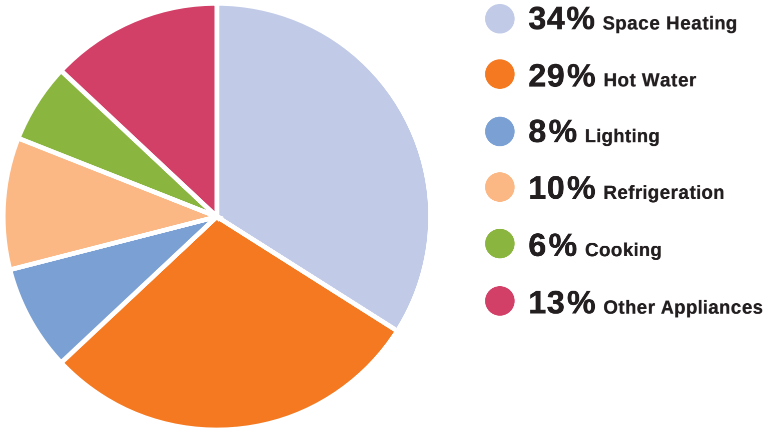
15 Derived from direct emissions and indirect electricity emissions from *New Zealand Energy Greenhouse Gas Emissions 1990–2005,* MED, 2006.

16 *The Burden of Asthma in New Zealand*, Dr Shaun Holt, P3 Research, Wellington; Professor Richard Beasley, Medical Research Institute of New Zealand; December 2001.

17 *Housing, Heating and Health Study*, University of Otago, Wellington School of Medicine and Health Sciences, 2007.

18 *A Cost-benefit Evaluation of Housing Insulation: Results from the 'Housing Insulation and Health' Study,* Chapman, Howden-Chapman and O'Dea, 2005.

Figure 3: Total energy use by end use



Source: BRANZ Study Report SR 155, 2006

Many families face barriers to investing in energy efficiency and renewable energy.[19] These include difficulty in meeting up-front costs and knowing where to find credible information to help make energy efficiency choices. Split incentives also exist where the person responsible for paying for improvements does not benefit from the day-to-day benefits delivered. For example, tenants, rather than landlords, benefit from lower bills and more comfortable homes while landlords meet the cost of insulation. New Zealand's temperate climate and historical housing design and construction practices also contribute to low levels of adoption of energy-efficient measures. This applies to housing for all income groups.

The government announced an Energywise Homes package in Budget 2007, costing $66 million, to be delivered over four years and comprising eight programmes. This forms the core of the many programmes detailed in this chapter. It enhances existing programmes that target energy efficiency improvements to houses and further addresses the barriers families face in investing in energy efficiency and renewable energy.

The $66 million includes funding for:

- interest-free loans for energy efficiency installations or upgrades
- Energywise home grants
- clean heat upgrades
- the voluntary Home Energy Rating Scheme (HERS)
- an information campaign for householders
- research and sector development to identify new energy-efficient technologies and to ensure that industry has the capability to deliver them to the public
- support for local councils to implement the new Building Code and other energy efficiency-related initiatives
- partnerships with the private sector to develop new financial incentives for energy efficiency.

The Energywise Homes section of the NZEECS will be delivered by central government and in partnership with local government, the private sector, and the community and voluntary sector. Future programme funding will be evaluated through the annual planning process to ensure partnerships and energy efficiency outcomes are delivered to achieve the greatest benefits.

[19] *The Impact on Housing Energy Efficiency of Market Prices, Incentives and Regulatory Requirements*, Centre for Housing Research, 2006.

Making changes in our homes

How to cut your bills by around $600 per year with no cost and low cost actions at the same time as making your home more comfortable to live in:

- Use your heated towel rail for just a few hours per day instead of leaving it on permanently – typical saving $90 per year.
- Scrap (or switch off) the spare fridge – typical saving $150–$300 per year.[20]
- Use cold water for laundry – typical saving $50 per year.
- Set your hot water cylinder back from 70 to 60 degrees Celsius – typical saving $30 per year. You will need an electrician to do this if you don't have a consumer adjustable thermostat.
- Turn appliances off instead of leaving them on standby – typical saving $75 per year.
- Replace five commonly used normal light bulbs with energy saving ones. The Electricity Commission runs voucher schemes with partner organisations, offering reduced-cost energy saving bulbs. One deal has offered five bulbs for $10. Installing five energy saving light bulbs saves around $80–$90 per year.[21]
- Install a low flow shower head. These typically cost around $80 and can cut hot water bills by around $45 per year.[22]
- An $80 hot water cylinder wrap can cut your power bill by around $40 per year.[23]
- Good, thermal backed and lined curtains can cut heat loss through windows by 25 per cent and can save up to $100 per year for a whole house.
- In addition to these low cost and no cost actions, ceiling insulation costs around $1,400, and is estimated to result in $4,600 of health and energy savings over its lifetime. Energy savings alone are estimated to be $140 per year .[24]

Images: EECA

[20] There are estimated to be 430,000 deficient fridges in New Zealand, amounting to 16% of the total number of fridges (BRANZ 2007).

[21] Electricity Commission analysis 2007.

[22] 2007 BRANZ net benefit model.

[23] Ibid.

[24] Ibid, assumes a 30 year life for ceiling insulation.

This chapter is presented as follows:

2.1 Improving the performance of existing homes
2.2 Better products
2.3 Improving the performance of new homes
2.4 Better information
2.5 Increasing the uptake of household renewable energy

2.1 Improving the performance of existing homes

The BRANZ 2005 House Condition Survey indicates that around 375,000 New Zealand homes have inadequate ceiling insulation and over one million have inadequate under-floor insulation.[25]

Research has shown that for every dollar spent on improving basic energy efficiency measures, such as draught stopping and insulation, the householder realises $2.20 in health and energy savings.[26]

30,000 warmer homes

In March 2007, the Urwin family of Ellerslie became the 30,000th household to receive energy efficiency measures under the Energywise home grants programme. Eco Insulation installed ceiling and under-floor insulation, and draught stoppers throughout the house.

Before the installation, the Urwin's three-year-old son Jack often suffered from respiratory problems and regularly ended up in Starship Hospital during the winter.

The family has already noticed some big changes. "With Jack we would normally expect some kind of chest infection but since the insulation was put in, we have not had any issues – it has been great."

The 30,000th house was part of the Snug Homes for Auckland project which was jointly funded by the ASB Community Trust, Auckland City Council, Manukau City Council, Procare Network Auckland, Procare Network Manukau, Auckland District Health Board, the Starship Foundation and EECA.

Prime Minister Helen Clark on the right, and Ross Robertson MP Manukau East, on the left, with the Urwin family.

A recent study concluded that air pollution contributed to the premature death of around 1,100 people each year in New Zealand. The total economic cost of air pollution in New Zealand (from both premature death and adverse health impacts) was estimated to be $1.14 billion per year, or $421 per person. Emissions from open fireplaces in homes were identified as a significant contributing source.[27]

[25] *New Zealand House Condition Survey,* BRANZ, 2005 – homes, with roof space access, with less than 100% insulation.

[26] Estimates are based on net benefit modelling developed by BRANZ, for EECA in 2007.

[27] *Health and Air Pollution in New Zealand,* G. Fisher et al 2007.

Clean and efficient water and space heating systems are cheaper to run than inefficient systems and lead to air quality improvements. Renewable options include solar water heating, clean wood burners and wood pellet fires. Other options for space and water heating include heat pumps and flued gas appliances.

A significant problem exists with rental properties. The costs for improvements fall to the owner, but the day-to-day benefits are accrued by the tenant. Programmes like the Home Energy Rating Scheme (HERS) aim to incentivise both owner-occupiers and landlords to take action, as this will allow the market to value improvements. Another approach to overcome split incentives in the rental market is to investigate the possible application of MEPS to rental properties.

Taking action (2.1 Improving the performance of existing homes)

Energywise interest-free loans – A new programme announced in Budget 2007 to finance interest payments on around 70,000 loans for insulation, energy efficiency or clean heat upgrades. EECA is developing partnerships with the private sector, community groups, and local government to deliver this programme.

Energywise home grants – A programme to give grants to low income families and the landlords of properties with low income tenants, for energy efficiency improvements. EECA aims to bring the total number since the programme began to 100,000 by the end of 2012. Around 35,000 had been completed at the end of the 2006/07 financial year. Current commitments are to 12,500 home upgrades per year.

Energywise clean heat grants – A new programme following on from a successful pilot. To be administered alongside Energywise Home Grants. It will install 800 clean heating devices per year in low income homes in areas of poor air quality.

HNZC retrofits – Housing New Zealand will complete an additional 7,200 state house energy efficiency retrofits by the end of 2010. Through its Energy Efficiency Retrofit and Healthy Housing programmes, HNZC will have retrofitted a total of 21,000 properties by the end of 2010. This will leave approximately 20,000 state houses still to be retrofitted. A decision to expand the programme will be made in 2008.

Minimum Energy Performance Standards – Investigate MEPS for existing buildings (especially rental properties) to apply at change of occupancy. Make recommendations to government by the end of 2009.

2.2 Better products

A lack of standards (regulations) can result in poorly performing products, such as whiteware and home electronics, entering the market and locking families into years of extra costs and sub-standard appliance performance.

The EECA products programme utilises some of the most cost effective measures to improve the energy efficiency of domestic appliances and commercial and industrial equipment. The measures include Minimum Energy Performance Standards (MEPS), Mandatory Energy Performance Labelling (MEPL) and voluntary labelling Energy Star®.

MEPS are necessary to stop the least energy efficient products from entering the market; MEPL compares the relative energy performance of similar products and provides a simple indicator to the best- and worst-performing models within a class of products. Energy Star is an endorsement label that helps consumers identify the most energy-efficient models in a product class.

The MEPS programme received $3 million of government funding to March 2006 and resulted in savings of 1.65 PJ (460 GWh) of electricity worth around $60 million.[28]

This programme is to be expanded by the addition of 17 new product categories and the updating of stringency levels for seven existing product categories by the end of 2012. The key priorities over this period will be a lighting strategy that incorporates the phase-out of inefficient incandescent light bulbs and the introduction of the standby strategy that will reduce the amount of electricity used by electronic appliances on standby to less than one watt.

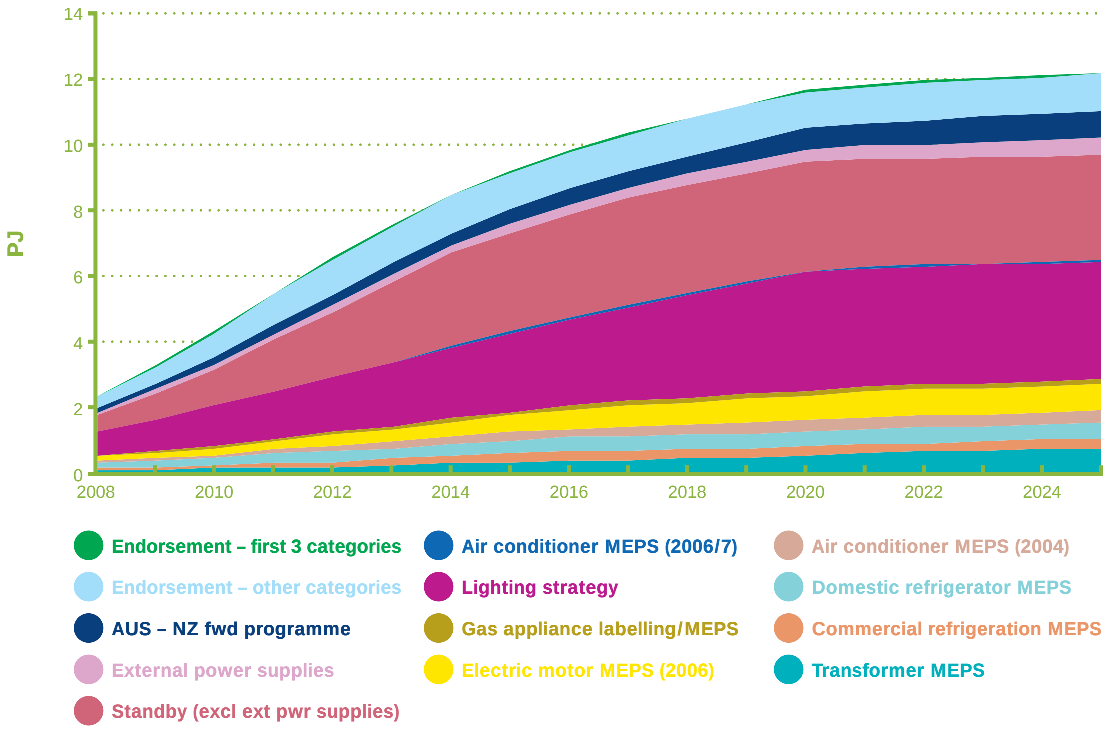
[28] EECA Products Programme sales data analysis February 2007.

New Zealand and Australia share a common economic market; there is a joint approach to developing and implementing MEPS and labelling to common standards and implementation schedules. EECA will continue to work with its Australian counterparts, industry, and consumers to implement an agreed programme.

Combined savings from MEPS and labelling schemes (including Energy Star) are forecast to be:

- 6.5 PJ of energy savings, 1.25 Mt CO_2 and $147m pa in 2012
- 12 PJ of energy savings 2.3 Mt CO_2 and $179m pa in 2025
- cumulative savings of over 23 PJ energy, 4.5 Mt CO_2 and $473m[29] by 2012
- cumulative savings of over 162 PJ energy, 31.5 Mt CO_2 and $2.7 billion by 2025.

Figure 4: Energy savings from NZEECS products programme initiatives



Source: EECA

Research into price trends shows that regulating minimum standards and labelling, such as star ratings, have not resulted in price increases for whiteware products.

[29] Derived from *New Zealand Energy Data File* (MED) Electricity Price and Sales Information.

Efficiency labelling

A modern fridge with a 3.5 star energy rating will cost around $100 per year to run compared to a 10-year-old fridge of the same size that costs $200 per year to run. As the average age of a fridge is around 16 years, the savings made over the life of the new fridge can be as much as the initial purchase price.

A heat pump that qualifies for an Energy Star label can save the consumer around $150 per year compared to one that only meets Minimum Energy Performance Standards.

Taking action (2.2 Better products)

MEPS and MEPL – Standards will be developed for 17 additional product classes and revised for seven existing classes by the end of 2012. Key priorities will be to phase out inefficient incandescent light bulbs and introduce a one watt requirement for standby power.

Product retirement – Design and implement a programme to accelerate the withdrawal of inefficient products, such as a trade-in scheme for refrigerators, targeting 450,000 appliances over 20 years to save 0.1 PJ, 7,000 tonnes CO_2,[30] and $2.3 million per year in 2012.

Efficient lighting strategy – Implement the New Zealand Lighting Strategy with a target to reduce lighting energy consumption by 20 per cent by the end of 2015 by implementing:

- MEPS for a range of light technologies, including incandescent light bulbs, compact fluorescent lamps, commercial and public amenity lighting
- an information and financial incentives programme to accelerate the uptake of better lighting technology including residential (energy-efficient compact fluorescent lamps) commercial and street lighting
- improvements to the Building Code.

Energy saving light bulbs – Continue this Electricity Commission programme to complete contracts for, and put additional contracts in place, for an additional $5.7 million compact fluorescent lamps by the end of 2009.

Energy Star – Expand this voluntary programme that identifies the most efficient products, usually the top 25 per cent, against set energy performance criteria. Energy Star complements MEPS and MEPL to set standards, to endorse high-performing products with the Energy Star label and raise consumer awareness to lift overall product efficiency. The scheme is to be expanded to cover a further 15 product categories by the end of 2012.

[30] Based on average not marginal emissions (EECA 2007).

2.3 Improving the performance of new homes

The standard to which homes are built and renovated has a significant impact on how healthy and comfortable they are to live in, how affordable they are to heat, and overall energy use and emissions for the life of the building.

The Building Code sets minimum performance standards for new homes and renovations. The typical home has a life of 80 years. Recently announced changes to the Building Code for thermal insulation[31] are projected to save families between $760 (Auckland) and $1,800 (Dunedin) per year in energy running costs with a payback period of three to seven years.

Building Code energy efficiency requirements will be progressively improved as new technologies become available and the benefits of energy savings increase. Ultimately it may be cost effective for new homes to be self-sufficient in terms of net energy production (zero energy homes). Ways to increase investment in zero energy homes will be investigated by the end of 2010. One step towards this is to incorporate consideration of the embedded greenhouse gas emissions into the Building Code.

NOW Home®

Beacon Pathway is a consortium of Building Research, Scion, Waitakere City Council, Fletcher Building and New Zealand Steel. It was established to research and educate the sector on how to build cost effective sustainable homes that meet the needs of the average Kiwi family.

The first NOW Home®, in Waitakere, is an architecturally designed, single storey, three-bedroom home. Results from the first year of monitoring show the house uses 40 per cent less water and 55 per cent less electricity for water heating than other Waitakere homes; it only needs additional heating a few days per year. Overall, it uses around one-third less electricity than comparable households, and 45 per cent less energy compared to its family's last home.

Image courtesy of Craig Robertson Photography.

Taking action (2.3 Improving the performance of new homes)

Building Code – Amendments to address thermal performance and hot water systems by the end of 2008.

Carbon lifecycle analysis – Investigate and report on mechanisms to support investment in zero energy houses by incorporating embodied energy (emissions) and carbon lifecycle analysis by the end of 2010.

Home Energy Rating Scheme – Promote the use of the Home Energy Rating Scheme (HERS) as a design and compliance tool for the Building Code to capture energy efficiency services, including passive solar design by the end of 2009.

Support for local councils – To implement changes to the Building Code, consider other energy efficiency measures and work to address the barriers to the uptake of renewable energy technologies.

[31] Biggest energy efficiency steps in 30 years, Frequently Asked Questions, New Zealand Government, May 2007.

2.4 Better information

Lack of information has been identified as a major barrier to the uptake of energy efficiency, conservation and renewable energy in homes. Improved information increases awareness of benefits and promotes uptake by householders and industry.

Taking action (2.4 Better information)

Home Energy Rating Scheme (HERS) – Develop a star energy rating for the energy performance of a home that will advise potential purchasers, or tenants, of its energy performance and how it could be improved. This will act as an incentive to make further improvements and allow for those features to be better reflected in sale prices and rents. Voluntary from 2007, it will be reviewed in 2008 with recommendations made to achieve mandatory disclosure of ratings.

Eco-design advisors – Consideration is to be given to expanding the existing eco-design advisor scheme with recommendations made by the end of 2008.

Research – A five-year research programme to identify future opportunities for energy efficiency and conservation in households. This will include investigating new technologies and products.

Sector development – Working with business to build capacity and develop quality assurance processes for installing new technologies. Implementation plan to be developed by the end of 2008.

Energywise Homes information campaign – A nationwide campaign that will raise awareness of the need to be energy efficient. Actions are likely to include:

- a general awareness campaign supported by partnerships with the private sector, local and regional councils and community groups
- targeted information, including a comprehensive website that inspires families to make homes more energy efficient and sustainable
- the Energywise brand to deliver all government programmes in the area of residential energy efficiency and conservation.

2.5 Increasing the uptake of household renewable energy

Clean and efficient water and space heating systems are cheaper to run than inefficient systems; they can also lead to air quality improvements. Renewable options include solar hot water, log burners (which can use wood and fire logs) and wood pellet fires which meet local air quality standards under the Clean Heat Programme.

Solar hot water promotion

The government is running a comprehensive programme to lift standards and encourage the uptake of solar hot water systems with a medium-term goal to make the industry more competitive and sustainable.

The programme comprises:

- technical programmes, system testing and measurement of cost effectiveness
- $500 grants for homeowners installing qualifying systems or up to $500 towards the cost of interest on a loan
- a grants scheme for volume builders of new homes
- training for installers
- information campaigns and resources, including the www.solarsmarter.org.nz website and call centre
- work with local councils to reduce consenting costs
- an innovation fund.

Government Spokesperson on Energy Efficiency and Conservation, Jeanette Fitzsimons checks the alignment of a solar hot water system.

Taking action (2.5 Increasing the uptake of household renewable energy)

Solar water heating – Install 15,000–20,000 household systems by the end of 2010. The programme is focused on expanding unit sales, improving quality standards, assisting with installer training and reducing financial barriers by offering a range of assistance to homeowners and builders.[32] Review programmes in 2009, including consideration of funding priorities for beyond 2010.

Solar Industries Association – Continue support for industry to advocate for renewable energy technologies and to drive increased capability, training and product performance within the sector.

See also New Zealand's efficient and renewable electricity system (page 61). A target for increasing the supply of woody biomass in the residential (and commercial) sectors is shown under Energywise Business (page 31).

[32] See http://www.solarsmarter.org.nz/

3. Energywise business

Objective:

More energy efficient and competitive businesses using more renewable energy and emitting less carbon dioxide

Biomass heat plant owned and operated by Energy for Industry for Winstone Pulp International (WPI).
Photo courtesy of WPI.

Energywise business – Summary of actions

Action	Outcome	Delivery
3.1 Industrial energy efficiency and renewable energy		
3.1.1 Industrial energy efficiency		
3.1.1a Direct assistance		
Capital grants for Energy Intensive Businesses (EIB) Expand programme by the end of 2008	0.14 PJ 2,000 tonnes CO_2 pa in 2025 3.5 PJ 0.06 Mt CO_2 pa in 2025	EECA (Funded) EECA (Under consideration from 2008)
Emprove programme – energy audits and improvement implementation Expand programme by the end of 2008	0.3 PJ 5,000 tonnes CO_2 pa in 2025 4.1 PJ 0.07 Mt CO_2 pa in 2025	EECA (Funded) EECA (Under consideration from 2008)
Totals	**8.1 PJ** **0.14 Mt CO_2 pa in 2025**	
3.1.1b Technology transfer		
Compressed air systems project	0.4 PJ 0.078 Mt CO_2 pa in 2012	EC (Funded)
Electric motor project	1 PJ 0.194 Mt CO_2 pa in 2012	EC (Funded)
Industrial heat processes	1 PJ 0.194 Mt CO_2 pa in 2012	EECA (Under consideration)
Totals	**2.4 PJ** **0.466 Mt CO_2 pa in 2012**	
3.1.1c Information, capacity and capability		
Encouraging the use of best energy management practices	Improved practice	EECA (Funded)
Provide teaching of energy efficiency in worker education and trade training	Implement workers' training programme by the end of 2009 and trade training by the end of 2012	EECA (Funded)
Increase professional energy management services	Enhanced capacity	EECA (Funded)
Enhance energy efficiency advice services for business	Establish advice service by the end of 2009	EECA (Under consideration)
Energy efficiency opportunities reporting	Recommendations to government by December 2008	EECA (Under consideration)
3.1.2 Renewable energy programmes		
Capital grants, information and demonstration projects for increasing the supply of woody biomass	Grants available through FIDA and EIB	EECA (Funded)
Support for BANZ and NZGA	Ongoing support	EECA (Funded)
Pilot scheme to convert school coal-fired boilers to woody biomass	30 boilers converted by the end of 2008. Savings of 1,400 tonnes CO_2 pa in 2009 Decision made by the end of 2009 on converting remaining boilers	EECA (Funded) (Under consideration)
Total	**1,400 tonnes CO_2 pa in 2009**	

Action	Outcome	Delivery
3.1.3 Better commercial buildings		
Improve the performance of lighting and heating, ventilation and air conditioning (HVAC) systems	Amend Building Code by the end of 2008	DBH (Funded)
Support for voluntary commercial building sustainability rating tool – Green Star	Increase the uptake of international best practice in New Zealand	MfE (Funded)
Implement an electricity efficiency programme for commercial buildings	1 PJ 0.194 Mt CO_2 pa in 2012	EC (Funded)
Research energy use in commercial buildings Building Energy End Use Project (BEEP)	Commence by the end of 2008	DBH/EECA (Funded)
Investigate a Building Energy Rating Scheme (BERS)	Recommendation by the end of 2009	DBH (Under consideration)
Investigate Minimum Energy Performance Standards (MEPS) for existing commercial buildings	Recommendation by the end of 2011	DBH (Under consideration)
Totals	**1 PJ** **0.194 Mt CO_2 pa in 2025**	
3.2 Primary production – agriculture, horticulture, forestry and fishing (excluding primary production processing)		
Energy-efficient technologies deployment programme	Potential for future gains quantified and industry led programme developed by the end of 2008	MAF/EECA (Funded)
Investigate, and subsequently demonstrate, leading edge energy efficiency and renewable technologies	At least two demonstration model farms by 2010	MAF/EECA (Under consideration)
Enhance the capacity and capability of rural energy advisors	Programmes established by the end of 2008	MAF (Partially funded)
Encourage energy efficiency and renewable energy in glasshouse production	Capital grants	EECA (Funded)
Promote existing grant funding for primary sector energy efficiency and renewable energy projects	Capital grants	MAF/EECA (Funded)
Encourage the uptake of biodiesel in farm and forestry machinery	Report by the end of 2009	MAF (Under consideration)
Primary production sector energy end-use research	Report by the end of 2008	MAF/EECA (Under consideration)
Greenhouse gas footprinting strategy for the primary production sector	Implement strategy from late 2007	MAF (Funded)
3.3 Tourism		
Increase tourism industry participation in energy saving programmes	Plan of action for increased participation by the end of 2010	EECA (Funded)
Improve the energy efficiency of tourist accommodation	Increased uptake of energy-efficient technologies and practices	EECA/Ministry of Tourism (Funded)
Refine the sustainability tourism charters, including energy use measures	Enhanced sustainable energy in tourism	Ministry of Tourism (Funded)
Include energy efficiency and conservation criteria in Qualmark by the end of 2008	Improved consumer information	Ministry of Tourism (Funded)
Introduce environmental excellence awards including a sustainable energy category by the end of 2008	Recognition of best practice	Ministry of Tourism (Under consideration)
Improve sustainable tourism information to industry including energy use indicators	Improved market information and sharing of best practice	Ministry of Tourism/TNZ (Funded)

The industrial and commercial sectors consume 196 PJ or 39 per cent of New Zealand's energy, and are responsible for 12.6 Mt or 37 per cent of energy greenhouse gas emissions.[33]

New Zealand's economic development depends largely upon the success of its businesses and primary production enterprises.

Business has a real opportunity to enhance its success, and to become more efficient, productive and competitive by adopting energy efficiency and conservation measures and increasing its uptake of renewable energy. In doing so it can better manage energy and emissions prices and become more profitable.

A growing number of businesses also have a specific interest in managing customer demands around taking responsibility for their emissions.

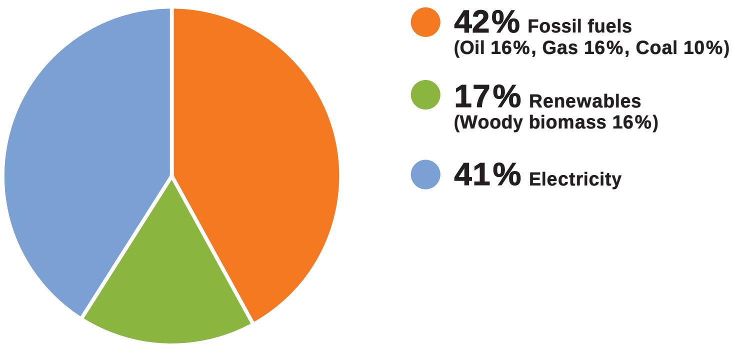
In common with other sectors, the business sector faces barriers to the uptake of energy efficiency and conservation measures including access to capital, lack of information, weak price signals and split incentives.

These barriers tend to be higher for small and medium-sized enterprises. Other barriers include:

- managers being subject to short payback criteria from investments
- smaller businesses are typically not exposed to cost-reflective electricity pricing
- the purchase and control of energy is often separated within businesses.

There is significant potential to increase the utilisation of renewable energy such as woody biomass and, where available, geothermal used directly by businesses and rural enterprises. Figure 5 shows that just 17 per cent of the sector's energy needs is met directly from renewable sources.

Figure 5: Energy consumption by the business sector in 2005: total 218 PJ



Source: EECA

In addition, solar water systems can be used to meet hot water requirements and displace electricity in industrial and commercial settings.

[33] Includes industrial and commercial combustion-based activities and thermal electricity generation emissions allocated on pro-rata basis of electricity use. *New Zealand Energy Greenhouse Gas Emissions* 1990–2006, MED, June 2007.

Renewable fuel savings

Verkerks, a Christchurch-based producer of speciality meat products, has converted its 1.2 MW diesel boiler to burn a renewable fuel, tallow, with the help of the government – resulting in annual savings of $150,000 and a reduction in carbon dioxide emissions by 900 tonnes per year.

Then Verkerks Engineering Manager, Jerry Scales, beside the 8,000 litre heated tallow tank.

This chapter is presented as follows:

3.1 Industrial energy efficiency and renewable energy

3.1.1 Industrial energy efficiency

Around 300 businesses account for about 90 per cent of total business energy consumption, mostly of stationary energy. Energy use in the commercial sector is dominated by several hundred large multi-storey buildings, with much of this space tenanted.

The balance of stationary energy is utilised by a large number of relatively small businesses for which energy is dispersed over many end uses, making it difficult to target and a less significant part of their costs.

Direct assistance

The promotion of energy efficiency through information (including audits) and incentives can increase the uptake of cost effective energy management practices and technologies. Over 4.4 PJ of savings were reported by companies between 2001 and 2005, worth $88 million under the government's Energy Intensive Businesses and Emprove programmes. Further cost effective savings under these programmes of 1.3 PJ per year in 2010 and 3 PJ per year in 2020 could be achieved.[34]

Technology transfer

Many businesses can become more efficient and competitive by adopting modern energy-efficient technologies and practices such as efficient industrial lighting, industrial motor drives and industrial heat processes. Many businesses also use appliances and lighting common to the residential sector that are subject to MEPS (see page 24).

The Electricity Commission has identified economic electricity efficiency potential in the industrial and commercial sectors to save 7 PJ and 6.7 PJ respectively by 2016.[35] However, due to various market barriers, only part of this potential is likely to be realised.

Information capacity and capability

One key way to advance the uptake of energy efficiency measures is to improve the ways businesses manage their energy use, ideally bringing it into line with world's best practice. This relies on businesses having staff who are skilled in energy management and able to access high-quality information and advice from private sector providers of energy management services.

New system means big savings

Tegel Foods Ltd has worked with the government under the Energy Intensive Businesses programme to improve the efficiency of its New Plymouth plant with the introduction of a heat recovery system leading to annual savings of $110,000 and 600 tonnes of carbon dioxide emissions.

The compressor used to compress the ammonia gas during the chilling process.

[34] *Benefit Cost Analysis of the New Zealand Energy Strategy* (preliminary draft #2) 11 May 2007, MED.

[35] KEMA New Zealand Efficiency Potential Study (draft) Vol 1 2007 – the potentials relate to electricity efficiency measures that are cost effective when compared with supply-side alternatives.

Taking action (3.1.1 Industrial energy efficiency)

Direct assistance

Energy Intensive Businesses – Continue and expand capital grants and information programmes for energy intensive businesses to facilitate the uptake of energy efficiency measures, low carbon technologies and renewable energy.

Emprove – Expand this cost effective programme targeting New Zealand's larger energy consumers to help them become more energy efficient and to drive the uptake of renewable energy. Includes energy audits and action plans to implement improvements.

Technology transfer

Compressed air project – Develop and deliver a best practice package for industrial compressed air system operation and maintenance by June 2008.

Electric motor project – Develop awareness programmes and policies for motor replacement and consider a motor replacement incentive programme by June 2008.

Industrial heat processes project – Investigate and establish a best practice programme by the end of 2009. Achieve 3 PJ savings by 2015 through improving energy use in industrial heat processes, such as heating, furnace and boiler systems.

Information, capacity and capability

Energy Management – Continue a programme to partner with business to improve the use of best energy management practices by 30 per cent by the end of 2012.

Training – Encourage workplace participation in energy management by establishing a programme to equip workers to engage in making energy efficiency improvements by the end of 2009. Programme to be developed in partnership with the Council of Trade Unions, Tertiary Education Commission, industry training organisations, employee unions and tertiary education providers.

This includes the provision of energy efficiency and renewable energy training in tertiary education investment plans for building- and engineering-related trade training, such as for architects, builders, plumbers and electricians, by the end of 2012.

Sector support – Double the size of the professional and expert energy management services sector, including accredited energy auditors, by the end of 2012 through the provision of financial assistance to stimulate growth, industry training, continuing education, and the establishment of quality standards.

Energy efficiency advice service – Develop a one-stop shop, including a web resource, linking business to information, demonstration sites, guidelines and a referral service. To be operating by the end of 2009.

Energy efficiency opportunities reporting – Investigate a requirement, and make recommendations to government by December 2008, for businesses over a certain energy threshold to report their energy efficiency opportunities, as currently occurs in Australia. Subject to government approval, develop a reporting system by December 2009.

3.1.2 Renewable energy programmes

Up to an additional 9.5 PJ per year of woody biomass and geothermal energy could be used directly in the industrial, commercial and residential sectors by the end of 2025.[36] If this potential is to be realised, around 0.66 Mt of carbon dioxide equivalent emissions could be avoided each year by displacing fossil fuels and meeting new energy demand with woody biomass and geothermal energy – where it is practical and cost effective to do so.

To help realise this potential, three sector-specific targets for encouraging the uptake of woody biomass and the direct use of geothermal energy have been set:

- **to provide an additional 7 PJ per year of consumer energy from forestry residue by 2025 off a base of 0.8 PJ per year in 2005**

This target will encourage the uptake of forestry residue left over from forest harvesting operations. Barriers to uptake include the costs of collecting, processing and transporting forestry residue. If achieved, around 0.5 Mt of carbon dioxide could be displaced each year by 2025.

- **to provide an additional 3.5 PJ per year of residential and commercial consumer energy from woody biomass by 2025 off a base of 8 PJ per year in 2005**

This target will encourage the uptake of wood pellets, firewood, fire-logs and wood chips in residential and commercial wood burners. If achieved, the target will see woody biomass consumption increase by around 50 per cent by 2025, displacing 0.24 Mt of carbon dioxide each year by 2025.

- **to provide an additional 2 PJ per year of direct use geothermal energy by 2025 off a base of 10 PJ per year in 2005**

There is potential to encourage more use of geothermal heat in industrial and primary production processes. Geothermal heat pumps may also play a useful role in the future. If achieved, this will increase direct use of geothermal by 20 per cent and could potentially displace 0.13 Mt of carbon dioxide each year by 2025.

These targets provide guidance to the sectors responsible for increasing the utilisation of forestry residue, woody biomass and geothermal for heat and power. The targets are interlinked and have been designed taking into account the complex interconnections between them. They therefore cannot be simply added together.

Taking action (3.1.2 Renewable energy programmes)

Capital grants, information and demonstration projects for woody biomass – Provide capital grants for woody biomass projects to overcome information and financial barriers to the uptake of woody biomass through the Forestry Industry Development Agenda (FIDA). Grants for woody biomass and geothermal projects are also available through the Energy Intensive Businesses programme.

Working with and supporting renewable energy industry associations – Continue to work with the Bioenergy Association of New Zealand and the New Zealand Geothermal Association to effectively promote woody biomass and the direct use of geothermal energy.

Pilot scheme to convert school coal-fired boilers to woody biomass – A pilot programme will see 30 coal-fired school boilers converted to woody biomass fuels by the end of 2008. A decision on expanding the programme to other schools to be made by the end of 2009.

See also the Primary production section for the uptake of renewable energy by rural businesses (page 42).

Renewable energy technologies, upon reaching the demonstration and pre-commercial deployment phases, may be able to access funding from the Low Carbon Energy Technologies Fund (see page 60). See also Annex 1 (page 80) for further information on government funding programmes.

[36] This excludes wood processing residues. This form of woody biomass is also likely to make a significant contribution to renewable direct use in the future. The potential however is uncertain, given the strong dependence on the economic performance of the wood processing sector.

3.1.3 Better commercial buildings

Poor energy efficiency in the building stock locks businesses into higher costs and emissions over the life of buildings. The best time to improve energy efficiency is at the design stage or during major refurbishment of building services. Opportunities for energy efficiency gains are mainly in heating, ventilation and air conditioning (HVAC) and lighting systems, and in equipment, such as machinery and appliances, purchased for use within buildings.

Setting minimum performance standards is an effective way of ensuring such buildings are cheaper to run and have lower whole-of-life energy costs.

Work is required to improve the data available on energy use in commercial buildings, to help further identify the economic potential for savings, and to develop appropriate ways of realising them.

Taking action (3.1.3 Better commercial buildings)

Building Code – Improve the stringency of lighting and heating ventilation and air conditioning (HVAC) performance requirements by the end of 2008.

Green Star – Continue support for this voluntary commercial building sustainability rating tool, and ensure consistency with the BERS.

Commercial buildings electricity efficiency project – Develop and implement a commercial building electricity efficiency programme including building HVAC systems and energy management best practice, by June 2008.

Research energy use in commercial buildings – Develop the Building Energy End Use Project (BEEP), a cross-government project to develop understanding of how and where commercial buildings use energy. EECA will work with agencies and the Building Research Council to develop BEEP, ensuring that it is consistent with the Energy Domain Plan, from 2008/09.

Building Energy Rating Scheme (BERS) – Investigate a building energy rating scheme by the end of 2009. Investigate and make recommendations on the merits of the compulsory disclosure of ratings by the end of 2010. This will provide information of likely energy costs to prospective tenants. Landlords will have an incentive to make improvements and realise better value from high-performing buildings.

Building Minimum Energy Performance Standards (Building MEPS) – Investigate and make recommendations by the end of 2011 on introducing Minimum Energy Performance Standards for existing commercial buildings.

3.2 Primary production – agriculture, horticulture, forestry and fishing

The primary production sector accounts for 21.4 PJ (4.3 per cent) of total national energy use including 5.4 PJ of electricity (4 per cent) and is responsible for 1.6 Mt, or 4.8 per cent[37], of New Zealand's annual greenhouse gas emissions from the energy sector.

The previous (2001) strategy did not target the primary production sector. This version of the strategy now specifically promotes initiatives for a wide range of land-based agricultural, horticultural and forestry enterprises. Off-site processing of primary produce (such as dairy factories, fish processing and sawmills) has already been covered earlier in this chapter.

The fishing sector is an intensive user of energy and is vulnerable to rising diesel prices. Support is currently available through the Emprove and EIB programmes. Further action in this area will progress as the opportunities become better understood.

The primary sector faces similar barriers as other businesses to adopting energy efficiency and conservation measures and renewable energy. For example, a number of farms are tenanted or have share-milkers meaning those responsible for investing in efficiency improvements don't directly get the benefit of lower running costs.

The primary sector also faces a unique set of challenges as a result of anticipated higher global energy prices and climate change. Consumers, particularly in Europe, have become more concerned about the carbon footprint of food production and distribution. Security of energy supply is also a critical issue for rural communities and businesses.

New Zealand's primary production sector has the opportunity to better manage on-farm energy costs and related emissions, by adopting energy efficiency and conservation measures as well as by increasing its use of renewable energy.

Government announced a Sustainable Land Management and Climate Change Plan of Action in September 2007. The Plan of Action will see the agriculture and forestry sectors, local government and Maori working in partnership with government to develop a comprehensive package to tackle climate change issues in the land management sector. A technology transfer programme is part of the plan of action and the energy efficiency and renewable energy actions in this section will inform and complement this programme.

[37] Derived from direct emissions and indirect electricity emissions from *New Zealand Energy Greenhouse Gas Emissions 1990–2005*, MED, 2006.

3.2.1 On-farm energy systems

Dairy sheds and irrigation systems are some of the most electricity-intensive parts of New Zealand farming. Studies[38] show that energy costs typically make up around 6.5 per cent of farm cash expenditure for non-irrigated dairy, and eight per cent for irrigated dairy.

Experience gained from demonstration farms shows that there is significant scope to make cost effective efficiency improvements in hot water and vacuum systems. Similar opportunities exist to make efficiency and emissions savings through investing in heating and cooling systems (including cold storage), lighting and motor-driven processing equipment. Such savings can help improve the competitiveness of vineyards and fruit growers that rely on storage, and help contribute towards meeting sustainability related marketing goals.

An energy efficiency study by Meridian Energy noted that cost effective energy savings of around 27 per cent could be realised on a typical dairy farm.[39]

Further work will be undertaken to determine the potential for cost effective measures to be rolled out across the sector and the best way to go about doing so.

On-farm energy efficiency

A New Zealand Centre for Advanced Engineering study covering 15 Southland farms has concluded that most dairy sheds could reduce electricity costs by $3,000 to $5,000 per year through limited capital expenditure on efficiency measures, with a payback period of less than five years.[40]

The study found the biggest savings are to be made from heat exchangers used to recover heat from the milk vat chiller to heat water. A system with a four-year payback could save around $2,200 per year. When variable speed drives are fitted to vacuum pumps, the combined energy savings for these two initiatives could total around 30 per cent of energy use.

Photo courtesy of New Zealand Centre for Advanced Engineering.

[38] *Energy Use and Efficiency Measures for the New Zealand Dairy Farming Industry*, EECA 2005.

[39] Meridian Energy, Dairy farmers receive practical energy efficiency pack from Meridian Energy, 2005.

[40] Dairy farm energy efficiency study for Venture Southland, New Zealand Centre for Advanced Engineering, 2007.

3.2.2 On-farm renewable energy

The rural sector has a role to play in the achievement of the renewable electricity target set in the NZES, especially through the development of innovative local energy systems.

Not all renewable electricity projects need to be large scale. There are opportunities for individual or groups of farmers to develop local energy systems that generate electricity for their use. Surplus power could also be sold to produce a revenue stream.

The combination of energy efficiency, renewable energy and enhanced demand management will support the development of more resilient and secure electricity supplies for rural communities. Refer to New Zealand's efficient and renewable electricity system (page 61) for further detail.

A rural renewable energy system

A joint project between Industrial Research Limited (IRL), Massey University and a group of farmers in Manawatu's Totara Valley has resulted in the development of a scheme comprising three solar photovoltaic systems, a solar hot water system, a heat pump hot water system, a micro-hydro generator and a biodiesel generator to meet the power needs of three farms.[41]

The scheme also includes an innovative wind turbine-powered hydrogen system. The wind turbine powers a hydrogen production unit. The hydrogen is then stored and utilised in a fuel cell to produce electricity when needed.

The objectives of the project are to gain experience in using a combination of renewable technologies to provide a system that is cost effective and meets the power needs of the local community.

The participants are already reporting that their day-to-day energy costs are lower as a result of the project. The scheme's backers envisage that such projects will have a wider application, outside of isolated communities, within the next decade.

Steve Broome, left, Research Engineer, and Alister Gardiner, Hydrogen and Distributed Energy Platform Manager, from IRL, stand on a hill in front of the Hylink water electrolyser which produces hydrogen fuel gas which is then pumped to a fuel cell and water heater at the farm below. Photo courtesy of IRL.

3.2.3 Carbon footprint management

Issues around greenhouse gas emissions such as food miles and the carbon footprints of products are becoming increasingly important for the sector. The ability to accurately measure emissions and manage them, can make a significant difference to the competitiveness and market position of producers. This requires focusing on energy efficiency, renewable energy and offsetting, and having high-quality accreditation.

[41] http://www.irl.cri.nz/scienceandtechnology/ourexpertise/energy-gen-dist/distributed-energy-systems/integrated-distributed-energy-systems.aspx

CarboNZero

The New Zealand Wine Company, responsible for the Grove Mill brand, was the first winemaker to achieve carboNZero status in the world. This was achieved by targeting electricity and fossil fuel use and making efficiency improvements across its production and distribution systems. Investments have been made in insulation and innovative cooling and heat recovery systems.

Grove Mill states that it took this course to deliver benefits to the bottom line from energy savings and to overcome emissions-related consumer issues. In doing so the firm has realised a unique international marketing benefit.

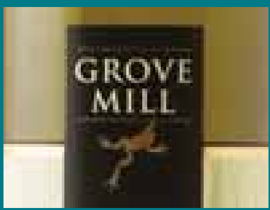


Photo courtesy of Grove Mill.

Taking action (3.2 Primary production – agriculture, horticulture, forestry and fishing)

Energy-efficient technologies deployment programme – Quantify the potential for sector-wide gains available from current energy efficiency technologies prior to developing, by the end of 2008, an industry-led programme to facilitate their uptake. The actions in this area will inform and complement the technology transfer programme, as part of the Sustainable Land Management and Climate Change Plan of Action, as well as existing Energywise Business programmes.

Investigate, and subsequently demonstrate, leading edge energy efficiency and renewable energy technologies through model farms – Begin a project to demonstrate leading edge energy efficiency and renewable energy technologies in real-world situations, providing technical performance and productivity data for new technologies and alternative energy systems. At least two demonstrations to be established by 2010.

Enhance the capability and capacity of rural sector energy advisors – Establish programmes to enhance the knowledge and skills of those providing energy efficiency and renewable energy advice to rural businesses and communities by the end of 2008. This will also include advice on biofuel production.

Encourage energy efficiency and renewable energy in glasshouse production of protected crops – Provide grants through the EIB programme to increase the uptake of energy efficiency and renewable energy actions in glasshouse production of protected crops.

Rural energy project grants – Better coordinate information on the availability and application of a range of existing government grant programmes. Examples of funds available include the Sustainable Farming Fund, EIB grants, the Low Carbon Energy Technology Fund and the Marine Energy Development Fund. For an overview of related funding mechanisms, see Annex 1.

Encourage the uptake of biodiesel in farm and forestry machinery – Most diesel-powered farm and forestry machinery is capable of being run on biodiesel blends of 5 per cent or greater. A report with recommendations on how to increase the uptake of such machinery that is capable of running on higher blend levels is to be produced by the end of 2009.

Primary production sector energy end-use research – Research and report on the energy end-use trends in the agriculture and forestry sectors with recommendations on how to better realise the potential for cost effective energy efficiency, conservation and renewable energy gains by the end of 2008.

Greenhouse gas footprinting strategy for the primary sector – Implement a strategy to allow primary producers to measure and verify energy-related greenhouse gas emissions associated with their production from late 2007.

See also, for additional actions on renewable energy, transport biofuels and electricity generation, Energywise Transport (page 47) and New Zealand's efficient and renewable electricity system (page 61).

3.3 Tourism

Tourism is a large and growing part of New Zealand's economy. It relies heavily upon the natural environment, both as the basis for many of its tourism products and to underpin New Zealand's image in international markets.

Delivering on the 100% Pure brand promise is fundamentally important to the sector. Travel, accommodation and activity-related energy use and greenhouse gas emissions are prominent issues as the sector seeks to serve increasingly climate-conscious travellers.

A recent international survey found that the majority of respondents were worried about emissions from flying and 93 per cent said they would, or might, participate in more environmentally friendly travel in the future.[42]

In acknowledging New Zealand's distance from many key source markets, the sector needs to ensure that New Zealand is serviced by more fuel-efficient aircraft. Air New Zealand is already investing to ensure that it will have one of the world's most fuel-efficient international fleets from 2010. It has also announced plans to test biofuel in one of its aircraft. Steps are also being taken to improve flight plans and routes to reduce fuel consumption (see page 56). Encouraging the uptake of similar measures by other airlines is an ongoing challenge. Increasing fuel costs and policies to address greenhouse gas emissions will help to drive this.

New Zealand can also offer real opportunities for tourists to reduce their energy use and emissions once they arrive here. Energy use in the tourism sector is dominated by transport and accommodation activities. Significant scope exists for increasing the uptake of biodiesel for bus travel in line with the ability of fuel providers to supply it, to move to long-distance passenger rail and to accelerate the uptake of more efficient buses. Actions addressing these opportunities are covered under Energywise Transport (page 47).

Carbon neutral transport for tourists

InterCity Group, New Zealand's largest transport and tourism operator, has set itself the goal of becoming the world's first carbon neutral public transport operator by achieving carboNZero status for all its operations by 2010.

It has already achieved this status for its corporate operations by improving energy efficiency in its offices. One project has cut electricity use by computer systems by 70 per cent. The firm has also spent over $20 million upgrading its vehicles to meet stringent emissions performance standards.

The first of four mega-coaches being built by InterCity Group. Photo courtesy of InterCity Group.

[42] Lonely Planet's annual *Travellers' Pulse* survey, 2007.

Tourism operators are also realising that to be competitive they need to tell their clients an accurate story about the environmental footprint of their business and the measures they have in place to reduce that footprint. Energy efficiency and conservation is a key part of that story and will be included in the future marketing of businesses and the sector as a whole.

Government will look to the sector to provide continued leadership in accelerating the uptake of energy efficiency and conservation measures and renewable energy. This may involve the sharing of best practice and experience of energy savings that have been realised by others through efficiency improvements made to tourist transport and accommodation.

There are many examples of accommodation that is already energy efficient. However, there is still significant scope to adopt energy efficiency and conservation measures and renewable energy more widely across the accommodation sector. For example, there is significant scope to increase the use of solar hot water systems, low-flow shower heads and energy-efficient lighting in the sector.

Sustainable accommodation

In 2007, the Youth Hostel Association's Wellington hostel was named Best in Oceania by Hostelworld.com. It was refurbished in 2005 with energy efficiency in mind. Features include a solar hot water system, an innovative shower heat recovery system, upgrades of room heating and cooling systems and double glazing.

Then Manager Hamish Allardice said: "The recognition from the award lets other organisations know that sustainability is good for business and good for the environment. It's just common sense. If you cut down on the resources you use, you save money."

The Hostel also won a Trailblazer award in the Sustainable Business Network's September 2007 Get Sustainable Awards.

Guests enjoy free bagel breakfast Mondays in the Atrium dining room at YHA Wellington City. Photo: Masa Udagawa

Taking action (3.3 Tourism)

Increase tourism industry participation in energy saving programmes – Identify opportunities to encourage the tourism sector to participate in the Emprove programme. A plan of action, including estimated savings, is to be produced by the end of 2010.

Improve the energy efficiency of tourism accommodation – Work with accommodation providers to increase the uptake of energy-efficient technologies such as solar water heating, low-flow showerheads and more efficient lighting. To be delivered through existing buildings initiatives.

Sustainability tourism charters – Refine the charters programme, including energy use measures, to allow for an extension beyond the current six pilot regions.

Qualmark – Include energy efficiency and conservation criteria in the Qualmark programme by the end of 2008.

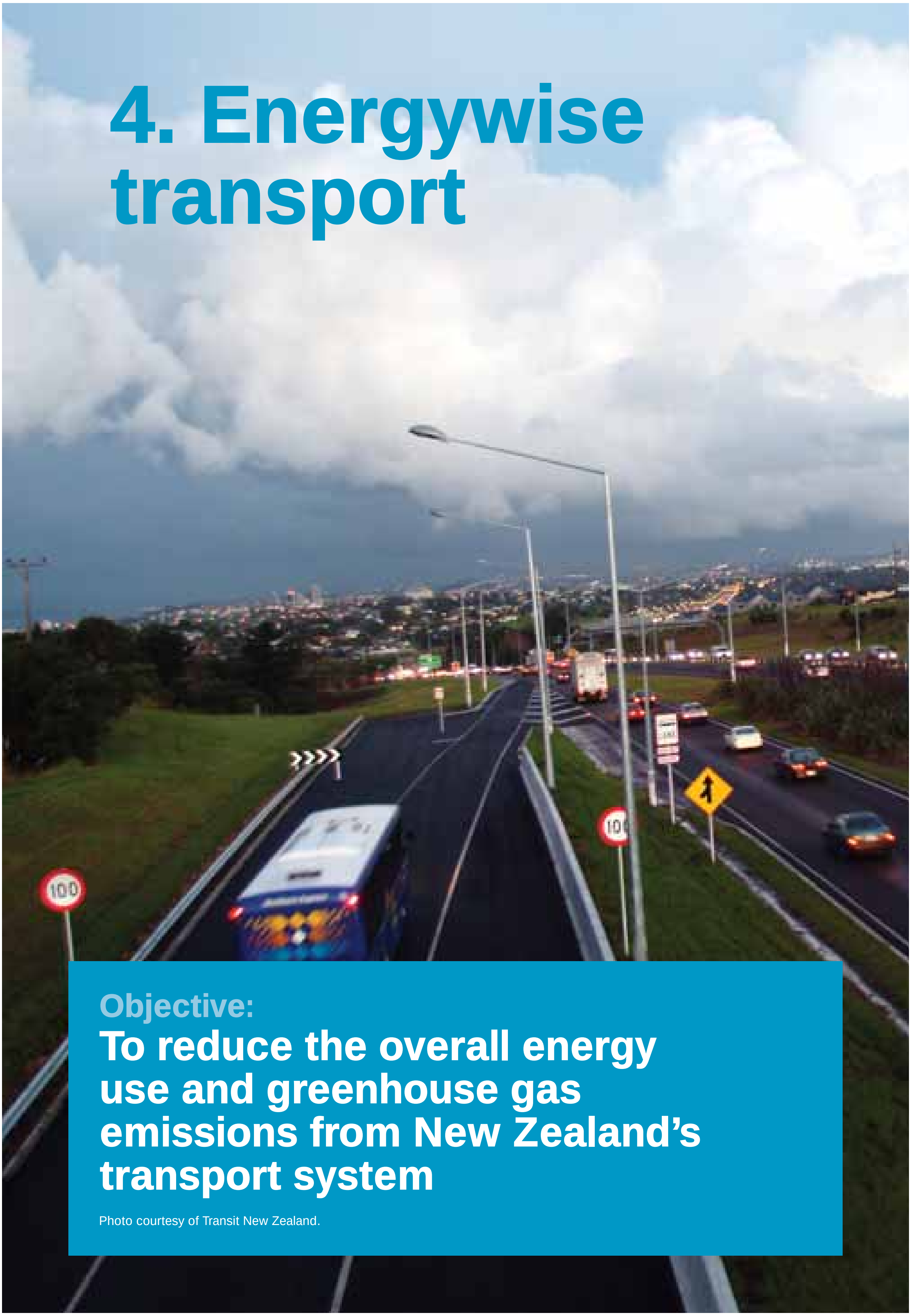
Recognition of best practice – Establish environmental excellence awards and include a sustainable energy category, by the end of 2008.

Sustainable tourism information – Provide sustainable tourism information, including energy use indicators, to the industry from sources such as the sustainable tourism website, published sustainability guides and intelligence from key markets.

See also the Energywise homes chapter, for more on energy efficiency, conservation and renewable energy in buildings and accommodation (page 17).

For more on biofuels and improving the efficiency of air and domestic land transport see Energywise Transport (page 47).

4. Energywise transport



Objective:

To reduce the overall energy use and greenhouse gas emissions from New Zealand's transport system

Photo courtesy of Transit New Zealand.

Energywise transport – Summary of actions

Action	Outcome	Delivery
4.1 Managing demand for travel		
Work with local government to promote travel demand management planning	Reduction in vehicle kilometres travelled (VKTs), energy use and emissions	Land Transport NZ (Funded)
Support businesses to put travel plans in place	Reduced VKTs, emissions and congestion	Land Transport NZ (Funded)
Support schools to put travel plans in place	Increased walking (including walking school buses) and cycling	Land Transport NZ (Funded)
4.2 More efficient transport modes		
Review funding policies to encourage greater provision of public transport, walking and cycling	Recommendations by the end of 2008	MoT (Funded)
Regional public transport planning	Targets set in Regional Land Transport Strategies by the end of 2012	Regional Authorities (Funded)
Complete Auckland rail electrification with the rolling replacement of diesel trains with electric units	Capacity and patronage increases	Ontrack and ARTA (Funded)
Complete the Wellington rail upgrade	Estimated double peak time capacity	Ontrack, GWRC and Land Transport NZ (Funded)
Support efficient bus use	Complete passage of Public Transport Management Bill by the end of 2007	MoT (Funded)
Bus infrastructure improvements including completion of the Northern Busway in Auckland	Save 1,000 tonnes CO_2 pa in first stage	ARTA and local councils (Funded)
Implement the Walking and Cycling Strategy and fund the Bikewise programme	Reduce VKT	MoT/Land Transport NZ (Funded)
Support development of Neighbourhood Accessibility Plans to encourage mode shift	Emissions reductions and health benefits	Land Transport NZ (Funded)
Active living programme	Encouragement for mode shift from cars to walking and cycling	SPARC (Funded)
Collect data on freight movements	Inform policy development by the end of 2009	MoT/MED (Funded)
Develop a New Zealand Domestic Sea Freight Strategy	Discussion document published in 2007	MoT (Funded)
Review heavy vehicle weight limits	Recommendations by the end of 2009, new land transport rule, if required, by the end of 2011	MoT (Funded)
Investigate options for improving the efficiency of the North Island main trunk line	Report with recommendations by the end of 2010	MoT (Under consideration)

Action	Outcome	Delivery
4.3 Improving the efficiency of the transport fleet		
Average fuel economy standards for new and used light vehicles entering the fleet	Decision by December 2007	MoT (Funded)
Introduce fuel economy labelling scheme for light vehicles by March 2008	$333m energy savings 0.98 Mt CO_2 cumulative by 2033	EECA (Funded)
Report on the potential for better tyres to improve vehicle fuel efficiency	Report by June 2008	EECA (Under consideration)
Collection of fuel economy data on vehicles entering the fleet	Rule in place by December 2008	MoT (Funded)
Continue the fuelsaver.govt.nz website and launch the rightcar.govt.nz website	Informed consumers	Land Transport NZ (Funded)
Develop a fleet commitment and driver training programme for heavy vehicle drivers	Savings of 0.011–0.014 Mt CO_2 pa	MoT (Funded)
Vehicle Fleet Strategy to promote optimal fuel economy, safety and air quality	Final strategy published by June 2008	MoT (Funded)
Work with the aviation industry to encourage the use of more fuel-efficient practices and aircraft	Improved aviation energy efficiency	MoT (Funded)
Vehicle retirement (scrappage) scheme	Extend trial to 2009	MoT (Under consideration)
4.4 Developing and adopting renewable fuels		
Develop voluntary sustainability consumer information for biofuels	Publish by the end of 2009	EECA (Funded)
Establish an Advisory Group to look at future vehicle technologies, such as biofuel and electric vehicles, and barriers to their early adoption	Establish by December 2007	MoT (Funded)
Introduce the Biofuel Sales Obligation and review the post-2012 obligation levels in 2010	Savings of 1.08–1.12 Mt CO_2 cumulative by 2012	MED (Funded)
Funding support for new low carbon energy research and development	Implement fund by the end of 2008	MoRST/FRST (Funded)
Accelerate the uptake of plug-in hybrid and electric vehicles	Establish work programme by the end of 2008	MoT (Funded)

National transport consumes 219.5 PJ (44 per cent) of energy used nationally. Freight modes account for approximately 43 per cent of New Zealand transport energy use, and passenger modes 57 per cent. In 2006 transport was responsible for 14.5 Mt of greenhouse gas emissions or 43 per cent of New Zealand's annual greenhouse gas emissions from the energy sector.

Unless action is taken, emissions from this sector are set to grow by 35 per cent by 2030. Such an outcome is economically and environmentally unacceptable.

New Zealanders have a strong desire for travel and mobility, yet they face unique issues in terms of physical geography and distance from global markets.

New Zealand is also primarily a technology taker with respect to vehicle and fuel systems. These circumstances create challenges that need to be met if the issue of climate change is to be dealt with successfully. Improvements in fuel efficiency and reductions in greenhouse gas emissions will depend upon:

- the extent to which New Zealanders are prepared to modify their travel behaviour
- the extent to which behaviour change is supported and encouraged by central and local government policies and programmes, such as through funding policies, urban planning and the promotion of active modes like walking and cycling
- the speed and extent to which fuel efficiency improvements are incorporated into vehicles from source markets
- the potential for consumer preferences to dilute gains from efficiency improvements and the changing nature of these preferences
- the rate of fleet turnover and the extent to which the second-hand market impacts on the benefits of technological advances
- the availability of biofuels and vehicles compatible with high biofuel blend levels.

Since 1990, emissions from the transport sector have been growing at a rate of 3.1 per cent each year with some reduction in the rate of growth between 2005 and 2006. This reduction corresponds to higher fuel prices. While the price of fuel will continue to impact on emissions from transport, it cannot be relied on to arrest growth in greenhouse gas emissions.

The government has a number of other strategies in which its objectives for an efficient transport sector are also reflected. In particular, the New Zealand Transport Strategy (NZTS) has an objective of ensuring environmental sustainability. An implementation document is currently being developed for the NZTS which will provide clearer guidelines for investment and strategic decision making by transport and local government agencies.

The NZES also sets out a low carbon transport future scenario to 2050. Actions here, and in the 'Resilient, low carbon transport' chapter of the NZES, will support the transition to a low carbon and efficient transport system.

Achieving significant gains from alternative fuels will depend on the realisation of second generation biofuels and the emergence of high volumes of plug-in hybrids, full electric vehicles and fuel cell and hydrogen vehicles.

It is reasonable to set targets for transport, though it is not yet possible to forecast the contribution of specific technologies.

The targets which will be used to assess progress include:

- to reduce per capita greenhouse gas emissions from the transport sector by 50 per cent from those in 2007 by 2040
- to position New Zealand to be one of the first countries, if not the first, to widely deploy electric vehicles
- reduce the kilometres travelled by single occupancy vehicles, in major urban areas on weekdays, by 10 per cent per capita by 2015 (compared to 2007)
- review regional passenger transport mode share targets by the end of 2012 through scheduled reviews of Regional Land Transport Strategies, and subsequent Regional Passenger Transport Plans
- reduce the rated CO_2 emissions per kilometre of the combined average of new and used vehicles entering the fleet to 170 grams CO_2 per kilometre by 2015 (approximately 7 l/100 km). The current average is in the region of 220 grams CO_2 per kilometre (between 9.5 and 10 l/100 km). This will equate to average fuel consumption figures of 7.4 l/100 km for petrol vehicles and 6.5 l/100 km for diesel vehicles
- by 2015, 2.1 million vehicles (80 per cent of the fleet) to be capable of using at least a 10 per cent blend of bioethanol or biodiesel, or electric powered
- by June 2009, the government will establish baseline data for the volume of freight, and the CO_2 emissions per tonne kilometre of freight moved domestically by different modes.

The potential savings from the transport targets are:

- up to 110 million litres of fuel, 3.7 PJ of energy, and a reduction of 0.26 Mt CO_2 emissions through reducing single occupancy vehicle trips by 10 per cent by 2015
- cumulative savings of 441 million litres of fuel, (16.2 PJ of energy) and 1.10 Mt CO_2 emissions over an eight-year period by reducing carbon dioxide emissions from vehicles entering the light vehicle fleet to 170 g CO_2 /km by 2015
- the gains to 2025 are estimated as 4,826 million litres (175.1 PJ of energy) and 11.8 Mt of CO_2 emissions. This outcome is based on vehicles travelling slightly less due to the Emissions Trading Scheme and fleet entry and exit remaining at the 2006 level. An underlying efficiency gain of 1 per cent per annum for newer vehicles has been assumed, as there will be gains not directly attributable to this initiative.

This chapter is presented as follows:

4.1 Managing demand for travel

4.2 More efficient transport modes

4.3 Improving the efficiency of the transport fleet

4.4 Developing and adopting renewable fuels

The 'Resilient, low carbon transport' chapter of the NZES contains additional information on these four topics.

4.1 Managing demand for travel

The urban environment has a significant impact on the need for transport services and the connectivity and social cohesion of communities. Issues relating to urban form are discussed more fully in the Government leading the way chapter of this strategy.

In addition to improving urban design, the most effective demand measures are: pricing, then mode quality improvements (better services, networks and facilities), then social marketing to promote behaviour change.

Travel demand management measures can also spread demand across modes and across time as a means of reducing peak demand, congestion, and its energy use and emissions impacts. For example, flexibility around working times can ease peak demand as can the scheduling of freight movements.

Telecommunications infrastructure, such as broadband, can serve to manage demand by replacing the need for travel through video conferencing or remote working, where this is practical and appropriate.

Travel behaviour change in Auckland

Auckland Regional Council studies show that traffic flows over the Auckland Harbour Bridge at peak times have fallen slightly in recent years. This trend has coincided with an increase in the provision of public transport, with many more buses now crossing the bridge as work on the new North Shore Busway project has progressed. There is also evidence of behaviour change among drivers as they have changed their times of travel.

Photo courtesy of Transit New Zealand.

Improving the overall quality of the vehicle fleet will reduce tailpipe emissions that are harmful to health. Also, effecting mode shift away from private cars to walking, cycling and passenger transport is particularly relevant to the aim of reducing the number of single occupancy vehicle kilometres travelled in urban areas at peak times.

Taking action (4.1 Managing demand for travel)

Working with local government – Central government agencies will work with local councils to develop travel demand management strategies that may incorporate urban design, investment planning and behaviour change tools.

Workplace travel plans – Assist workplaces in formulating and implementing workplace travel plans to reduce car and fuel use. This work contributes to congestion targets in Regional Land Transport Strategies.

School travel plans – Ongoing support for the implementation of school travel plans, walk to school week and walking school buses.

Government funding for the above plans has increased to 75 per cent of the overall cost since July 2007.

Car pooling is one simple activity that can reduce vehicle trips and can be promoted through these programmes.

4.2 More efficient transport modes

4.2.1 Personal travel

Moving to more efficient transport modes, across both passenger and freight transport, provides an opportunity to realise efficiency gains and reduce overall emissions.

Much household travel comprises short trips. One-third of all car journeys are less than two kilometres. The provision of walking and cycling infrastructure can assist with mode shift away from private cars.

Public transport also has a growing role to play, especially for commuting. Between 1999 and 2006, public transport use is estimated to have gone up by 68 per cent in Christchurch, 43 per cent in Auckland and 23 per cent in Wellington, saving an estimated 49 million car trips. This issue is also highlighted in the NZES.

As part of *Implementing the New Zealand Transport Strategy* the government is developing objectives for passenger transport in New Zealand. The NZES points out that there has been an historic under-investment in public transport. Much has been done to correct this since 1999. Funding in this area has increased ten-fold between 1999 and 2007. Additional funding of $650 million was announced in Budget 2007 for national rail improvements and for the upgrade of Wellington and Auckland commuter rail services. These recent developments are reflected in funding priorities and the development of targets for public transport.

A number of local authorities have already made good progress and set targets in promoting alternative modes of transport. These targets include:

- Auckland Regional Transport Authority aims to increase public transport patronage to 60 boardings per person per year by 2016
- Greater Wellington Regional Council has set a target to increase public transport use for journeys to work by 21 per cent by 2016
- Environment Canterbury has set a target for the proportion of all trips (excluding walking) in Christchurch being made by public transport to rise to six per cent by 2011
- Otago Regional Council plans that 4.5 per cent of all trips in the region will be made by public passenger transport by 2014.

Central government intends to engage with and support local authorities as they review their transport strategies and develop their targets.

Public transport in the regions

Public transport funding has increased and public transport operators are showing leadership in the adoption of renewable fuels.

In the Auckland region, major projects include the new North Shore Busway and a $600 million investment programme in commuter rail. It is estimated that the busway saved 3.9 million kilometres of vehicle travel during the 2006/07 year.

In Wellington, the commuter rail network is now undergoing a $500 million upgrade. A contract has also been let to upgrade the city's fleet of 60 electric trolley buses. This will increase capacity and provide more attractive services to the public.

In Christchurch, passenger transport operators are currently trialling biodiesel at 5 to 20 per cent blend levels.

Prototype of the new Wellington trolley bus.
Photo courtesy of Greater Wellington Regional Council.

Taking action (4.2.1 Personal travel)

Funding policy review – In line with the NZES, complete a funding policy review to encourage greater provision of public transport, walking and cycling and make recommendations to government by the end of 2008.

Regional public transport targets – Regional passenger transport mode share targets are to be set by the end of 2012 through scheduled reviews of Regional Land Transport Strategies.

Auckland rail electrification – Complete the electrification of the Auckland passenger rail system by the end of 2013.

Wellington rail upgrade – Complete the $500 million Wellington regional rail upgrade by the end of 2013. Depending on timetabling and train lengths, the upgrade could double peak time capacity.

Support efficient bus use – A programme to increase the uptake of low carbon and fuel-efficient buses (including hybrid and electric buses) used by passenger transport contracted to councils. The Public Transport Management Bill 2007 will enable regional councils and the Auckland Regional Transport Authority to set standards for, and impose controls on, commercial scheduled urban public transport services, while still allowing operators to register such services on a commercial basis. Controls regional councils may impose include requiring participation in integrated ticketing schemes and the use of low emissions buses. The passage of the Bill is to be completed by the end of 2007.

Bus infrastructure improvements – Complete the new North Shore Busway project by the end of 2008 and give higher priority to providing bus priority lanes, park and ride sites and bus shelters on the state highway network.

Getting there – on Foot, by Cycle (Walking and Cycling Strategy) – Implement the initiatives outlined in the Walking and Cycling Strategy's strategic implementation plan, including the walking and cycling model communities programme, the Long-distance Cycle Networks Investigation Project and the expansion of road user training and education related to pedestrians and cyclists.

Bikewise Week – Implement Bikewise week annually to promote cycling.

Neighbourhood accessibility plans – These are community-based programmes to improve safety and access at the community level. The objective is to develop resources and provide programme support to communities.

Active Living Programme – A SPARC programme[43] to encourage active travel modes such as walking and cycling to encourage less car use.

4.2.2 Land freight and maritime transport

A better understanding of the true costs of moving a tonne of freight by different modes, including environmental externalities, will help develop policies for efficient freight movement. Data from the United Kingdom has shown energy use for freight movement across different modes as follows: road transport 0.7 MJ (per tonne-km), rail 0.6 MJ, coastal tankers 0.3 MJ, and container ships 0.12 MJ.

New Zealand's circumstances are different from those in the United Kingdom, so there is a need to assess the levels of costs and fuel efficiency here. Such information can help guide the most efficient use of infrastructure, charging regimes and investment planning. The government proposes reviewing the Surface Transport Cost and Charges Study and is considering including maritime transport in it.

More information about land and marine freight movement is available in the 'Resilient, low carbon transport' chapter of the NZES.

Some businesses are already working together to make more efficient use of existing infrastructure to move freight, as the following case study illustrates.

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[43] http://www.sparc.org.nz/partners-and-programmes/active-communities/active-friendly-environments/overview

Freight integration

Fonterra and Toll NZ are working together to make rail the primary transport mode for dairy products in the Waikato. They are taking around 45,000 truck movements off the road between the Waikato, Auckland and Tauranga, thus reducing carbon emissions by around 3,000 tonnes each year.

A hub has been established which is linked by rail to a number of manufacturing sites. The company is also using rail to transport milk from the Hawkes Bay, Manawatu and Wairarapa regions to Whareroa. This results in saving an extra 6,100 tonnes of carbon emissions each year.

In addition, the transfer of so many truck movements from the roads onto rail acts to reduce demand for roading and damage to it, improve safety, reduce congestion and reduce exhaust emissions that are harmful to health.

Fonterra's Crawford St site, a logistics hub acting as a distribution centre for Fonterra's Te Awamutu, Morrinsville, Waitoa, Hautapu, Waharoa, Lichfield and Tirau manufacturing sites. Photo courtesy of Fonterra and Toll NZ.

Taking action (4.2.2 Land freight and maritime transport)

Freight Efficiency Study – The government will establish baseline data for the volume of freight, and the CO_2 emissions per kilometre per tonne of freight moved domestically by different modes by the end of 2009.

The New Zealand Domestic Sea Freight Strategy – In line with the NZES, a work programme with the shipping industry, rail and road operators, to develop and publish a discussion document on a New Zealand Domestic Sea Freight Strategy by the end of 2007.

Heavy-vehicle weight limits – Study the costs, including the likelihood of increased damage to roads, and safety factors, and make recommendations on targeted changes to road freight weight and size limits by December 2009.

North Island main trunk line electrification – Conduct a desktop feasibility study into options, including electrification, for improving the efficiency of the North Island Main Trunk Line and report with recommendations by the end of 2010.

4.3 Improving the efficiency of the transport fleet

In addition to taking action to better manage travel demand and provide more efficient transport modes, action needs to be taken to increase the efficiency of vehicles in the transport fleet.

4.3.1 Commuter rail

The efficiency and environmental performance of commuter rail is being addressed through the electrification programme in Auckland. The majority of the commuter rail system in Wellington is already electrified and this is being extended on the Kapiti Coast.

4.3.2 Aviation

Government is working with the airline industry to improve flight plans and routes to optimise fuel efficiency. Modern commercial aircraft also offer further fuel efficiency gains. Further information is available in the NZES.

Airways New Zealand

Airways New Zealand, the national air navigation services provider, offers a range of measures to help airlines improve efficiency and reduce greenhouse gas emissions as they fly into and over New Zealand's airspace.

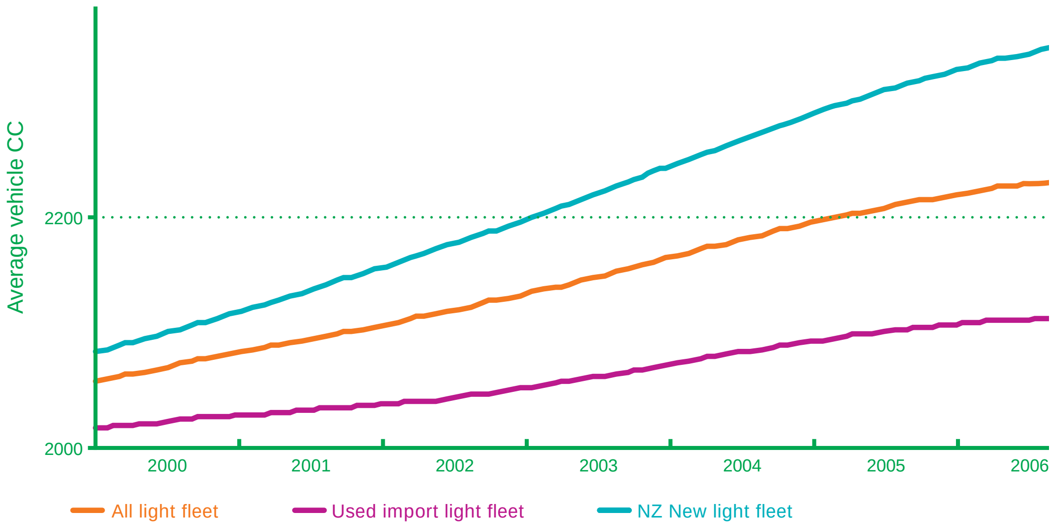
Initiatives include User Preferred Routing which allows pilots to alter their routes whilst airborne to take advantage of prevailing wind patterns, and an optimised arrival trial which enables landing aircraft to follow continuous descent approach procedures into Auckland Airport. Aircraft engines can be set at idle during these descents, significantly reducing fuel burn and greenhouse gas emissions.

Airways New Zealand estimates that its existing fuel saving programmes save the New Zealand airline industry approximately \$20 million per year. This equates to savings of over 23 million litres of aviation fuel (0.73 PJ) and almost 0.06 Mt CO_2 emissions.

4.3.3 Private cars

The fuel efficiency of the light road vehicle fleet (primarily private cars) needs to improve. Better performance should reduce emissions of greenhouse gases as well as carbon monoxide, and fine particulates (PM_{10}s) which are harmful to human health.

Figure 6: Light fleet average engine capacity



Source: Ministry of Transport

Figure 6 shows the growth in the average engine size of New Zealand's light vehicle fleet. Engine size provides an approximate indicator of fuel economy, as a vehicle with a smaller engine size will, on average, use less fuel. However, as engine technology is improving, an increase in the average engine size of vehicles entering the fleet does not automatically imply an increase in average fuel consumption. Conversely, reduced average engine size of new or used vehicles entering the fleet implies improved average fuel economy.

Actual data on the fuel economy of the New Zealand light vehicle fleet has only been collected since March 2005. The data up to July 2007 shows no significant change in fuel consumption, despite a trend of increased engine size over this period.

The average light vehicle in the New Zealand fleet is over 12 years old and has a poor efficiency performance of around 10.2 l/100 km. Many modern petrol and diesel light vehicles (family cars) are already capable of around 4 to 5 l/100 km.

The average new import entering the fleet has a performance of 9.4 l/100 km and the average used import returns 8.5 l/100 km.[44] Government has agreed a target of reducing the rated CO_2 emissions per kilometre of combined average new and used vehicles entering the light vehicle fleet to 170 g CO_2 per kilometre (approximately 7 l/100 km) by 2015. The changes required for the fleet to achieve this target are set out in the 'Resilient, low carbon transport' chapter of the NZES.

A longer-term target has been set to reduce per capita emissions from the transport sector by 50 per cent by 2040. One of the key strategies to achieve this target is to position New Zealand to be one of the first countries, if not the first, to widely deploy electric vehicles.

Government will consider options for a sales-weighted fuel economy standard in November 2007. Options will include consideration of the timing, number and stringency of interim targets between 2008 and 2015, while noting the desirability of seeking some early savings.

Action will also be taken to accelerate the uptake of more efficient vehicles including the more widespread adoption of hybrids and early adoption of plug-in hybrids, all-electric and hydrogen-powered vehicles as they become available. The NZES contains detailed information on electric-powered vehicles and hydrogen.

Improving the choice and maintenance of tyres can also lead to lower fuel consumption.

[44] Petrol only and tested to the European standard.

4.3.4 Driver behaviour

Driver behaviour can have a significant impact on fuel economy.

Easy and safe ways to cut your fuel bill by 20 per cent

Keep your tyres inflated to the correct pressures and save up to 5 per cent

Don't speed – As well as being illegal, driving at 110 km/h uses around 13 per cent more fuel than driving at 100 km/h

Avoid short trips where you can – Cold engines can use up to 20 per cent more fuel

Drive smoothly – Accelerate smoothly and gradually. Use economy mode where fitted in automatics

Reduce idling time – If you are going to be stationary for more than 30 seconds, switch your engine off

Look ahead – Keep a good distance between you and the vehicle ahead to avoid lots of accelerating and braking

Look after your vehicle – A properly serviced car can be around 5 per cent more fuel efficient

Watch air conditioning – Switch it off when it's done its job and save up to 10 per cent

Keep your load down – Take unnecessary weight out of your car and take off roof racks etc when not in use

Photo courtesy of Land Transport New Zealand.

The tips in the box above apply drivers of private cars. The government has undertaken additional research into the potential for similar measures to be adopted across the heavy and light commercial fleet. It is estimated that up to 40 per cent of drivers could be expected to adopt similar measures, delivering a 10 per cent saving. If realised, this would save around 74 million litres of fuel per year and 0.19 Mt of carbon dioxide emissions.

Taking action (4.3 Improving the efficiency of the transport fleet)

Average fuel economy standards – Set a target to reduce the rated CO_2 emissions per kilometre of combined average new and used vehicles entering the light vehicle fleet to 170 g CO_2 /km by 2015. This will equate to average fuel consumption figures of 7.4 l/100 km for petrol vehicles and 6.5 l/100 km for diesel vehicles.

Vehicle fuel economy labelling – Introduce a point of sale vehicle fuel economy labelling scheme for new and used vehicles, by early 2008 to produce $333m and 0.98 Mt of savings by 2033.

Energy-efficient tyres – Investigate the potential for improving vehicle fleet efficiency by increasing the uptake of low-rolling resistance tyres and any complementary measures and make recommendations by June 2008.

Fuel economy data – Implement a rule by the end of 2008 to facilitate the collection of fuel economy data on vehicles entering the fleet.

fuelsaver.govt.nz – Continue to provide the fuel$aver website and update information on vehicle fuel economy in response to changing technologies.

rightcar.govt.nz – Launch the rightcar website by December 2007 to provide car buyers with safety and sustainability information.

Driver training – Develop a fleet driver behaviour training package to improve fuel economy, by the end of 2008.

Vehicle Fleet Strategy – Develop a strategy to enable the co-ordination and focus of policies promoting the purchase of more fuel-efficient vehicles by June 2008.

Aviation efficiency – An ongoing work programme identified in the NZES involving the New Zealand-based aviation industry and international forums, to encourage the use of more fuel-efficient practices and aircraft.

Vehicle retirement (scrappage) scheme – Building on the results of an Auckland pilot, extend the trial programme to two years and to other urban areas.

4.4 Developing and adopting renewable fuels

Another important step in reducing New Zealand's reliance on imported fossil fuels is by producing greater volumes of renewable fuels domestically. There is scope to do this through developing the supply of biofuels and encouraging the uptake of electric and plug-in electric vehicles. Other alternative fuelled vehicles such as fuel cell vehicles and those powered by hydrogen may also become available.

The uptake of renewable transport fuels, including electricity over the medium to long term, has the potential to transform the efficiency and emissions performance of the New Zealand vehicle fleet. This is dependent, however, upon the global car industry supplying compatible vehicles in sufficient numbers and consumers buying them. New Zealand will continue to be a technology taker for vehicles.

4.4.1 Biofuels

There are currently two main types of biofuel:

- bioethanol – in New Zealand principally made from whey (a by-product of the dairy industry)
- biodiesel – in New Zealand the single biggest source is tallow (a by-product of the meat processing industry). Biodiesel can also be made from used cooking oil and oil crops.

Research is underway into a number of second-generation and alternative biofuel production methods. This includes research into the conversion of woody biomass into ethanol, trials of willow (Salix) as an energy crop and biofuels from sewage algae. Scope also exists to use kiwifruit waste and straw to produce ethanol.

The government announced a Biofuels Sales Obligation in February 2007 to ensure that biofuels are used in the transport sector. It starts at a low level in 2008 (approximately 0.5 per cent) increasing to 3.4 per cent by 2012. More information on the sales obligation is available in the 'Resilient, low-carbon transport' chapter of the NZES.

Government programmes will investigate what actions can be taken to encourage vehicle compatibility with biofuels and will work towards the following target: by 2015, as much as 80 per cent of the fleet will be capable of using at least a 10 per cent blend of bioethanol or biodiesel, or be electric powered.

It is important to minimise conflict with food production, and not to contribute to the unsustainable production of biofuels in other countries that involve the clearance of native forests overseas. Hence a set of voluntary guidelines and consumer information will be developed and put in place around the supply of biofuels to the New Zealand market.

4.4.2 Electricity

The government has agreed in principle that New Zealand will be one of the first countries in the world to widely deploy electric vehicles. A number of high volume manufacturers are currently undertaking multi-billion dollar investment programmes to bring cost effective plug-in mass market electric vehicles to the market around the end of the decade. As New Zealand is a technology taker, the government will put policies in place to accelerate the uptake of such vehicles as the market makes them available.

Electric cars

Car manufacturers are developing a range of zero (tailpipe) emissions technologies aimed at the mass market with at least one manufacturer having a goal of launching a mass market small car in production from 2010.

Research is focusing on fuel cells, high performance batteries, highly efficient electric motors, regenerative braking systems and electrically driven air conditioning and vehicle charging systems.

Electric plug-in vehicles have downsized fuel tanks compared to fuel-only vehicles.

State-owned energy company Meridian Energy is trialling electric vehicles in New Zealand from 2008.

Left: The NZ Eco-UltraCommuter electric car which has been designed and built by engineering students at Waikato University. The NZ Eco project aims to demonstrate New Zealand's potential for sustainable battery electric commuter cars.
Photo courtesy of the project.

Right: Honda FCX Concept hydrogen fuel-cell car, a precursor to the production car coming in 2008 to the USA.
Photo courtesy of Honda New Zealand Limited.

Taking action (4.4 Developing and adopting renewable fuels)

Biofuels sustainability information – Publish voluntary sustainability guidelines and consumer information for biofuels in New Zealand by the end of 2009.

Research – Investigate renewable energy options for transport and make recommendations by the end of 2009.

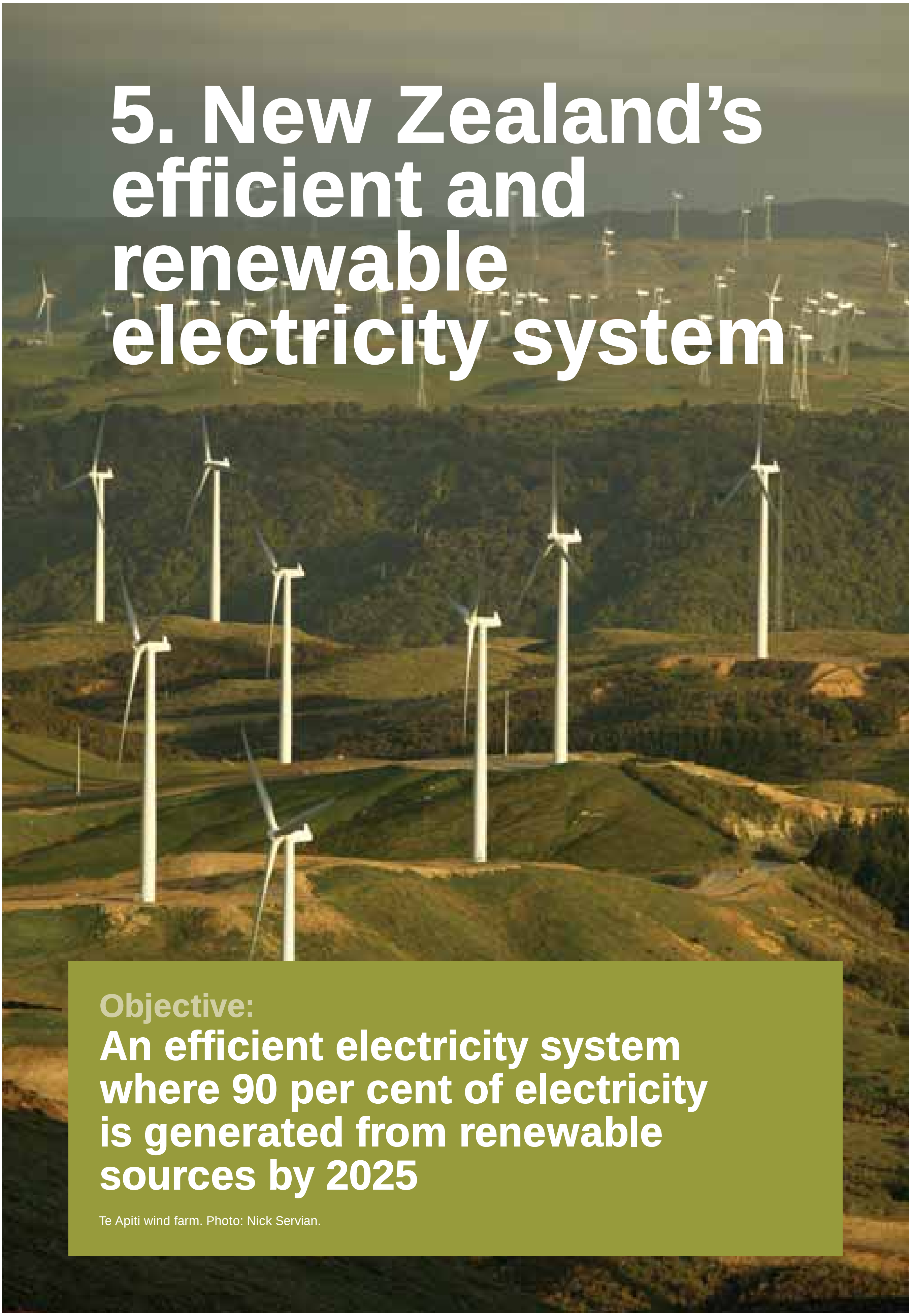
Advisory group on fuels and vehicles – In line with the NZES, establish an expert group to look a future vehicle and energy technologies such as biofuels and electric vehicles and barriers to their adoption, by December 2007.

Biofuel Sales Obligation – In line with the NZES, implement the Biofuel Sales Obligation, which requires 3.4 per cent (approximately 7.25 PJ per year) of petrol and diesel sales to be biofuels by 2012. Review the post-2012 obligation levels in 2010.

Low Carbon Energy Technologies Fund – Administer this fund to help bring forward the use of alternative energy sources such as liquid biofuels, biomass, solar, hydrogen, wind power, and low carbon fossil fuels. This fund is also discussed in the 'Sustainable energy technologies and innovation' chapter of the NZES.

Plug-in electric and hybrid electric acceleration – In line with the NZES, implement a programme to position New Zealand to be a leader in the deployment of plug-in hybrid electric and electric vehicles. Programme to include intergovernmental contact and be established in 2008.

5. New Zealand's efficient and renewable electricity system



Objective:

An efficient electricity system where 90 per cent of electricity is generated from renewable sources by 2025

Te Apiti wind farm. Photo: Nick Servian.

New Zealand's efficient and renewable electricity system – Summary of actions

Action	Outcome	Delivery
5.1 Promoting an efficient electricity system		
Smart meters	Guidelines published by the end of 2007 Decision on regulation by the end of 2009	EC (Funded)
Market design review	Recommendations by June 2008	EC (Funded)
Demand-side bidding and forecasting. New arrangements in place by June 2008	~8.5 MW of demand response from improved price forecasts[45]	EC (Funded)
Consumer participation potentials study	Published by the end of 2008	EECA (Under consideration)
Distribution network pricing	Published by December 2008	EC (Funded)
Supplier obligations to undertake energy efficiency	Recommendations by the end of 2007	MED (Funded)
Distribution network losses	Recommendations by June 2008	EC (Funded)
5.2 Promoting the uptake of renewable electricity		
National Policy Statement (NPS) for renewable energy	Complete by the end of 2008	MfE (Funded)
Provide information to local government to assist with planning processes for renewable energy	Ongoing information programmes	MfE / EECA (Funded)
Provide guidance to councils around consenting small-scale renewable energy systems	Ongoing support programme to help reduce compliance costs	EECA (Funded)
Identify changes to market arrangements to manage higher levels of wind generation in the future	Complete the Wind Integration project by June 2008	EC (Funded)
Relax some conditions around investment in renewable generation by lines companies	Introduce amendments to the Electricity Industry Reform Act 1998 by the end of 2007	MED (Funded)
Itemised billing arrangements for small-scale generation	Recommendations by the end of 2009	EC (Under consideration)
Raise awareness of distributed generation	Ongoing information programmes	EECA (Funded)

[45] Demand-side bidding and forecasting consultation paper, Electricity Commission, 2007.

Action	Outcome	Delivery
5.2 Promoting the uptake of renewable electricity (continued)		
Report on strategic implications of distributed generation on lines networks	Report completed by the end of 2009	MED (Funded)
Distributed generation capacity and capability building	Establish programmes by the end of 2009	EECA (Funded)
Technical guidelines for small-scale distributed generation programme	Publish guidelines by the end of 2009	EC (Under consideration)
Monitor the uptake of distributed generation of less than 10 MW	Report annually in Energy Data File from 2008	MED (Funded)
Consider options to further encourage additional uptake of distributed generation	Recommendations by the end of 2009	MED / EECA (Under consideration)
Improve rural security of electricity supply	Develop demonstration projects by the end of 2010	MAF / EECA (Under consideration)
New Zealand Marine Energy Deployment Fund	Administer fund from late 2007	EECA (Funded)
Marine energy atlas	Publish in 2009	EECA (Under consideration)
Marine energy technical and industry standards	Recommendations by the end of 2011	Standards NZ, EECA and EC (Under consideration)
Support for SEANZ, NZWEA, AWATEA and NZGA to promote renewable energy	Ongoing support	EECA (Funded)

There is significant scope to improve the operation of the electricity generation, transmission and distribution system to make it more efficient and increase the proportion of electricity generated from renewable energy resources.

This chapter is presented as follows:

Further information on these areas is also available in the 'Security of electricity supply' and 'Low emissions power and heat' chapters in the NZES.

5.1 Promoting an efficient electricity system

The economically efficient management of New Zealand's electricity system can be promoted in a number of ways:

- improving consumer (or demand-side) participation, where consumers actively manage their use of electricity in response to signals[46] associated with high wholesale market prices or network constraints
- optimising the operation and management of transmission and distribution systems to minimise losses
- considering the potential to reduce peak demand when prioritising electricity efficiency investments or programmes
- increasing the uptake of distributed generation, particularly where it is located close to load or where it is able to reliably generate during periods of peak demand
- recognising the greater value of managing demand in winter versus summer when considering investments or programmes to more efficiently manage our electricity system.

An efficient electricity system can help reduce peak electricity demand. By relieving congestion on transmission and distribution networks, line losses can be reduced, system reliability improved (helping to increase security of supply), and the overall cost to consumers reduced. Over time, investment in new peaking generation, transmission and distribution assets (and their associated costs) may be delayed or avoided. Reducing peak demand can also reduce emissions from fossil fuelled generators that are currently required to provide power at peak times.

An efficient electricity system can also improve the ability of consumers to respond to wholesale prices. This helps temper market volatility and reduce potential abuse of market power when supply is tight. It may also raise consumers' awareness of their energy consumption and provide incentives for behaviour change around the uptake of energy efficiency, conservation and renewable energy.

5.1.1 Consumer participation

The potential for consumer participation to help manage electricity load in New Zealand is likely to be significant.[47] A survey of 222 businesses in 2004 identified at least 160 MW of consumer demand that could easily be used as a resource to manage peak demand or network constraints.[48] The potential for consumer participation is likely to grow in the future as enabling technologies, such as smart meters, become more widely used.

[46] Which may be ripple signals (sent over power lines), radio frequency signals, or information sent via the internet or telecommunications networks (mobile or landline) depending on the application and type of consumer.

[47] The technical potential for consumer participation was estimated at between 250 and 900 MW by EECA in 2003. This potential *only* includes the top 300 industrial sites in New Zealand.

[48] A total of 438 MW of demand response capability was identified in the survey, which could be utilised with varying degrees of difficulty.

Large electricity consumers typically have direct exposure to the wholesale electricity market; they already have strong incentives to shift or shed demand when wholesale prices are high. There is scope to improve how this group of consumers participates in the market.

Many medium-sized consumers do not have time of use related tariffs and as such have little incentive to respond to real-time price signals. This situation varies from supplier to supplier and across distribution networks. More work is required to better understand the load profile of such consumers and quantify the potential for load shedding.

New Zealand residential demand has been managed for a long time, principally through regional control of water heating though ripple control. Recent studies have shown significant capacity to further shed residential demand at peak times.

The supply contracts that small users have with electricity retailers generally[49] offer the same flat rate for every unit of electricity consumed, regardless of whether wholesale prices are high or if there are network constraints. As a result there is little incentive for small users to respond to pricing signals, or for them to be aware of swings in wholesale pricing.

Smart meters, coupled with appropriate tariffs, can enable greater consumer participation in the market, particularly by domestic customers and small businesses.

Demand-side aggregation will be another key ingredient to unlock consumer participation from small- to medium-sized electricity consumers. This offers consumers a way of capturing the financial benefits that may accrue from participating in the market while avoiding the complexities of the electricity system. Existing electricity market rules and regulations may need to change to encourage greater demand-side aggregation.

Smart meters help manage usage

A Californian study introduced smart meters and tariffs to make peak price signals more transparent to 2500 domestic and small business consumers.[50] Tariffs were structured to reward consumers for reduced demand during peak periods.

Peak reductions of up to 27 per cent were achieved for some groups of consumers.[51, 52] The trial also found that most consumers were open to adopting smart metering technology and peak-related tariffs and that peak time response was maintained over days and years.

In many households in New Zealand, hot water cylinders are already remotely controlled by lines companies to control network demand. The California study demonstrated that smart meters and tariffs can motivate consumers to manage electricity consumption in other household appliances. A particularly effective approach is to automatically link smart meters to consumer goods, such as air conditioners or washing machines in the home. The appliance can be linked to the meter to, for example, delay the time at which the washing machine starts until a cheaper power rate is on offer, or to limit the power drawn by an air conditioner at peak times.

Smart meter. Photo courtesy of Arc Innovations.

[49] The remote control of domestic hot water cylinders by lines companies (using ripple signals) to manage local network demand is an important exception to this statement.

[50] *Impact Evaluation of the California Statewide Pricing Pilot*, Charles River Associates, 2005.

[51] The largest peak demand reductions occurred for a small number (for a given year) of critical days when demand on the electricity system was particularly high.

[52] *Dynamic Electricity Pricing in California, Do Customers Respond?* Matt Burgess (2006).

5.1.2 The role of network operators

Distribution and transmission network operators may use pricing (for network services) as a way of encouraging consumer participation to better manage network demand or constraints.

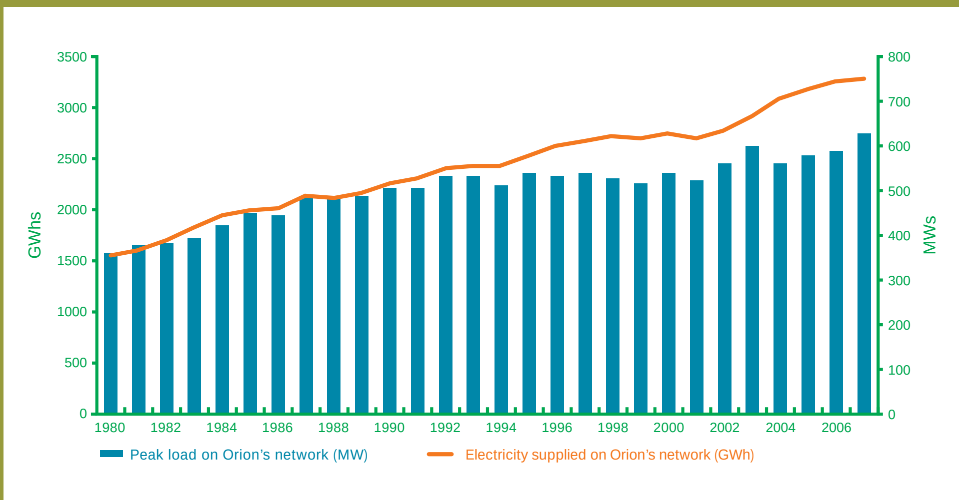
Lines companies have historically invested in electricity efficiency, distributed electricity generation and demand response only to manage demand on their networks, or to provide an additional revenue stream. Supporting the energy efficiency efforts of their customers has been less of a priority. The economic regulation of lines companies currently falls under the Commerce Act, and may discourage some lines companies from investing more widely in these areas.

Under the NZES, a review is underway of the regulatory control provisions relating to incentives for lines companies in the Commerce Act. The government is further considering the role of lines companies and retailers in delivering energy efficiency initiatives.

Managing peak demand success for Orion

Orion New Zealand Limited is a lines company in Christchurch. Confronted with growing demand peaks, in 1990 it instituted a range of energy efficiency and demand-response measures. Peak demand has been successfully decoupled from growth in energy demand. Orion attributes much of its success to peak load pricing, which has induced various consumers to undertake demand management activities.[53]

Figure 7: Managing electricity local peak demand



Source: Orion

5.1.3 The role of electricity suppliers

Energy efficiency programmes currently undertaken by the Electricity Commission and EECA involve partnerships with a range of organisations, including electricity suppliers. Such partnerships have proven to be an effective way to leverage government and levy funds and harness synergies that would prove difficult through normal commercial mechanisms.

An alternative approach is to place regulatory obligations on electricity suppliers, or more broadly energy suppliers, to deliver a specified level of energy efficiency improvements. Under this approach, electricity suppliers (retailers or lines companies) would be obliged to deliver a minimum volume (specified, for example in MWh) of pre-approved efficiency programmes, such as home insulation retrofits or the replacement of old refrigerators.

[53] *Alternating Currents or Counter-Revolution*, Evans & Meade, Victoria University Press, 2005.

Experience from overseas, for example the UK Energy Efficiency Commitment programme, shows that such an approach can be effective in increasing the uptake of energy efficiency measures.

5.1.4 Network losses

Transmission and distribution losses account for around 11 PJ or 7.5 per cent of electricity generation per year.[54] Transmission losses occur on the national grid; distribution losses occur as lines companies take power from the grid and deliver locally. They arise out of the design, operation and physical characteristics of distribution and transmissions systems and increase as the utilisation of (or load on) the system increases.

High-level incentives are already in place to better manage transmission losses. The management of distribution losses, though, is subject to a split incentive. Lines companies have few incentives to manage network losses as the cost of losses is borne by retailers. Several of the Electricity Commission's programmes listed below address aspects of this challenge and will enhance the energy efficiency of local networks over the life of this strategy.

Taking action (5.1 Promoting an efficient electricity system)

Smart meters – Publish voluntary technical guidelines for smart meters by the end of 2007. Investigate whether regulation is required to roll out smart meters, including the need for mandatory minimum technical standards should voluntary guidelines prove inadequate, and report with recommendations by the end of 2009.

Market design review – A work programme (part of a larger Market Design Review project) to improve electricity market rules and regulation to facilitate consumer participation. Work will focus on the extent to which consumers respond to variations in wholesale electricity prices, over the short term (for example price spikes) to the long term (as currently occurs in dry years). Recommendations to be made by June 2008.

Demand-side bidding and forecasting – A work programme (part of a larger demand-side initiatives project) to promote consumer participation in the wholesale electricity market by relaxing bidding requirements and improving the quality of information provided from the market. Implementation to be complete by June 2008.

Consumer participation potentials study – Publish a study by the end of 2008.

Distribution network pricing – Investigate barriers to demand-side participation as part of the development of the model distribution pricing methodologies project. Distribution pricing methodology to be published by December 2008.

Supplier obligations – An investigation into whether regulatory obligations on energy suppliers will deliver net benefits over current delivery mechanisms for energy efficiency is to be concluded, with recommendations, by the end of 2007.

Distribution network losses – A work programme to develop model approaches to improve distribution loss factor calculations and recommendations for the management, minimisation and allocation of distribution losses, reporting by June 2008.

54 *New Zealand Energy Data File*, MED, June 2007, p 102.

5.2 Promoting the uptake of renewable electricity

It is in New Zealand's longer-term and environmental interests to meet increases in demand through an economic mix of renewable energy sources that will meet security of supply objectives. It is easier for New Zealand than almost any other country, to commit to a low emissions electricity system.

A renewable electricity target has been set in the NZES to increase the proportion of electricity generated from renewable resources to 90 per cent by 2025. This is a challenging target, but given New Zealand's wealth of renewable energy resources, it is considered achievable without the imposition of significant costs on the electricity sector. The resultant generation mix should ensure New Zealand's energy system is well placed to prosper in a low carbon economy. To achieve this outcome requires a very high rate of investment in renewable generation, lower utilisation of existing thermal plant and the decommissioning of older thermal plant.

Meeting the target will require generating electricity from a diverse range of renewable sources such as wind, geothermal, hydro and biomass. Emerging renewable technologies such as wave, tidal and solar photovoltaic, may also contribute to achieving the target. More distributed generation, including small-scale generation, could also make useful contributions to achieving the target.

Greater uptake of demand-side measures such as electricity efficiency and consumer participation (discussed on page 64) will also help meet the target.[55] Investment in electricity efficiency can lower the rate of growth in electricity demand, reducing the need for new generation capacity. Improved consumer participation can help the electricity system respond to changes in output from renewable forms of generation that are intermittent.

Communities living on islands or in very remote locations often rely on expensive diesel electricity generation. Encouraging more of their electricity to be generated from local renewable resources may help to reduce the cost of their electricity generation, increase security of supply and lower carbon emissions.

The review of lines companies' obligations to supply (Section 62 of the Electricity Act 1992) set out in the 'Security of electricity supply' chapter of the NZES will include an investigation of the benefits of distributed generation (including from renewable energy) where it is an economic alternative to supply by lines.

A number of barriers have been identified that are hindering the uptake of renewable electricity. They include:

- The lack of greenhouse gas emissions pricing – disadvantages renewable generation economically as fossil-fuel generation does not include the cost of greenhouse gas emissions. This is being addressed through the emissions trading work programme.
- Regulatory barriers – can discourage developers from investing in renewable generation. For example, some of the provisions in the Electricity Industry Reform Act 1998 can inhibit investment in renewable generation by lines companies. Other examples include the lack of national guidance on renewable energy which can make obtaining consents for large-scale renewable energy developments more difficult. For small generation, obtaining consents under the Resource Management Act (RMA) and Building Code can be a challenge.
- The market for small-scale renewable generation – is small and has not yet been able to take advantage of economies of scale to reduce costs. The capability and capacity of suppliers and installers to meet increases in demand will need to be improved.
- The lack of pre-commercial funding for emerging renewable technologies – some developers of emerging technologies do not have access to sufficient funding to allow for pre-commercial development of their technologies.
- The lack of information – industry, local government and consumers need to be well informed on the benefits and costs of renewable generation in order to help these sectors achieve the target.

[55] This is particularly so for demand-side measures that contribute to reducing or managing demand during winter when electricity supply is more likely to be tight.

Waiuku family are 100 per cent renewable

The Watts family of five from Waiuku has invested in a 100 per cent renewable home electricity system comprising a 480 W solar photovoltaic panel array, a 1 kW wind turbine and a battery bank that can store enough power to supply the house for five days. The family uses LPG for cooking and a wood-fired hot water system.

Compared to the average power bill of $1,600 per annum for a New Zealand home, the family's electricity system cost $21,000 and the only bills associated with it have been spending a few dollars on distilled water for the battery system. Over the past six years, the family has not experienced a power cut and estimates it has avoided emissions of around 12 tonnes of CO_2.

The cost of such systems needs to be considered against the cost of establishing new connections to the grid which are in the region of $18,000–$24,000 per km for lines.

The photovoltaic panel array and small wind turbine.
Photo courtesy of Charmaine A. Watts, Sustainable Electricity Association New Zealand.

5.2.1 Potential for distributed generation

Studies have shown that there is significant technical potential for renewable distributed generation to contribute to New Zealand's future energy supplies. However, the markets for distributed generation, in particular for small-scale generation less than 10 MW, are in the early stages of development due to their high costs when compared to conventional electricity supply.

Through future technological advancements, distributed generation costs are expected to reduce. As they do, some of the technical potential that has been identified will become realisable and more cost effective. The programmes set out below are designed to ensure that the right regulatory and market environments for distributed generation are developed in the first instance.

Taking action (5.2 Promoting the uptake of renewable electricity)

National Policy Statement (NPS) on renewable energy – Will provide high-level national guidance on renewable energy projects under the RMA. This action is discussed more fully in the NZES. It is expected to be finalised in 2008.

Renewable energy information for local government – Assist with RMA policy and plan making and local government energy strategy development. Programmes include expanding EECA's regional renewable energy assessment programme and updating The Quality Planning website (www.qp.org.nz) with a planning note on renewable energy in 2008.

Reducing compliance barriers – An ongoing work programme to provide guidance to councils of consenting issues around photovoltaic, micro wind and micro hydro systems so that they can reduce compliance costs.

Identify market arrangement changes to enable additional wind generation to be integrated into the electricity system – Identify options, including wind forecasting, to successfully integrate higher proportions of wind generation into the system over the next five to 10 years.

Taking action continued (5.2 Promoting the uptake of renewable electricity)

Relax restrictions on investing in renewable generation by lines companies – Introduce amendments to the Electricity Industry Reform Act to relax some of the restrictions on investing in renewable generation by lines companies, by the end of 2007. This will include allowing lines companies to trade in financial hedges and to manage the risks of selling electricity on the wholesale market. More details are provided in the NZES.

Itemised billing arrangements for small-scale generation – Review the case for itemised billing (showing imports and exports) for small-scale generation, by the end of 2009.

Raise awareness of the benefits and costs of distributed generation – A programme will be established to raise the awareness of the benefits of distributed generation, in particular small-scale generation, for end-use consumers and local government from late 2007. The programme will include providing information on potentials for distributed generation and advice to local government.

Report on strategic implications of distributed generation on lines networks – Investigate and report on the long term strategic impacts of distributed generation on distribution networks, by the end of 2009.

Distributed generation capability and capacity building – Establish a programme to support the suppliers and installers of distributed generation in order to meet increased demand, in particular for small-scale generation from the end of 2008.

Technical guidelines for small-scale distributed generation – Establish a work programme to develop technical guidelines or standards for domestic-scale distributed generation to reduce regulatory compliance costs and improve the safety of connecting to local networks, by the end of 2009.

Monitor the uptake of distributed generation – Establish a reporting programme through the Energy Data File that will provide information on the uptake of electricity generation of 10 MW and less, from 2008 onwards.

Consider options to further encourage additional uptake of distributed generation – Report on the progress of the uptake of distributed generation in the urban and primary production sectors, including forestry, under this strategy, by the end of 2009. Make recommendations on additional policies and programmes, including consideration of possible specific economic incentives for encouraging additional uptake of distributed generation, by the end of 2010.

Improve rural security of electricity supply – Develop demonstration projects, both on and off grid, to further identify potentials for distributed generation to contribute to security of supply in rural areas, by the end of 2010.

Marine Energy Development Fund – Administer a four-year, $8 million, contestable fund to bring forward the deployment of wave and tidal energy by facilitating the early adoption of the technology. The fund will be open for requests from late 2007. This action is also discussed in the 'Sustainable energy technologies and innovation' chapter of the NZES.

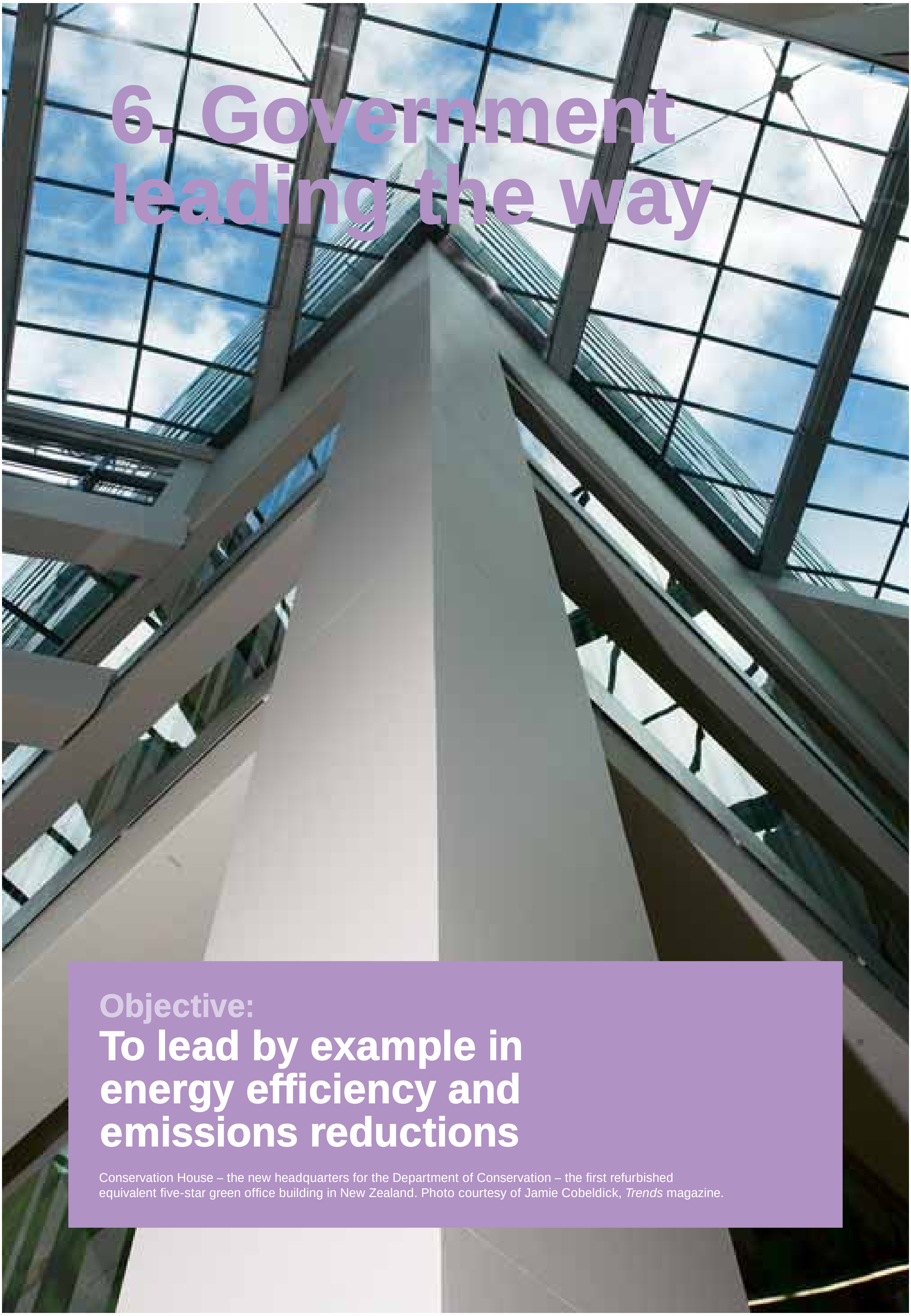
Marine energy atlas – Publish an atlas of New Zealand's wave and tidal current energy potential by the end of 2009.

Marine energy deployment standards – Establish a programme that will consider technical and industry standards for supporting the roll-out of marine energy systems from 2010.

Working with and supporting renewable electricity associations – Continue to support the Sustainable Electricity Association of New Zealand, the Aotearoa Wave and Tidal Energy Association, the New Zealand Wind Energy Association, and the New Zealand Geothermal Association, to promote the uptake of renewable energy.

See Annex 1 for an overview of the funding schemes to encourage the uptake of energy efficiency and renewable energy.

6. Government leading the way



Objective:

To lead by example in energy efficiency and emissions reductions

Conservation House – the new headquarters for the Department of Conservation – the first refurbished equivalent five-star green office building in New Zealand. Photo courtesy of Jamie Cobeldick, *Trends* magazine.

Government leading the way – Summary of actions

Action	Outcome	Delivery
6.1 Urban form and design		
New Zealand Urban Design Protocol implementation	11 case studies published in 2008; monitoring report by June 2009	MfE (Funded)
Integrated Approach to Planning project	Recommendations by the end of 2008	MoT (Funded)
Urban Design national guidance	Investigate the role for greater national guidance and make recommendations by November 2007	MfE (Funded)
Enhanced travel demand management planning	Enhanced planning capacity	Land Transport NZ (Funded)
Traffic system design and management tools	Recommendations for implementation by the end of 2009	EECA (Under consideration)
6.2 Central government		
Carbon neutral public service	Six lead core public service agencies to be carbon neutral by mid-2012. Remaining 28 public service departments to be on the path to carbon neutrality by mid-2012	MfE (Funded)
Public service procurement policies	Incorporate sustainability into a single procurement policy and make recommendations for the application to the wider state sector by November 2007	MED (Funded)
Departments to adopt a minimum five-star Green Star New Zealand rating for the construction of all new Grade A office buildings and refurbishments	Improved performance of public service accommodation	MfE (Funded)
Reduction in public sector energy use	10 per cent reduction in energy use, per full-time staff equivalent (FTE), by the end of 2012 compared with 2006/07	EECA (Under consideration)
Public service departments to have a workplace travel plan in place	15 per cent aggregate reduction in kilometres travelled by the end of 2010	MoT / Land Transport NZ (Funded)
Public service departments to reduce their average CO_2 emissions by 25 per cent per vehicle in their fleets by the end of 2012	0.20 PJ pa 13,000 tonnes CO_2 pa	MoT (Funded)
Public service departments to reduce their consumption of energy-intensive consumables such as paper	Reduction of 10 per cent by the end of 2010 from 2006 baseline	MfE (Funded)
Crown loans for government sector investment in sustainable energy	Provision of financial assistance	EECA (Funded)
Energy Domain Plan	A comprehensive database by December 2009	EECA (Under consideration)

Action	Outcome	Delivery
6.3 Local government		
The NZES/NZEECS engagement and partnership framework	Establish framework by the end of 2008	MED (Funded)
Support the development of energy strategies and RMA policy and plan making	Support programmes established by the end of 2008	EECA / MED (Under consideration)
Support local authorities to implement the Building Code energy efficiency amendments	Ongoing support	DBH/MfE (Funded)
Develop best practice tools and information for sustainable procurement for all agencies to use (including local government)	Tools and information available by December 2007	MED (Funded)
Advice and support on energy efficiency through the Sustainable Households Programme	Programme established in 2007	MfE (Funded)

The government has a responsibility to improve its own performance with regard to energy efficiency, conservation and the uptake of renewable energy. Doing so will form a key part of the government's programme for the core public service to help it become carbon neutral by 2012.

Local government has a key role to play in building more reliable, resilient and renewable energy systems. How local government manages energy issues will also have a major impact on the future use and development of these systems. Central to this will be the quality of urban form and design and how this influences the need for energy and transport services.

This chapter is presented as follows:

6.1 Urban form and design

There is an increasing awareness that quality urban form and design increases economic activity, improves community quality of life and reduces environmental impacts. These benefits can be achieved by planning for a more compact urban form, mixing land use, and ensuring greater connection within and between urban areas.

From a transport perspective, compact and mixed-use development helps ensure shorter travel distances to housing, shopping, offices and restaurants, thereby increasing accessibility to a variety of activities. Design of an integrated transport network aids this by providing easier access to numerous destinations through a range of different routes and modes of transport. A key aim is to encourage people to choose walking, cycling and public transport, rather than driving.

The New Zealand Urban Design Protocol recognises the wider benefits of good urban form and design. These include:

- enhancing community well-being by creating well-connected, inclusive places that support a mix of housing, uses and facilities
- emphasising a reduction in vehicle emissions and reduced fuel use through energy benefits
- providing environments that encourage people to become more physically active
- enhancing economic activity by providing easier access to people, goods and services
- achieving better environmental outcomes that include reduced greenhouse gas emissions and improved air quality
- encouraging innovative design that can include incorporating renewable energy sources and passive solar gain.

A number of regional and sub-regional strategies in New Zealand recognise the benefits of good urban form and design. A common feature of these strategies is an aim to integrate land use planning and transport investment decisions to reduce sprawl, increase access and reduce congestion. To help achieve this each strategy encourages an urban form and settlement pattern that focuses on intensifying key urban areas linked to transport corridors. The overall strategic intent is to increase economic competitiveness, enhance community well-being and protect the environment.

Taking action (6.1 Urban form and design)

New Zealand Urban Design Protocol implementation – Publish 11 case studies by the end of 2008 and complete a second monitoring report by June 2009. A key aim of the Protocol is to improve cross-sector commitment to quality urban design; including central and local government. The ability of the Protocol to make a difference to the quality of the urban environment depends on the implementation and success of its signatory action plans. Actions include continuing professional development workshops, establishing urban design panels and other initiatives that increase awareness of quality urban design and that demonstrate its value.

Integrating land use and transport – Complete the Integrated Approach to Planning project, and provide recommendations to central government and transport sector chief executives by the end of 2008. This project aims to promote better integration of land use, transport planning and funding. It will recommend actions to raise the capacity and capability of central and local government for making better decisions on the integration of transport and land use; for example, ways in which central government can provide guidance, and scope the development of guidelines, for integrating New Zealand's key land use and transport legislation so that any solutions are better integrated.

Urban Design national guidance – Government will decide on the desirability of providing national guidance on urban design by November 2007. This action is also discussed in the 'Resilient, low carbon transport' chapter of the NZES.

Enhanced travel demand management – Continue to work with local authorities to further develop their travel demand management planning capacity, that incorporates the use of urban design, investment planning and behaviour change tools.

Develop traffic system design and management tools for optimising traffic flows – Building on the results of a pilot study in the Auckland urban area, further investigate the use of traffic management and route optimisation as means of reducing energy use and emissions, and develop appropriate advice and tools, by the end of 2009.

6.2 Central government

Government will demonstrate sustainable outcomes in its vehicle fleet, its buildings, its purchase of equipment and consumables and the behaviour of public service employees. These will contribute to a carbon neutral public service.

Targets for central government include:

- Carbon neutral public service – Six lead core public service agencies to be carbon neutral by mid-2012. Remaining 28 public service departments to be on the path to carbon neutrality by mid-2012.
- Public service accommodation – Departments are to adopt a minimum five-star Green Star New Zealand rating for the construction of all new Grade A office buildings and refurbishments from 1 July 2007 and all new government buildings are to meet a minimum five-star rating from 2012.
- Energy use reductions – To achieve a 10 per cent reduction in energy use per FTE of premises occupied by public sector departments by the end of 2012, compared with 2006/2007.
- Workplace travel plans – Public service departments to have a workplace travel plans in place by the end of 2010 aiming for an aggregate 15 per cent reduction in kilometres travelled, including by air.
- Vehicle carbon emissions – Public service departments to reduce their average CO_2 emissions per vehicle in their fleets by 25 per cent by the end of 2012 based on a 2006/2007 baseline.

6.2.1 More sustainable government procurement

Collectively, the core government departments spend about $6 billion each year on goods and services. Sustainable procurement practices will use the government's purchasing power to grow the market for environmentally friendly services and products. This will help ensure government departments purchase goods and services that are more energy efficient, emit less carbon, produce less waste, and are accredited or environmentally certified where possible. As a result New Zealand businesses can expect to benefit from the increased market provision of these goods and services.

6.2.2 Improving information

A lack of information around the potential to make cost effective savings still remains a barrier to the design of programmes in some sectors. A comprehensive programme, the New Zealand Energy Domain Plan, is proposed to identify and improve understanding of the potential to make gains and underpin the ongoing development and implementation of programmes in the NZEECS.

The Energy Domain Plan looks out five years and beyond to clarify:

- the enduring topic areas that need to be informed by official statistics
- data sources and information that currently inform these topic areas
- statistical challenges limiting our ability to get the information needed
- topic areas that most urgently need further information and research, and initiatives that could be undertaken.

The plan will be used to inform policy development and it will be a benchmark against which future versions of this strategy will be developed.

Taking action (6.2 Central government)

Carbon neutral public service – Six lead core public service agencies to be carbon neutral by mid-2012. Remaining 28 public service departments to be on the path to carbon neutrality by mid-2012.

Procurement policies – Public service departments to have incorporated sustainability into a single procurement policy, and recommendations made on applying sustainable procurement policies to the wider state sector, by November 2007.

Public service accommodation – Departments are to adopt a minimum five-star Green Star New Zealand rating for the construction of all new Grade A office buildings and refurbishments from 1 July 2007; all new government buildings are to meet a minimum five-star rating from 2012.

Reduction in public sector energy use – Departments to take action to achieve a 10 per cent reduction in energy use per FTE. Departments will also reduce the use of energy-intensive consumables such as paper by 10 per cent.

Workplace travel plans – Departments to have travel plans in place and take actions to reduce aggregate kilometres travelled by 15 per cent. The Ministry of Transport and Land Transport New Zealand will publish guidance on sustainable vehicle procurement and workplace travel planning by the end of 2008. Adoption of measures will be mandatory in 2012, as will their use by other government departments.

Improvements to the public sector vehicle fleet – Departments will make purchasing and leasing decisions that will reduce the average CO_2 emissions per vehicle.

Energy-intensive consumables – Public service departments will reduce their consumption of energy-intensive consumables such as paper by 10 per cent by the end of 2010.

Expand Crown Loans for government sector – Decisions on expanding the Crown Loan scheme to include loans for renewable energy are expected in 2008.

Energy Domain Plan – Create and maintain a comprehensive database on energy use in New Zealand by December 2009.

6.3 Local government

Local government has a key role to play in the successful implementation of this strategy and the NZES. It has indicated a strong willingness to assist central government in the implementation of both strategies.

A number of programmes in the preceding chapters have set out actions that involve local government. This section sets out some additional actions that will help to realise the objectives of both the NZES and NZEECS.

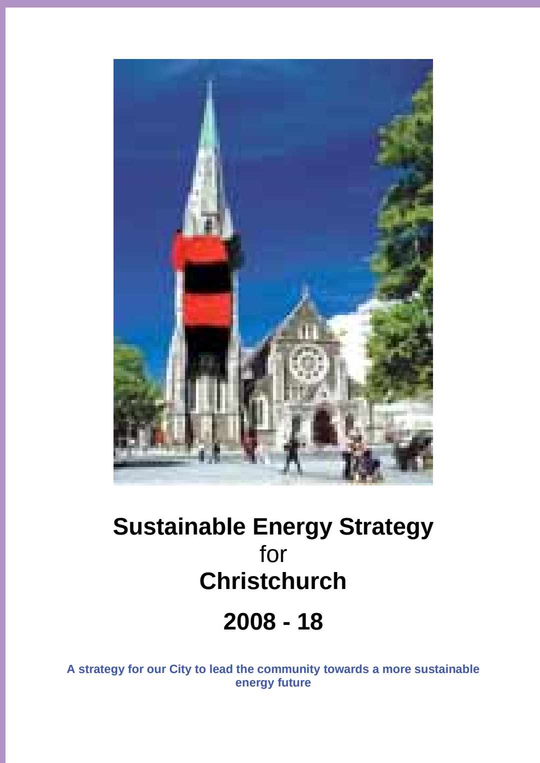
Local government has vital communications links with local householders, businesses and the energy industry that can be used to help implement many of this strategy's programmes and actions. It can also influence this strategy's objectives through its administration of the Resource Management Act, the Building Code, Regional Land Transport Strategies, responsibilities for public transport and travel demand management.

Local government, and its various subsidiaries, can be large users of energy; for example, when powering water treatment and supply systems. It has the opportunity to showcase best practice in sustainable energy technology and practices to its communities of interest. Many local authorities are already doing so and are leading the way through developing their own energy strategies and participating in the Communities for Climate Protection (CCP) programme.

Christchurch City Council

Christchurch City Council has produced a Sustainable Energy Strategy. The Council's long-term (2050) vision for the city's energy future is that:

- Christchurch's energy supplies are provided solely from renewable sources, and the city's energy systems are efficient and secure, ensuring sustainability and net zero impact on climate, local environment and public health
- Energy in Christchurch is affordable – so that all households are warm and dry, fuel poverty is eliminated and all cross sections of our community are able to afford to heat their homes to an acceptable and healthy standard
- Energy in Christchurch is affordable and secure – so that industry and commerce prosper and the city becomes attractive to more businesses and industries
- Christchurch is seen as a city that shows responsible leadership using the best sustainable energy practices and does its part in the global effort to reduce greenhouse gas emissions.



It has a target to reverse the upward trends of energy consumption and associated emissions within 10 years.

In addition, Environment Canterbury has a goal to make public passenger transport services in Christchurch carbon neutral.

The 2005 amendments to the RMA empowered regional councils with a measure of responsibility for planning for the strategic integration of electricity infrastructure and land use. This provides regional councils with a mandate to plan for their region's future renewable energy infrastructure requirements. Allowance for these new requirements can be made in second-generation Regional Policy Statements or, preferably earlier, through specific changes to plans.

Other examples of local government taking action include integrating travel demand management into transport strategies and helping government to deliver the Energywise home grants programme.

Community swimming pools

The government has granted a $920,000 Crown Loan to Dunedin City Council to improve the energy efficiency of its Moana Pool. The loan funded the installation of a new heat pump which recovered waste energy to heat pool water. In doing so it has displaced the need for around $135,000 worth of gas each year that would otherwise have been used. The system saves around 570 tonnes of carbon emissions each year.

From left, Moana Pool Manager Steve Prescott, DCC Energy Manager Neville Auton, Minister of Energy Hon David Parker, Dunedin Mayor Peter Chin, and ECCA Programme Manager Alastair Hines, 2006.

Taking action (6.3 Local government)

Establish the NZES/NZEECS framework for engagement and partnership – Promote co-operation and communication between central and local government in key areas of the energy strategies. The primary aim is to ensure local government input in designing programmes that fall within the regulatory, planning and delivery functions of local government.

Support energy strategy development and RMA policy and plan making – Provide support for local government initiatives to develop energy strategies and RMA policies and plans relating to energy matters.

Building Code amendments – Work with local government to assist them to implement the energy efficiency activities in the Building Code, with a particular focus on removing regulatory barriers and lowering compliance costs.

Develop best practice tools and information for sustainable procurement – For all agencies, including local government, to use, by December 2007.

Energy efficiency promotion – Through the Sustainable Households Programme, local government will be provided with advice and support to help promote energy efficiency and sustainability.

7. Accountabilities, monitoring and reporting

The success of this strategy depends on all New Zealanders contributing to the actions and targets – based on their own actions and responsibilities.

Most of the necessary investment in energy efficient and renewable technologies and processes will come from the private sector. New technologies will increasingly become available as the world responds to the need to reduce carbon emissions. Many of these smart technologies also improve economic efficiency and provide benefits such as health improvements.

As individuals, smarter everyday actions are necessary to reduce energy use in the home, in the workplace and in the way we travel. For example, by breaking past habits many individuals are already experiencing the benefits of smarter travel choices. Combining trips saves time and money, and using public transport avoids parking hassles. People also need to choose more energy-efficient and less intensive goods and services, as well as reduce wasteful consumption.

Central and local government need to play a role by making smarter choices easier for people to make. They must also lead from the front by demonstrating a high level of energy efficiency and uptake of renewable energy. This includes setting energy performance standards for buildings, products and vehicles they purchase or lease, and the way they manage those assets. Local government also has a major influence on future energy use by shaping community land-use patterns and transport systems.

This strategy also assigns formal accountabilities and responsibilities to government agencies. The Minister of Energy is accountable for the overall performance of the strategy.

The Ministry of Economic Development (MED) will report the progress made on implementing the NZES and the NZEECS to the Minister of Energy.

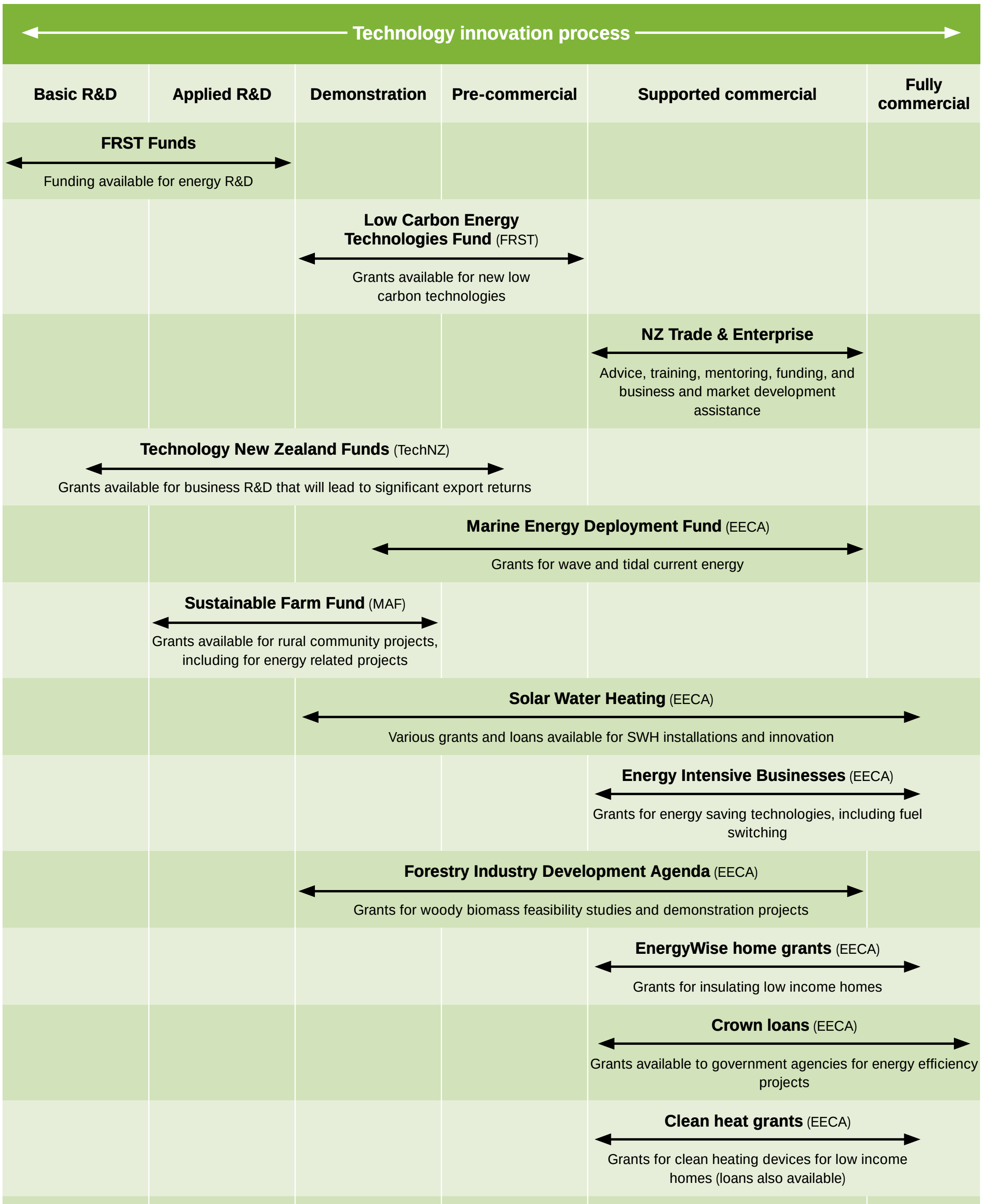
EECA has a role to play, over and above the delivery of its own programmes and actions, by monitoring sector level achievements.

MED will publish annual NZES/NZEECS progress reports. This will allow emerging problems and opportunities to be identified and actions to be taken. As a result the NZEECS will remain current and responsive to a dynamic energy policy environment over its five-year life.

The NZEECS identifies the agencies that are accountable for delivering each individual programme and meeting any targets. This includes monitoring and reporting to MED on the impact of a programme and how this contributes to the overall objective.

Annex 1: Energy efficiency and renewable energy funding programmes

Government funds available for encouraging the uptake of energy efficiency and renewable energy are set out below.



Annex 2: Glossary of terms

ARTA	Auckland Regional Transport Authority.
AWATEA	Aotearoa Wave and Tidal Energy Association.
BANZ	Bioenergy Association of New Zealand
BERS	Building Energy Rating Scheme – a system to rate the energy efficiency of non-residential buildings.
Biofuels	Biofuels are any gaseous or liquid fuels produced from biomass that can be used as a fuel for engines. They are a renewable energy source. For the purposes of the Biofuels Sales Obligation, the term biofuels refers to those biofuels which are used as a direct replacement for petrol or diesel in petrol or diesel engines, such as biodiesel and bioethanol.
Biofuels Sales Obligation	The government has announced the Biofuels Sales Obligation which requires a percentage of total petrol and diesel sales to be biofuels, starting from 1 April 2008. More information is available at http://www.mot.govt.nz/biofuels-440-index/
Building Code	The New Zealand Building Code is the first schedule to the Building Regulations and sets out performance standards that building work must meet. All new building work in New Zealand must comply with the Building Code. Clause H1 specifies energy efficiency performance requirements.
CarboNZero	A carbon neutrality auditing and accreditation scheme run by Landcare.
CO_2	Carbon dioxide, a greenhouse gas.
Co-benefits	Sustainable energy programmes usually aim to maximise a primary benefit such as reductions in energy use or cost. These same measures may also reap additional benefits such as CO_2 reductions, improved health, and reduced lost work days.
DBH	The Department of Building and Housing.
Demand-side	The load that creates the demand for energy as opposed to supply side which refers to energy generation and supply systems. Demand-side is simply on the customer side of the meter.
Demand-side management	Measures which aim to reduce either energy consumption or peaks in demand. Most often used in relation to electricity, the term includes energy efficiency demand-response measures (such as shifting load to other times or cutting load during periods of peak demand).
Distributed generation	Also known as DG, it usually refers to electricity generation connected into either a distribution network or end-users system. DG can be effective in reducing transmission losses.
EC	Electricity Commission – a New Zealand Government Crown entity.
Economic potential	Economic potential is the fraction of overall technical potential that can theoretically be realised economically in the market assuming full uptake rates. See also Market potential, Realisable potential and Technical potential.
EECA	Energy Efficiency and Conservation Authority – a New Zealand Government Crown entity.
EIB	Energy Intensive Businesses – a business that uses a relatively large amount of energy to produce its output; generally applies to a whole industry sector. EECA's Energy Intensive Businesses programme was launched in 2005 to help energy intensive businesses reduce greenhouse gas emissions and improve energy efficiency.

ENERGY STAR®	ENERGY STAR® is the global mark of energy efficiency, identifying the most energy-efficient products and appliances in a category. It is recognised and trusted in the US, Canada, Europe, Australia and Asia. In New Zealand, heat pumps, dishwashers, washing machines, TVs, DVD players, home theatre systems, computers and office equipment meeting the specification are available.
Electric hybrid vehicles	A hybrid car uses an internal combustion engine (such as petrol or diesel) alongside regenerative braking systems to provide power to the wheels while also charging a battery. An electric motor then uses the stored energy in the battery to move the vehicle at low speeds and while accelerating. This dual or hybrid drive train can use less fuel than a conventional car, sometimes only half as much.
Emprove	An EECA programme that supports the energy management initiatives of organisations that spend more than $500,000 per year on energy.
Energy efficiency	As defined by the Energy Efficiency and Conservation Act 2000, it means a change to energy use that results in an increase in net benefits per unit of energy used.
Environmental sustainability	A movement towards redesigning the ways society's needs and wants are met so that they can be accommodated within the long term carrying capacity of the environment.
FIDA	Forest Industry Development Agenda – aims to ensure the forest industry can make its optimal contribution to New Zealand's sustainable development.
FRST	Foundation of Research, Science & Technology
fuelsaver.govt.nz	A Land Transport New Zealand website that provides information about fuel consumption of vehicles available on the New Zealand market.
Geothermal	Heat from the earth's interior made available by extraction of geothermal hot water or steam. New Zealand has a world-class geothermal energy resource due to its location on an active plate boundary.
Govt³	A Ministry for the Environment-led programme for government agencies to improve the sustainability of their activities. The 3 stands for three pillars of sustainability – environmental, social and economic.
Green building	Green, or sustainable, building is the practice of promoting healthier and more resource-efficient building construction, renovation, operation, maintenance and demolition.
Greenhouse gases (GHG)	Gases in the atmosphere that retain more energy from outgoing infra red radiation than from incoming solar radiation. They include carbon dioxide, methane and water vapour.
Green Star New Zealand	A comprehensive environmental rating system for buildings. Green Star evaluates building projects against eight environmental impact categories, plus innovation. Refer to www.nzgbc.org.nz for more detail.
GWh	Giga Watt hour. One million units of electricity or 106 kWh. GWh is the normally used unit of electricity energy supply. 278 GWh is equivalent to 1 petajoule (PJ).
GWRC	Greater Wellington Regional Council
HERS	Home Energy Rating Scheme – a proposed system to rate the energy performance of houses, for example, through a star rating similar to that used on whiteware sold in New Zealand.
HNZC	Housing New Zealand Corporation.
HVAC	Heating Ventilation and Air Conditioning.
INZTS	*Implementing the New Zealand Transport Strategy*.
LPG	Liquefied Petroleum Gas.
MAF	The Ministry of Agriculture and Forestry

Mandatory Energy Performance Labels (MEPL) 	Mandatory labels under the MEPS programme.
Market potential	Market potential is the fraction of overall technical and economic potential that can actually be realised in the market assuming business as usual. See also Economic potential, Realisable potential and Technical potential.
Megawatt (MW)	One million watts. It is a standard unit for electricity generation. One MW of capacity is enough to supply the peak electricity needs of about 500 households. The Huntly power station has a capacity of 1,000 MW.
Minimum Energy Performance Standards (MEPS)	Minimum Energy Performance Standards (MEPS) specify the minimum mandatory energy efficiency requirements for selected energy-using products.
MED	The Ministry of Economic Development.
MfE	The Ministry for the Environment.
MoRST	The Ministry of Research, Science and Technology.
MoT	The Ministry of Transport.
Next Steps	The name of a government review of the transport sector.
NPS	National Policy Statement.
NZES	*New Zealand Energy Strategy* – www.med.govt.nz
NZGA	New Zealand Geothermal Association
NZWEA	New Zealand Wind Energy Association.
Petajoule (PJ)	1015 joules – approximately the amount of electricity used by a city the size of Nelson each year.
Realisable potential	The fraction of overall technical and economic potential that can actually be realised in the market including the new expanded market potential that the strategy is expected to realise. See also Economic potential, Market potential and Technical potential.
rightcar.govt.nz	A website that will provide integrated safety and sustainability information for consumers.
Renewable energy	Renewable energy utilises natural resources such as sunlight, wind, tides and geothermal heat, which are naturally replenished. Renewable energy technologies range from solar power, wind power, marine energy and hydroelectricity to biomass and biofuels for transportation.
RMA	Resource Management Act 1991.
SEANZ	Sustainable Electricity Association New Zealand.
Second-generation biofuels	Generally refers to new methods of producing biofuels. Examples include the conversion of plant lignin and cellulose into fuels by enzymes and the gasification of biomass material followed by a gas-to-liquid Fischer-Tropsch process. Biomass that could be used in these processes includes all types of trees, grasses, agricultural plant wastes, straw and algae. Second-generation biofuels are not yet ready for commercial development but are the subject of extensive R&D both in New Zealand and internationally.
SIA	Solar Industries Association.
SPARC	Sport and Recreation Council.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission definition). Sustainable development must be based on the efficient and environmentally responsible use of all of society's scarce resources – natural, human and economic.
Sustainable energy	Sustainable energy resource use and supply is an important area of emphasis contributing to sustainable development.

Technical potential	The benefits from sustainable energy that could theoretically be gained if the best-performing technologies were taken up by all consumers in the market. In practice, this level of technology uptake will not normally be achievable. For example, the amount of energy that could be produced if all of New Zealand were covered with solar panels represents the technical potential for solar energy. Technical potential is always increasing with new and emerging technologies that improve energy efficiency and that enable new renewables. See also Economic potential, Market potential and Realisable potential.
TNZ	Tourism New Zealand.
Mt CO_2	Million tonnes of carbon dioxide. Generally this refers to the CO_2 equivalent of a mix of greenhouse gases.
Travel behaviour change programmes	These typically encourage voluntary changes in personal or private travel behaviour. Programmes often provide consumer information and encouragement for people to utilise energy-efficient and sustainable modes of travel (such as walking, cycling and public transport) and to reduce the requirement for travel (such as encouraging working from home). Includes travel awareness and travel planning.
Travel planning	As a form of travel behaviour change, it typically focuses on encouraging people to travel to specific destinations (schools, workplaces, etc) by modes other than the private vehicle (such as public transport, cycling, walking, etc). Travel planning is most commonly carried out in New Zealand in schools and workplaces.
Vehicle kilometres travelled (VKTs)	Sometimes abbreviated to VKT, it reflects the distance travelled by private vehicles over a particular period of time, Importantly, it does not capture the occupancy rate of those vehicles.

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Te Tari Tiaki Pūngao

ANNEX VIII

D R A F T

THE ANGUILLA NATIONAL ENERGY POLICY: 2008-2020

The Government of Anguilla

Office of the Chief Minister: July 2008

TABLE OF CONTENTS

SECTION 1: UNDERSTANDING THE POTENTIAL CRISIS

SECTION 2: STRATEGIES FOR CHANGE

SECTION 3: APPENDICES

UNDERSTANDING THE POTENTIAL CRISIS

- SECTION I -

1.1 HISTORICAL BACKGROUND: ANGUILLA AND ENERGY INDEPENDENCE

It is historically accurate to conclude, that energy, or more exactly the absence of it, was one of the prime causes of the Anguilla Revolution of 1967. The cauldron of discontent with the Colonial arrangement of St. Kitts, Nevis and Anguilla which manifested itself as early as 1825, boiled over into a crescendo of rebellion one hundred and forty-two years later largely as a result of the glaring absence of what was then popularly considered to be four commonplace markers of modernity. Those four markers in the eyes of rebels were, (1) Political autonomy, (2) Decent roads, (3) Basic health and educational services and (4) Electricity.

It is also historically accurate to note that following the British invasion of 1969 one of the key areas of friction between U.K. officials and the former leaders of the revolution was the issue of island-wide electrification.

The insistence on the part of those Leaders for that "marker" to be obtained, continued unabated until a nascent Power Plant and Ice Plant was erected in The Valley and gradually grew in generation to expand its reach outwards from The Valley towards the east and the west, until all major villages were electrified by 1984.

In 1991 the Anguilla Electricity Company, Ltd. (ANGLEC) emerged as an efficient and well-run state-owned company. The Utility's demonstrable efficiency diminished political controversy, and a further entrenchment of the Utility's centrality to the island's political and economic life was achieved in 2003 when 60% of Anglec's shares were marketed and sold to Anguillians.

It is now evident that Anguilla has been transformed into a thoroughly energy-dependent economy. The markers of modernity have been achieved. But that achievement has been coupled to the reality of looming threats to the local environment and the economic threat of the island's total dependence on fossil fuels, a finite commodity under increasing worldwide demand.

The successful growth of a new tourist industry, boosted in 2002 by new and relatively large tourism projects have exponentially increased the demand for power as all sectors of the economy have surged with the building boom. But the demands of growing competition in the tourist sector from other facilities in the region and the world, coupled with the high and increasing price of fossil fuels, and the Island's present complete and total dependence on fossil fuels for electricity generation, has placed Anguilla's competitiveness in doubt. As of July 2008, the cost of oil has topped the US$130 per barrel mark, with constant volatility in prices, and it is forecasted that such prices will continue to rise. This high cost and its effect on electricity retail prices are further exacerbated by the island's small size and relative inability to achieve meaningful economies of scale.

In addition, the reliability of the supply of oil to Anguilla indefinitely is now in real doubt. The geopolitical risk of a conflict or terrorist attack half the world away could result in an interruption of shipments of oil to Anguilla. The interruption would only have to be for a few weeks to create enormous damage to Anguilla's economy.

With this local reality confronting Anguilla, along with the global realities of climate change, the Government and the people of Anguilla must now revisit the policies that have guided a very successful energy transformation on the island thus far, and initiate and develop a new, creative, progressive and practical paradigm shift in the development of this critical sector.

That shift must analyze with urgency the use of the only two sources of renewable energy which the island possesses in large measure---wind and solar power, and find ways to implement their utilization in order to reduce the island's dependence on fossil fuels in the short-term, and in the long term, to achieve energy independence.

Energy Independence: A Vision for Anguilla's Future

We define energy independence as the ability for the island to meet its vital energy needs with reliable, affordable and renewable energy resources. This requires the pursuit of a balanced and advantageous transition toward control of our energy future, built upon a solid and ever growing foundation of our own free, abundant, clean, and renewable energy resources---the wind and the sun.

1.2 ANGUILLA AND CLIMATE CHANGE

The environmental slogan “think globally, act locally”, is an apt and appropriate rallying cry for the need to develop and implement a new energy dispensation for Anguilla.

On the global level, the continued use of fossil fuels and the increasing levels of green house gases in the atmosphere threaten the world with the alarming possibility of sea level rise. Of all the dangerous consequences that climate change poses to the planet, including a greater frequency and strengthening of hurricanes, a rise in vector borne diseases, species loss, mass migrations, loss of productive agricultural lands etc, a minimal rise in sea level of one metre and a slight warming of ocean temperature could have devastating social and economic consequences for Anguilla.

The engines of Anguilla’s tourism-based economy, led by Cap Juluca, Altamer, Cove Castles and other hotels located on relatively low lying sand bars could face increasing erosion from higher and stronger wave action and even inundation in some places. For example, the village of Sandy Ground could conceivably become untenable, as well as areas in parts of Island Harbour, The Forest and Corito.

A warming of the ocean could result in massive coral bleaching and coral die-off which would severely impact the fishing industry with the loss of marine habitat, and the tourist industry with the degradation of snorkeling, dive sites and the general beauty of the marine environment. Coral die-off would also eliminate much of the protective and mitigating effects from ground sea erosion along the north coast provided by the Prickly Pear, Shoal Bay and other inshore reefs.

Anguilla, like most other small island developing states (SIDS) has an enormous vested interest in climate change and its potential impacts. It will no doubt be argued that Anguilla’s contribution to green house gases world-wide is so miniscule as not to warrant any serious local remedial action. This overlooks the moral question which each and every self-respecting people should face if they consider themselves responsible citizens of the planet. Carbon emissions and atmospheric pollution have no national affiliation or border controls and all nations will be negatively affected in some form or another if this trend is not arrested or reversed. Sea level rise aside, the continued and growing demand for fossil fuels increase the likelihood of marine and terrestrial spillage and pollution.

The growing prosperity of the island brings with it more vehicles and consumer goods, which will place greater stress on the island’s environment and demand increasing levels of management. Focusing on these issues is essential to ensuring orderly and controlled growth without exceeding the island’s carrying capacity.

Energy and its costs are also critical to the production of water. Advances in reverse osmosis technologies have freed Anguilla from its historic constraint upon economic growth due to the scarcity of water and the island's semi-arid climate. This technology has revolutionized the public supply of water, enabled the establishment of a golf course, giving the tourist industry a major boost, and has the potential to further enable agriculture and other water-dependant industries. It has also guaranteed that the basic right to water, and therefore to life, is ensured. However, it is also a fact that the process of reverse osmosis demands large amounts of electricity. If future costs of water produced by this method continue to be directly linked to energy generated by fossil fuels, it would mean that the cost of water, which is already quite expensive, could become prohibitive in the future, retard economic growth and severely disadvantage the poor and underprivileged. However, if Anguilla could supplement and eventually replace energy generated from fossil fuels with energy created from renewable resources, a double-win for the environment would be achieved. More water could be had for industry, agriculture, horticulture and basic needs at sustainable prices and a reduction in carbon emissions, the chief agent of climate change, would also occur.

Acting locally therefore, takes the following key environmental points into account:

(a) the island's opportunity to successfully exploit its abundance of wind and sunshine

(b) the fragility of the island's environment and the need to more fully appreciate the value of conservation

(c) the absolute importance of the healthy maintenance of the marine environment on which most of the successful tourist industry depends

(d) the need to integrate issues of energy with those of long-term social and economic sustainability

(e) the promotion of Anguilla worldwide as a leader in environmental responsibility, to the benefit of local pride and competitiveness in the tourist industry, and as a model of these values among other island communities and beyond.

1.3 MANDATE FOR A SUSTAINABLE ENERGY SUPPLY

The Government of Anguilla proposes a new mandate for assuring the sustainability of Anguilla's culture, prosperity and environmental integrity through the following goals:

1. Ensure universal access to an affordable electricity supply for all Anguillans, particularly those below the poverty line for whom basic access is still in doubt.

2. Reduce dependence on fossil fuels for power generation and transportation.

3. Use locally available renewable resources such as wind and solar power to the greatest extent possible to meet both existing and increasing demand for power generation.

4. Promote the development of technological education and expertise in the renewable power generation sectors in Anguilla for the support and advancement of a local skill base.

5. Promote aggressive energy efficiency measures and an ethic of conservation amongst the Government, Civil Society and the private sector.

6. Support ANGLEC's prudent and viable transition from primarily diesel-based to primarily renewably-based power generation.

7. Create a legislative framework for customer-generated renewable power.

8. Reduce negative environmental impact of all power generation methodologies

9. Promote through fiscal incentives a transition in the transport sector from fossil fuel powered vehicles to those that are powered by the use of hybrid, electric and hydrogen technologies.

1.4 KEY ENERGY POLICY GOALS

The sustainable energy policy goals for Anguilla represent the necessary outcomes to be achieved by the implementation of the National Energy Policy. They represent medium- and long-term outcomes and the strategy and programmes necessary to achieve them.

The key goals of the energy policy are:

1. Policies, legislation, regulations, standards and incentives that promote energy efficiency, foster the use of renewable energy resources, and facilitate the transition to and adoption of renewable energy technologies.

2. Integration of sustainable energy strategies into national sustainable development planning and programming.

3. National awareness and consensus on sustainable energy policy, and the active participation of all stakeholders in advancing the Energy Independence agenda.

4. Research and development facilities, projects and initiatives in renewable energy, making Anguilla a centre of excellence on sustainable energy self-reliance and independence among very small island state communities.

5. Development of a framework for direct and competitive participation in the emerging global carbon credit market by all stakeholders in Anguilla.

1.5 ENERGY INDEPENDENCE AND TOURISM

As Anguilla's tourism industry continues to develop, its image and brand in the world travel market place will become even more critical. The island is now facing stiff competition from other regional and global destinations eager to attract the luxury market and duplicate or outpace Anguilla's success in this area. Whatever promotional advantage Anguilla can harness in this increasingly competitive market must therefore be seized and exploited if the island is to remain as a special, unique, and sought after destination. Although the solutions to this promotional challenge are multifaceted, there should be no illusions that a very crucial facet in this construct will be the perception of Anguilla as an environmentally progressive and sustainable destination.

The global economy and global consciousness generally is rapidly approaching a tipping point in which a paradigm shift in the way we "do business" is inevitable. That shift will be grounded in a deeper understanding of what sustainability really means in terms of changing economics and the people best placed to appreciate and encourage this shift are the wealthy and educated, precisely the travel market that Anguilla has focused on since 1980. Anguilla must do everything it can to retain this market segment.

Apart from all the sound economic, social, cultural and environmental reasons stated within this document, as to why Anguilla needs to revise its energy practices and steer a new policy aggressively towards a far greater reliance on renewable energy, there needs to be a conscious realization that such a policy will help the island considerably in the battles for promotional advantage. A calculated effort to turn Anguilla "green" in fundamental and meaningful ways will be an enormous boon to the promotional efforts of public institutions and private entities that are so reliant on the tourist trade. An Anguilla that can someday boast that its source of energy is sunshine and cool breezes and its mode of transport is essentially oil free will remain an island of choice for the conscious and discerning visitor, and an island remaining true to its natural heritage.

STRATEGIES FOR CHANGE

- SECTION 2 -

2.1 FOSTERING RENEWABLE ENERGY

Renewable Energy refers to energy obtained from sources of which there is an infinite supply. It includes amongst others solar, wind, hydropower, geothermal, biomass, and ocean energy. There are currently two main commercially viable renewable energy sources available within Anguilla, these are solar and wind.

Anguilla currently depends on imported fossil fuels for electricity generation and the transportation sector. A significant aspect of fossil fuel use is price volatility, which makes economic planning difficult. The ramifications for small island nations such as Anguilla are serious. In the face of escalating oil prices and increasing competition to access a limited supply in the region, Anguilla has little bargaining power relative to larger island nations. A near-future scenario could see Anguilla unable to access sufficient fuel oil to meet its increasing demand.

The use of renewable resources will reduce the volatility of the cost of energy, in particular because renewable energy resources are indigenous rather than imported. In order to develop truly sustainable energy practices it is essential to exploit indigenous resources and support local capacity building. Foreign exchange savings and stabilization of the local energy market are important benefits to the use of renewable energy.

By initiating a transition from the exclusive use of fossil fuels for electricity generation and transportation to a greater dependence on indigenous renewable resources, Anguilla will benefit by reducing its carbon emissions, providing economic and educational opportunities for its residents and enhancing its global reputation as a leader in environmentally sound and sustainable development.

To minimize its dependence on fossil fuels and move toward energy independence, Anguilla will undertake the following steps:

POLICY RECOMMENDATIONS:

1. Identify available renewable energy sources and technologies that are practical, commercially viable and suited to the culture and economy of Anguilla

2. Draft and implement legislation and regulations to promote energy efficiency measures

3. Update current legislation to enable regulatory and legislative enactments to encourage the utilization of renewable energy sources in the energy sector

4. Environmental Impact Assessments of new energy-related projects to be mandatory

5. Encourage short and long-term programs for active research, development and training in renewable energy technologies and designs

6. Establish bilateral and multilateral cooperation programs as a means of harnessing existing expertise from within and outside of Anguilla

7. Implement appropriate pricing policies to ensure that adequate energy supplies are delivered to all economic sectors efficiently

8. Facilitate an improved and sustainable energy supply network with sufficient incentives to encourage private sector investments.

Further strategies to promote the use of renewable energy:

1. Increase public awareness of the benefits of renewable energy

2. Provide tax incentives for the use of renewable energy technologies

3. Ensure that renewable energy resources are used in an economically, environmentally and culturally sustainable manner

4. Build the local capacity to install, manage and maintain the standardized equipment necessary for sustainable energy production

5. Establish a long-term task force to stay abreast of innovations in renewable energy technologies

6. Encourage partnership in development with the private sector

7. Promote renewable energy throughout all levels of the educational system.

2.2 RETHINKING TRANSPORTATION ON ANGUILLA

Efficient transportation is essential to maintain both a growing economy and high quality of life on Anguilla. As Anguilla continues to develop at a rapid rate, the impact of vehicle transportation plays a larger and larger role in managing both of these desirable goals. In particular, the 11% annual growth of vehicle fuel consumption on Anguilla over the last eight years underscores the need for national energy and transportation policies to provide a secure, efficient, affordable, and environmentally responsible supply of energy for the transportation sector. Responsibility for implementation of these policies will, as always, be shared between several sectors of Anguillian society, including the choices made by individual businesses and residents to promote and effect these goals. But there are a number of important policy steps that must be established by Government in order to redirect from what is currently an unsustainable and destructive pattern of growing dependence on the inefficient use of expensive and polluting fossil fuels.

These goals will primarily be achieved by focusing on the many ways available to Anguilla to reduce demand for fossil fuel consumption in vehicles. These ways range from promoting public transport to increasing the use of efficient vehicles and engines. In addition, the possibility that current and emerging technologies of renewable energy production and vehicle battery storage will converge in the near future to solve several problems at once for Anguilla should be closely watched and all efforts made to take advantage of this possibility. Some expansion of these points follows, along with specific policy recommendations to pursue:

For the future, Anguilla's policy should be to adopt a demand-side approach. The vehicle and fuel tax structure should be overhauled to discriminate in favour of small engine sizes, diesel and other fuel-efficient units, such as electric hybrids and electric vehicles. Tighter controls are to be maintained when granting special concessions for heavy construction related vehicles.

With the rapid growth of the economy Government's policies must call for a comprehensive review of transport taxes and road user pricing to reflect best international practices.

Public transport needs to increase its share of the transport market, thus it must implement a high quality of service in terms of frequency, reliability and an acceptable travel time.

Constraints to the use of electric vehicles have been overcome through the use of hybrid vehicles. A hybrid vehicle integrates a gas engine and an electric motor to provide the power. Flexi vehicles use gasoline and biofuels, such as ethanol, in various proportions.

The miles per gallon performance of hybrid vehicles is better than twice that of comparable conventional vehicles, especially when driven on flat terrain at low speeds of up to 40 m.p.h. As such, Anguilla offers an ideal environment for hybrid and flexi vehicles because of its flat terrain and relatively low road speed. Hybrid vehicles are currently more expensive initially than conventional vehicles, but because of their lower operating cost, over their useful economic life the cost per mile will be much lower, particularly here in Anguilla.

Plug-in and electric powered vehicles represent a potential 'double' advantage in helping Anguilla to reach its energy independence goals. When powered from the electricity grid, they will both reduce fuel usage dramatically for average Anguillians; and once the island has reached substantial levels of renewably based energy generation, the batteries in all plug-in hybrids may also be able to serve as critically useful power storage units for supplying energy back to the electrical grid when the wind or sun is not producing.

POLICY RECOMMENDATIONS:

1. Maintain a lower level of import duty on vehicles with smaller engines than on vehicles with larger engine sizes.

2. Maintain taxation policies that provide strong incentives for the importation and use of more fuel-efficient and diesel-powered vehicles.

3. Establish fuel-efficient vehicle import standards.

4. Institute a data collection mechanism to track imports of vehicles according to fuel type.

5. Reduce import tax on hybrid, flexi (biofuel-based) and electric vehicles through a discriminatory tax regime that favours fuel diversification and fuel-efficient vehicles.

6. Introduce rigorous enforcement of vehicle emission standards, along with tax incentives for energy efficient, low-emission vehicles.

7. Pursue a reliable, frequent, high-quality mass transport system on Anguilla using a high efficiency fleet.

2.3 ENHANCING ELECTRICITY SECTOR PERFORMANCE

The primary focus of the National Energy Policy is to provide a reliable and quality supply of electricity to all sectors of society at an equitable price.

The Policy acknowledges the fact that a transition period measured in years will be necessary to switch from full dependence on non-renewable fossil fuels to a mix of renewable and non-renewable energy resources, with greater emphasis being put on renewable energy technologies as these technologies develop over time. This change must be achieved however, without compromising the reliability and quality of electricity supplies to customers of the Utility by over-accelerating the process of change.

During this transition period, there will need to be a strong emphasis on promoting greater conservation of energy through customer energy awareness programmes and demand side management strategies. Appliances for reducing the overall system energy demand on the Utility, such as solar hot water systems, energy efficient light fittings and high efficiency appliances will need to be actively promoted.

With the aim of lowering the daily peak demand, customer-driven energy conservation strategies centred around the Utility's tariff structure will be examined for possible implementation. The introduction of 'time-of-use' and 'demand' tariffs will provide either cost benefits or cost penalties to customers based on individual electricity usage patterns. For the Utility, any significant reduction in peak demand will have a retarding effect on the timing of the next generation expansion.

The National Energy Policy actively encourages plans for interconnecting neighbouring island countries, such as the planned submarine cable linking Anguilla to St Martin, St Maarten and St Barths; and to monitor the progress of the proposed natural gas pipeline from Trinidad. By doing so, neighbouring utilities will achieve economies of scale with collective purchasing and possible shared fuel storage facilities, resulting in reduced operational costs to the Utility.

The NEP (National Energy Policy) likewise encourages discussions with West Indies Power (Nevis) Ltd. and the Nevis Island Administration with regard to accessing geothermal generated electricity from that island. It has been proven that vast amounts of geothermal energy exist in many of the volcanic islands of the Eastern Caribbean. Some of these islands, including Nevis, are actively pursuing the development of this natural and clean source of energy as a means to generate a reliable electricity supply. West Indies Power Holdings B.V. is attempting to harness this energy on the islands of Nevis and Saba, generate electricity, and export it to neigbouring islands via submarine cable. This is an exciting development that should be carefully monitored and explored. However, as there will be little or no control by Anguilla over the cost and reliability of supply, or any direct interest in the infrastructure of the generation of this supply, caution will be necessary in deciding on the use of this energy as a sole or even dominant alternative to fossil fuel based electricity.

By regular benchmarking with other Caribbean utilities through the auspices of CARILEC, the Utility will continue to improve its operational efficiency. However, greater emphasis should now be put on renewable energy benchmarking in order to maintain the impetus for the change from electricity production using fossil fuels to renewable energy technologies.

The electricity tariff needs to be carefully and appropriately set in order to maintain a careful balance between fair prices for customers on the one hand, and shareholders' expectations for a reasonable return on their investment on the other.

To facilitate the policy recommendations of the National Energy Committee as it applies to the electricity sector, a thorough review and subsequent amendment of the Electricity Act and its associated Regulations will need to be carried out, in order to bring the document into line with the latest ideas and technologies pertaining to renewable energy.

POLICY RECOMMENDATIONS

1. Encourage the deployment of latest proven technologies in equipment and materials that will promote higher energy efficiencies by reducing transmission and distribution energy losses in the Utility networks.

2. Encourage neighbouring utilities in Dutch St Maarten, French St. Martin, and St Barth's to participate in collective purchasing and fuel storage programmes by interconnecting island networks.

3. Based on current studies showing technical feasibility, utilize expertise in tertiary institutions in the region to advise on engineering issues such as renewable energy technologies which may be unique to small island Utilities.

4. Implement feasible time-of-use tariffs and demand tariffs, as a means of reducing customer electricity usage.

5. Actively promote customer educational programmes pertaining to energy conservation and encourage demand side management strategies.

6. Promote energy efficient equipment technologies such as solar hot-water heaters and energy efficient light fittings.

7. Continually monitor the Utility's increasing operational efficiency with comparative benchmarking with other Caribbean electricity utilities carried out on a regular basis.

8. Review and amend as necessary, the Electricity Act and associated Regulations in order to facilitate the policy recommendations of the National Energy Committee.

2.4 GENERATING POWER EFFICIENTLY

The primary focus of the National Energy Policy in respect to power generation is to provide reliable and quality electricity to Anguilla, produced with maximum efficiency and in an environmentally responsible manner.

With the rapid growth currently being experienced in Anguilla, fuel consumption levels have increased at an average of 10% annually, reflecting an unusually high rate of electricity demand in Anguilla over recent years, which has averaged 9.7 % annual load-growth since 2003 . With Anguilla going through a period of rapid development, this high annual load-growth is likely to continue at its present rate or even higher for the foreseeable future; which will require new generating plant of around 5 Megawatts to be installed every two to three years if the present load-growth continues at its present rate.

ANGLEC must therefore be prepared to have sufficient generating plant installed in time to cater for these inevitable load-increases. An obligation, however, exists on the part of the Utility to implement proven high-efficiency, low-pollutant power generation technologies, whether using renewable or non-renewable energy resources. Impact studies of technologies that may become workable and affordable in a decade or more, must be carried out and their development closely monitored. Similarly, Utility transmission and distribution energy losses must be minimized by utilizing the latest technologies available in equipment and materials.

Agreements need to be negotiated with customers having large standby generator facilities, as a viable alternative to the Utility continuously financing and installing sufficient generating capacity to meet the system energy and peak demands as well as maintaining adequate reserve margins.

Smaller independent power producer's utilizing solar panels or small wind-power generators will also be considered for 'feed-in' agreements, should the technology be capable of being safely and efficiently integrated into the Utility's electrical network. Equally important is promoting strategies for extending the life of fossil fuel reserves. Should it prove economically viable, a reduction in the dependence on fossil fuel can be achieved by fuel diversification; namely the blending of fossil fuels for electricity generation with renewable bio-fuels.

The Anguilla Electricity Company Ltd is committed to actively pursuing over the coming years the aims and aspirations of an Energy Policy explicitly designed for Anguilla's unique situation, that will provide electricity efficiently and in an environmentally sensitive and responsible manner to all Anguillians. The following Policy Recommendations provide the blueprint to achieve this goal.

POLICY RECOMMENDATIONS

1. Identify, develop and promote alternative or renewable energy resources, technologies and systems for supplementing current diesel power generation using renewable energy resources.

2. Promote the deployment of advanced high-efficiency, low-pollutant power generation technologies such as low-emission diesel generation, and monitor developing technologies for possible future implementation.

3. Investigate, and if found economically viable, reduce the amount of non-renewable fossil fuels needed for electricity generation by blending with renewable bio-fuels.

4. Encourage agreements with customers having large standby generator facilities, whereby additional generating plant can be called upon, if or when required.

5. Investigate feed-in agreements between the Utility and small IPP's using renewable energy resources such as solar panels or small wind-generators, and implement provided that all safety and integration issues have been adequately addressed.

6. Monitor closely new and emerging technologies to supplement renewable energy technologies as a long-term strategy.

2.5 PROMOTING ENERGY EFFICIENCY AND CONSERVATION

The significance of reducing energy usage through increased efficiencies cannot be overstated when talking responsibly about renewable energy investments. The one must equal the other in order for the strategy to be viable. As the formula goes: “Renewable energy plus energy efficiency equals energy independence: or RE+EE=EI.” To the consumer, it holds the greatest power to actually reduce current monthly electricity costs. And to the investor, whether ANGLEC, individuals or businesses who may participate in generating renewable power in the future, it holds the promise of maximizing returns while meeting goals of providing least cost electricity to the customer.

The goal of energy efficiency is to use less energy for the same services, both at the point of supply and at the end use. Improvements in energy efficiency can reduce energy costs by up to 30%. Globally only 37% of energy consumption is converted to useful energy, thus there is great potential for improvements in energy efficiency, measured in what are known as “negawatts” --- electricity saved rather than generated.

Strategies to encourage energy efficiency will help to moderate environmental problems as well as save energy in spite of the expected growth of Anguilla’s demand for energy. Energy intensity – the amount of energy used per unit of activity - is the inverse of energy efficiency. The energy intensity of our activities depends on how equipment is designed, operated and maintained, how well capacity is utilized, and also on the type of energy used. In Anguilla today, energy intensity is high and must be reduced.

To optimize the use of energy it is important to implement measures to minimize its consumption and intensity, and increase the efficiency of its use. Often these measures are at low or no cost, and therefore should be implemented immediately. In addition, this is an area in which widespread public education to promote literacy about personal energy usage can yield great savings, personal motivation and long-term influence over helping to create a nation of energy conscious and energy independent users.

POLICY RECOMMENDATIONS

1. A National Energy Code for buildings, which will address building for energy efficiency in a comprehensive fashion, is required. The code should demand that all new buildings meet or exceed minimum standards that will provide a cost effective degree of energy efficiency. The code should cover, among other aspects, lighting, ventilating, air-conditioning systems, water heating systems, and electrical power requirements.

2. The energy efficiency of consumer products should be identified wherever possible by product labeling and by verification through a local and regional Standards agency.

3. Government should emphasize fuel efficiency in vehicles, imposing progressively higher taxation on vehicles with larger and less efficient engines.

4. Government should provide incentives for the use of energy efficient lighting and new high-efficiency appliances through tax measures, including lesser import duties and loan programs through local lenders. At the same time, Government should provide disincentives for the use of incandescent bulbs, inefficient refrigerators, air conditioners, etc.

5. The Utility should institute Demand Side Management (DSM) as an important element of long-term resource planning. The objective of DSM actions is to develop programs that modify consumer loads with resulting benefits to the consumer, the utility and society.

6. On the supply side, as part of least-cost or integrated-resource planning, the utility should approach future planning by evaluating all options, emphasizing flexibility and low-risk, improving customer relations, reducing pollution and implementing least-cost growth.

7. In order to change the national perception of energy efficiency, efforts should concentrate on public awareness and 'energy literacy', and on promoting a sound attitude toward efficiency among school children through school curricula.

8. Actively promote best practice energy efficient building designs that utilize natural ventilation, day-lighting, extensive natural shading and other sustainable design techniques.

9. Introduce energy audits as regular and standard practice in all commercial and industrial and residential structures.

10. Institute regulatory policies that assure that Anglec receives an equal or greater return on investments in Energy Efficiency compared to traditional investments in Energy Supply.

11. Accessing international financing resources through the carbon credit market and other identified sources.

RE	**+**	**EE**	**=**	**EI**
Renewable Energy	+	Energy Efficiency	=	Energy Independence

2.6 FINANCING RENEWABLE ENERGY

Financing a national energy policy founded on the development of renewable energy and the pursuit of energy independence requires using the emerging financing opportunities carefully. The national energy policy will promote and facilitate the reduction of dependence on oil for the generation of Anguilla's energy needs. It will promote and facilitate research, development, pilot testing and commercial roll out of alternative and especially renewable energy technologies and systems. It will also encourage the adoption and use of more fuel efficient methods in oil powered electricity generation, the switch to hybrid fuel vehicles and vehicles that use primarily bio-fuels as well as battery powered vehicles to reduce the level of automobile emissions. The policy will also promote education and cultural awareness that will change the patterns of consumption of energy to generate demand and preference for renewable sources of energy to create a sustainable level of energy independence.

Financing options required to deliver on the objectives in the National Energy Policy will need to be diverse and creative to respond to the dynamic and changing scenarios that will evolve as the national energy policy is implemented over the short, medium and long term. The options that Anguilla should consider and explore range from traditional financing methods currently employed by Anglec to sustain and expand its existing operations, to new approaches stimulated by the need of the international community to respond effectively to the environmental threat posed by the high and increasing levels of carbon emissions into the atmosphere from the burning of fossil fuels.

Renewable Energy Financing Options:

1. Commercial bank financing of commercially proven and viable energy technologies.

2. Capital market debt financing of commercially viable and proven energy technologies.

3. Private and/or public equity financing of commercially proven and viable energy technologies.

4. Carbon trading under the Kyoto protocols for research and development and new energy technologies.

5. Venture capital financing of the research development and pilot testing of renewable and alternative energy technologies and systems.

6. Public grant financing for research, development and testing from governments, bilateral and international agencies.

7. Private foundations (and other entities) grant financing

8. Tax rebates and drawbacks by the Government for renewable energy ventures.

9. Commercial bank financing at special rates to consumers and businesses investing in energy saving and renewable energy solutions to their energy needs.

10. Tax concessions to consumers and businesses investing in energy saving and renewable energy solutions to their energy needs.

2.7 BUILDING A BROAD COMMUNITY MOVEMENT

If Anguilla is to achieve its goal of energy independence, all stakeholders in society must be drawn into the effort. A broad social movement to attain 'energy literacy' and to actively share public awareness about energy usage on the island is critical among individual residents young and old, government officials, tourists, and all professional and business sectors.

This challenge is an opportunity to mount a broad-based effort that is not restricted to technical and policy expertise, but will also need to draw the participation and skills of Anguillians across society. Particular early emphasis must be placed upon planning a campaign that will result in a new and larger identity for Anguilla as a self-reliant and forward thinking society with regard to its fragile environment and its energy usage.

To succeed, this effort must also extend to the untapped large global market for eco-tourism, and the strengthening of Anguilla's identity abroad as a 'green island' destination among globally conscious tourists who will help Anguilla achieve its new energy and environmental goals.

An important marker of success in this effort will be the development of a local skill base in energy technology that would provide Anguillians with an exportable skill, and an international conferencing market that will bring not just tourists but international professionals to Anguilla in all seasons to focus on renewable energy training and transition.

POLICY RECOMMENDATIONS

1. Establish a permanent Energy Committee for the overall supervision and coordination of the Energy Policy, with a professional PR/Marketing/Outreach position as a permanent member or consultant.

2. Develop an overall strategy and budget needed to educate all constituents and stakeholders as to the need for, and basic elements of, Energy Independence.

3. Conduct an analysis and collection of input from all stakeholder groups and their specific issues related to an awareness campaign.

4. Develop a 'brand' for the energy independence awareness campaign.

5. Create a working network among existing civic, church, educational, and community groups to gain input, support, and participation in the Energy Independence Plan and its implementation.

6. Coordinate efforts with the Anguilla Tourist Board and the Anguilla Hotel and Tourism Association toward marketing to and educating tourists about Anguilla's Energy Independence Plan.

APPENDICES

- SECTION 3 -

APPENDIX A: GLOSSARY OF TERMS

CARILEC: The Caribbean Electric Utility Service Corporation is an association of electric Utilities, suppliers, manufactures and other stakeholders operating in the electricity industry in the Caribbean. CARILEC was established in 1989 with nine (9) members as part of an electric Utilities modernization project funded by USAID and implemented by NRECA under a five-year "Co-operative Agreement".

Bio-Fuel: fuel (diesel, alcohol or gas) produced from biomass (fresh organic materials – manure, domestic waste, plants/plant parts, etc) via processing or enhanced natural de-composition and subsequently referred to as biogas, bio-alcohol or biodiesel.

Carbon Credit: A permit that allows the holder to emit one ton of carbon dioxide. Cred-its are awarded to countries or groups that have reduced their greenhouse gases below their emission quota. Countries or groups which do not utilize their credits or emit less than they are allowed to emit can then transfer the credits through trading at market prices, resulting in a profit from investments on low carbon-producing technologies.

Climate Change: This is any long-term significant change of an area in the "average weather conditions" such as rainfall, temperature, sunlight, winds. Climate change is used to refer to changes in weather conditions brought on primarily as a result of human industrial and urban practices.

Coral Bleaching: the loss of color from corals when the attached single cell algae (which gives the coral the color) is released due to stress caused by changes in the water chemis-try, sedimentation, sunlight, temperature, salinity or pathogens such as sewage release.

Coral Die-Off: the mass loss of coral reef primarily (in recent times) as a result of coral bleaching.

Demand-Side Management: DSM is also referred to as energy demand management and it entails actions that influence the quantity or patterns of use of energy being consumed by end users; such as actions targeting reduction of peak demands during periods when energy-supply systems are constrained. Peak demand management does not necessarily decrease total energy consumption but could be expected to reduce the need for investments in networks and/or power plants.

Energy Efficiency: the relative measure of energy lost from the production to consumption of energy. Increases in efficiency are equivalent to energy saved by the consumer and production not required by the supplier.

Energy Intensity: This is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP. High energy intensities indicate a high price or cost of converting energy into GDP. Low energy intensity indicates a lower price or cost of converting energy into GDP.

Flex Vehicle: A flexible-fuel vehicle (FFV) or dual-fuel vehicle (also sometimes called only flex-fuel) is a vehicle that can typically use different sources of fuel, either mixed in the same tank or with separate tanks and fuel systems for each fuel. A common example is a vehicle that can accept gasoline mixed with varying levels of bioethanol (gasohol) . Some cars (see bio-fuel) carry a natural gas tank making it possible to switch back and forth from gasoline to natural gas.

Fossil Fuels: fuel (gas, oil, gasoline, diesel) from natural gas reserves or petroleum base compounds stored in the earth's crust subsequent to millions of years of fossilization of organic matter. Therefore a non-renewable resource.

Greenhouse Gases: harmful gases which persist in the atmosphere and absorb or reduce the outward flow of short wave radiation emitted primarily from the earth's surface.

Hybrid Vehicle: a vehicle powered by two or more distinct sources of energy or fuel; electricity from a battery and biogas, etc.

Kilowatt: The kilowatt (kW) is the equivalent to one thousand watts. This is commonly used to state the power output of engines and the power consumption of tools and machines. A kilowatt is roughly equivalent to 1.34 horsepower.

Megawatt: The megawatt (MW) is the equivalent to one million watts or one thousand kilowatts.

Negawatt: the ability to reduce, on command, the electrical load on the power grid during a given time of need; when departments of companies turn off lights and cut back air conditioning in their offices the overall electricity in use is reduced, the amount of megawatts of "load" taken off the grid is referred to as "negawatts" – negative watts.

Plug-In Vehicle: a vehicle for which its fuel or energy source is entirely or in part supplied through the connection of a plug to an electrical power source for recharging.

Renewable Energy: energy produced by renewable resources such as wind and sun, or by fuel or fuel based products which can be replenished faster or at the rate at which it is being consumed.

Reverse Osmosis: is a separation process used for the desalinization of water that uses pressure to force a solution through a membrane that retains the solute on one side and allows the pure solvent to pass to the other side where it is in low concentration; this requires the input of energy since it is the reverse of naturally occurring osmosis.

Sustainability: the ability of a system or process to be maintained almost indefinitely or for extremely long periods at an optimal operating level.

APPENDIX B: RESOURCE LIST

The following relevant documents are available for perusal at the Department of Environment:

CARILEC Energy Policy

OECS Draft Energy Policy

St. Lucia Draft Energy Sector Policy and Strategy (A Green Paper for Discussion)

Barbados Draft Energy Policy

Solomon Islands Draft Energy Policy

World Bank Report on OECS Energy Options

APPENDIX C: Members of the National Energy Policy Committee

David Carty - Chairman

Fabian M. Fahie – Steering Group Deputy Chairman

Karim Hodge – Steering Group Executive Director / Director, Environment

Beth Barry - Steering Group Secretary / Liaison to NGO/Private Sector

Rhon Connor - Steering Group Asst. Secretary

Keith David, - Co-ordinator Conservation Education, Department of Environment

Neil McConnie- General Manager, Anguilla Electrical Company [Anglec]

Thomas Hodge – General Manager Designate, Anguilla Electricity Company Ltd

Michael Nation – Anguilla Electricity Company Ltd

Crefton Niles – Director Public Utilities - MICUHAF

Trudy Nixon – Executive Director, Anguilla Hotel and Tourism Association

Aidan Harrigan PhD. – Permanent Secretary, EDICT

Larry Franklin – Permanent Secretary, MICUHAF

Peter Reynolds – Liaison to NGO/Private Sector Member

Peter Lillienthal PhD. - Energy Consultant

ANNEX IX

Government of Bermuda
Ministry of Energy, Telecommunications and E-Commerce

Department of Energy

Energy Green Paper

A National Policy Consultation on Energy

Purpose of Consultation

The Bermuda Government considers it vital to have broad public consultation to accompany this Energy Green Paper. This will form the foundation for Bermuda's future energy strategy. All interested parties are welcome to put forward comments and suggestions as part of this consultation process.

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Table of Contents

List of Figures

Glossary of Terms

Alternative Energy: In the context used within this paper, an energy source which does not rely on imported oil.

Anaerobic Digestion: The process using of micro-organisms to break down biodegradable material in the absence of oxygen, producing a biogas that can be used to generate electricity and heat.

Availability Factor: Describes the reliability of power plants. It refers to the number of hours that a power plant is available to produce power divided by the total hours in a set time period, usually a year.

Base Load Demand: The minimum continuous demand for electricity over a given period of time, which is calculated based on historical demand from consumers.

Base Load Plant: Electrical generating units that are principally operated to supply power to meet base load demand requirements. As such, they are often operated continuously, at a steady output.

Biomass: The total mass of living matter within a given unit of environmental area; plant material, available on a renewable basis including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, aquatic plants. These materials can be used as fuel or an energy source.

Biofuel: A fuel that has been derived from biomass, for example, biodiesel and bioethanol.

Carbon Dioxide: The main greenhouse gas, it is a necessary by-product from any reaction of carbon containing fuels with oxygen. Living organisms produce carbon dioxide through respiration and many man-made processes produce carbon dioxide through combustion.

Capacity or Load Factor: The ratio of a power plant's average energy production to its maximum continuous rated energy production capability.

Climate Change: A large scale, long term, change in the climate.

Coal to Liquids: The process of converting coal to liquid fuels.

Cogeneration: The simultaneous production of two or more forms of useable energy, often electricity and heat, from the combustion of a single fuel source.

Combined Heat and Power: See Cogeneration.

De-manufacturing: The dismantling of products at the end of their useful lifecycle, in order that their constituent parts may be reused, recycled or disposed of separately.

Dish Concentrator: A solar collector that uses reflective surfaces to concentrate sunlight onto a small area, where it is absorbed and converted to heat or, in the case of solar photovoltaic (PV) devices, into electricity. Concentrators can increase the power flux of sunlight hundreds of times. The principal types of concentrating collectors include: compound parabolic, parabolic trough, fixed reflector moving reflector, Fresnel lens, and central receiver. A (PV) concentrating module uses optical elements (Fresnel lens) to increase the amount of sunlight onto a PV cell. Concentrating PV modules/arrays must track the sun and use only the direct sunlight because the diffuse portion cannot be focused onto the PV cells. Concentrating collectors for home or small business solar water heating applications are usually parabolic troughs that concentrate the sun's energy on an absorber tube (called a receiver), which contains a heat-transfer fluid.

Dual Metering: Also known as 'Net Metering' is bi-directional metering of electricity between a large central utility and a small independent power producer with an alternative/renewable energy technology installation. The rates charged either way are agreed in contract prior to any power transfer.

Electric Grid: The infrastructure necessary to deliver electricity between generators and end-users.

Electrolyte: A substance containing free ions that is electrically conductive.

Energy Conservation: The avoidance of the consumption of energy.

Energy Efficiency: The use of less energy to achieve the same end result.

Energy Management: Is the sum of measures planned and carried out to achieve the objective of using the minimum possible energy while the comfort levels (in offices or dwellings) and the production rates (in factories) are maintained.

Feedstock: A raw material that can be converted to one or more products.

Fiscal agent: An entity or person contracted by the Department of Energy to assist in the financial management of the Sustainable Energy Utility.

Flex Fuel: A vehicle which may operate on more than one fuel, such as mineral diesel and bio-diesel.

Freshwater Lens: An underground pool of freshwater that floats on top of a brackish or salt water base of ground water and takes the shape of a lens, commonly found underneath coral or limestone islands. In itself, this freshwater lens is a fragile resource.

Gas to Liquids: The process of converting gaseous fuels to liquid fuels. It is a refinery process, which converts short-chain hydrocarbons into longer-chain hydrocarbons.

Geothermal Energy: Energy produced by the internal heat sources include: hydrothermal convective systems; pressurized water reservoirs; hot dry rocks; manual gradients and magma. Geothermal energy can be used directly for heating or to produce electric power.

Global Warming: A long-term warming of the Earths' climate due to the greenhouse effect and largely attributed to human activity.

Greenhouse Gas: Any gas which contributes towards global warming. These are gases such as water vapour, carbon dioxide, tropospheric ozone, methane, and low level ozone that are transparent to solar radiation, but opaque to long wave radiation, and which contribute to the greenhouse effect.

Hedge Fund: A Hedge fund is a private and largely an unregulated pool of capital whose managers can buy or sell any asset. In the case of oil prices and oil futures, Hedge Fund managers speculated on falling as well as rising oil prices on the chance they would make large profits.

Hydrogen Economy: The theory of an energy infrastructure based around the use of hydrogen as an energy storage medium.

Installed Capacity: The maximum continuous power output available from an electrical generator, sometimes referred to as the name-plate rating.

Intergovernmental Panel on Climate Change: Established in 1988, a body of scientists who survey worldwide scientific and technical literature and publish assessment reports that are widely recognised as the most credible existing sources of information on climate change.

Kilovolt: Equal to one thousand volts, a volt is the unit used to measure difference in electrical potential.

Kilowatt: A standard unit of electrical power equal to 1,000 watts. One kilowatt can power ten 100 watt light bulbs.

Kilowatt Hour: A unit of energy equal to one kilowatt of power expended for one hour; the standard unit of measure used for electrical billing.

Kyoto Protocol: An international agreement under the United Nations Framework Convention on Climate Change that sets legally binding greenhouse gas emissions targets for signatory countries. The agreement was negotiated in 1997 and required that the UK makes an 8% reduction on the 1990 levels of greenhouse gas emissions by the period 2008 to 2012.

Mariculture: The cultivation of marine organisms in their natural environment.

Megawatt: One Megawatt equals 1,000 Kilowatts.

Municipal Solid Waste: Waste material that includes durable goods, non-durable goods, containers and packaging, food waste , yard trimmings, inorganic wastes from households and businesses in a community that is not regulated as hazardous.

Net Metering: See Dual Metering.

Oil Sands: Sands containing a form of tar like hydrocarbon, which may be removed by heating to produce liquid oil.

Parabolic Trough Concentrator: See Dish Concentrator.

Pelamis: A wave energy technology developed by Pelamis Wave Power Limited that has reached commercial production.

Peak Oil: The theory that oil production rates will reach a peak and then enter into a permanent decline.

Photovoltaic: Technology that converts sunlight directly into electricity.

Proton Exchange Membrane: A membrane commonly found in hydrogen fuel cells that is permeable to protons, whilst being an electrical insulator.

Renewable Energy: Energy that is obtained from naturally occurring sources which are replenished within our lifetimes. Commonly includes, but not limited to solar, wind, ocean wave, ocean thermal, geothermal, hydro and tidal.

Seasonal Energy Efficiency Ratio: A commonly used rating of how efficiently residential air conditioning system that performs over an entire cooling season.

Shale Oil: Oil derived from distillation of rocks rich in hydrocarbons.

Smart Meter: Advanced type of usage meter, which is capable of providing significantly more information on consumption patterns than conventional meters and is often capable of net or dual metering. Most smart meters can measure how much energy is used, and then communicate this information to another device, which in turn allows the consumer to view how much energy they are using and how much it is costing.

Solar Tower or Solar Chimney: A hollow tower that uses convection of air heated by solar thermal collectors to drive turbines to generate electricity.

Spinning Reserve: Electric generation equipment that is on line and running at low power, It is ready to generate power immediately to meet an increase in demand or failure of another generator.

Symbiotic: A close, prolonged association between two or more organisms, which is mutually beneficial.

Thermosiphon: Type of solar hot water system that uses the difference in density between hot and cold fluids to circulate water through the system.

Foreword by the Minister of Energy, Telecommunications and E-Commerce

The question of energy in Bermuda is a large and ever present issue. Our continued reliance on oil and the increases in our energy consumption are problematic and must be addressed. Today we face the critical challenge of developing sustainable, reliable and affordable energy, and the Government of Bermuda is determined to meet this challenge.

When the Government adopted the March 2008 Sustainable Development Implementation Plan, it was noted that sustainable development is not possible without a progressive energy agenda. To achieve this agenda, the Government created the Department of Energy. A key element of the department's mandate is to gain an in-depth understanding of the global supply and demand for crude oil and petroleum products, and the way this influences the price of energy in Bermuda.

To develop this understanding, we will draw on the daily energy experience of the average Bermudian. We will put these experiences into a broader context from reputable sources that include energy, financial and environmental organizations, such as: the US Energy Information Agency; the International Energy Agency; the Bermuda Government's Ministry of Finance; the Department of Planning within the Ministry of the Environment and Sports; British Petroleum; Esso Bermuda Ltd.; the Bermuda Electric Light Company (the electric utility); Rubis Energy Bermuda Limited; the Bermuda Institute of Ocean Sciences and various other non-governmental organisations. Of course, we will not overlook the most important source – the people of Bermuda.

Global demand for energy is increasing and carbon dioxide emissions associated with the use of fossil fuels are expected to rise 60% worldwide by the year 2030. Future changes in global petroleum production and distribution represents serious supply and demand issues to Bermuda. The cost of imported fuels has pushed Bermuda's electricity rates among the highest in the world.

Other global factors such as worldwide investment speculation in the oil and commodity markets, geo-political tensions, a weak US Dollar, and weather extremes that include both severe drought conditions and record floods compound the potential problems we face. Given our location and size, Bermuda could be significantly affected by these world events. We must act quickly and responsibly.

The Department of Energy's mission is serious yet stimulating. We are striving to become world leaders in the transition to a society reliant on sustainable and green energy sources, as we diligently work toward breaking our dependence on foreign oil, forging Bermuda's first steps toward self-reliance.

We already set an example in water harvesting, and have, perhaps unwittingly, for generations. It was necessity and local ingenuity that effected this achievement. We have an opportunity to do the same with our energy needs. We have an abundant supply of free resources—sun, wind, and waves. We must apply that same economy of means, economy of effort, and economy of scale that we have in the past, and utilize those resources, and perhaps some yet undiscovered, to set that example again.

Energy Conservation, Efficiency, Energy Renewable and Alternative is the new reality of the 21st century and, as a responsible world leader in business, finance, insurance, and re-insurance, Bermuda must do its' part. This Energy Green Paper summarises information about Bermuda's current energy sources and usage. It also lays out options that will help us to harness indigenous energy supply streams, conserve and efficiently use our energy resources and adopt technologies, policies, legislation and incentives that will help us achieve our energy goals.

In order to ensure public involvement in this part of the process, the Department of Energy will continue its broad consultation process, and seek the insights of our own citizens as well as overseas consultants. We are committed to forging relationships between Government, industry, utility, non-government organizations and end users. To this end, we will engage the public in another series of Town Hall Meetings across Bermuda.

Developing and researching new energy policies, rules and regulations will help in discovering and implementing new energy solutions and the appropriate governance and governance models necessary for our successful path to the future. Understanding energy policies, rules and regulations, will help in discovering and implementing emerging energy solutions and the appropriate governance necessary and the appropriate governance models necessary for their successful implementation. Working together, all of us will meet the challenges to move Bermuda towards energy security.

The Honourable Terry E. Lister, JP, MP

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Executive Summary

The Department of Energy was formed in January 2008 to address energy related issues identified in the Sustainable Development Implementation Plan. A series of nine Town Hall Meetings across Bermuda were commissioned to engage residents to begin the public dialogue in search for solutions to these issues. Out of this, considerations for an energy strategy in Bermuda were discussed, and this paper was created to lead the way forward.

Part 1 - Issues with World Energy Supply and the State of Energy in Bermuda

Source of energy exist in many forms and we may convert it from one form to another to satisfy our requirements. Some forms of energy are naturally replenished and may be used on a sustainable basis, while others occur in limited supply. We may choose which of these resources and how much of each we use, though the costs vary widely depending on these choices. Electricity is instantly produced to meet demand, so a higher value is placed on energy sources which may provide power exactly when it is required.

Oil has powered the world for more than a century and demand for this oil is constantly increasing although the world-wide economic slowdown has forced deep cuts in oil demand and price. Despite this, oil is still a finite resource and inevitably this will lead to a gap in supply and demand. Peak oil describes the inevitable peak and consequential decline in world oil production and has been estimated by many industry experts to be occurring soon, if not already. Oil prices are highly unstable and very sensitive to many factors, notably the depletion rates of known reserves. If timely action is taken to reduce our almost complete dependency on oil in Bermuda, we will mitigate the effects of the inevitable rises in cost and difficulties in securing supplies.

To further compound the problem of using oil as Bermuda's main source of energy, its combustion produces greenhouse gases. These gases contribute toward climate change, the most important environmental and economic issue of our time, which will have profound effects on Bermuda. Fortunately, there are many solutions that we may draw upon to solve our energy challenges.

Fuel imports to Bermuda have increased every year for the past decade, mainly due to transportation fuel use. In 2007, Bermuda imported a total of 1.76 million barrels of fuel, of which, just over 1 million was used by the electric utility to produce electricity. The electric utility progressively improved their efficiency, thereby allowing them to use almost the same amount of fuel for the past five years, despite an increasing demand from consumers over the same period. The Tynes Bay Waste to energy Facility contributes 2.2% of our annual electrical generation. Metering of electricity in Bermuda is currently unregulated and handled by the electric utility.

Part 2 - Finding Energy Solutions for Bermuda

The potential for reducing energy demand in Bermuda through conservation and efficiency measures is significant. By applying incentives such as the Customs Tariff to regulate the importation of key energy consuming technologies such as air conditioning systems, lighting products, other electronic appliances and vehicles, Bermuda can move toward more efficient use of energy.

Conservation can be adopted with little capital cost, though it is only reasonable to expect most people to conserve energy up to a certain point, beyond which it becomes inconvenient in their day to day activities. Conservation measures may be used in both residential and commercial arenas, reducing the increasing cost of living and improving profitability respectively.

Energy cannot be effectively managed if it cannot be measured. Smart metering technology offers easy to access, real-time electricity use data. Smart meter trials in other jurisdictions have shown up to a 15% reduction in electricity use as a result of consumers changing their consumption patterns based on the information provided by the smart meters.

The electric utility and end user may benefit from introducing a time of use rate structure, which provides an incentive for consumers to reduce peak demand and provides an opportunity for savings. These meters also permit two-way metering; enabling independent power producers to sell electricity back to the utility at a predetermined rate, this is essential in encouraging the uptake of alternative and renewable technologies.

Bermuda has a diverse mix of indigenous renewable energy resources. It makes both environmental and economic sense to invest in these technologies as most are environmentally benign, are not subject to rapid price fluctuations, and allow for the investment of millions of dollars back into the local economy, rather than to foreign oil companies. Wind and solar energy are both well developed and attractive solutions, whilst developing technologies such as wave energy and ocean thermal energy conversion also offer potential. The current waste to energy facility is to be expanded to produce more power using the same amount of waste, while combined heat and power systems make effective use of heat energy which would otherwise be lost. Globally, alternative options for transportation are somewhat limited, although Bermuda's small size offers opportunities not found in other jurisdictions. For example, the limited driving range of electric vehicles has discouraged their use in the US, but the small size of Bermuda means this is not an issue.

A key issue with alternative and renewable technologies is their intermittent nature. This causes difficulties with matching energy supply to demand. The value of energy is greatly increased if it can be supplied on demand, thus the ability to store energy in large quantities improves the economics of alternative/renewable energy projects. Hydrogen offers the potential to store energy on a large scale, although this is currently still in development. Hydrogen fuel cells offer a means to convert the energy in hydrogen directly to electricity at relatively high efficiencies. They may have applications ranging from personal transportation to utility scale energy production. Flow batteries are a commercially available energy storage technology. They can replace fossil fuel powered plant that supplies peak demand by using more efficient base load plant or alternative/renewable energy to charge the batteries.

Part 3 - Bringing Energy Solutions to Bermuda

The high cost of electricity in Bermuda is a strong driver for alternative/renewable energy technologies. Clear policies on grid connection and the rates paid for power produced from these technologies will offer a strong incentive for their uptake. Whilst transportation fuels are also relatively expensive, our small size reduces the impact of these costs.

Since the 1970's oil shocks, governments in countries such as Denmark, Germany and the UK have taken energy policy more seriously. This has led to the formation of many national energy policies, each with varying degrees of success. These policies have provided excellent examples, both in terms of their successes and their failures. Looking at these policies, some of the key features have now become generally accepted principles, on which successful energy policy may be based. There are many incentives which can be used by the Bermuda Government for the Department of Energy to fulfil its mandate. These range from creating national energy targets, to the adjustment of duty rates for selected goods.

The Department of Energy is responsible for developing energy related policies and legislation, while a Regulatory Authority will be established to oversee regulation of the energy sector. The Regulatory Authority is likely to be required to regulate prices and fees in a fashion that promotes competition and encourages alternative/renewable energy technologies. Administration requirements will be minimized by combining the Energy Regulatory Authority with the proposed Telecommunications Regulatory Authority.

The Department of Energy looks forward to receiving comments and suggestions inspired by this Energy Green Paper. A brief series of questions has been provided to help guide your responses in Appendix 5.

Part 1

Issues with World Energy Supply and the State of Energy in Bermuda

1 Introduction

1.1 The Department of Energy

The Bermuda Government established the Department of Energy to take the lead in meeting both the challenges of Bermuda's own need for energy and our responsibility in order to set an example for the rest of the world.

The Department of Energy's strategic goals are to:

- Reduce fossil fuel dependency;
- Ensure a secure energy supply, in terms of both quantity and cost; and
- Encourage Greenhouse gas emissions reductions related to energy use in Bermuda.

These will be achieved through the regulation of energy in Bermuda and developing policies, legislation and incentives, which address:

- Promoting a culture of energy conservation;
- Developing energy efficiency;
- Encouraging alternative and renewable energy technologies;
- Monitoring and regulating energy importation, production and distribution in Bermuda; and
- Collaboration between government agencies and other key stakeholders in matters relating to energy.

The Department of Energy will consult on its proposed policies, legislation and incentives, thereby providing a transparent process for the creation of an energy regulatory framework for Bermuda.

1.2 An Energy Strategy for Bermuda: Balancing Sustainable Development

More and more countries are embracing the principles of sustainable development and the need to develop environmentally friendly practices. Bermuda has entered a new energy era that requires energy policy directions that will ensure socially, economically and environmentally sustainable energy supplies. The Department of Energy is encouraging and supporting initiatives that harness indigenous sources of fuel and strategies that reduce Bermuda's carbon footprint.

On March 6, 2008, Premier, Dr. the Honourable Ewart F. Brown outlined a recommended Sustainable Development Implementation Plan. The Plan acknowledged that Bermuda will have to act quickly and responsibly, and requires the Department of Energy to develop and implement an energy strategy.

Elements for a Bermuda Energy Strategy recommended from page 41 of the Sustainable Development Implementation Plan include:

- Establishing a renewable energy target;
- Facilitating take-up of new technologies;
- Ratifying the Kyoto Protocol to limit emissions of greenhouse gases; and
- Improving energy efficiency.

To reduce the environmental issues associated with energy use, the Plan required the Government to accept the United Kingdom's (UK) ratification by extension of the United Nations' Kyoto Protocol to Bermuda. This requires an 8% reduction on the 1990 levels of greenhouse gas emissions by the period 2008 to 2012. Figure 1 shows an estimate of Bermuda's carbon dioxide emissions since 1980, along with the level required to meet the Kyoto Protocol target.

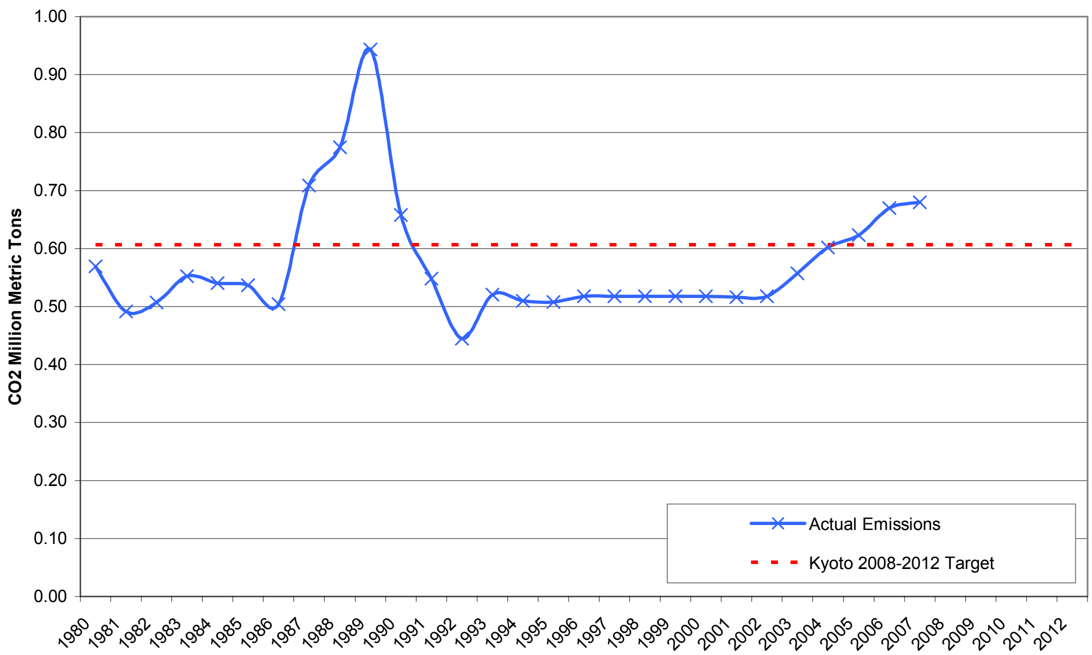

Figure 1: Bermuda Carbon Dioxide Emissions and Kyoto Protocol Target
Department of Energy, 2008

To address the social and economic effects of the high energy costs, the Government legislated, as noted in the Financial Assistance Amendment Regulations of 2008, increases in the financial assistance program to meet the new electric rates. Support was also extended to commercial fishermen and tour boat operators in the form of financial rebates.

1.3 Town Hall Meetings

The Honourable Terry E. Lister, J.P., M.P. launched the preliminary public consultation process through a series of nine Town Hall Meetings – these meetings enabled the Government and Bermudians to collaboratively explore energy issues, as described in Figure 2.

Meeting Subject and Summary	Presenters
Energy 101 and the Environment Aspects: *Overview of fuel supply and use to generate and distribute electricity in Bermuda. Environmental implications of fossil fuel use.*	Bermuda Electric Light Company, Dr. Anthony H. Knapp (Bermuda Institute of Ocean Science)
Combined Heat and Power in Bermuda: *Highlighted a promising solution for achieving greater energy efficiency by leveraging traditional fuel sources and renewable sources.*	Patrick Caton (Caliper Engineering)
Biofuel Produced from Spent Cooking Oils: *Focused on biodiesel as a renewable, non petroleum-based diesel routinely derived from vegetable oils and fats.* **Biofuel Produced from Algae:** *Suggested algae as an effective, cost efficient means of providing feedstock for biodiesel production. biodiesel reduces emissions of carcinogenic compounds, as well as carbon dioxide emissions relative to petro-diesel over time.*	Bermuda Bio-fuels Dr. Gerald Plumley (Bermuda Institute of Ocean Science)
The Green Agenda: *Bermudians urged to develop a carbon strategy where they regularly monitor their carbon footprint as they would monitor their blood pressure.*	Gary Austin (International Business Machines, Canada)
Public Policy on Energy and Environment: *Outlined how Bermuda could gain 10% to 20% of its electricity from renewable sources by 2015. Identified proven energy technology solutions and effective energy strategies, including the Sustainable Energy Utility.*	Dr. John Byrne (Center for Energy and Environmental Policy, Univ. of Delaware)
Conservation: *Identified ways Bermuda can conserve energy that included the use of Government tariffs to provide incentives for energy efficiency; reform of how the utility generates and distributes power; and embracing the model of a Sustainable Energy Utility.* **Tynes Bay Waste to Energy Facility:** *Presented information on Tynes Bay and the importance of waste to energy.*	Andrew Vaucrosson (President, Greenrock) Kirk Outerbridge (Principal Engineer at Tynes Bay)
Passive Solar: *Addressed utility-scale rooftop photovoltaic technology.* **Photovoltaic:** *Outlined how Caribbean countries can effectively and affordably harness solar energy.*	Tim Madeiros (Alternative Energy Solutions) Catherine York (Caribbean Solar Alliance)
Wind Energy: *Presented wind energy options. Highlighted the pros and cons of onshore and offshore wind turbines siting. Examined a wind energy pilot for Bermuda.* **Ocean Wave Energy**: *Focused on the vast potential of energy generated by the ocean. Explored wave energy conversion, marine current, tidal barrages and ocean thermal energy conversion.*	Chris Worboys (Department of Energy) Jeff Manson, Tim Hasselbring (Triton Corporation)
Regulatory Options and Considerations: *Outlined policy options found to be effective in achieving ambitious alternative energy targets such as ensuring fairness in pricing for consumers and independent power producers while promoting energy efficiency and reliability.*	The Honourable Sharon Pratt (BI Solutions) Dr. John Byrne (Centre for Energy and Environmental Policy, Univ. of Delaware)

Figure 2: Summary of Town Hall Meetings

Town Hall Meetings were well attended, stakeholders were totally engaged and entertained excellent questions. Experts, vendors and policymakers have stimulated debate and ignited new ideas and initiatives from the electric utility, independent power producers and others. The Government is poised to embrace the most promising ideas advanced through the public consultation process.

Dr. John Byrne, of The Centre for Energy and Environmental Policy and shared winner of the 2007 Nobel Peace Prize for his role with United Nations Intergovernmental Panel on Climate Change, was invited to speak at the Town Hall Meetings. Dr. Byrne indicated that Bermuda could reduce its dependence on imported oil for electricity production by up to 20% using cost effective conservation/efficiency plans and alternative/renewable technologies.

This view was shared and supported by Greenrock, a local sustainable development group, who indicated the following initiatives could be embraced by the Government and other key stakeholders:

- Establishing community-based conservation outreach and educational programs;
- Creating Government policies and tariffs that provide incentives for energy efficiency and guidelines for energy usage and generation;
- Reforming how utilities generate and distribute power;
- Pricing energy to promote conservation; and
- Establishing alternative ways to finance energy conservation through Sustainable Energy Utilities, issuing Green Energy Bonds, or participating in Renewable Energy Credit Markets.

1.4 Considerations for an Energy Strategy in Bermuda

Bermuda's dependency on imported oil has led to more rapid increases in the cost of electricity than in the US, as shown in Figure 3. The graph on the left shows the percentage increase in energy costs since 2000. The bar chart on the right shows the actual cost of energy in 2008.

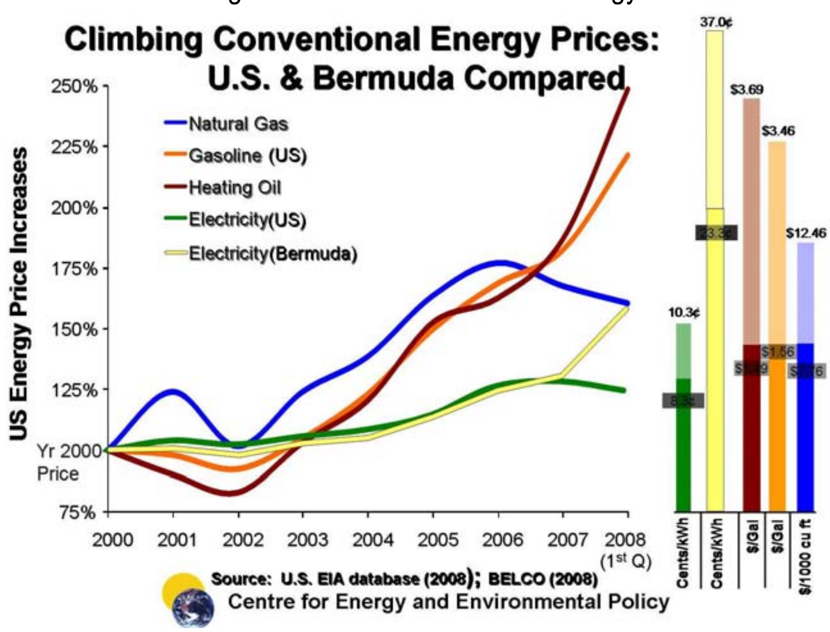

Figure 3: Percentage of Energy Price Increases

As Bermuda considers an energy strategy, the unique aspects of the country must be considered:

- Bermuda is a small, remotely located island;
- The island is densely populated and almost fully urbanised through a combination of residential and commercial development;
- Bermuda relies extensively on electricity;
- The economy is highly dependent on the finance and hospitality sectors that require dependable electricity for computing, telecommunications, lighting and air-conditioning;
- There are no major industrial requirements for power;
- There is a large population of vehicles;
- At almost 2300 motorised vehicles per square mile, Bermuda has one of the highest densities of motorised vehicles in the world;
- Bermuda's electricity rates are some of the highest in the world and transportation fuels are also expensive compared to many other jurisdictions.
- Bermuda's sensitive ecosystem, including fisheries and coral reefs, may limit new infrastructure facilities;
- Nearly all of Bermuda's electricity is supplied by a single, private company; and
- Bermuda is over 99% dependent on imported fuels for its total energy requirements.

1.5 Purpose of the Energy Green Paper

The Energy Green Paper is one of the Department of Energy's first steps in carrying out its mandate in developing Bermuda's National Energy Policy. This document will help to educate Bermudians on the challenges and opportunities we face in the 21st century energy landscape.

This Energy Green Paper seeks to act as a catalyst, leading to renewed energy initiatives at all levels of Bermudian society. In addition, this document seeks to make a significant contribution to both local and international communities, by way of example and leadership. It will lead to action by the Department of Energy, who will draft an energy strategy for Bermuda, following on from the consultation process.

The momentum created by this Energy Green Paper will make energy conservation/efficiency and alternative/renewable technologies a priority. Attention should be given, as to how technology can be used or adopted to meet our specific needs and how best it can be deployed.

This Energy Green Paper has been prepared by the Department of Energy with input from the people of Bermuda through the Energy Town Hall Meetings, experts in alternative/renewable energy technologies, Esso Bermuda Ltd., Rubis Energy Bermuda Ltd., (Shell), the electric utility, non-governmental organizations and a team of consultants, who explored the regulatory options.

2 Energy Fundamentals

2.1 Important Facts about Energy

Energy comes in many forms and although it cannot be created or destroyed, it may be captured, stored and converted into more useful forms. Energy is commonly recognised in the form of electricity, heat or fuels for transportation. Converting other forms of energy to heat energy is a simple process as in a hairdryer or oven. Conversely, heat energy can be converted to electrical energy in power plants by using internal or external combustion engines and generators. Providing energy for generating electricity or powering transportation vehicles requires fuel such as coal, natural gas, wood, gasoline or sunlight.

Fossil fuels like coal, oil and gas are depleted as they are used for electricity, heat or transportation. Unlike fossil fuels, renewable energy sources are able to provide energy on a sustainable basis. Naturally occurring resources such as sunlight, wind, waves, ocean currents, the tides, ocean thermal gradients, geothermal energy and biomass are options for renewable energy. Many of these resources are indigenous to and abundant in Bermuda. As fossil fuel resources continue to decline and prices continue to rise, the world is increasingly looking toward other energy sources.

2.2 Economics of Energy

Despite the international economic crisis, the alternative/renewable energy market continues to gain momentum. Regardless of the economic issues we face, the world could be plunged into an economically and politically depressed state without access to robust supplies of affordable energy sources. The cheap fossil fuels that have been used for the past 100 years are either no longer cheap or, in some instances, close to disappearing altogether.

Although the economics associated with bio-fuels may be more stable in the long-term, they suffer from the overall fuel market's rapid variation of the short-term prices as seen by recent oil price fluctuations. As a result, many bio-fuels may require short-term support to establish themselves as a viable alternative to the use of oil as a transportation fuel.

The economics of energy conservation/efficiency and alternative/renewable energy projects vary widely. Factors such as the type of renewable resource, distance to the power grid, utility connection rules and maintenance requirements along with technology maturity and the cost of financing, all affect overall costs and thus any project's economic viability. Understanding how technology performance and resource availability relate to energy yield is a key requirement for understanding the associated energy economics.

Because demands for electricity vary over time, computer simulations are often used to estimate hourly generation demands. When added up, the hourly estimates result in monthly or yearly generation totals. If electricity is more valuable during certain times of the day or during certain months of the year, then proposed projects to generate electricity must take this into account.

In order to perform an economic analysis of electricity markets, we must consider various technologies that deal with loads, power sources and storage as discussed in Sections 6, 7 and 8, respectively. For those who are interested in performing their own economic analyses, free copies of personal computer based design tools such as HOMER; Hybrid 2; RETScreen R International and Energy-10 are available on the Internet. These computer models can aid novice users in performing their own economic analyses.

3 Energy Challenges

This section of the Paper describes the energy challenges facing Bermuda, and the rest of the world. While these challenges are global, they also provide opportunities that can benefit Bermuda.

3.1 Defining the Problem of World Oil Use

The global demand for energy and the resulting carbon dioxide emissions are expected to rise 60% by 2030. Global oil consumption has increased by 20% since 1994, and is now projected to grow by almost 2% per year.

3.1.1 Oil

Oil and petroleum products have powered the world for more than a century. Demand had continued to grow with oil, gas and coal meeting the largest part of that demand, with oil alone the key ingredient in producing thousands of products that make our lives easier.

In recent years, oil supply and demand problems have disrupted economies around the world. Countries that need oil are competing with each other to lock up scarce supplies. The world's largest developed countries are drastically changing the way they buy and sell oil, while in many oil-rich developing countries, large oil proceeds may be the best hope for their economic development.

3.1.2 Outlook for Future Supply

The International Energy Agency, headquartered in Paris, France, acts as an energy policy advisor to the Organisation for Economic Cooperation and Development comprised of twenty-eight member countries, guiding them toward reliable, affordable and clean energy for their citizens. The International Energy Agency has studied depletion rates and reserves on 800 oil fields, to form a supply forecast that was released in November 2008. The opening paragraph gives an excellent summary on the future energy outlook:

> "Current global trends in energy supply and consumption are patently unsustainable – environmentally, economically, and socially. But that can – and must – be altered; there's still time to change the road we are on. It is not an exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two central energy challenges facing us today: securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of an energy revolution".

The US Department of Energy is also conducting supply studies that could be completed by the summer of 2009. This report may prove to be sobering as well, as the US Department of Energy has already suggested that the current output of 84 million barrels per day will level off.

3.1.3 Predicting Peak Oil

It is impossible to predict precisely when peaking will occur, though in July 2007, the International Energy Agency, officially acknowledged the advent of “Peak Oil”. The Association for the Study of Peak Oil and Gas has researched this subject extensively and predicted future oil production rates, as shown in Figure 4.

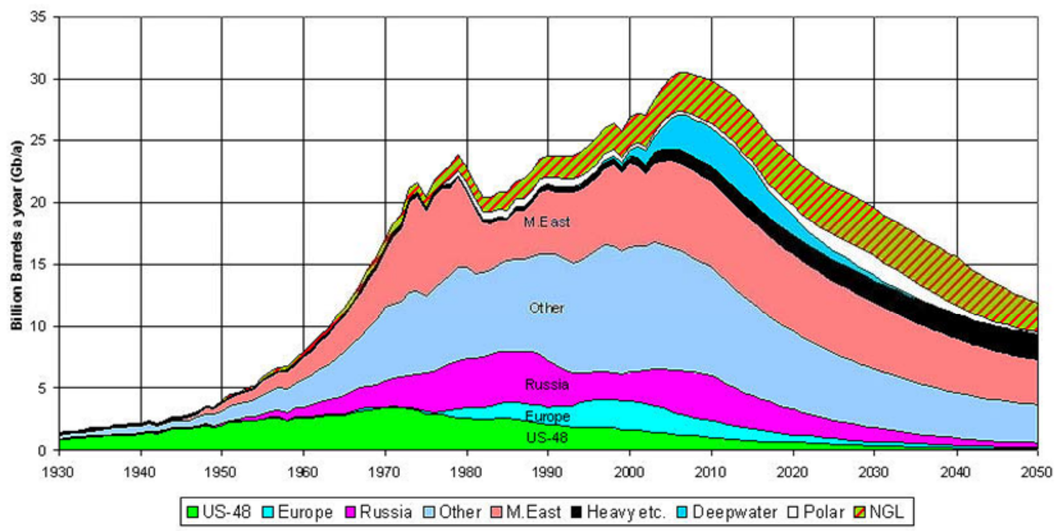

Figure 4: Oil Production Rates
Association for the Study of Peak Oil and Gas, 2004

Predicting peak oil is important for assessing where we are in terms of global oil supplies and forecast use. Once we are on the down side of the curve shown in Figure 4, we will move quickly toward the end of the world’s oil supplies. How quickly depends on our current and forecasted use. Predicting peak oil is difficult because much of the data needed for an accurate forecast is proprietary to oil companies and the Governments of major oil exporting countries. It is also possible that the data will be politically and economically biased. However, even large differences in estimated remaining world oil reserves would not significantly change the date of world oil supply peaking.

According to the US Energy Information Administration:

> “[Our] results [related to oil peaking] are remarkably insensitive to the assumption of alternative resource base estimates. For example, adding 900 billion barrels (more oil than had been produced at the time the estimates were made) to the mean US Geological Survey resource estimate in the 2% growth case, only delays the estimated production peak by 10 years. Similarly, subtracting 850 billion barrels in the same scenario accelerates the estimated production peak by only 11 years.”

A number of forecasters have accepted at face value the estimates of oil reserves by the Organization of Petroleum Exporting Countries, in part because no independent source of verification is available. This acceptance is notable in light of the fact that past history raises significant questions about the validity of their reporting.

In the words of the International Energy Agency as quoted by Wood et al (2003):

> "What is clear is that revisions in official (Middle East and North Africa [MENA] reserves) data had little to do with actual discovery of new reserves. Total reserves in many MENA countries hardly changed in the 1990s. Official reserves in Kuwait, for example, were unchanged at close to 97 billion barrels from 1991 to 2002, even though the country produced more than 8 billion barrels and did not make any important new discoveries during the period. The case of Saudi Arabia is even more striking, with proven reserves estimated at between 258 and 262 billion barrels in the past 15 years, a variation of less than 2% (in spite of production of well over 100 billion barrels)."

To understand peaking forecasts, it is important to know the types of liquids each forecaster has considered. This is not always obvious. Over 95% of the current world oil production is of relatively light, "conventional" oil. Unfortunately, conventional oil definitions vary among forecasters. While they always include onshore and shallow offshore light oil, they might not include light oil from deepwater offshore oil fields, natural gas liquids, arctic oil and/or refinery gains, etc. Worldwide, unconventional oil is produced at relatively modest levels, compared to about 85 million barrels of oil per day consumed. Unconventional oil includes heavy oil, oil sands, gas to liquids, coal to liquids, shale oil and biomass to liquids. Heavy oil and oil sands are the largest contributors of unconventional oil, but this type of oil contributes less than 3% of the world liquid fuels supply. The contributions of gas to liquids, coal to liquids and biomass are considerably less. For purposes of the Energy Green Paper, we are interested in the broad range of peak oil forecasts.

Figure 5 shows the estimated date of peak oil forecasts by world recognised experts. Some forecasters indicate that peak oil may be occurring now. This is possible even though the world may not yet be aware of it, because a peak is not necessarily pronounced. Experience from oil fields and large oil producing regions demonstrates that maximum oil production is sometimes characterised by steady production rates for several consecutive years.

Forecaster	Background	Forecast Date for Peak Oil
Pickens, T. Boone	Oil and gas investor	2005
Deffeyes, K.	Retired Princeton professor and retired Shell geologist	December 2005
Herrera, R.	Retired BP Geologist	Close or past
Bakhtiari, S.	Former Iranian National Oil Co. Planner	Now
Simmons, M. R.	Oil industry investment banker	Now
Westervelt, E.T. et al.	US Army Corps of Engineers	At hand
Groppe, H.	Oil / gas expert and businessman	Very soon
Goodstein, D.	Vice Provost, Cal Tech	Before 2010
Bentley, R.	University energy analyst	Around 2010
Campbell, C.	Retired oil company geologist; Texaco and Amoco	2010
Skrebowski, C.	Editor of Petroleum Review	2010 +/- 1 year
World Energy Council	World Non Governmental Organisation	After 2010
Meling, L.M.	Statoil oil company geologist	A challenge around 2011

Figure 5: Important Peak Oil Forecasts
International Energy Agency, 2005

Some Bermudian observers believe that because small island communities like Bermuda depend so heavily on expensive oil, they will experience the greatest effects of post peak production decline.

3.1.4 Oil Pricing

In September 2003 the global price for oil was $25 per barrel. This rose to $75 per barrel in the summer of 2006 and hit a record high of $147 per barrel in the summer of 2008. Experts in the field were amazed at the speed with which this latest peak price was reached – over 35% more then the beginning of 2008.

According to an International Energy Agency report in June 2008, it is difficult to escape the conclusion that world oil markets will be tight for the second half of the year, even though recent events in world economies have led to reduced demand and pushed oil prices down. Projected demand is anticipated to re-establish its upward movement through 2015, even though it is anticipated that oil production has peaked and will begin dropping within 15 years.

During the late 1970s, the Texas Railroad Commission exercised a virtual monopoly over the flow of oil in the United States. The Commission manipulated the market by turning the spigot on and off. From 1974 to 2004, Saudi Arabia's excess production capacity usually acted as a buffer between supply and demand. During this period, the Organization of Petroleum Exporting Countries engaged in greater organization, governance, and price structuring policies, which adjusted the world oil pricing dynamic. Following this period, Russia, Canada, South America, and the Caribbean entered the world oil market with more production, again shifting the focus and stability of oil pricing and forecast. Bermuda, as an oil dependant economy, is therefore reliant on an extremely unstable oil pricing marketplace.

The circumstances surrounding oil pricing are volatile and the impact of the high cost of oil has exposed fragile economies and contributed to dangerous situations in world affairs, with the consequences of these situations amplified by natural disasters such as recurring droughts and typhoons. The following factors have played a key role in causing oil prices to skyrocket:

- Global peak oil demand, with unknown depletion rates of working oil wells, in addition to unknown oil reserves;
- Hedge fund speculation on commodity markets;
- A weak US dollar;
- Political instability in oil producing regions; and

Some consequences of the high cost of oil are:

- Instability of economies around the world;
- Increased cost of producing agricultural fertilisers leading to high food prices; and
- In some cases, increased demand for biofuels produced from food crops has driven-up demand and consequently driven up the price of food.

3.1.5 Climate Change and Global Warming

Climate change and global warming have been attributed primarily to human activity. Since the 1992 United Nations Conference on Environment and Development, these subjects have been at the forefront of environmental issues and have created major concerns both locally and globally. Overwhelming scientific evidence suggests that the global climate is warming with an accompanying rise in sea levels and increasingly unpredictable weather patterns.

Figure 6 shows carbon dioxide emissions per capita for a number of countries including Bermuda, which currently produces around 11 tons per capita, the fifteenth highest in the world. Emissions per capita for twenty-two other countries are also shown in Figure 6, to offer some perspective on our worldwide ranking.

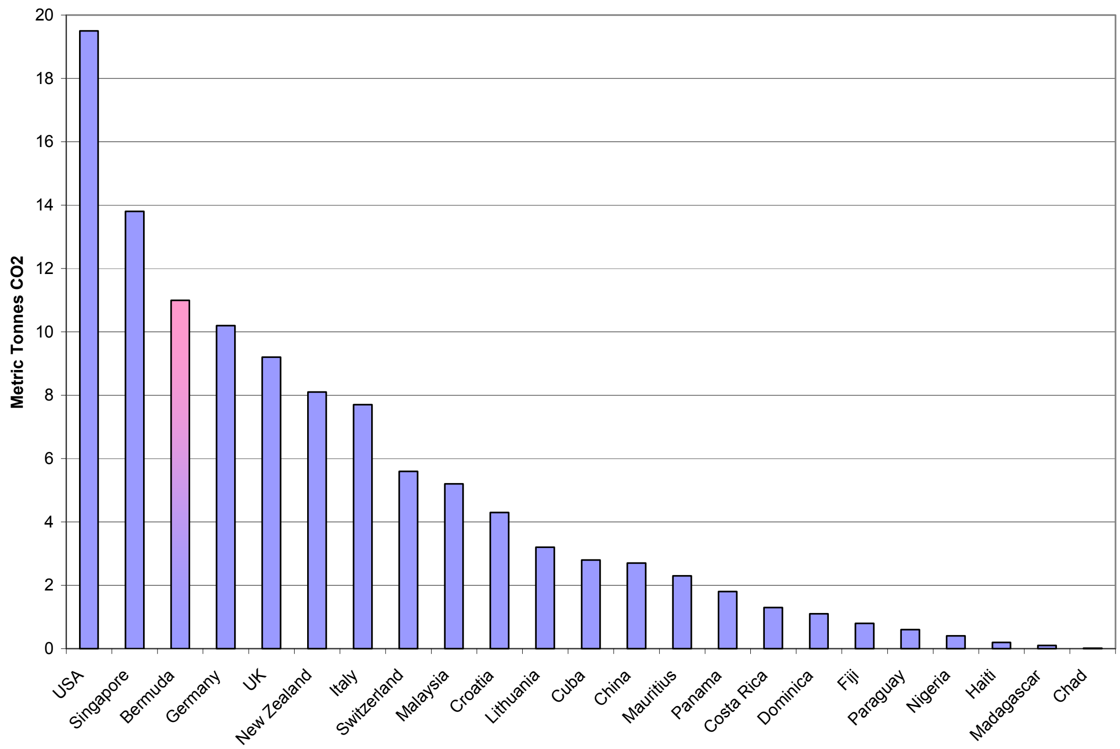

Figure 6: Per Capita Carbon Dioxide Emissions by Country
World Resources Institute. 2003, Department of Energy, 2008

The world can expect even warmer temperatures, which will rise between 1.4 ºF and 5.8 ºF by the end of the century. Small islands in general, are among the most vulnerable to climate change impacts. For example, as the climate changes, the growth of certain crops is likely to be affected by heat stress, changes in soil moisture and plant physiology. Changes in the weather, including changes in hurricane, flood and drought patterns, are also likely. Separately or in combination, these changes can cause serious health hazards and may prove socially and economically disastrous. The resulting loss of life and damage to property and the infrastructure could easily cripple small economies.

Examination of local sea level data is shown in Appendix 4 and indicates a 2 to 3 millimetre annual rise in sea level in Bermuda over the past century. A rise in sea levels and the resulting salt water intrusion will have a major impact on the freshwater lens. This rise combined with storm surges from hurricanes, may cause extensive property damage and serious coastal erosion.

Rising surface seawater temperature and increasing carbon dioxide concentrations will have profound effects on marine ecosystems. Many important marine organisms including fish and corals will be affected by changes in surface seawater temperature. According to research at the Bermuda Institute of Ocean Science, if corals are exposed to seawater temperatures exceeding the normal average by as little as 1ºC for an extended period of time, their symbiotic algae may leave and the coral will "bleach." In some cases where the temperature has returned to normal, corals have recovered from bleaching, however, this is by no means guaranteed.

A substantial portion of the carbon dioxide released into the atmosphere from human activity is taken up by the ocean. Since carbon dioxide forms a weak carbonic acid in solution, this leads to acidification of the oceans. The acidity of surface seawater has increased by about 30% since the industrial revolution and could increase by another 80% during this century. This will undoubtedly have profound effects on marine ecosystems. For example, corals and other marine calcifiers which deposit skeletons and shells of calcium carbonate such as certain algae, shells and mussels, will be negatively affected in an increasingly acidic ocean.

Dissolution and erosion of calcium carbonate sediments and structures will increase. Reef structures will become weaker and more vulnerable to physical stress such as storms and hurricanes as the carbonate cement that holds these structures together may not form as easily as it does today. Some organisms such as sea grasses are likely to benefit from an increasingly acidic ocean, but overall, coral reefs and marine ecosystems in general, will undergo significant changes in response to ocean acidification that could pose serious threats to the livelihood of small islands such as Bermuda.

Many people live in coastal areas and share similar vulnerabilities to the effects of rising sea levels caused by climate change and these areas include agriculturally productive river deltas in various countries worldwide. Many small islands like Bermuda are densely populated; we have approximately 3,000 inhabitants per square mile. As a result, there will be little space to begin relocating people, homes and businesses as sea levels rise.

If current predictions prove correct, the climate changes over the coming years are expected to be larger than any since the dawn of human civilization – the results of these changes are uncertain. The risks are real that the climate will change rapidly and dramatically over the coming decades and centuries. Scientists have made the case that shifts in climate in the past have shaped human destiny. Until now, humans responded by adapting to the changes and migrating if necessary. Now our success as a species may have backed us into a corner. The world's population has grown to the point where we have less room for large-scale migration should it be necessitated by a major climate shift.

Figure 7 illustrates the reductions in some greenhouse gases required to stabilise atmospheric concentrations at current levels.

Greenhouse Gas	Required Reduction
Carbon Dioxide	>60%
Methane	8-20%
Nitrous Oxide	70-80%
Chlorofluorocarbon-11	70-75%
Chlorofluorocarbon-12	75-85%
Hydrochlorofluorocarbon- 22	40-50%

Figure 7: Greenhouse Gas Emissions Reductions Necessary to Stabilise Atmospheric Concentrations at Current Levels
Intergovernmental Panel on Climate Change Second and Third Assessment Reports

3.1.6 Timing and Impact of Mitigation Efforts

Efforts to mitigate the adverse effects of these problems in Bermuda will require action by both the Department of Energy and the energy providers. The replacement of conventional power plant will require large financial investments and prudent forward planning that reflects long lead times. It will also take time for individuals and commercial entities to replace and upgrade energy-consuming goods such as vehicles and appliances.

Waiting until world oil production peaks before undertaking mitigation measures is not advisable. By acting now, the economic costs to Bermuda can be minimised by insulating ourselves from high oil costs and the associated instability. This is especially important for Bermuda, as we are in no position to negotiate over the price we pay for imported oil.

3.2 Addressing Energy Challenges

Bermuda is an economic success story that has depended extensively on oil as its fuel for power generation. We will have to accept that changes are required in the way our energy is provided, if we are to continue this success into the future. If we do not create a competitive domestic energy market within the next few years, we will be forced to continue to meet our energy requirements through expensive unsecured imported products that will grow more costly as supplies dwindle.

In the new energy reality of the 21st century, Bermuda must embrace conservation and efficiency and develop alternative and renewable sources of energy. New infrastructure and large investments will be needed over the next few years to develop these sources to meet Bermuda's energy needs.

Bermuda has not yet developed a competitive domestic electricity market. Establishment of such a marketplace will allow Bermudian residents and businesses to enjoy the benefits of security of supply and lower prices. To develop a competitive domestic electricity market, Bermuda will need effective legislation to deliver a sound regulatory framework, a consistent interconnection policy and a stable rate structure for all power producers. The rules of competition will then need to be vigorously enforced.

Bermuda has the ability to tackle the new energy reality. Our unique geography lends itself well to adopting alternatives for transportation and the electric utility has an exceptional record in demand management. Diversifying the types of energy we use will create conditions for further economic growth, new high skilled jobs, greater energy security and a much improved environment. Renewable energy technologies are not just attractive and exciting technologically, they are cost-effective 'green', 'clean' and infinite.

4 The State of Energy in Bermuda

This section describes Bermuda's current sources and uses of energy. Figure 8 shows Bermuda's increased reliance on fossil fuels over the last seven years. The electric utility's consumption of imported oil has remained level due to efficiency improvements, whilst overall consumption has increased, largely due to transportation fuel use, which has almost doubled, as shown by the green line in Figure 8.

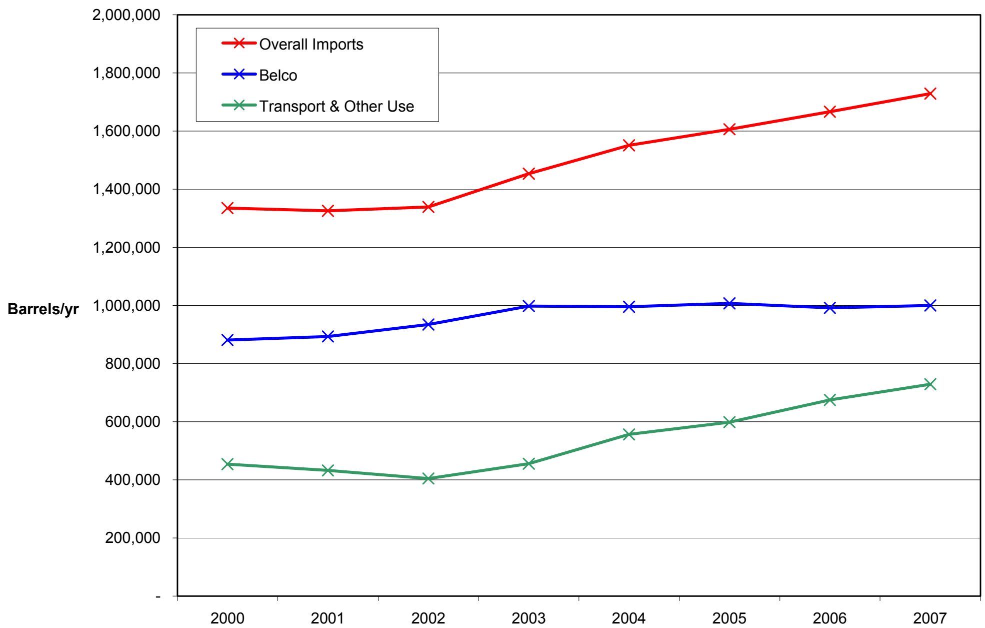

Figure 8: Bermuda's Oil Imports for the Electric Utility, Transportation and Other Uses
Department of Energy, 2008

Figure 9 summarises the quantities of various fuels imported into Bermuda in 2007.

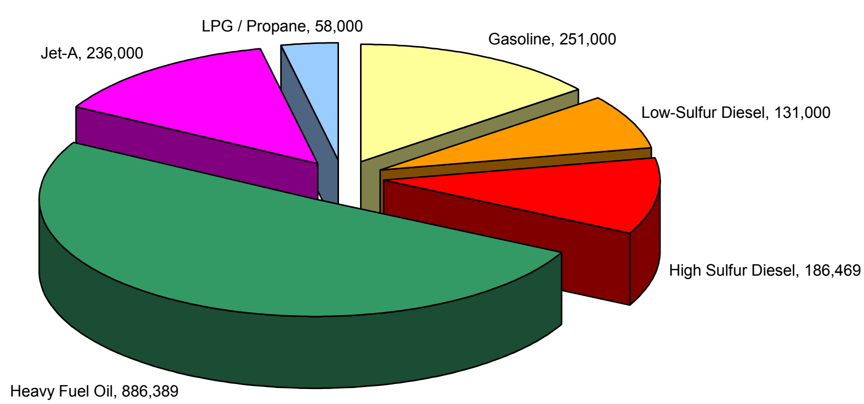

Figure 9: 2007 Fuel Imports into Bermuda in Barrels
Department of Energy, 2008

Heavy fuel oil and high sulphur diesel are used primarily by the existing electric utility to generate electricity, although they have other uses such as heating boilers. Liquefied petroleum gas and propane gas is primarily used for cooking and heating, it is also used as fuel in forklift trucks. The remaining fuels are predominantly transport fuels. Jet-A fuel is used in aircraft, whilst gasoline and low sulphur diesel power vehicles for road and marine use.

The sub-sections below provide more information about Bermuda's primary energy sources including electricity, liquefied petroleum gas and propane gas and transport fuels.

4.1 Electricity

Bermuda relies heavily on electric power with one of the highest costs for electricity in the world. The electric utility reported that the total rate charged per kilowatt hour in November 2008 was 42.5¢ per kilowatt hour. This consisted of a 22¢ per kilowatt hour base charge and a fuel adjustment cost of 20.5¢ per kilowatt hour. This means that the fuel adjustment cost was almost the same as the base rate charge. The fuel adjustment cost therefore represents 48% of the total charge per kilowatt hour for that period.

Until the establishment of the Tynes Bay Waste to Energy Facility in 1994, the electric utility, situated on a 23 acre site in Pembroke Parish, was the sole producer and distributor of electrical energy for the Island.

Electricity demand currently peaks in the summer at close to 120 megawatts. In order for the electric utility to maintain reliable year-round supplies, the electric utility carries generation capacity of this peak demand plus 40 megawatts.

All of the electricity produced by the electric utility comes from the importation and combustion of petroleum products. Esso Bermuda Ltd. was the sole supplier of fuel oil and diesel to the electric utility at an average of $30 million/year until the 2007 competitive replacement by British Petroleum. Based on $100 per barrel fuel costs, the electric utility will now be spending around $100 million a year on fuel.

Figure 10 illustrates that the electric utility's sales of electricity are split almost evenly between residential and commercial customers and have been increasing steadily over the last decade.

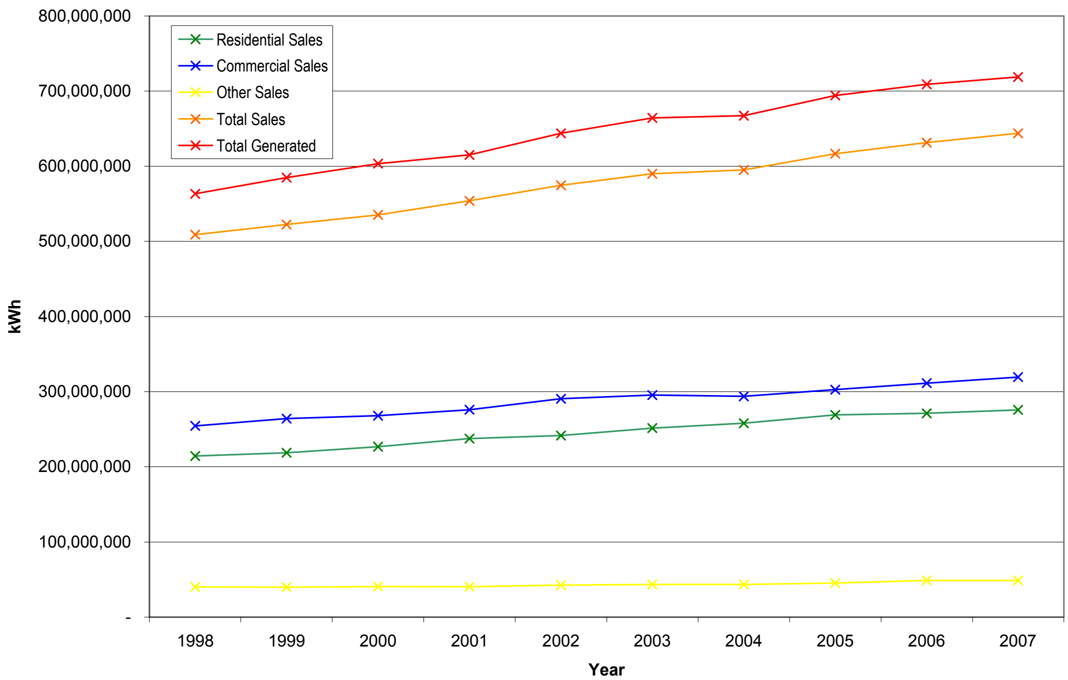

Figure 10: Electricity Sales by Customer Type
Department of Energy 2008

4.1.1 Electricity Generation

4.1.1.1 Bermuda Electric Light Company Limited

The electric utility operates internal combustion diesel engines and combustion turbines. The diesel engines are separated into two classes, D Engines and E Engines, based on their respective locations. The combustion turbines are separated into categories based on their manufacturer, rated capacity and fuel type.

Efficiencies range from 23% (small gas turbines) up to 44% (base load diesels). The quantities and class of the electric utility's engines are as follows:

- Six D engines located in the Old Power Station. All of the D-units operate on diesel. Four of these engines have individual and relatively short exhaust stacks. The more recently installed diesels exhaust via a 130-foot steel stack;
- Eight E engines located in the East Power Station. All of the E-units operate on heavy fuel oil. These include the newest and most efficient base load diesel generators. They exhaust through two concrete stacks and are 205 feet above mean sea level. Each has four exhaust flues inside, which allows for the future addition of diesels; and
- Seven gas turbines located northwest of the Old Power Station. All gas turbines operate on diesel and are all equipped with individual weatherproof enclosures.

For various economic and technical reasons, in October 2003, the electric utility officially ceased using heavy atmospheric gas oil to produce energy.

With the passing of the Clean Air Act in 1991 and the introduction of air quality standards in 1993, the electric utility undertook a program of retiring older, less clean burning engines and installing more efficient, cleaner-burning engines with the exhaust emitted into the atmosphere through higher smoke stacks. As a result, emissions now meet the Bermuda Air Quality Standards as defined in the Clean Air Regulations, 1993. Additionally, extensive computer-aided studies have been undertaken to develop enhanced generation operating regimes that minimise fuel consumption while at the same time continuing to meet system reliability and security criteria. Maintenance procedures have also been reviewed and new more efficient practices introduced.

Since bringing two new engines online in 2005, the electric utility has increased its use of heavy fuel oil from around 60% to 82% while reducing its use of the more expensive light fuel oil from 40% to 18%. The electric utility has consistently increased the amount of electricity extracted from each barrel of oil, therefore maximizing the use of this increasingly valuable resource. Last year, a new level of 719 kilowatt hours of electricity per barrel of fuel was achieved.

In 2007, the electric utility used 819,920 barrels of heavy fuel oil and 179,983 barrels of light fuel oil to generate 718,670 megawatt hours of electricity. After transmission losses, they were able to sell 643,821 megawatt hours of electricity. This resulted in the production of 483,784 tons of carbon dioxide. This equates to 751 grams of carbon dioxide being produced per kilowatt hour of electricity sold, compared to 422 grams of carbon dioxide per kilowatt hour in the UK. (It is worth noting that the UK has a lower figure as it generates electricity from a mix of different technologies).

4.1.1.2 Tynes Bay Waste to Energy Facility

The Tynes Bay Waste to Energy Facility burns over 70,000 tons of waste a year, producing net electricity output of 15,541 megawatt hours, which equates to around 2.2% of Bermuda's annual generation. In 2007 and 2008, the average amount of power exported to the electric grid per ton of waste burned was 221 kilowatt hours. Also, as part of their programme, burning waste produces 5,000 ash/concrete blocks that are used to reclaim land at the airport dump.

The Tynes Bay Waste to Energy Facility is capable of generating 3.6 megawatts of power. Almost half of this power (1.5 megawatts) is exported to the electric utility under a ten year contract due to expire in December 2009. The remaining power is used to operate the facility and the reverse osmosis desalination systems.

Currently, higher waste volumes lead to a decrease in net electricity output. This occurs because although the facility has the capacity to burn the extra waste, it does not have the capacity to use the extra energy released to generate more electricity and processing the extra waste actually uses more energy to run the plant, therefore the overall electrical output is reduced.

4.1.2 Transmission

The electric utility has a robust transmission network of 33 kilovolt and 22 kilovolt underground cables feeding thirty-one distribution substations.

4.1.3 Distribution

Fifty-five percent of Bermuda's distribution network is underground. The distribution substations feed into around 5,400 distribution transformers, which provide large commercial customers with 480 volt three-phase electric power and residential or small commercial customers with 240/120 volt single-phase electric power.

4.2 Liquefied Petroleum Gas and Propane Gas

Liquefied petroleum gas and propane gas is used primarily in cooking and heating water. This section provides a brief overview of how Bermuda acquires, stores, and distributes these fuels.

4.2.1 Acquisition

Liquefied petroleum gas and propane gas is currently sourced from Trinidad and Tobago. Rubis Energy Bermuda imports these products eight times a year, averaging 58,000 barrels annually.

4.2.2 Storage

Rubis has three liquefied petroleum gas and propane gas storage tanks with a combined capacity of 10,500 barrels, which equates to a seven to eight week supply at current consumption rates.

4.2.3 Distribution

Liquefied petroleum gas and propane gas is distributed to the public through Bermuda Gas & Utility Co. Ltd. and Sunshine Gas Limited.

4.3 Transportation Fuels and Other Petroleum

Transportation fuels, as the name implies, are used primarily in transport vehicles — aircraft, automotive vehicles, boats, etc. As shown in Figure 9, gasoline, jet-A and low sulphur diesel are the main transportation fuels.

The majority of the gasoline and diesel fuel is used for private vehicles - Bermuda, in addition to the public service vehicles, had over 40,000 private cars and bikes registered in 2007. Figure 11 shows this breakdown by type of vehicle.

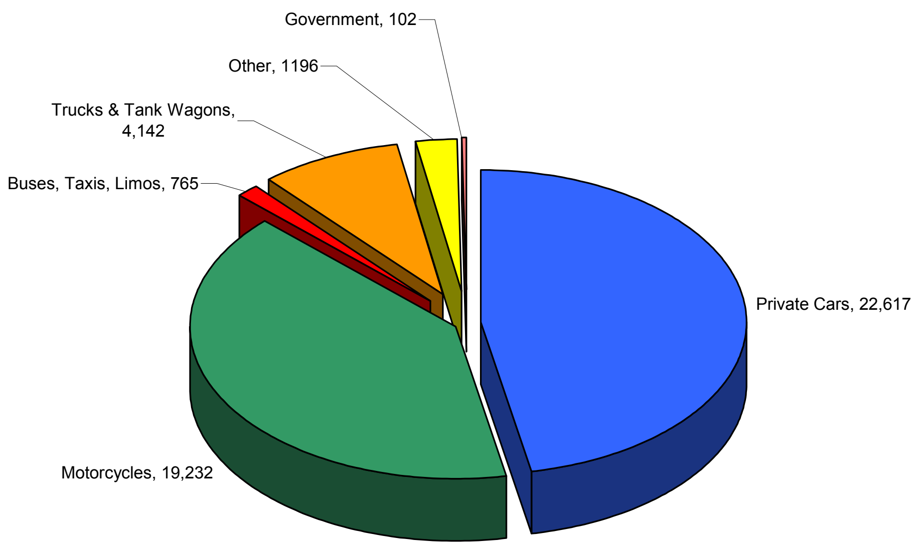

Figure 11: Number of Vehicles in Bermuda by Type in 2007
Department of Energy, 2008

4.3.1 Acquisition

Transport fuels are imported by both Rubis Energy Bermuda and Esso Bermuda approximately three to four times a year. In 2007, Rubis Energy imported about 139,000 barrels of gasoline and 100,000 barrels of diesel and Esso Bermuda imported 112,000 barrels of gasoline, 31,000 barrels of low sulphur diesel, 186,469 barrels of high sulphur diesel, 236,000 barrels of jet-A fuel and 886,389 barrels of heavy fuel oil during the same period.
(N.B. Low sulphur diesel is used primarily for transportation, while high sulphur diesel and heavy fuel oil are used primarily by the electric utility.)

4.3.2 Storage

Rubis Energy Bermuda has four gasoline storage tanks in St. George's, which have a combined capacity of 104,000 barrels which equates to approximately a nine month supply. They also have two diesel storage tanks in Dockyard, with a combined capacity of 104,000 barrels which equates to approximately a twelve month supply.

Esso Bermuda has a combined storage capacity of 408,596 barrels. This equates to a six-week minimum reserve of heavy fuel oil and a twelve-week minimum reserve of high sulphur diesel, both targeted for the electric utility. The minimum reserve for other products is around a four-week supply.

The electric utility has the capacity to store a twenty-five-day supply of 51,000 barrels of heavy fuel oil and 65,000 barrels of diesel.

4.3.3 Distribution

Rubis Energy Bermuda distributes fuel using tank wagons through the Shell retail service station network and Esso Bermuda distributes fuel through a combination of pipelines and tank wagons.

Part 2

Finding Energy Solutions for Bermuda

5 Energy Conservation and Efficiency

In terms of energy use, conservation refers to avoiding the use of energy, while efficiency refers to using less energy in a particular application to achieve the same end result. Conservation and efficiency will form a major part of Bermuda's future energy strategy, staving off the inevitable effects of increasing fuel costs. The potential for energy savings from conservation and energy efficiency is significant.

The State of California provides a real example of this potential for savings. In the late 1960s the State of California instituted the strictest power and emissions guidelines within the US. Figure 12 shows the electricity sales in kilowatt hours per customer for both California and the US since the 1960s. Note that the demand in California has barely changed over 40 years, while it has almost doubled in the rest of the US. According to the California Energy Commission the difference is "due in large part to cost-effective building and appliance efficiency standards and other energy efficiency programs".

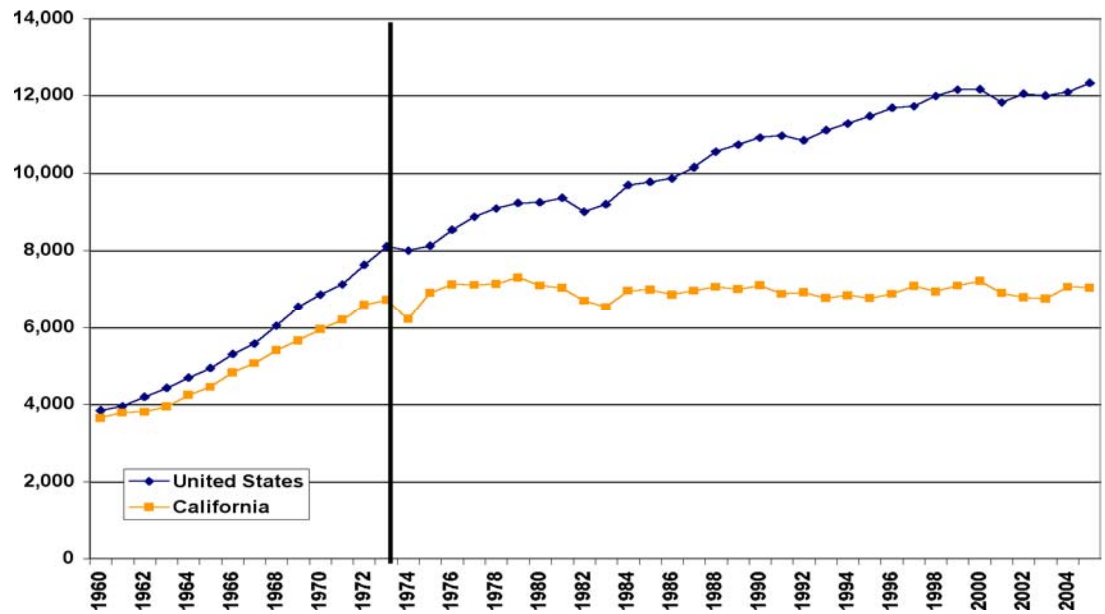

Figure 12: Electricity Sales – California Compared with the US
California Energy Commission, 2007

Current year figures from the electric utility support the potential for savings through conservation and efficiency improvements. The company posted a 5.56% reduction in energy use over the first five months of this year while increasing the number of residential units added to the grid by 2%. The potential savings to be realised could be further increased with individual conservation measures and the introduction of energy efficiency standards. As a result, the Department of Energy will use this opportunity to develop legislation to create incentives for energy efficient goods as discussed in Section 9.

In Bermuda, the benefits of electrical conservation and efficiency are increased during warmer months.

Our electrical appliances all act like small heaters, eventually turning electrical energy into heat. By using inefficient appliances and leaving electrical items turned on when not required, we are, in effect, heating our buildings.

The total amount of waste heat produced from a number of small heat sources such as light bulbs, refrigerators, stoves, televisions and other appliances can become significant and will require even more electricity to be used for powering air conditioners and ventilation equipment.

Currently, energy use is poorly accounted for; technologies such as smart metering offer the opportunity to quantify the use of this increasingly valuable resource. The extent to which individual conservation measures are adopted will vary. Some forms of conservation may be adopted without significantly impacting the quality of life. Employing conservation measures to a fuller extent, however, requires lifestyle changes to reduce consumption, which will place limits on the degree to which conservation can be employed.

Implementing energy efficiency standards offers Bermuda significant benefits made possible in part through our unique situation. For example, since we have no manufacturing industry, we rely on imported goods. This means that we can use the Customs Tariff as a powerful yet highly flexible tool for influencing new standards for energy efficiency. With no significant manufacturing industry in Bermuda, the Government has the opportunity to create stricter efficiency standards than those of other countries. The high cost of fuel will ensure that these goods pay for themselves within a reasonable period through the monthly savings on consumer's electricity bills.

Opportunities for improvements in energy efficiency are plentiful; energy consumption in both residential and commercial buildings may be reduced by incorporating energy efficiency. The greatest opportunity for achieving this is during the design stage, though significant opportunities for energy savings remain throughout the construction phase, the buildings useful life and its final disposal. Adoption and enforcement of high standards will ensure that new buildings meet progressive energy saving criteria. Existing standards such as the Leadership in Energy and Environmental Design in the US and the Code for Sustainable Homes in the UK may be drawn upon to further develop the Bermuda Building Code.

Improving building shell insulation standards will reduce air conditioning loads. Many existing buildings will be difficult to retrofit due to solid walls, however there is potential to improve the level of insulation in windows, doors, floors and roofs of these buildings.

Minimum appliance efficiency standards could be used to prevent the least efficient products from entering Bermuda. If desired, these standards could be set to permit only the most efficient products available into Bermuda and in doing so would set an international example in energy efficiency. These standards may be adjusted with a view to future fuel costs and developments in technology. International standards, such as the Energy Star program, which originated in the US in the 1990s, and the European Union's energy label, cover most domestic and office appliances. These standards have been extensively researched, continually updated and, by adopting these standards in Bermuda, we can avoid the extensive resources that would otherwise be required.

Key areas for improving energy conservation and efficiency are outlined in Figures 13 and 14.

End Use	Considerations for Improvement
Air conditioning	Use natural ventilation. Use thermal zoning (only cool specific areas, rather than the entire building). Understand how to control your system. Set thermostats closer to the ambient temperature. Avoid running systems for any longer than necessary.
Hot water	Set clothes washers and dishwashers to lower temperatures. Reduce shower and faucet use where practical. Install timers on water heating elements.
Lighting	Use natural light. Avoid unnecessary use of light. Install photosensitive switches where applicable.
Appliances	Turn off when not in use. If not used for extended periods of time, unplug from socket. It is important that people know how to do this properly, where to access the appropriate outlets and which appliances they may turn off. Use a line to dry clothes.
Transportation	Avoid unnecessary journeys. Spend more time on logistics. Share rides where possible. Use public transportation.

Figure 13: Key Energy Conservation Measures

End Use	Considerations for Improvement
Air conditioning	Purchase units with a Seasonal Energy Efficiency Ratio of 14 or above. Mount outside portion of air conditioning units in the shade using plants or purpose built structures. Insulate air conditioning pipe work and thermally insulate buildings.
Hot water	Use low flow faucets and shower heads. Check water use of clothes washers and dishwashers, and purchase models that use the least amount of water, lower temperature settings and skip the auto-dry cycles. Insulate hot water tanks and pipes to save energy on heating water and reduces heat leaking into your building, ,which would increase air conditioning load.
Lighting	Use compact fluorescents in place of conventional light bulbs and light emitting diodes in place of halogen spotlights. Use straight fluorescent tubes where possible with T5 tubes and electronic ballasts. Replace older T12 tubes with T8 tubes.
Appliances	Check energy consumption of appliances before purchase, and buy Energy Star-rated appliances. Maintain adequate clearance around refrigerators and freezers. Purchase laptop computers in preference to desktop computers, they use 20% of the energy.
Transportation	Purchase the most fuel efficient vehicle possible - when driving in the Bermudian environment, modern cars may achieve between 15 and 55 miles per gallon of fuel. This is a significant difference. Remove unnecessary weight. Ensure tires are low rolling resistance (IEA-20% of resistance) and properly inflated. Buy a car with manual transmission if possible. Keep engine revolutions low.

Figure 14: Key Energy Efficiency Measures

5.1 Residential Conservation and Efficiency

Many Bermudians are not aware of how their use of electricity impacts the environment. Each kilowatt hour of electricity sold in Bermuda currently produces approximately 751 grams of carbon dioxide. This resulted in the emissions of around 6.5 metric tons of carbon dioxide per residential electricity customer in 2007.

Residential conservation and efficiency measures offer residents the chance to reduce their impact on the environment and to lessen their dependence on increasingly expensive energy sources. The Department of Energy has researched the sources of electricity consumption in homes and believes Figure 15 closely represents the proportions in which it is used in Bermuda.

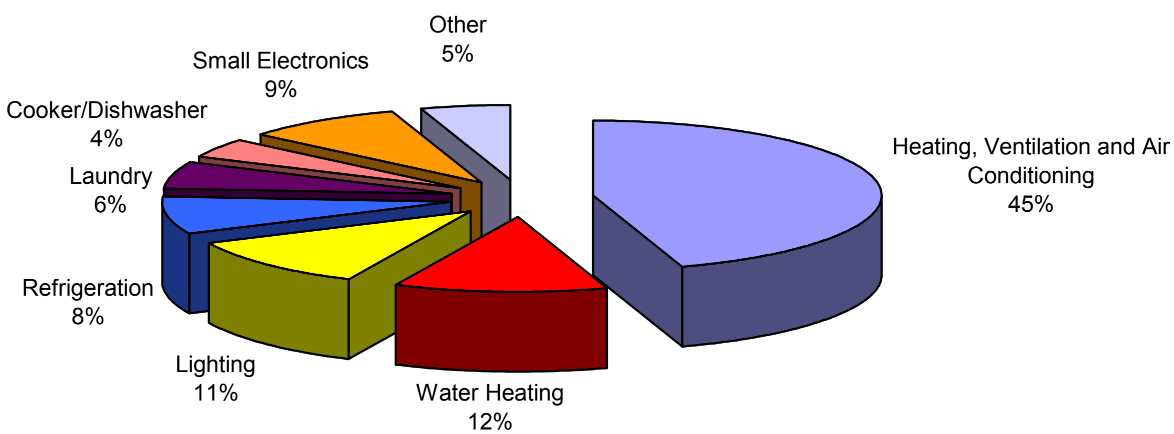

Figure 15: Residential Electricity Consumption by End Use
Department of Energy, 2008

Most individuals cannot be expected to fully understand the energy use implications of their purchases. Information from the Government could help consumers make decisions that are economically, environmentally and socially sound. Campaigns will be undertaken to raise public awareness of their energy use and how it may be reduced. Mandatory minimum appliance efficiency standards combined with appropriate duty rate adjustments will ensure that more efficient appliances become the norm. Mechanisms and incentives could also be put in place to ensure residents go a step further and buy the most efficient appliances available.

5.2 Commercial Conservation and Efficiency

Historically, energy has been seen as a routine operating cost to businesses since it has represented a small proportion of overall expenditure. As energy costs and environmental awareness increase, businesses are beginning to shift away from the traditional attitude of just paying the bills. Reducing energy use makes companies more competitive by increasing their profits. The Department of Energy has researched energy use in commercial environments and believes that Figure 16 offers a good indication of the proportions in which energy is used in an office environment.

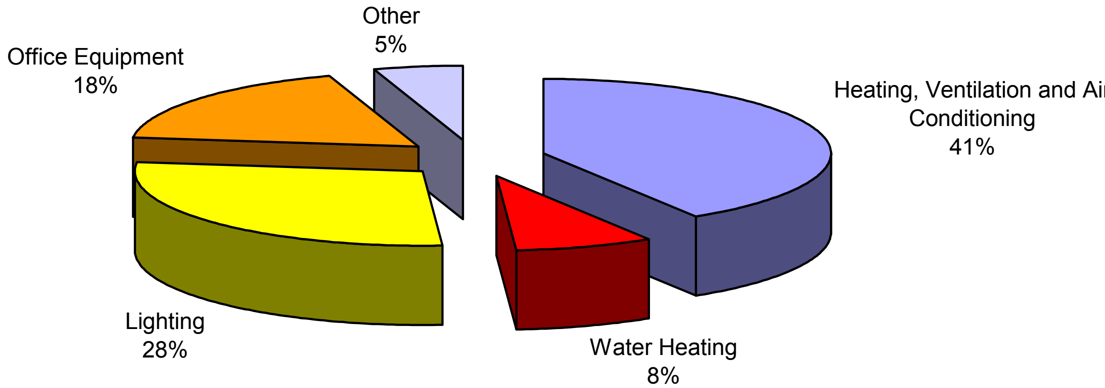

Figure 16: Office Electricity Consumption by End Use
Department of Energy, 2008

The overall potential for savings in this sector is significant, with many conservation measures having little or no effect on business operations. Cost savings derived from energy conservation will help to offset increasing fuel costs in the future. A symbolic and visual indicator of the potential for savings from conservation is offered by offices that leave their lights on at night, with many more less visible examples of unnecessary energy use likely to be present.

Sound energy management practices should be adopted by all commercial enterprises in Bermuda.
The end-use of energy will vary depending on each sector's specific energy requirements (e.g. offices, hotels or warehouses have different energy needs and different times of peak demand). However, the attitudes and management practices required to reduce commercial energy consumption are universal.

Appendix 1 discusses energy management further and contains a copy of the UK Carbon Trust's energy management matrix, a commonly used tool for assessing and planning an organization's level of energy management. Businesses will be encouraged to study an energy management model such as this to assess their current performance and plan for the future.

5.3 Transportation Conservation and Efficiency

As shown in Section 4, fuel imports to Bermuda have increased significantly since 2003, despite the relatively stable demand from the electric utility. This increase is thought to be largely due to transportation fuel use. The rising cost of oil, both in economic and environmental terms, necessitates changes in our attitudes toward transportation.

How can we reduce our dependency on fossil fuels for transportation?

- By avoiding the use of fuel in the first place by walking, cycling, avoiding unnecessary journeys, choosing more efficient routes and in time by using vehicles powered from renewable energy;
- By getting as much out of each gallon of fossil fuel as possible. This may be achieved by shared transport such as buses, ferries or car-pooling and by purchasing the most fuel efficient vehicles possible. Given a single gallon of fuel, most cars in Bermuda today will be able to travel 25 to 30 miles. There are cars on the market in other jurisdictions, which may achieve twice this distance on the same amount of fuel.

5.3.1 Pedal Cycles

Our low speed limit has the potential to offer a safe environment in which to use pedal cycles, although cycle theft, bad weather, traffic volumes and driving attitudes currently deter people from riding. These issues will need to be addressed where possible with solutions such as secure facilities to lock cycles, cycle racks on buses and cycle paths where possible. Facilities to lock bikes securely and to take showers at work are other means to encourage people to ride.

5.3.2 Public Transportation

According to research commissioned by the Bermuda Government, the current use of public transportation is low. Private transportation offers the benefit of anytime, anywhere transport with the minor effort of turning a key. Those who have invested in their own cars have an interest to get the most out of their investment. For public transportation to offer a realistic alternative for consideration, it should strive to offer a similar or higher level of convenience to private transportation.

The Bermuda public transportation system has good geographical coverage, though there is room for improvement. This could be achieved through extended operating times, increasing geographical coverage further and offering fast, efficient payment options. An electronic swipe card system, previously investigated by the Department of Transport, could simultaneously track transport use and charge commuters electronically. Tracking transport use in real time would allow for more effective route planning. It has also been suggested that a policy of free, island-wide public transportation could be adopted.

To reduce dependency on fossil fuels, public transportation services should be run as close to full capacity as possible, this could be achieved by extending minibus services. Alternative fuel vehicles should be considered for public transport where appropriate, and the most efficient vehicles available should be procured when existing vehicles need to be replaced.

5.3.3 Private Cars

Car-pooling will reduce dependency on fossil fuels and ease congestion, amongst other benefits. Public relations campaigns and incentives such as congestion charging based on occupancy are options to encourage car-pooling.

Vehicle efficiency has improved significantly over the past few decades and improvements in fuel economy continue to be made by manufacturers. This is important, as the fuel efficiency of a vehicle is almost directly proportional to its carbon dioxide emissions. By tackling one issue, we may resolve both. It is important to note that due to the low speeds on Bermuda's roads, our requirements for fuel efficient vehicles differ from those of most other countries. For example, low rolling resistance tyres and tyre inflation pressure monitors could offer significant improvements in fuel economy.

Other than the price of fuel, there is currently little incentive to purchase more efficient vehicles. Vehicle import duty is based on the dollar value of the vehicle and the re-licensing fee is based on its length in inches.

Fuel economy and carbon dioxide emissions data are available for most new vehicles and could provide a basis to calculate both import duty and re-licensing fees.
As has been proven by the adoption of such emissions based taxation schemes in several European countries, this would increase awareness and encourage people to purchase more fuel efficient, less polluting vehicles.
The re-licensing fees charged in this system could be adjusted to ensure that the revenue is maintained at the same level provided by the current system.

Electric, hybrid and flex-fuel vehicles often have increased fuel economy and reduced greenhouse gas emissions when compared to conventional vehicles and are therefore often encouraged in other jurisdictions. The Department of Energy believes that incentives should be fair and consider all types of vehicles as:

- Some manufacturers are using hybrid internal combustion/electric technology to offer performance gains, with marginal, if any, improvements in fuel economy; and
- Electric vehicles charged from any outlet in Bermuda would <u>not</u> be zero-emission. Currently, 751 grams of carbon dioxide is produced for each kilowatt hour of electricity used to charge them.

An emissions based taxation system could take both of these factors into account.

5.3.4 Motorcycles

Motorcycles use significantly less fuel than cars, achieving 80 to 120 miles per gallon. This makes motorcycles among the most efficient motor assisted vehicles in the world and represents excellent conventional green transport. Motorcycles currently represent the second largest number of vehicles on the road in Bermuda, so tax incentives to purchase more efficient models are desirable for further energy savings. The use of motorcycles in preference to cars, where appropriate, offers a means to reduce transportation fuel consumption.

5.3.5 Commercial Vehicles

Although commercial vehicles represent a small number of vehicles on the road when compared to private cars and motorcycles, they still represent a significant portion of vehicle contributions to energy use and carbon dioxide emissions. Application of emissions-based taxation schemes will also be recommended for commercial vehicles to ensure consistency in transportation policy and to provide incentives for commercial organizations to consider efficiency when replacing their fleets.

5.3.6 Aviation

Due to the absence of domestic airlines and the importance of air travel to Bermuda, options in this field are limited. Airlines should be encouraged to use fleet management measures to ensure flights run as close to full capacity as possible. Taxation schemes proposed in other countries include charges based on factors such as takeoff weight and capacity. Future international energy policy and rising fuel prices are likely to influence this sector regardless of domestic policy.

5.3.7 Marine

Key fuel users in the marine sector are international shipping, fishing, Government vessels, police vessels and other commercial vessels mainly in the tourism industry. Due to the variety of vessels, engines and propulsion systems, and the lack of standardised efficiency information, adoption of efficiency standards would be difficult. The fuel consumption of various craft and power plants would need to be considered on a case-by-case basis.

6 Smart Meters and Net/Dual Metering Capability

To effectively reduce our energy use, we must be able to monitor it. Smart meters are excellent examples of how this may be achieved. Traditional electricity meters are often difficult to access and, as a result, provide relatively infrequent data. Many consumers only realise how much electricity they have been using once they receive their bill, by this time it is too late to reduce energy consumption. Electricity is currently sold at a flat rate and it is difficult for small scale generators to supply power to the electric utility's power grid for credit.

Smart meters will resolve many of these issues and allowing consumers to track their energy use could lead to reductions of up to 15% on their electricity bill.
Smart meters will provide a means of cost control to counter future increases in the cost of electricity.

6.1 Smart Meter Overview

Smart meters have features often not found in conventional electricity meters. For example, they:

- Provide consumers with real time information on energy use, allowing greater control over energy costs;
- Offer two-way communications, which allows the electric utility to retrieve billing information automatically and return it to the consumer;
- Track the time of use, which would allow for a more flexible rate structure, designed to smooth peak loads;
- Have net/dual (two-way) metering, allowing electricity produced from small scale alternative/renewable energy technologies to be tracked; and
- Can also track water consumption, in some cases.

6.2 Smart Meters in the New Energy Environment

6.2.1 Real-Time Tracking of Electricity Use

Smart meters offer real-time tracking of electricity use to the consumer, either directly through display units, or indirectly via an internet page hosted by the electric utility. Figure 17 provides an example of the information that may be offered by such a web based billing system. This would allow the consumer to become familiar with his or her electricity use and to note behaviours which may lead to savings as shown by the spike in Figure 17, which is due to an air conditioner being switched on.

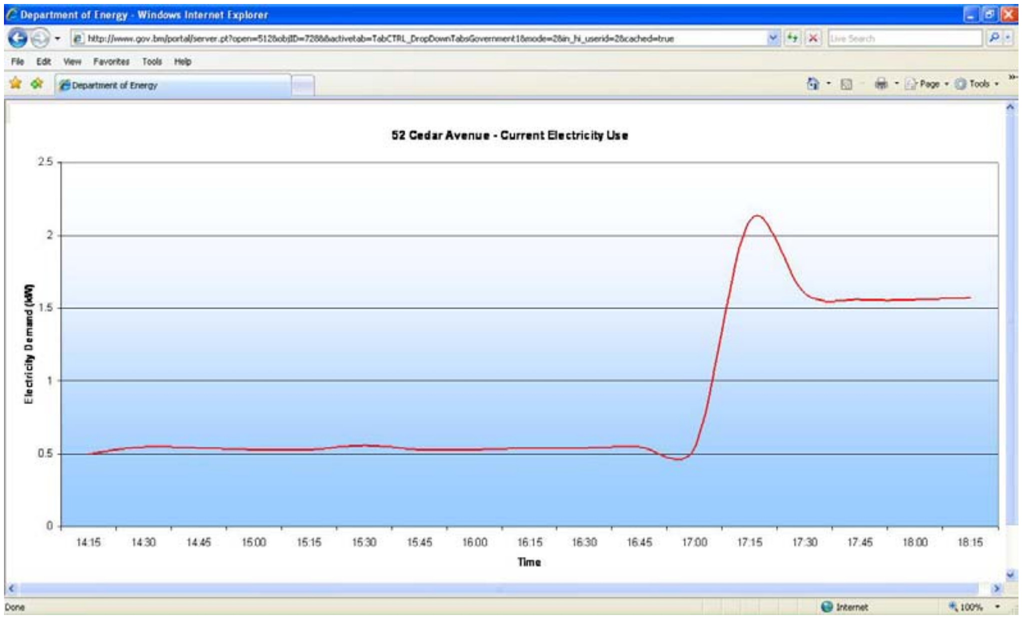

Figure 17: Screenshot of Real-Time Electricity Use Displayed from Internet via Smart Meter
Department of Energy, 2008

6.2.2 Rates Based on Time of Electricity Use

Electricity rate structures based on time of use will create opportunities for savings by both the electric utility and the consumer. These benefits are achieved by consumers striving to purchase electricity at the cheapest rates, which smoothes out peak demand. This allows consumers to reduce their electric bills and the electric utility to cater for a lower peak demand. Many successful schemes in the UK, Canada and the US have realised this potential for savings.

The rate structure would be similar to that for the cell phone industry, where the cost of a call differs based on the time or day when it is placed. Using the 2006 electricity rates for Ontario, Canada in Figure 18 as an example, the consumer could choose times to operate certain appliances at the lowest cost.

Day of the Week	Time	Time-of-Use Period	Time-of-Use Price* (cents/kWh)
Weekends & holidays	All day	Off-peak	4.0
Summer Weekdays (May 1st - Oct 31st)	7:00 a.m. to 11:00 a.m.	Mid-peak	7.2
	11:00 a.m. to 5:00 p.m.	On-peak	8.8
	5:00 p.m. to 10:00 p.m.	Mid-peak	7.2
	10:00 p.m. to 7:00 a.m.	Off-peak	4.0
Winter Weekdays (Nov 1st - Apr 30th)	7:00 a.m. to 11:00 a.m.	On-peak	8.8
	11:00 a.m. to 5:00 p.m.	Mid-peak	7.2
	5:00 p.m. to 8:00 p.m.	On-peak	8.8
	8:00 p.m. to 10:00 p.m.	Mid-peak	7.2
	10:00 p.m. to 7:00 a.m.	Off-peak	4.0

Figure 18: Ontario Smart Meter Pricing Chart
Ontario Energy Board, 2008

6.2.3 Net/Dual Metering

For consumers who have the ability to generate electricity from alternative/renewable technologies, net metering allows for the flow of electricity both ways, typically through a single meter. During times when a consumer's generation of power exceeds usage, electricity is permitted to flow back through the electric grid. The flow of electricity is independently recorded in both directions, allowing separate, negotiated rates to be applied to the electricity consumed and produced. For example, homes with solar panels may produce electricity when consumers are not using it. Smart meters would allow these consumers to sell that electricity back to the grid and reduce their electric bills.

Net metering is required by law in most states in the US as shown in Figure 19. The numbers in the figure indicate the individual system size limit in kilowatts. The size limits in some states vary depending on the customer type, technology and application.

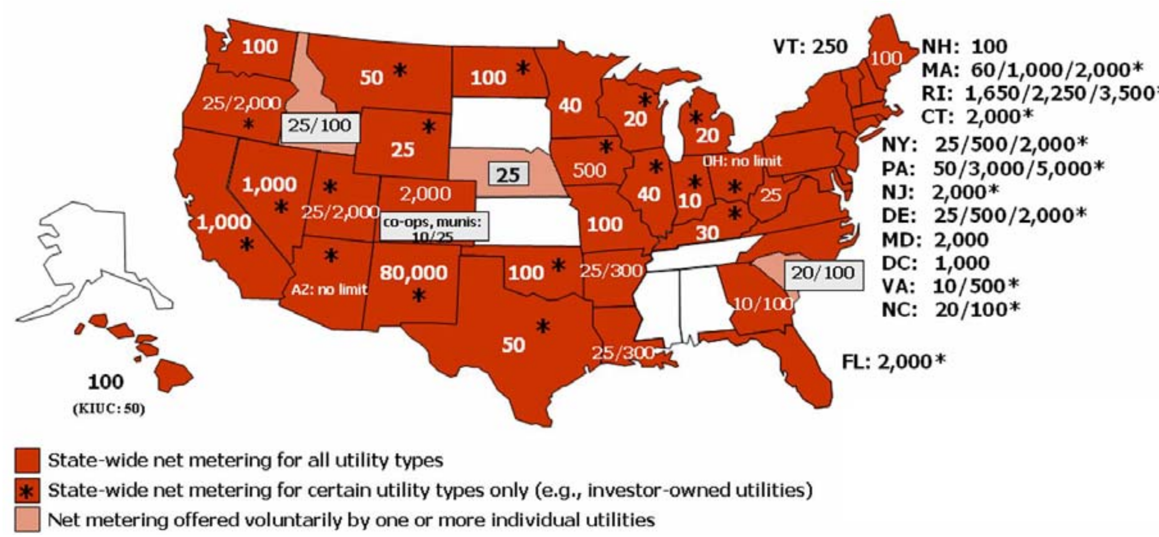

Figure 19: Status of Net Metering in the US
Database of State Incentives for Renewable Energy, 2008

Best practices for the inclusion of net metering include:

- Encouraging consumer-sited installation; and
- Linking net metering to Island-wide renewable energy targets.

In some jurisdictions, there have been issues with the transition from conventional to net metering, for example:

- Restricting eligibility to certain classes of customers;
- Limiting the size of individual eligible renewable energy systems;
- Introducing excessive limitations on excess generation and rollover credits;
- Capping the total combined capacity of all customer-sited generators on the basis of arbitrary limits (i.e. outside of objective engineering criteria);
- Charging discriminatory or unclear fees and standby charges;
- Creating an excessively prolonged or arbitrary process for system approval; and
- Failing to promote the program to all eligible consumers.

Bermuda can benefit from awareness of the above as we consider the implementation of smart metering.

We must also consider the technology necessary to meet the applicable safety, power quality and interconnection requirements. These technology requirements are not insignificant and include:

- Making the electricity generated compatible with that in the grid; and
- Providing a mechanism to disconnect the feed in the event of grid failure.

The system architecture requirements to integrate renewable energy sources into the power grid infrastructure are well proven through experiences throughout the world. An example of system architecture is presented in Figure 20.

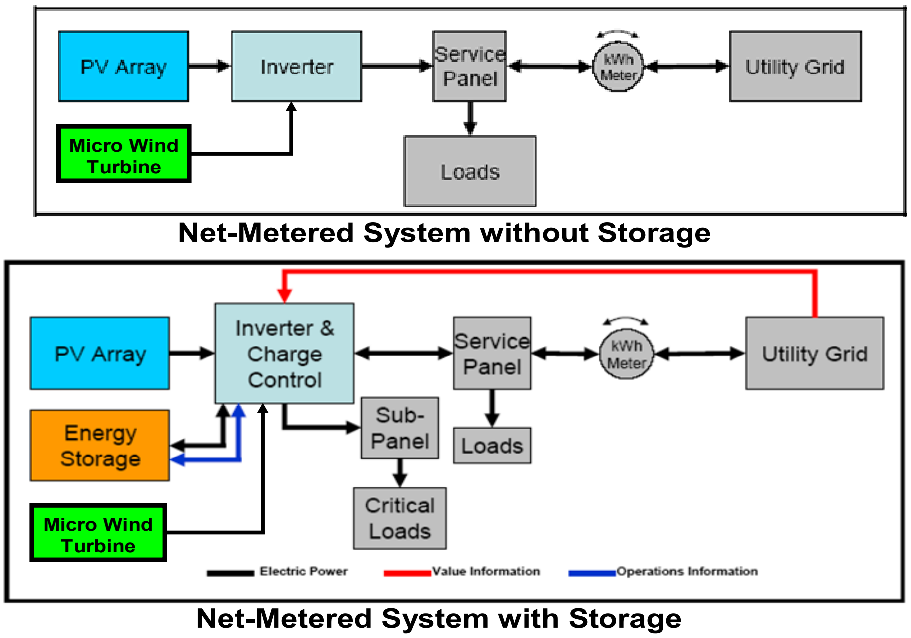

Figure 20: System Architecture for Integrating Net Metering to the Grid
US Department of Energy and Sandia National Lab, 2007

Since Bermuda has only one electricity provider, issues of technology compatibility, and lack of common communications platforms are less likely to occur. Additionally, Bermuda will base standards for a regulatory system on those established for the telecommunications industry. The new regulatory system will include the necessary elements for the adoption of net metering.

7 Alternative and Renewable Energy Resources and Technologies

The Bermuda Government intends to provide a competitive energy production environment that will facilitate commercial development of all viable technologies. Each kilowatt hour we are able to generate from renewable resources decreases our dependence on increasingly expensive imported oil. It also reduces our emissions of greenhouse gases and other pollutants. Alternative/renewable energy is especially important because Bermuda is particularly vulnerable to the effects of climate change and the unpredictability of global oil markets. With an emphasis on alternative and renewable energy technologies, Bermuda can set a global example of how to move forward in an energy sustainable manner.

Bermuda's environment provides a diverse mix of indigenous renewable energy resources.

Some of the technologies for harnessing this energy are very well developed, while others are undergoing further Research, Development and Demonstration. Most are environmentally benign. It makes both economic and environmental sense to invest in these technologies since these energy sources are not subject to international supply and demand price pressures. It also allows for the re-investment of millions of dollars back into the local economy rather than foreign petroleum companies and oil producing countries.

Many of these technologies can be developed with a modest economic stimulus. We have the potential to jumpstart an indigenous energy industry that will create a window of opportunity for interaction among scholars, policymakers and practitioners in business, law and government. Bermuda may lend itself well to adopting or even developing various renewable energy technologies, which could lead to the establishment of Bermuda as a world-recognised example in sustainable energy. These technologies could prove to be distinctive tourist attractions, boosting Bermuda's gross domestic product and creating a respectable commercial and environmental presence worldwide.

Renewable energy options for transportation remain limited, though there are many promising developments in bio-fuel research. Shifting to an electrical generating system based on renewable energy will lay a solid foundation for electric and hybrid vehicles. Flex-fuel vehicles will offer a non-electrical based alternative once reliable alternative fuel supplies are established.

7.1 Solar Energy

7.1.1 Solar Energy Resource

Bermuda's strong solar resource can be utilized to produce useful forms of energy such as electricity and heat for water. Figure 21 shows that our solar resource is closely aligned with electricity demand on an annual basis.

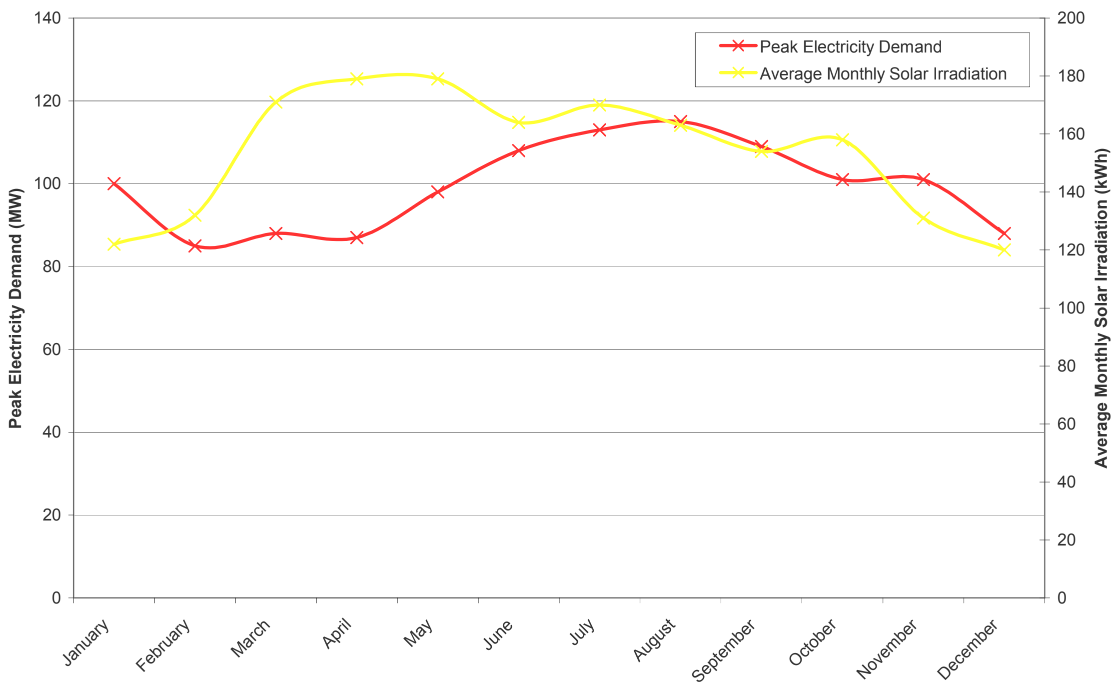

Figure 21: Peak Electricity Demand and Average Solar Monthly Irradiation
Department of Energy, 2008

Solar energy is gathered through collectors, often placed on rooftops or other open areas. The optimum collector mounting angle for maximum energy yield is approximately 32º (our latitude angle) and facing south. The Bermuda Residential Building Code of 1998 (which all residential development must adhere to) already states that residential "roof pitches shall not be less than 22.6º or greater than 39.8º for the main roof." This historical accident has provided us with thousands of sites that have a great potential for harvesting solar energy.

We may estimate the potential solar resource in Bermuda by looking at the total annual solar resource for Charleston, South Carolina, in the US, as it is on the same latitude. The average annual irradiation is 1,675 kilowatt hours per square meter for a horizontal surface and 1,843 kilowatt hours per square meter for a south facing 35º incline. This illustrates the benefit from optimised collector orientation.

7.1.2 Solar Energy Technologies – Solar Hot Water

One of the simplest uses of solar energy is to heat water. Use of solar energy for this purpose avoids the use of electrical energy derived from fossil fuels, whilst also avoiding issues with grid interconnection.

Solar hot water systems consist of either a flat plate or an evacuated tube collector, a means to circulate the water, a storage tank and, often, a conventional resistance heater. This ensures that hot water is available twenty-four hours a day.

The flat plate collector is the simplest and most economical type of collector. It is essentially a well-insulated, glazed panel which contains a dark collector surface and pipes that transfer the heat to water as it flows through the panel. The evacuated tube collector consists of a series of glass tubes, which each contain a dark collector surface insulated by a vacuum. The collector surface is thermally linked to a pipe which allows for heat transfer to the water.

The water is circulated around the system using either a small pump (often itself powered by a small photovoltaic panel) or in a thermosiphon system through the varying densities of hot and cold water. Thermosiphon systems are the least costly and tend to be more reliable as they have fewer moving parts, though the storage tanks must be located above the panel. This places aesthetic and structural limitations on these systems, particularly when considering their structural integrity during hurricanes.

Most systems installed in Bermuda to date are open-loop systems, meaning that the water passes through the panel directly into the hot water tank. According to a local Energy company, a typical system for a household of three to four people would require a 3 meter by 1.2 meter collector with a 550 litre hot water tank. This system would cost around $9,000 installed, while a smaller system for two to three people would cost approximately $6,000.

Similar systems in the US would cost around $2,500 to $3,500 installed. The higher costs in Bermuda are due to increased installation costs associated with the structure of the houses, shipping costs and the duty paid on all system components other than the solar collectors. It is possible however, to retrofit solar hot water panels to existing water tanks which may reduce these costs.

Though these systems do not generate electricity, it is estimated by various authorities such as the US Department of Energy that heating water accounts for up to 15% of residential electricity use and even more in hotels and restaurants. Solar hot water heating could further augment energy conservation and efficiency efforts to reduce demand for electricity.

The Ministry of Finance in Barbados has mandated that all materials for solar hot water systems are duty free.
Partial or full tax deductions are offered for the cost of the heaters. The component cost for each system is about $2,000. Today, more than 38,000 solar hot water systems have been installed. These systems are estimated to save $6.5 million a year in fuel costs. Fifty hotels have large scale installations where waste heat from air conditioning systems is used to pre-heat the water entering the panels.

7.1.3 Solar Energy Technologies – Solar Photovoltaic

Solar photovoltaic technology converts electromagnetic energy from the sun into direct current electrical energy. This may be used directly to charge batteries, or converted to alternating current by an inverter. The inverter also conditions the power so that it is suitable to be fed into the electrical grid and ensures that the electricity may be isolated in the event of a fault. Due to the extra financial and environmental costs of backup battery banks, it is anticipated that grid connected photovoltaic systems could offer the greatest benefits.

Solar photovoltaic panels offer a scalable solution to addressing fossil fuel dependency. They contain no moving parts, maintenance requirements are minimal and there are international standards for testing performance and durability. Costs have levelled off and even risen slightly due to increasing demand and a shortfall in supply. This situation shows signs of easing as new production comes online, and costs are expected to drop further.

There are many other variations of solar energy technologies designed to generate electricity including solar towers, parabolic trough concentrators, dish concentrators and solar chimneys. These technologies are developmental and aimed at utility scale, rather than consumer sited, power production.

The capital cost per installed kilowatt of capacity for a complete grid-connected photovoltaic system ranges between $6,500 and $7,500 [figures from the International Energy Agency Photovoltaic Power Systems Programme, 2006]. Such costs have acted as a deterrent to the mass uptake of these systems in the past, though the high cost of electricity now realises payback periods of seven to ten years. The combined effect of many small scale rooftop systems has the potential to contribute toward a meaningful amount of non-fossil fuel based energy.

Twenty megawatts of south-facing solar photovoltaic installations mounted at close to the optimum angle of 35º should produce approximately 28 gigawatt hours of electricity each year. This represents just under 4% of Bermuda’s annual electricity production in 2007 and avoid the use of more than 38,400 barrels of oil per year.

7.2 Wind Energy

7.2.1 Wind Energy Resource

Bermuda has a strong wind resource, estimated to be on average over 7 meters per second. However, as shown in Figure 22, the wind resource is out of phase with annual electricity demand and as this resource is highly intermittent, it cannot provide a constant source of electricity. Fortunately, wind turbines in combination with existing diesel powered generators would provide a stable power supply. Wind technology offers a well developed and economically viable solution to reducing the amount of fossil fuels used to generate electricity. The strength of our resource, coupled with the high cost of oil, makes it likely that investments in wind technology will be paid back within an acceptable period of time.

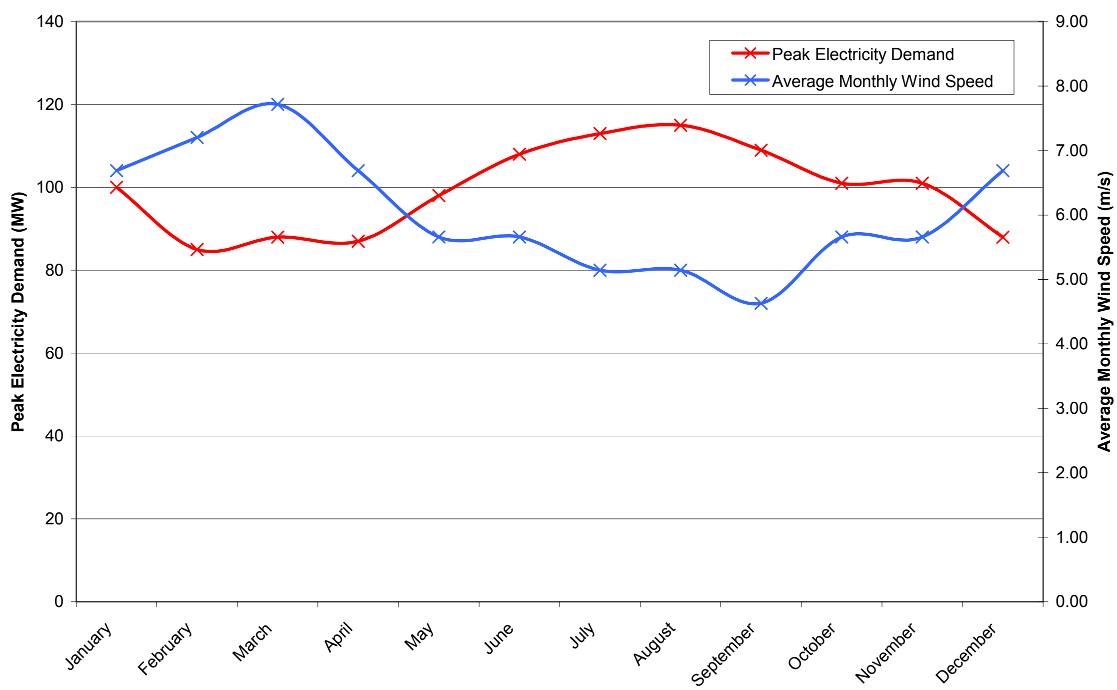

Figure 22: Peak Electricity Demand and Average Monthly Wind Speed
Department of Energy, 2008

7.2.2 Wind Energy Technologies

Wind power has emerged as one of the fastest growing renewable energy technologies. Historically, windmills have been used to generate mechanical power for pumping water and grinding crops. Modern wind turbines convert energy available in the wind into mechanical energy that is used to power generators to produce electrical energy. Designs are carefully optimised to operate as closely as possible to the maximum possible efficiency of almost 60%, while remaining safe, economical and unobtrusive.

Although various wind turbine designs exist, horizontal axis, three-bladed turbines dominate the utility scale market. Two types of generators (induction and synchronous) are used in wind turbines. The synchronous generators are more costly and are preferred for low noise applications as they do not require a gearbox. Induction generators, though cheaper, rely on a reference frequency from the grid and are generally not capable of operation if isolated from the grid due to a fault.

Modern utility scale turbines are ready to operate 95% of the time and Bermuda's wind resource will allow them to produce 30% of their installed capacity. Issues associated with wind turbines include noise, bird and bat strikes and flicker from blade shadows. Research shows that these concerns may be successfully mitigated through the careful design of the turbines and appropriate site selection.

Although Bermuda has limited free space for onshore turbines, there may be some appropriate locations, particularly when considering their small footprint, which allows land to be used for other purposes. Offshore sites offer greater potential with feasibility studies concluding that offshore wind power development is technically viable and that the existing electrical system is capable of accepting connections from an offshore wind farm. The costs of going offshore, however, are significant.

Enormous progress has been made over the past three decades in the development of wind turbines. At the end of 2007, worldwide capacity of wind-powered generators was 94 gigawatts, providing 1% of the world's electrical power. In 2007, wind power accounted for approximately 19% of electricity production in Denmark, 9% in Spain and Portugal, and 6% in Germany and the Republic of Ireland.

A key difference between the wind and solar industries is in the design of equipment for small and large scale applications. Both large and small solar installations are constructed from similar modules that have met rigorous testing and performance criteria. Wind energy technology, on the other hand, has developed into a large industry, based mainly upon utility-sized devices that provide from hundreds of kilowatts to multiple megawatts. Residential devices tend to be produced by smaller, specialised companies that do not have the same resources to develop turbines.

Turbines may be categorised into three sizes, based on their installation and operation requirements:

- Micro Scale: A few hundred watts to several kilowatts; may be mounted on suitable existing residential structures;
- Small Scale: Five kilowatts to around 50 kilowatts; usually require dedicated towers; and
- Utility Scale: Hundreds of kilowatts up to several megawatts; requiring specialist professional installation and operation.

Utility scale turbines are designed to withstand maximum winds of around 150 miles per hour. Local engineering contractors are capable of installing smaller utility scale devices, of about 2 megawatts, both onshore and offshore. Larger devices would require specialised equipment to be brought to Bermuda for installation which could greatly increase the costs. Many modern turbines have built in maintenance cranes, which would reduce the dependency on separate, large cranes needed to carry out maintenance and repairs.

While onshore turbines are much cheaper than offshore turbines, perceived visual intrusion is an issue that must be quantified and addressed. Offshore turbines require sub-sea grid connections and foundations engineered to withstand extreme wave forces, making them inherently more expensive.

The costs per installed kilowatt for wind turbines are as follows: modern utility scale onshore wind turbines between $1,000 and $1,400, offshore wind turbines around $2,400, small scale turbines around $4,800 and micro-turbines between $3,000 and $7,000. These costs are based on information from various authorities such as the American, British and Danish wind energy associations. Costs are currently increasing due to both the price of raw materials and demand for wind turbines.

A 20 megawatt wind farm would be expected to output around 70 gigawatt hours of electricity a year, which is approximately 10% of Bermuda's annual demand. Such a wind farm would offset the purchase of about 100,000 barrels of oil per year.

7.2.3 Micro-Turbines

The siting of turbines to maximize the wind resource is key to obtaining good energy yield and favourable economics since the energy available in the wind is proportional to the cube of the wind speed. Also, the lack of site-specific wind resource data and aerodynamic understanding of residential installations has led to questionable outputs from many smaller devices.

To justify the investment in wind power systems usually requires a minimum of six months and preferably a full year's research into the wind conditions at that site, as close to the turbine hub height as possible, and comparison with historical data to predict power output.

There will be locations and technologies that are able to provide useful power outputs and good rates of return, although mechanisms will need to be in place to ensure that micro-turbines are appropriately sited. However, due to the lack of standard testing procedures, these will have to be assessed on a case-by-case basis. Loads on wind turbines during peak winds can be considerable, and existing structures need to be carefully assessed to ascertain if they are suitable foundations for these devices.

7.3 Wave Energy

7.3.1 Wave Energy Resource

Bermuda has a strong and relatively consistent wave climate and every household in Bermuda is within a mile or two of the Atlantic Ocean. This proximity to the ocean minimises the transmission requirements for wave energy technologies. Waves may be predicted days in advance, which increases the value of the power generated as it may be smoothly integrated with conventional power generation.

7.3.2 Wave Energy Technologies

Wave energy technologies convert energy in waves into electrical energy using various intermediary energy transfer mechanisms. They are classified in terms of:

- Location: onshore, near-shore or offshore;
- Position: floating or fixed;
- Extent to which they absorb wave energy: terminators, attenuators or point absorbers; and
- Method by which they absorb wave energy: oscillating water columns, hydraulic drives, air or water driven turbines.

The variety of devices developed to date is an indication of the infancy of most of these technologies, as is evident by the dozens of different designs in various stages of development. Some devices require massive steel and concrete structures, while others only require simple moorings. They may be located on the seabed, on floating platforms, on the shoreline or a combination of the three. While some have been more successful than others, no single design has yet proven to be the most viable option.

Potential leaders in the field are the attenuator device known as *Pelamis*, which consists of many segments joined together, with hydraulic rams linked to motors that power generators; and *CETO*, which is a series of point absorbers consisting of submerged hydraulic rams and floats that produce high pressure seawater. These are the first two devices that are nearing or are currently in stages of commercial production and each has its own specific advantages. The entire *Pelamis* unit is designed to be disconnected and towed to shore for maintenance; while the *CETO* system is capable of producing both high pressure seawater for desalination and electricity generation, with all of its electrical components located on shore. The respective focus of these devices to offer on-shore maintenance and electricity generation is significant and may lead to more affordable power production, especially when considering the costs and complexity of offshore engineering

Any offshore components must be compatible with marine life and reef infrastructure. Australia, Hawaii and Ireland have all conducted wave energy feasibility studies, assessing the local wave climate, electrical distribution system and current energy legislation to determine opportunities for pursuing wave energy technologies on a national scale. The results of these studies have led these countries to determine that their respective territories were ideally suited to develop national wave energy programs and Bermuda appears to have many similar characteristics.

It is anticipated that once a suitable technology emerges, Bermuda may be able to take advantage of this resource, simultaneously becoming an international test-bed for some of the first commercial applications of wave energy technology.

7.4 Ocean Current Energy

While ocean currents move slowly relative to the wind, they carry a great deal of energy because seawater is around 900 times denser than air. The minimum speed for an economically viable installation is usually considered to be 2 to 2.5 metres per second, although with the higher cost of power in Bermuda, lower velocities may be feasible.

Research suggests that ocean currents in the vicinity of Bermuda are rarely greater than 20 to 30 centimetres per second and are highly variable in nature, exhibiting no consistent current flow. There may be some localised effects that accelerate current flows, but these are unlikely to offer a useful energy resource. Given the poor nature of the resources available in Bermuda and the developmental nature of technologies to date, it seems unlikely that any significant amount of energy will be derived from ocean currents in the near future.

7.5 Tidal Energy

Tidal energy is a form of hydropower that converts the energy of tides into electricity. A tidal range of 16 feet is usually considered viable for power generation. Tidal ranges in Bermuda vary from around 1 to 4 feet. Despite the high cost of electricity, the tidal resource available does not seem to offer a practical energy alternative. As an example, if a barrage and turbine were placed under Flatts Bridge to utilise the tidal flow through to Harrington Sound, it would be able to generate less than 0.5% of the Island's annual power demand. The figure is likely to be lower as there are many underwater caverns that link Harrington Sound to the ocean. These caverns would allow water to bypass the turbine.

7.6 Ocean Thermal Energy Conversion

7.6.1 Ocean Thermal Energy Conversion Resource

The storage of solar energy as heat in the oceans is the largest energy collection and storage system in the world. Ocean thermal energy conversion originates from the sun's electromagnetic energy which heats surface water. Ocean thermal energy conversion uses this temperature difference between deep and shallow waters to generate electricity. Ocean thermal energy conversion requires a temperature difference of around 20ºC. Deep ocean water is around 5ºC, which requires surface waters of at least 25ºC. Figure 23 depicts ocean thermal energy resources by illustrating the temperature differences between surface and deep water around the world.

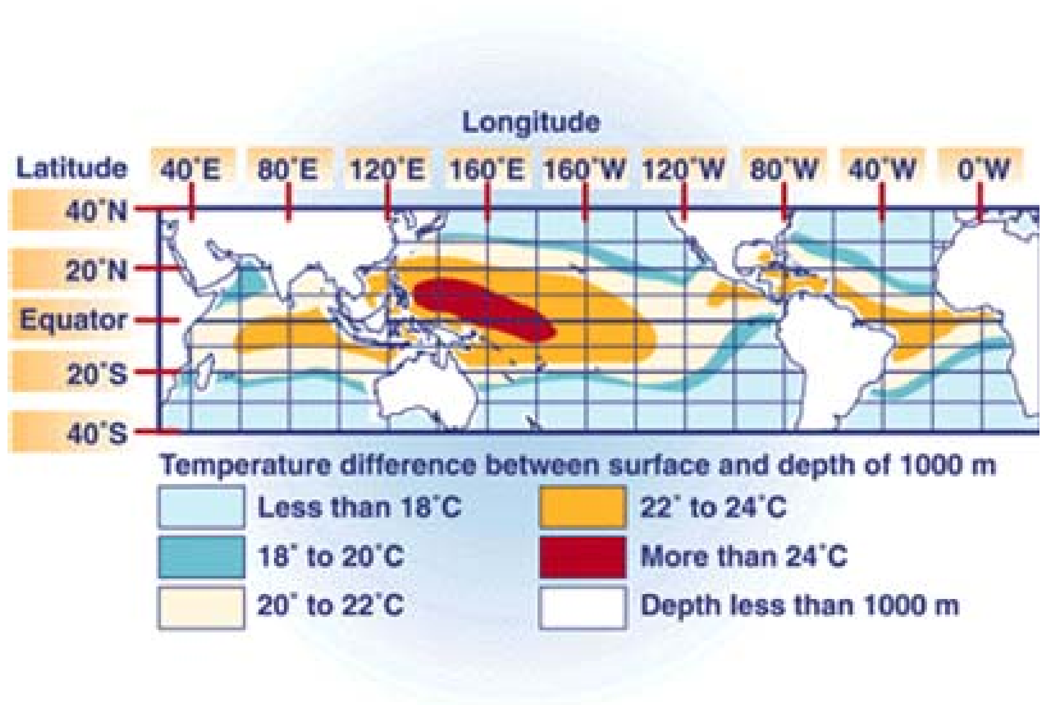

Figure 23: Ocean Thermals
National Renewable Energy Laboratory, 2008

Power from an ocean thermal energy conversion plant is available twenty-four hours a day, seven days a week, 365 days a year. The resource varies annually, in phase with power demand, increasing in the summer and decreasing in the winter.

Bermuda's oceanography places the deep ocean water within easy reach and our location offers the warm surface water necessary to develop this resource.

7.6.2 Ocean Thermal Energy Conversion Technologies

Electricity is produced by tapping into the temperature difference between surface ocean water and deep ocean water. With zero fuel costs and low operating costs, this technology is an attractive base load energy source. As the maximum theoretical efficiency for the process is only 6% to 7%, very large plants are required to produce any useful power output. Ocean thermal energy conversion power can be generated on land or offshore and transmitted to shore by electrical cable. Additionally, electricity can be generated and used at sea for the manufacture of energy-intensive products or fuels.

Ocean thermal energy conversion plants may employ either an open or a closed loop cycle to drive turbines to produce electricity. In an open loop system, warm surface water is evaporated under low pressures to produce steam which drives low pressure turbines. Closed loop systems direct warm seawater through a heat exchanger to heat a working fluid, usually ammonia, to drive a turbine. The working fluid is then condensed in another heat exchanger using the cold, deep ocean water.

Ocean thermal energy conversion plants offer the following additional potential benefits each with the potential of stimulating the establishment of local industries:

- Millions of gallons of freshwater may also be produced as a co-product by either system. Warm surface seawater is flash evaporated under partial vacuum to produce water vapour, which is then condensed using the cooler deep ocean water via the ammonia in the evaporator. This water treatment method has not yet been built as an integrated system but, like an ocean thermal energy conversion power system, the components have been tested and there are no major unknowns;

- Both processes also offer nutrient rich deep seawater as a by product, which, by careful combination with surface waters, may provide the required temperatures and nutritional environments for significant mariculture of finfish, shellfish and algae for transportation bio-fuels;

- The cold water may also be used in heat exchangers to improve the efficiency of conventional heat pumps, driving refrigeration and air conditioning systems. This would require significant infrastructure to be used to maximum effect; and

- The creation of the facility itself could serve as a major driver to incorporate new technology, innovation and lead to the establishment of state-of-art sea farm park aquariums and other research facilities that will foster public awareness and appreciation for the marine environment.

It is estimated that the construction of an ocean thermal energy conversion system producing 10 megawatts of electricity and 5 to 10 million gallons of desalinated water per day would cost $35 to $45 million.

7.7 Geothermal Energy

7.7.1 Geothermal Energy Resource

Geothermal energy originates from either the earth's absorption of radiation from the sun or the decay of radioactive isotopes within the earth itself. As Bermuda is located on an extinct volcano, many have suggested there may be a source of geothermal energy which could be utilized to generate power. Such a high grade heat source could be used to drive steam turbines to power generators as is evident by the many such power plants in operation around the world today.

The average global flow of geothermal heat energy is insufficient to generate significant amounts of power at around 60 milliwatts per square metre. Aumento and Gunn (1975) report heat fluxes of around 57 milliwatts per square metre from boreholes in Bermuda, indicating that there is no appreciable high grade heat source to use for power generation.

Over a period of time, low grade heat energy from open loop heat pumps has been disposed of in groundwater under the City of Hamilton. In some cases, disposal has been maintained at an unsustainable rate, and organisations involved in this field have indicated that in these areas, the groundwater is now over 89ºF, at which point the performance of the heat pumps is affected to the point where there is no advantage in using geothermal heat sinks.

Fortunately, this appears to be a localised problem and groundwater temperatures of 75ºF to 80ºF are reportedly still available. If heat flows are maintained at a sustainable rate, possibly through a centralised and well managed system, this could offer a good resource for further heat pump installations.

7.7.2 Geothermal Energy Technologies

Most cooling technologies transfer heat energy between the inside of buildings and outside air using air to air heat exchangers. As demand for cooling increases in line with ambient air temperatures, these devices are trying to dispose of heat energy into an environment already at a relatively high temperature. This limits the cooling efficiency, particularly as the external heat exchangers are often located in bright sunlight on the grounds or on the roofs of buildings. One simple example would be to place a refrigerator in bright summer sunlight – it would use far more energy to keep the inside cool than if it were located in the shade.

By disposing of the waste heat energy into a cooler medium than the ambient air such as rock, the ocean sea water or groundwater, the efficiency of cooling systems may be greatly increased. Many heat pump technologies exist which are capable of using these other transfer mediums, though expensive boreholes are often required, and systems need to be carefully designed and located to provide sustainable rates of heat transfer.

7.8 Waste to Energy and Biomass

7.8.1 Waste to Energy and Biomass Resource

Bermuda produces approximately 70,000 tons of municipal solid waste each year. Research suggests that 450 to 550 kilowatt hours of electricity could be generated per ton of municipal solid waste with energy contents of 9 to 11 megajoules per kilogram. This indicates that the Tynes Bay facility could potentially provide over 5% of Bermuda's annual electricity requirements.

The de-manufacturing of vehicles, recently estimated to contain around eleven percent by mass of plastics and other goods, could provide an alternative source of high energy fuel. Additionally, other potential energy sources are 800 tons per year of vehicle tires, 18,000 tons per year of horticultural waste, and 500,000 gallons per year of waste oils/sludge, though the impact of including these in the waste stream would have to be researched.

The landfill at Marsh Folly is suspected to be producing methane gas with a projected lifetime yield per ton of waste likely to be 40,000 to 80,000 gallons. The Ministry of Works and Engineering have indicated that they do not believe that this is a useful resource in the context of utility scale power generation.

Bio-energy commonly refers to energy derived from recently living organisms such as wood, food scraps and animal wastes. Crops may be grown specifically for use as an energy source, though to provide any significant amount of energy in Bermuda would require an impractical amount of land. Instead, we may look toward using existing sources of biomass, which are currently discarded.

In a 2000 survey, 18% of residential waste comprised discarded food. This is currently combusted at Tynes Bay, though due to the high moisture content of this food there would be a significant benefit to the efficiency of the Tynes Bay Waste to Energy Facility if it could be removed from the waste stream. The food waste represents in itself a potential energy resource, though different technologies would be required to extract this energy.

Waste vegetable oil may be used as a feedstock for producing biodiesel, which is one of the few alternative options available for transportation fuels. There is also ongoing research in both Bermuda and the US into using algae to produce liquid bio-fuels, which could have the potential to provide a significant proportion of transportation fuels, though this is still at the research and development phase, with some small scale trials actually producing fuel.

7.8.2 Waste to Energy and Biomass Technologies

There are several technologies available to process municipal solid waste and biomass into useful, saleable fuels. The simplest involves direct combustion of the feedstock in a plant such as Tynes Bay (see Section 4) to produce steam which drives turbines. The efficiency of this process is limited by the moisture content of the feedstock though the economics of power generation are often better than other processes. While most of the technologies described below are able to produce useful fuels, they are of limited application to Bermuda due to the amount of feedstock required.

The planned expansion of generation capacity at the Tynes Bay Waste to Energy Facility is expected to more than double the power output for the same amount of waste. A combination of increased electricity sales and a potentially higher value per kilowatt hour if output becomes more reliable could provide an increased revenue stream to fund the operation. Many other waste to energy plants operate at a profit, charging to receive waste and selling the power they produce.

Gasification is a chemical process by which either municipal solid waste or biomass feedstock is converted into a gaseous fuel. Hot steam and oxygen react with the feedstock to produce a mix of gases, including hydrogen and methane, which may be used to drive turbines or to produce synthetic gas, from which almost any hydrocarbon compounds may be synthesized. The conversion efficiencies of this process vary between 40% and 70% depending on the system design.

Pyrolysis is a process where the feedstock is heated in the absence of oxygen and the volatile matter released is condensed to form oil. Municipal solid waste may be used as feedstock, though the product oil's composition may be highly variable, excluding it as a useful option for transportation fuels without further processing.

Fermentation is a biological process used to produce bioethanol from various biological feed-stocks and has been used extensively in countries such as Brazil, though the conversion efficiencies are very low.

The use of vegetable oils directly in engines may lead to engine damage and produce compounds which are harmful to human health. A more responsible approach involves the production of biodiesel through the conversion of vegetable oils. This process has consistently been shown to have higher energy conversion efficiencies than bioethanol and may utilize a variety of feed-stocks, most promising perhaps for Bermuda is current research into using algae to produce oil for this process.

Anaerobic digestion is a biological process in which bacteria break down organic matter, such as waste food, animal waste and plant matter, to produce biogas which may be used to power turbines. Each ton of dry waste could produce around 80,000 gallons of biogas consisting of between 50% and 75% methane.

7.9 Combined Heat and Power (Cogeneration)

Generating electricity from combusting fuels results in the production of large quantities of waste heat energy. Based on plant efficiencies described in Section 4, between 56% and 77% of the energy produced from burning oil to produce electricity in Bermuda is currently lost as heat by the electric utility. Combined heat and power refers to the use of this waste heat to drive useful processes such as absorption chillers and water heaters.

Because so much energy is currently lost as heat, it has been suggested that a more logical approach would be to design a plant to produce heat, with electricity as a co-product. This would be achieved by siting electricity generation close to demand for either heating or cooling. This is opposed to the current trend of siting an electricity generation plant and then trying to find a use for the heat.

This technology has perhaps been limited in the past due to difficulties with distributing heat economically, the new combined heat and power approach recognises that it is often much easier to transmit electricity than heat. Although combined heat and power in Bermuda would be likely to rely on fossil fuels, such technologies will help to reduce our dependence on fossil fuels. Not only could we use heat energy which would otherwise be wasted, we are offered the opportunity to greatly reduce our demand for the electricity which would otherwise be required to power these processes.

To date, around half a dozen systems are being considered for various large commercial properties around Bermuda in recognition of the efficiency of this process.

7.10 Nuclear Technology

Nuclear power is not defined as a renewable energy source as it is derived from non-renewable fuels. These fuels must be mined and processed by other countries, thus it does not represent an indigenous energy source. Nuclear power provides a steady output of energy which is well suited to provide base load electricity. Small amounts of carbon dioxide are associated with the generation of electricity from nuclear power due to the energy involved in constructing the plants, mining and processing uranium and disposing of nuclear waste.

France's carbon dioxide emissions from electricity generation fell by 80% between 1980 and 1987, as its nuclear capacity increased. Germany's nuclear power program has saved the emission of over 2 billion tons of carbon dioxide from fossil fuels since it began in 1961. There are however several issues with nuclear power that should be considered:

- Despite good safety standards, accidents can still occur and it would not be possible to create an evacuation zone in Bermuda;
- Any site containing nuclear fuel is a potential target for terrorist attacks;
- Uranium is a limited resource, so Bermuda would still be dependant on an imported fuel;
- Bermuda is densely populated, so it would be difficult to find sites away from populated areas; and
- Radioactive waste produced by the process of generating power must be stored safely for anywhere from a few thousand years to tens of thousands of years, depending on the regulations of the country where it is stored. It is very difficult to estimate the costs involved in this storage and as a result, taxpayers often end up subsidizing the disposal of waste from private nuclear energy companies.

7.10.1 Pebble Bed Modular Reactors

Pebble Bed modular reactors are a high temperature reactor with a closed-cycle gas turbine power conversion system. Very high efficiency and attractive economics are possible with these types of reactors without compromising the high levels of safety expected of advanced nuclear designs.

Safety is provided by inherent features that require no human intervention, and which are designed not to be bypassed or rendered ineffective in any way. If a fault occurs during reactor operations, the system is designed, at worst, to shut down and merely dissipate heat on a decreasing curve without any core failure or release of radioactivity to the environment.

A 165 megawatt Pebble Bed modular reactor would generate about 32 tons of spent fuel pebbles per annum, about 1 ton of which is uranium. The storage of spent fuel should be easier than for fuel elements or rods from conventional nuclear reactors, as no safety-graded cooling systems would be required to regulate the waste temperature.

7.10.2 Recent Developments in Nuclear Power

Several companies have recently brought out other miniature nuclear reactors. These sealed units are capable of generating around 25 megawatts of electricity, at an estimated cost of $25 million. This would provide approximately 30% of Bermuda’s annual energy requirement, if run at full capacity. The reactors are designed to be run for over five years, before being returned to the factory for re-fuelling.

While these reactors have been designed to be safe, reliable and low-maintenance, most of the issues previously outlined with nuclear power still apply. As these technologies further develop and are used in other jurisdictions, we may use their experiences as case studies to assist in our decision as to whether they are appropriate for Bermuda.

8 Utility Scale Energy Storage Technologies

The main issue with most renewable energy resources is their intermittent nature. As shown by hydroelectric energy storage, the value of energy is greatly increased if it may be stored and released on demand. Finding an appropriate utility scale energy storage system for Bermuda would allow many forms of renewable energy to become competitive with conventional forms of electricity generation on a much greater scale than would be possible without energy storage.

8.1 Hydrogen Energy Storage

Hydrogen offers the potential to store energy on a large scale and to cleanly and efficiently convert it into more useful forms of energy, notably electricity through fuel cells, although it may also be used to power combustion engines. Although costs are currently prohibitive, it is viewed by many to be the energy storage solution of the future.

Figure 24 shows some key drivers and barriers to the widespread development of hydrogen as a fuel, often referred to as developing a ‘hydrogen economy’.

Drivers for Hydrogen	**Barriers to Hydrogen**
Most abundant element in the world	Occurs almost exclusively with other elements (not accessible as a fuel)
Can be obtained from water	Extremely flammable and buoyant
Very good electrochemical activity	Currently produced from fossil fuels
Produces water when combusted with oxygen	Technically feasible, storage density is lower than liquid fuels
Highest energy density by weight of any known fuel	Has unique permeability characteristics through many materials
Compatible with both electrochemical and combustion processes	May cause embrittlement of materials

Figure 24: Drivers and Barriers to Hydrogen as a Fuel

The overall challenges to a hydrogen based energy system are cost reduction, storage and developing infrastructure. For transportation, hydrogen must be cost-competitive with conventional fuels and technologies on a per-mile basis in order to succeed in the commercial marketplace. Research continues into technologies to reduce the costs and increase the performance of hydrogen production, storage and use. There are commercially available technologies, though the range and costs of these do not currently lend themselves well to the development of an entire energy system based on hydrogen as a fuel.

8.1.1 Hydrogen Production

Since hydrogen does not exist on earth as a gas, we must separate it from other elements. We can separate hydrogen atoms from water, biomass, or natural gas molecules by using the two most common methods for producing hydrogen, which are:

- Steam reforming: Currently the least expensive method of producing hydrogen and accounts for about 95% of the hydrogen produced in the US.
- Electrolysis: A process that splits hydrogen from water and has reached efficiencies of up to 80%. Efficiencies of up to 94% have been predicted for some of the developing electrolysis technologies.

Energy to drive the electrolysis process is currently mostly derived from fossil fuels. The potential exists in the future to use alternative and renewable energy sources to create hydrogen.

8.1.2 Hydrogen Storage Technologies

There are three main methods currently available for hydrogen storage: as a pressurised gas, a cryogenic liquid or a metal hydride. They each present a different solution to the issues presented in Figure 24.

Hydrogen is a gas at room temperature and pressure; and under these conditions, 2.2 pounds of hydrogen would occupy a volume of 2,900 gallons. Pressures of 200 bars are commonly used to compress a useful amount of hydrogen into a cylinder of a reasonably practical size. Cylinders which may accept pressures of up to 800 bars have been developed; but the energy required to compress hydrogen to these pressures reduces the overall efficiency of this method of storage.

To store hydrogen as a liquid, which still has a relatively low density of 0.2 pounds per gallon, it must be cooled to -424ºF. As with compressing gaseous hydrogen, a significant amount of energy (30% to 40% of the energy in the fuel itself) is lost in cooling the hydrogen to these temperatures. The liquid hydrogen must also be kept at this temperature to avoid losses through evaporation.

Metals or metal alloys may be reacted with hydrogen to produce metal hydrides. These offer good volumetric storage efficiencies and are inherently safe, though they are also heavy.

There has also been research into physically storing hydrogen inside solid compounds. This method could offer a route to high energy storage densities and fast storage/recovery of the hydrogen.

8.1.3 Fuel Cell Technology

Fuel cells produce electricity directly by chemically reacting fuels, usually hydrogen and oxygen, to form water. By producing electricity directly and avoiding intermediary energy transfer mechanisms, fuel cells offer potentially much higher efficiencies than using internal combustion engines to generate electricity. Unlike conventional electrochemical batteries, the fuel supply of a fuel cell may be continuously replenished allowing for continuous operation.

Fuel cell systems consist of single fuel cells, combined to form stacks. These stacks are supported by various other systems, which take care of the fuel feed, thermal management, reaction product (water) management and electrical conditioning.

Research to date has focused on improving the performance of fuel cells whilst lowering their costs. This has been achieved using catalysts such as platinum, raising the temperature of the fuel cells and increasing the reaction area. However, platinum is an expensive catalyst and may become poisoned over time by impurities in the fuel or oxygen. This requires extensive quality control of the fuel to avoid sometimes irreversible damage to the fuel cells. The main fuel cell technologies are compared in Figure 25.

Fuel Cell Type	**Operating Temp. (°C)**	**Potential Applications**
Alkaline	50 – 220	Transport, space vehicles
Phosphoric Acid	~ 210	Small CHP systems
Molten Carbonate	~ 650	Medium-Large CHP systems
Solid Oxide	500 – 1,000	All CHP systems
Proton Exchange Membrane	40 – 100	Transport, small CHP systems
Direct Methanol Polymer Electrolyte	50 – 100	Transport, mobile and stationary power

Figure 25: Fuel Cell Technology Overview

Note: CHP refers to Combined Heat and Power generation, indicating electricity may be produced with heat as a by-product for further processing.

8.1.4 Fuel Cell Applications

Fuel cells have the potential to replace the internal combustion engine in vehicles and provide power in stationary and portable small scale power applications. They are also able to provide utility scale electricity production capabilities.

Fuel cell vehicles represent a radical departure from vehicles with conventional internal combustion engines. Like battery powered electric vehicles, they are propelled by electric motors. The fuel cell creates electricity using fuel containing hydrogen and oxygen from the air. Fuel cell vehicles can be fuelled with pure hydrogen gas stored onboard in high-pressure tanks. They also can be fuelled with hydrogen-rich fuels; such as methanol, natural gas, or even gasoline; but these fuels must first be converted into hydrogen gas by an onboard device called a reformer. When fuelled with pure hydrogen, fuel cells emit no pollutants; only water and heat; while those using hydrogen-rich fuels and a reformer produce only small amounts of air pollutants.

8.2 Flow Batteries

Flow batteries consist of two large storage tanks containing electrolytes. Pumps transfer the electrolytes to a power cell where they are separated by a proton exchange membrane. The capacity of the batteries range from several kilowatt hours to megawatt hours and may be increased by increasing the volume of the electrolyte storage tanks. The overall system power may be increased by adding more cells and upgrading the electrolyte pumping equipment.

If an economical and suitable flow battery system were to be designed and installed in Bermuda, it could reduce dependency on fossil fuels without installing any renewable energy devices. The flow batteries could replace the fossil fuel powered plant that currently only provides electricity for demand peaks. This would allow the more efficient base load plant to operate more evenly, with the grid charging the flow batteries while demand is low and drawing power from the batteries as demand increased.

Full scale devices have been in operation in other jurisdictions since the late 1990s and there are many case studies, which Bermuda could gain insight from. Notable examples include installations by VRB Power Systems Inc. at King Island in Tasmania, Castle Valley in Utah and Sumitomo Electric Industries, Ltd., which have sixteen operational plants in Japan.

Though flow batteries are based on various chemistries, vanadium flow batteries, which operate using a vanadium based electrolyte dissolved in dilute sulfuric acid, are available commercially. Vanadium flow batteries are able to respond quickly to changing loads, are capable of being moderately overloaded and as such are well suited to smoothing demand peaks. Current research is expected to significantly increase the energy density and operating temperature range for these batteries; and the safe handling and storage of the vanadium based electrolytes will also have to be managed.

Availability factors are reported to be in excess of 98% and these systems are designed for low maintenance operation. These systems can also withstand over 13,000 charge/discharge cycles without an appreciable deterioration to system efficiencies, of around 70% to 80%. If the electrolytes are cross mixed it does not result in contamination and they may be used almost indefinitely avoiding many of the disposal issues of conventional batteries.

These systems typically cost around $350 to $600 per kilowatt hour of storage capacity, though the additional cost per kilowatt hour for increasing the system size once in the megawatt hour range is much smaller, typically around $150 per kilowatt hour.

Part 3

Bringing Energy Solutions to Bermuda

9 Policy, Legislation and Incentives

Perhaps the greatest incentive to reduce the use of fossil fuels already exists in the form of the high cost of electricity in Bermuda. Although transportation fuels are also expensive, relative to countries such as America and Canada, the small size of Bermuda lessens the impact.

A key incentive would therefore be a clear policy for the connection of alternative and renewable energy technologies to the electrical grid and a stable rate structure for electricity fed back into the grid, based on its source. With these policies in place, the economics of renewable energy projects may be calculated thereby adding to investor's confidence in supporting these technologies, from residential to utility scale projects.

Many policies have been tried and have failed in countries across the world, and provide examples we may look toward when selecting incentives for Bermuda. Failing to address all the elements of a policy framework may undermine the entire policy and its objectives will not be reached. One of the most common failures in renewable energy policies is the creation of boom and bust cycles through policies with:

- Excessive time constraints;
- Unrealistic resource allocation; and
- Inappropriate technology or emissions targets.

It will be necessary to develop stable, easy to understand policies with well defined objectives, to attract businesses in the alternative/renewable energy industry. These policies need to be designed with the investor's requirements in mind to ensure the success of these projects.

9.1 Features of Successful Policies

9.1.1 Well Defined Objectives

The objectives of an energy policy should be clear in order that they may best achieve their goal. For instance, are the objectives for Bermuda to reduce fossil fuel dependency, diversify our generation mix, lower the price of energy, to reduce greenhouse gas emissions, or any combination of these?

Having defined these objectives, a policy framework should be designed to deliver a well defined set of national goals as they provide:

- Incentives to create legislation;
- Reasons to review existing legislation; and
- Assurance against obstructive legislation.

Spain, for example:

- Introduced a policy of guaranteed access to the electrical grid, with the objective of increasing competition in the electricity sector; and
- Simultaneously established a legal framework for the rates paid for electricity from alternative and renewable energy sources, with the objective of encouraging their use.

9.1.2 Making Informed Decisions

Effective policies must be based on the realities and limitations of the Bermudian environment. This requires informed decisions with regard to:

- Renewable energy resources, which must be well understood;
- Physical spaces available for development;
- Environmental impacts of developing particular technologies;
- Social aspects of prospective developments;
- Infrastructure limitations (road access etc.); and
- Grid access for alternative/renewable electricity projects.

9.1.3 Transparency and Clear National Policy

It is essential that the policy framework be clear enough that it may be used as the basis for obtaining funding from investors for alternative/renewable energy projects. By designing a framework to satisfy the financial realities of such projects they will have a much better chance of succeeding. Germany, for example, has used clearly defined rate structures based on the source of energy and has provided clear cut-off dates for these rates, which exceed the project lifetime. Transparent policies are also likely to attract more attention, particularly from foreign investors.

National policies will provide a clear and solid foundation on which to base a more detailed policy framework.

9.1.4 Accessibility

Policies should create opportunities that are equally accessible to all parties by carefully selecting criteria that will allow newcomers time to develop business strategies, and also by avoiding preferential treatment of any particular businesses. In the long term, this should lead to a fair and competitive energy sector.

9.1.5 Encouraging a Diverse Market

Markets with more competitors are more likely to result in lower costs therefore creating policy that encourages competition between many individual entities is highly desirable. It also reduces the possibility of over-reliance on several large providers and ultimately creates a more robust market.

9.1.6 Duration

Many alternative and renewable energy projects have lifetimes of twenty or more years, so creating short-term policies may lead to rushes of investment while the economics are favourable, followed by a flat market once the figures no longer favour a return on investment, or may lead to little if any investment at all. For example, if the rate paid for renewable energy was only guaranteed for five years, it would support wind over solar, as solar has a longer payback period. It would also favour projects that got off the ground within a year or so of the incentive, while discouraging latecomers

Policies should also be designed with the future development of alternative/renewable energy industries in mind, as opposed to simply focusing on meeting particular targets. This will inherently create policies that should serve to encourage the development of a stable industry. They should also take into account the eventual removal of support for particular technologies as they become competitive.

9.1.7 Consistency

Policies should be consistent with each other and with national policy objectives. Currently in Bermuda, wind turbines attract a duty rate of 33.5%, while solar photovoltaic panels have a duty rate of 0%; this is an example of an inconsistent policy.

Policy across different areas of government that influence the alternative and renewable energy sector must also be consistent in order to provide a secure environment for investors. In the UK, for example, there has been central government support for renewable energy, but progress has been delayed by regional planning departments refusing planning permission for developments. By ensuring consistency in policy across government, the risk of policies being undermined is minimized.

9.1.8 Periodic Policy Review: Flexible yet Stable

A certain degree of flexibility is important so that policies can be reviewed to ensure that their objectives are being achieved. Also, as technologies progress and developmental technologies reach the market, the level of support required is likely to change.

Spain and Germany for example, have both adjusted the rates paid for electricity generated from renewable energy to reflect a reduction in the costs associated with certain technologies. While this represents a change in policy, it has been designed to directly account for a separate change to market conditions, thus the overall economics of renewable energy projects should not be significantly affected and the overall policy on supporting renewable power generation remains stable, despite the change.

9.1.9 Appropriately Supported Technologies

It is desirable to design energy policies around Bermuda’s indigenous resources, and the technologies that may effectively utilize them. The desired policy objectives may be specifically targeted with an appropriate combination of technology specific and technology neutral policy.

There will be some benefit in adopting technology neutral policies, such as open grid access independent of the technology. This would help to meet the objective of diversifying supply and encouraging competition in the marketplace. Technology neutral policies are also a more natural market-based mechanism, with the aim of adopting the most cost effective solution through market competition.

Technology neutrality also has disadvantages:

- Companies may be able to take advantage of these policies to sell technologies that may not represent good value to the consumer;
- Natural market development may lead to an inappropriate mix of technologies as it may be desirable to have certain proportions of each technology for a stable energy infrastructure; and
- Certain developmental technologies may require additional support to become established.

Flexibility is essential when adopting technology specific policy, in order to react appropriately to new technologies as they emerge.

9.1.10 Policy Support to Match Industry Size

Policies should be designed to recognize that it may be harder for small, new technologies to penetrate an existing market, dominated by existing large industry players. Large existing companies may be able to internally support alternative/renewable energy projects at much lower rates of return than are required by small newcomers to the market. If the same support is offered to all, the larger existing players are likely to consume a large part of the resources allocated for the new technologies, which defeats the objective of encouraging uptake of these technologies to create a competitive market.

9.1.11 Recognition of Questionable Technologies

Certain technologies have been associated with environmentally unsustainable practices, such as the large scale adoption of certain bio-fuels and hydroelectric schemes that involve the flooding of huge areas of land. It is important to recognize these technologies and to ensure that appropriate safeguards are in place so they may be developed in a sustainable manner.

9.1.12 Policies Adequate for Industry Start-up

Jump-starting new renewable energy markets may require policies structured to help get the industry off the ground. This may not be economically efficient in the short term, but with clear objectives, it could accelerate the development of this new industry leading to long term self sufficiency.

9.1.13 Sustainability

To avoid boom and bust cycles, any resources allocated to support policy should be sustainable in the long term and take into account industry growth. The UK low carbon buildings program, for example, is the UK's principal means of supporting small scale renewable energy technologies. The funding required to support the level of interest generated by this program was not initially designed in a manner that could meet demand, and the fund was quickly used up leaving start up businesses with few customers.

9.1.14 Energy Market Reform

Various aspects of energy markets will need to be reformed to facilitate the entry of new players. Market based systems involve more uncertainty and risk, which may increase the cost of investment, though eventually lower energy costs may be achieved through market dynamics.

Certification and licensing requirements will have to be designed with some degree of technology specificity in mind. The requirements for a utility scale wind farm, for example, would differ significantly from the requirements for a rooftop turbine.

As most alternative and renewable energy technologies consist of many smaller generators, relative to conventional energy production, it is not appropriate to negotiate infrastructure access on a case by case basis. Instead, it is essential to have a streamlined and consistent policy, which allow energy producers access to consumers who wish to purchase their energy. The costs of connection and the use of infrastructure should be standardized and fair. If infrastructure upgrades are necessary for alternative/renewable technologies, the cost of these upgrades should be fairly distributed to encourage the uptake of these technologies.

Since the fuel for most renewable energy technologies is free, both in terms of economical and environmental costs, and it is usually not possible to store this energy, it is desirable to prioritize the use of energy from these technologies over the use of conventional technologies.

9.1.15 Well Identified Development Zones

Allocating land and sea for the development of alternative/renewable energy technologies can occur prior to the actual development of any projects and link national targets to individual developments. This removes uncertainty related to locating these technologies and saves time during project design and planning. It also encourages forward thinking with regard to energy infrastructure development.

9.1.16 Informed Stakeholder Consultation

It is essential to involve all key stakeholders during the formation of policy to initiate and maintain communication between stakeholders. This communication will lead to the sharing of information, which in some cases will be vital to policy development. It will also offer a better understanding of stakeholder requirements, to ensure that stakeholder interests are properly accounted for.

9.1.17 Facilitating Local Ownership

Individuals are more likely to accept new technologies if they are able to invest in these technologies themselves and play a part in their development. Policies should be designed to encourage local ownership of new energy sources. Locally owned alternative and renewable energy technologies will ease the financial burden of increasing energy costs, which will also keep tens of millions of dollars in the local economy through the use of indigenous energy sources.

9.1.18 Administrative Efficiency

It is important that for incentives to be effective, they should have a high level of administrative efficiency. Grants for renewable energy projects have often lead to short-term inundation of their respective departments in countries such as Germany and the UK.

Tax based incentives are often easier to administer than other forms of incentives because the knowledge, systems, and government organizations needed are often already in existence. As an example, in Bermuda, the Customs Officers are familiar with the application of various duty rates depending on the characteristics of the goods. Therefore it would be relatively straightforward to amend the Customs Tariff to support alternative/renewable energy and conservation/efficiency, without requiring additional staff support.

9.1.19 Informed Consumers

It is essential that consumers are well informed about relevant policy, legislation and incentives as they hold the spending power to effect change. Informing consumers helps them make the decision to purchase the equipment or systems sooner than they might otherwise do so.

A study of technology deployment in Egypt, Ghana, and Zimbabwe found that information and awareness of technologies was one of two significant barriers towards implementation. However, the need for greater information on alternative/renewable technologies and incentives is not unique to developing countries. In the US, studies have shown that consumers who were interested in installing these systems and equipment in their homes and businesses were not fully aware of all the available incentives.

9.2 Considering Policy, Legislation and Incentives in Other Jurisdictions

Although some examples have already been cited in the previous section, certain countries have tried various policies, legislation and incentives with similar goals to Bermuda and may provide useful examples to study. This section looks at some of these countries, with a view to adopting certain successful measures to apply in Bermuda.

9.2.1 Denmark

According to Sovacool, 2008:

> ‘Primary energy consumption nationally has grown only 4% from 1980 to 2004, even though the economy grew more than 64% in fixed prices. At the same time, total carbon dioxide emissions decreased by 16%’

Denmark’s energy policy emerged from a desire to develop the country’s indigenous energy resources, their main policy goals are:

- Encouraging sustainable development in the energy industry;
- Reduce carbon dioxide emissions in 2005 by 20% in comparison to 1988 levels; and
- Renewable energy to grow to 12-14% of total.

Denmark has shown a serious commitment to meeting these goals, with frequent policy reviews and revisions when necessary, to meet these targets. A range of legislative instruments have been used including:

- Feed in tariffs that require utilities to buy electricity from renewable energy technologies;
- Mandating the use of combined heat and power;
- Prohibition of many oil, diesel and coal powered generators;
- Long term financing of selected energy projects;
- Open, guaranteed electric grid access;
- A carbon tax on all energy; and
- Streamlined planning application process for renewables, run by the Danish Energy Agency.

Energy taxes were introduced for fossil fuels and electricity, which effectively curbed consumption and encouraged the growth of renewable energy. By 1992, a combined energy and carbon dioxide tax was created, from which renewables were exempt. Subsidies were also used at this stage, to encourage renewable energy technologies, resulting in a reduction of greenhouse gas emissions.

A policy review in 1993 led to revisions, designed to ensure that the original energy policy targets were met; this was achieved through the introduction of green taxes to key industries. In 1995, the green taxes were further employed to encourage efficiency in trade and industry, with the funds collected going to various initiatives, including subsidies for solar photovoltaic and small scale wind turbines.

A second key energy policy was produced in 1996, which ceased the construction of all coal fired power plants, which resulted in further encouragement for renewables, and included targets for wind powered electricity generation, which were reached in just over two years.

An important feature of Denmark's success in encouraging wind energy has been the encouragement of local ownership. According to Dambourg and Krohn (1998):

> 'In Denmark 80% of erected turbines are owned by individuals and co-operatives…The highest concentration of wind turbines in the world occurs in a place called Sydthy, Denmark. Sydthy has 12,000 inhabitants and 98% equivalent of its power comes from wind power. The reason that the community accepts and allows so much wind development may be explained by a poll by Anderson et al (1997), that reveals that 58% of the households in the municipality of Sydthy have one or more shares in cooperatively owned wind turbines'

9.2.2 Germany

In Germany renewable energy sources contribute approximately 14% of the country's electricity supply, in part due to a largely consistent ten year feed-in law, which has been regarded as one of the most important aspects of the success in their renewable energy policy. There were, however, various issues that have required policy refinement over the years.

Initiated in 1990, the Electricity Feed-in Law required grid operators to allow renewable energy generators to connect to the grid and to be paid an agreed rate per kilowatt hour for the power produced. A 1,000 solar roofs initiative, which offered 70% of the capital cost of systems, was used for five years to jump start the solar industry. Once this programme ended, no successor had been planned, which resulted in two of the largest solar manufacturers leaving for the US.

Also, regional support for renewable energy was not consistent, with each state offering different incentives to those being offered by the national government. This led to a confusing situation for those wishing to invest in these technologies. Despite this, some electric utilities offered solar installations, providing the end user was willing to pay a higher rate for electricity to finance the schemes.

In 1999 a 100,000 solar roofs program was launched, based on offering low interest loans, though it was not a strong enough incentive to be successful on its own. It took the 2000 Renewable Energy Law, which mandated that approximately six times the wholesale rate for electricity should be paid for electricity generated from solar power to get the 100,000 roofs scheme off the ground. The program lasted until 2003, when the solar industry stagnated again until 2004, when another revision to the Renewable Energy Law was released. This outlined the rates to be paid for wind and solar power for the next 20 years, with the rates set to decline by 5% a year.

9.2.3 United Kingdom

The UK produces approximately 5% of its electricity from renewable energy sources. Whilst this is a small percentage, it represents a rapid expansion over previous years and there are several key policies that provide relevant examples. Since the UK uses large proportions of energy on transportation and heating, this has become the focus of various energy reduction initiatives.

The UK is working towards national, European and international (Kyoto) energy and emissions targets. The presence of these targets as well as the desire to be seen to take a leading role has led to much of the current legislation.

The Carbon Trust was created to assist businesses and the public sector to reduce their emissions and has a large database of information and resources to assist in this process. The Energy Saving Trust is a similar organization, with the focus on residential and transportation efficiency. These Trusts are similar to the US based Sustainable Energy Utility concept in that they facilitate the uptake of alternative/renewable technologies to reduce dependence on fossil fuels.

The Carbon Reduction Commitment has been proposed as a mandatory emissions trading scheme to reduce the emissions from large commercial and public sector organizations. Beginning in 2010 it will involve a tax on greenhouse gases, with the revenues from the scheme being recycled back to all the participants based on their previous year's emissions. This is designed to act as a strong stimulus to reduce emissions.

The Climate Change Levy was launched in 2001, to replace the fossil fuel levy, which was originally intended to support the UK nuclear industry. It is a tax on each unit of energy used, based on the source of energy and its relative contribution to climate change. As a result, energy from renewable sources is not taxed, whereas energy from the worst polluters such as coal and oil are charged the highest rates. The revenues from this scheme are handed back to the employers in the form of a reduction in National Insurance contributions.

The main policy instrument for reducing emissions from existing households is the Carbon Emission Reduction Target, which obligates energy suppliers to achieve energy savings for their customers through energy conservation/efficiency and the use of wood as a fuel. It has been estimated that around 82% of the obligation has been met through offering insulation to consumers for free, or at reduced rates. The rest of the obligation has been met largely through heating and lighting efficiency. Priority groups such as the elderly and those spending more than 12.5% of their income on heating have been allocated 40% of the assistance.

The Building Regulations have been updated to raise efficiency standards and many buildings are now required to carry an energy performance certificate, with large public buildings required to clearly display these. Efficiency in rental accommodation has been encouraged through the Landlords Energy Saving Allowance, which offers up to around $3,000 in tax avoidance for the cost of installing various types of insulation.

Small scale renewables have been encouraged through the Low Carbon Buildings Programs, which offered fixed grants for various technologies. These were so popular, that funding has quickly run out.

The Renewables Obligation is the main mechanism by which utility scale renewable energy is being encouraged. It represents a target of 10.4% of electricity from renewable sources by 2010/11 and uses a tradable certificate scheme. Suppliers of electricity are required to provide a number of certificates, based on how much electricity they have produced and the annual Renewable Obligation target. If they do not have enough, they must either purchase Renewable Obligation Certificates from suppliers with an excess, or pay a penalty of around 5.3¢ per kilowatt hour.

The penalty revenues are then handed out to those who have met their targets. It has also been proposed that different renewable technologies be offered varying amounts of Renewables Obligation Certificates, in order to encourage a diverse market. Costs to consumers are limited by a price cap so the power producers must internally finance the means to meet the targets.

In addition to a fuel tax, the annual licensing fees for smaller fleet and private vehicles are based on their carbon dioxide emissions, this provides an incentive to purchase more efficient vehicles. In addition, the Renewable Transport Fuel Obligation aims for 5% of the fuel sold at UK petrol stations to be from a renewable resource by 2010 – this is based on a system of tradable certificates.

9.3 Examples of Policy, Legislation and Incentives for Bermuda

This section looks at some examples of policy, legislation and incentives that may be used in Bermuda. It is intended that a consultation period will further engage stakeholders in discussion concerning these and other options. This will lead to the creation of balanced, informed policies and legislation to move Bermuda forward.

9.3.1 National Energy Targets

Bermuda will set national renewable energy or greenhouse gas reduction targets, which will provide a stable, central policy background to base future energy policies upon. Experience has shown in other jurisdictions that this is an effective way of maintaining momentum and ensuring that policies are revised if they are ineffective in order to meet established goals.

9.3.2 Open Grid Policy

Common in many other jurisdictions, an open grid policy will require open access to the electrical grid, providing certain technical constraints have been met and will work together with a smart metering policy, to ensure that anyone wishing to generate his own electricity and feed it back to the grid is able to do so. With the high cost of electricity in Bermuda, it is likely that this alone could lead to many alternative/renewable energy installations.

9.3.3 Mandatory Smart Metering

It shall be mandatory to fit smart meters with net metering capabilities to all new buildings and to plan a retrofit program for existing buildings. This will provide the foundation for the interconnection of small scale renewable energy to the electric grid. In addition, as discussed in Section 6, it will enable consumers to track their electricity use and will therefore create greater opportunities for savings.

9.3.4 Feed-in Electricity Tariff

A rate structure shall be negotiated between key stakeholders and set for a reasonable time period, though periodic rate changes can be planned from the outset to account for technology advances. The rates could depend on factors such as:

- Technology type (solar, wind etc.) and how reliable the power output is;
- Cost of conventional fuels;
- National targets for energy production from various resources; and
- Pollution associated with the energy source.

This will provide a secure background for the calculation of alternative/renewable energy project finances and encourage their uptake.

9.3.5 Time of Use Electricity Tariff

A rate structure that varies depending on the time of use of electricity will be established. This will allow the electric utility to manage their load factor by encouraging the use of electricity at different times.

9.3.6 Customs Tariff Incentives

The Customs Tariff will be employed as a far-reaching and flexible incentive, from encouraging energy conservation and efficiency to the importation of cutting edge renewable energy technologies for generating electricity or creating transportation fuels. Import duty reductions in other countries are shown in Figure 26.

Country	Duty Reduction	Identified Technologies
Bangladesh	100%	Solar, wind
China	82% parts, 65% turbines, 30% photovoltaic	Wind, photovoltaic, biogas
Czech Republic	Up to 100%	All renewables
Finland	85%	Bio-fuels
Jamaica	83%	All renewables
Philippines	100%	Small Hydro

Figure 26: Import Duty Reductions in Other Jurisdictions

Currently, in addition to the duty exemption on solar photovoltaic panels, the Bermuda Hospitals Board pay a reduced duty rate of 23¢ per litre on diesel fuel, while the electric utility and hotels pay 9.5¢ per litre on the same fuel. The electric utility receives an end use exemption on all parts for the generation of electricity or heat recovery systems. Wind turbines have a duty rate of 33.5%.

Although a useful tool, most notably in terms of encouraging conservation and efficiency, the Customs Tariff will require supporting policies and legislation to effectively introduce more alternative and renewable energy generators to Bermuda (examples include grid connection policy and the creation of a feed-in tariff).

9.3.7 Incentives Based on Power Output

Financial incentives could be provided at a fixed rate for each kilowatt hour produced by alternative/renewable energy facilities. This incentive is favourable due to its focus on the encouragement of maximising power generation rather than investment capital into alternative/renewable technologies.

9.3.8 Grant Schemes

Grants can be provided to finance part of the capital investment in selected technologies. This, combined with other policies, can be used to initiate an alternative/renewable energy industry in Bermuda. The long term financial sustainability of such schemes should be considered, however, and other policies designed around these schemes to ensure that the boom-bust cycle is avoided.

9.3.9 Emissions Trading

Annual limits on emissions could be put into place to meet national emissions targets and a market created for the trading of units of emissions based on carbon dioxide equivalents. Renewable energy generators would be awarded certificates, which would have to be purchased by organizations producing greenhouse gases. The value of the certificates could be set annually, or left to market conditions, though the latter option leads to increased risk to investors and therefore higher capital costs. In Europe, the trading of carbon dioxide emissions has also been proposed to account for the wider implications of air travel, such schemes would have to be carefully weighed against their effect on Bermuda.

9.3.10 Vehicle Licensing Based on Emissions

Annual vehicle licensing fees could be based on standard carbon dioxide emissions data, instead of vehicle length. This would provide a strong financial incentive for consumers to purchase more fuel efficient vehicles, with lower emissions. In doing so it would provide an opportunity to slow and even reverse the increase in fuel used for transportation that has occurred over the last few years, as shown in Figure 8. The proposed system will also help protect consumers from future increases in the cost of transportation fuels.

The existing administrative system for licensing vehicles based on length may be used as a model to develop the proposed fee structure.

9.3.11 Minimum Efficiency Standards

Consumer products will have to meet minimum efficiency standards to be allowed into Bermuda. These standards would evolve to reflect advances in technology and changes in the world energy situation. For example, conventional light bulbs could be phased out in favour of compact fluorescent light bulbs and/or light emitting diodes, which would be the only technologies able to meet the minimum efficiency standards.

9.3.12 Upgrade Current Building Codes Relating to Energy Use

The Building Code will be revised to support more sustainable use of energy. This will affect new buildings and existing buildings undergoing significant renovations. For example, lighting systems could be required to have automatic occupancy sensors and would also adjust their output based on ambient light levels. Requirements for on-site alternative/renewable energy technologies such as solar water heaters could also be included within the Code.

The United Kingdom updated their building regulations in 2006 and introduced measures such as increased insulation requirements, air pressure testing on buildings to find air leaks, colour coded energy performance certificates for certain buildings and integration of small scale renewable energy technologies. The United Kingdom Government has also produced The Code for Sustainable Homes, a document that outlines the direction of future residential building standards.

9.3.13 Prioritized Planning Approval for Alternative/Renewable Energy Projects

Planning applications for alternative or renewable energy projects can be given priority in recognition of national energy goals, which will facilitate the rapid uptake of these technologies. Selected technologies that meet pre-defined criteria would be able to take advantage of a streamlined planning approval process. For example, solar hot water and photovoltaic systems could undergo streamlined planning approval if applications propose to locate them on south facing or horizontal roof areas of selected buildings.

9.3.14 Research, Development and Demonstration Tax Credits

Tax credits could be offered for investment in alternative/renewable energy technology development. The establishment of a research, development and demonstration fund by the Government of Bermuda would reduce capital investment costs for local programs allowing the exploration of burgeoning alternative/renewable technologies. The current bio-fuels from algae research at the Bermuda Institute of Ocean Sciences is one such example of a program that could be eligible. These programs would also allow for the Department of Energy to pinpoint areas of priority for Bermuda and direct funding toward promising initiatives.

9.3.15 Land Tax Deferrals

Owners of buildings on land utilized for alternative/renewable energy production or buildings meeting specified conservation/efficiency standards could be eligible for land tax deferrals for a period of several years.

9.3.16 Government Leadership

The Government will lead by example through the initiation of projects that will join schools, hospitals, and Government agencies in adopting energy conservation/efficiency programs and alternative/renewable energy technologies. Public sector participation would also encourage the deployment of these systems where the private sector is unable to.

9.3.17 Sustainable Energy Utility

A Sustainable Energy Utility could be created to design financial instruments to deliver comprehensive end-user energy conservation/efficiency and alternative/renewable energy technologies. The Sustainable Energy Utility would raise the capital required for financing these projects, allowing individuals to avoid making the investments themselves.

Investor-owned utilities must answer to shareholders who want to see greater profits, while an independent Sustainable Energy Utility could focus on:

- Reducing fossil fuel dependency;
- Ensuring a secure energy supply, in terms of both quantity and cost; and
- Confronting climate change.

A Bermuda Sustainable Energy Utility could have a mandate for promoting an Island-wide market for energy conservation/efficiency and the development of alternative/renewable energy technologies. Key design aspects of the Sustainable Energy Utility are as follows:

- Unaffiliated with any of the Island's energy service providers, public or private;
- Would operate under contract to the Department of Energy;
- A non-profit entity under which the contract administrator will operate according to the provisions of legislation developed by the Department of Energy;
- Accountable to an Oversight Board, comprised of public, private and academic sector representatives;
- The Department of Energy would prepare requests for proposals to solicit bid proposals to engage a contract administrator;
- The Department of Energy would determine and describe the roles of the contract administrator, the performance targets, as well as provide for performance incentives; and
- The Department of Energy would report to the Oversight Board on the progress of the Sustainable Energy Utility and the management of the contract administrator and fiscal agent contracts.

Sustainable Energy Utilities have been created in many communities across the US and in other parts of the world to serve the short-term and long-term economic, social and environmental interests of communities.

The Sustainable Energy Utility's management would be regularly evaluated by performance-based criteria such as price stability, the promotion of local energy competitiveness, environmental stewardship, and greater energy governance.

10 Energy Regulation

Energy policy, legislation and regulation will be covered in detail in a separate industry orientated supplement to this Energy Green Paper. The following information has been provided to give some indication of what will be available in the forthcoming supplement.

10.1 Regulatory Authority

The Department of Energy will be responsible for developing policies and legislation while proposing to transfer authority for implementing and overseeing electric, gas and other energy regulation to the proposed Regulatory Authority. The use of the same Regulatory Authority for multiple industries for which the Ministry of Energy, Telecommunications and E-Commerce is responsible will serve to reduce regulatory overhead and regulatory uncertainty for the industries. The Department of Energy will set a policy framework for the Regulatory Authority and establish the principles by which it will monitor and regulate industry compliance.

> The Regulatory Authority will issue regular data requests for all energy providers and will publish summary data for consumers to help them make informed choices. Providers will be obliged to comply with data protection and other relevant legislation.

10.2 Connecting Small Power Production Facilities to the Grid

As smart meters capable of net/dual metering are introduced, appropriate international interconnection standards will be used to design regulations for small power producers to connect to the electric grid. This will effectively manage:

- Grid loading;
- Safety;
- Reliability;
- System emergency procedures;
- The electric utility's obligations; and
- Current regulations.

It is essential that this emerging sector is regulated to ensure compatibility with existing infrastructure, safety and reliability. This will serve to protect both the consumer and the electric utility from the hazards associated with improper installations.

10.3 Transportation Fuel Standards

As new alternative/renewable fuels are developed and substituted for or blended with conventional fuels, regulations will have to be adopted to ensure these fuels meet the necessary quality standards. The American Society for Testing and Materials are an internationally recognized authority in this area, and has already produced a set of criteria for most alternative/renewable transportation fuels. It is likely that these standards, or similar, will become the standards that new fuels will comply with as a requirement for a license to operate.

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Appendix 1: Energy Management

Introduction

The concept of managing energy is not familiar to many Bermudians since historically energy costs have not been as high as today. Energy cost savings of around 30% are commonly produced when implementing an energy management scheme from a baseline where no such management exists. Up to half of this 30% is often obtainable with little or no capital investment required and in some cases cost savings of up to 70% have been achieved. These savings often rapidly exceed the additional cost of implementing energy management practices.

This section is intended to stimulate local organisations to research their expenditure on energy and to consider the potential for savings through adopting energy management. Whilst larger organisations may require a more formal structure and have much greater potential for savings, small organisations and households are typically more flexible and may be able to adapt more quickly and with less effort. The Department of Energy would like to hear of any organisations already benefiting from energy management and will provide information on the subject where possible.

Five Steps to Effective Energy Management

Get Commitment

In order for energy management to be effective, there must be a commitment from the highest level of the organization. This commitment should be full and will need to establish clear accountability with managers/directors to ensure they implement recommended measures and are responsible for meeting targets. An official and written energy policy, signed off by senior management is a key requirement.

Understand Your Organisation and Quantify Energy Use

The energy management matrix provided on page 91 offers a means to assess how your organization deals with issues relating to energy management. Each column addresses a different organizational issue, while the five tiers indicate the level to which each issue has been addressed. To complete the matrix, work across one column at a time and check off the tier which is most appropriate for your organisation. A completed matrix offers an insight into how well balanced your energy management structure is and where there may be room for improvement. It is anticipated that many organizations in Bermuda fall into the lower tiers, which offers much potential for improving energy management.

Energy cannot be managed if it cannot be monitored. Therefore quantifying energy use with an energy audit is an essential next step in the process, and needs to address the following questions:

- Where is energy used;
- When is energy used;
- What type of energy is used; and
- How much energy is used?

Answering these questions should immediately highlight potential for savings. For example, it may be discovered that 20% of energy use occurs during evenings and weekends, when the organization is not functional.

Plan and Organise

This involves developing a realistic timeframe for achievable targets and prioritizing the actions by which they may be accomplished. It is important at this stage to tailor the plan specifically to the organization, taking advantage of its strengths while avoiding areas which will require excessive resource allocation. Energy management should at this stage be integrated into the existing management structure, allocating well defined roles and responsibilities to appropriate individuals.

Implementation

Initially undertaking low or zero cost measures helps to establish credibility for energy management and the potential for savings, whilst testing the previously established monitoring systems. As the full potential for these measures is reached, more capital intensive measures may be adopted to further enhance savings.

By integrating energy management into general management systems, it merges with the other daily functions of the business and avoids it from being dismissed in the face of other priorities.

Energy savings may become tools for both internal and external public relations initiatives, gaining recognition for the results achieved. This is important as it will help to achieve sustained support from senior management.

Monitor Energy Management and Update Targets

Progress in the management of energy should be reported at regular intervals, this will allow for targets to be modified in light of any changes. By continually monitoring the effectiveness and having a floating target structure, savings can be maximized.

	Policy	Organising	Training	Performance measurement	Communicating	Investment
4	Energy policy action plan and regular review have active commitment of top management	Fully integrated into management structure with clear accountability for energy consumption	Appropriate and comprehensive staff training tailored to identified needs, with evaluation	Comprehensive performance measurement against targets with effective management reporting	Extensive communication of energy issues within and outside organisation	Resources routinely committed to energy efficiency in support of business objectives
3	Formal policy but not active commitment from top	Clear line management accountability for consumption and responsibility for improvement	Energy training targeted at major users following training needs analysis	Weekly performance measurement for each process, unit or building	Regular staff briefings, performance reporting and energy promotion	Same appraisal criteria used as for other cost reduction projects
2	Unadopted policy	Some delegation of responsibility but line management and authority unclear	Ad-hoc internal training for selected people as required	Monthly monitoring by fuel type	Some use of company communication mechanisms to promote energy efficiency	Low or medium cost measures considered if short payback period
1	Unwritten set of guidelines	Informal mainly focused on energy supply	Technical staff occasionally attend specialist courses	Invoice checking only	Ad-hoc informal contacts used to promote energy efficiency	Only low or no-cost measures taken
0	No explicit energy policy	No delegation of responsibility for managing energy	No energy related staff training provided	No measurement of energy costs or consumption	No communication or promotion of energy issues	No investment in improving energy efficiency

The Energy Management Matrix

Reproduced from CTV022 – Energy Management Strategy with kind permission from the Carbon Trust.

Appendix 2: Rooftop Water Harvesting

One of the most distinctive aspects of Bermuda's architectural heritage is our white washed roofs and water storage tanks, which allow us to harvest rainwater. It is unlikely that our forefathers anticipated that this legacy would one day distinguish Bermuda as an advanced and sustainable community with respect to the management of fresh water and energy resources.

Traditionally, rainwater was used as the principal source of potable water because there are no rivers or lakes, and potable groundwater resources are limited. *This indigenous resource now serves as a significant source of energy savings not normally recognised by Bermudian residents.*

These rainwater harvesting systems are simple to construct and operate, though proper techniques are required to avoid contamination of the water supply. This usually involves:

- Constructing roofs, tanks and gutters from appropriate materials;
- Taking measures to prevent animals from entering the system where possible;
- Removing foliage that overhangs roofs; and
- Periodically cleaning roofs, gutters, down pipes and tanks.

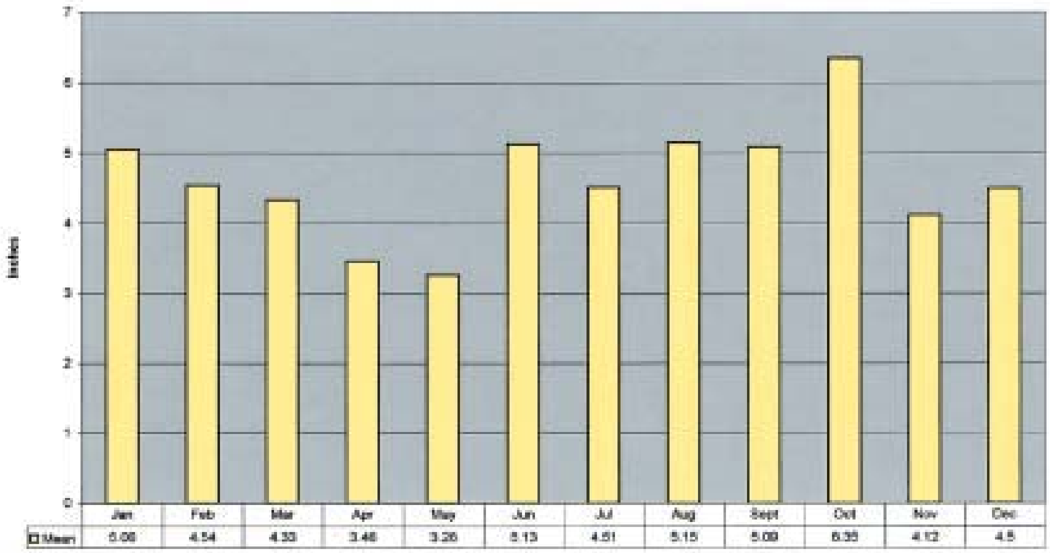
Bermuda uses more than 1.7 billion gallons of water a year, with over 1 billion gallons supplied from rainwater harvesting. The energy required to deliver a gallon of rainwater is low while the energy used to produce a gallon of water from reverse osmosis or steam distillation is high due to processing, pumping and delivery costs. As a result, significant energy and greenhouse gas emissions reductions are achieved through the harvesting of rainwater.

Today, Bermuda's public health laws mandate a supply of wholesome water for drinking and for other direct human purposes. The Government supports continuing the tradition of using rainwater to supply Bermuda's water requirements through the regulation of water harvesting systems.

The storage capacities of tanks are prescribed by Bermuda's Water Storage Regulations, which require that a 1,000 square foot catchment must be connected to the building and accommodate a minimum of 8,000 gallons of potable water.

A 1,000 square foot catchment can collect 28,860 gallons of water per year. Droughts make it necessary to have storage provisions for at least three months' supply or 7,215 gallons of water. The 8,000 gallon requirement provides a cushion, since collection efficiencies range from 75% to 95% due to losses from evaporation on hot roofs, gutter over-splash and tank overflow.

Bermuda's average annual rainfall is 55.5 inches, distributed relatively evenly across all months as shown in the bar chart below:



Average Monthly Rainfall in Bermuda

Rainwater harvesting technology in Bermuda offers the following advantages:

- It provides water at the point where it is needed, is owner operated and managed;
- The construction of the system is simple and local residents are highly skilled at building them;
- The roof and water tank structure result in an inherently strong building design;
- Running costs are low; and
- The properties of rainwater tend to be superior to those of groundwater or surface waters that may have been subjected to pollution, which in some cases may be undetected or from an unknown source.

Some disadvantages are:

- Water storage tanks can be unsafe for people if proper maintenance is not carried out;
- Health risks can result due to a lack of adequate maintenance; and
- Rainwater harvesting systems compromised about 20% of the cost of constructing a building in Bermuda.

Many alternative and renewable energy technologies could be adopted in a similar manner to rainwater harvesting. It could become the norm to install a solar hot water system on every house and to obtain electrical power from solar photovoltaic arrays mounted in appropriate locations. This would lead to our energy supply following the excellent model of sustainability already set in place through the capture of rainwater.

Appendix 3: Statement on Global Warming and SIDS

The Cabinet Office

Department of Communication and Information

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November 27, 2007

STATEMENT ON GLOBAL WARMING AND SMALL ISLAND STATES

The Government of Bermuda today announced plans to ratify the Kyoto Protocol to limit emissions of greenhouse gases. Bermuda will join the international fight against climate change and demonstrate to the world its commitment to the reduction of the emissions of carbon dioxide and five other greenhouse gases.

This is in furtherance of the Government's commitment to addressing global warming, which is a scourge on our planet. Climate change is a global phenomenon that some still do not recognise. Nations like Bermuda must be keenly aware of its potential impact because we are a small isolated island. This puts us in good company with our fellow Caribbean brothers and sisters, and many in the developing world who have historically made little contribution to global warming, but have and will continue to feel its disproportionate burden. Many countries have come together, including many small island nations, to get the world's attention on this issue. Bermuda wholly supports these efforts.

Bermuda's contribution to global warming is negligible compared to large industrialised and industrializing nations; however this does not mean that we should not act. Therefore, the Government of Bermuda has in the spirit of good Government been proactive and forward thinking in regards to how we can reduce our impact on the planet. These efforts are good for the world, but just as importantly, they are also good for Bermuda.

The Government has over the past several years made strong efforts to reduce Bermuda's negative impact on the environment, and also supports the valuable efforts of the public and private sector. Commendations should be extended to organizations that have taken their own initiative, as well as those who have partnered with Government due to their commitment to sustainable development.

Everyone in Bermuda contributes to the development of renewable energy through Tynes Bay which is a "Waste to Energy" facility. Energy derived from waste is considered "green" and "renewable" in that it is not generated from fossil fuels. This has a benefit for Bermuda in that it reduces the amount of fossil fuel required for electricity generation here and has a positive effect worldwide in conserving fossil fuel. Currently Tynes Bay takes the trash that we produce and converts it into energy sufficient to power 2500 homes. The development of the third stream of

Tynes Bay is well underway and is expected to be completed by 2011. The new third stream will be significantly more efficient than the existing ones and will result in a significant increase in renewable energy.

The Government also supports BELCo's efforts at diversifying its energy sources so that Bermuda will be less reliant on fossil fuel going forward.

There are a number of other smaller scale efforts at the development of renewable energy that are supported by Government:

The Department of Planning has for several years approved solar panels and, more recently, has approved a domestic wind turbine which will also generate renewable energy.

The Government has a policy of zero duty for electric cars, which have zero emissions.

The Environmental Authority recently approved the Bermuda Biodiesel Project, which is a private sector business endeavour where used cooking grease is collected and turned into bio-fuel for diesel engines. This fuel helps engines run quieter, and is cleaner than regular fossil fuels.

Waste oil is also collected in Bermuda and shipped to recycling companies in the US. The impact on Bermuda is less potential, and real contamination of the natural environment. The positive result is that much of this oil is cleaned up and resold for heating purposes in the US. This reduces fossil fuel consumption there.

But just as it is Government's responsibility to encourage energy alternatives, it is also the Government's duty to regulate and monitor those bodies that contribute to pollution. Functioning hand in hand with the Environmental Authority, a statutory body enacted to administer the Clean Air Act, the Department of Environmental Protection has the lead role in addressing the impacts and sources of pollution in Bermuda, such as industrial smoke stacks and automobile traffic. Not surprisingly, the major contributors of airborne heavy metals, dioxins and other environmental hazards are also at the top of the list of emitters of carbon dioxide gas resulting principally from the combustion of fossil fuels and the major portion of the Island's solid waste.

At the end of 2007, as Bermuda's two largest utilities as mentioned above, BELCO and Tynes Bay are simultaneously entering into the advanced planning stages of major expansion projects in electricity generation and garbage incineration, the challenge of integrating environmental quality might seem overwhelming. Yet it was in anticipation of challenges such as these that the Department of Environmental Protection was established. The Department's mission to 'Protect Bermuda's environment and to promote the sustainable use of the Island's natural resources' compels it to form uneasy 'partnerships' with the major point-source producers of greenhouse gases. A sizeable portion of the Department's annual budget goes towards the monitoring of air, land and water.

Various tools, including educational initiatives, expand the Department's influence over the gamut of air polluters. Viewed in a broader context, the varied and threatening impacts of global warming being witnessed around the world, resulting from an overproduction of greenhouse gases, are reason enough for Bermuda to capitalise on every opportunity to change the status quo. Through the combined instrumentality of the Clean Air Act, the Environmental Authority and the Department of Environmental Protection – and using the available support resources of legislation, enforcement, comprehensive planning and collaborative action in a period of rapid development – Bermuda is ideally positioned to achieve far reaching environmental solutions via new energy and waste management strategies that result in lower greenhouse gas emissions.

The Government is also setting an example in regards to conservation. Earlier this year, the Government through the Ministry of Works and Engineering, opened the new Recycling Plant, and launched an outreach and recycling awareness programme for businesses, the public and in our schools.

In partnership with firms from the private sector, the Government launched the "Recycle Bermuda Business Partnership Initiative," as part of a larger effort to get the entire Island to recycle. The Government has also worked hard to set an example for the public by distributing recycling bins across the public service to require Government employees to recycle at work and hopefully encourage them to do so at home. The Government is also planting the seed at schools to create young contributors to the recycling plant who will become lifelong users, and also influence their peers, parents, and other family members to help in this endeavour.

Our recycling programme results in the recycling of steel and aluminium cans. This recycling, particularly in the case of aluminium, results in saving the earth's natural resources both in the metal ore and also in fossil fuels since much less energy is required to produce products from the recycled material than from ore.

The Government also has a policy of replacing invasive species with endemic ones which will help our physical environment better adapt to any change in climate. The Department of Planning requires that new building developments must plant endemic and native species and all new residential development qualify for a landscaping voucher from the Department of Planning through the Department of Parks Tulo Valley Nursery, which provides native and endemic plants.

The Government also recognises the need to keep our ambient air clean. In that vein, legislative amendments were made to ensure that all vehicles imported to Bermuda met at least the minimum vehicle standards from the vehicles' country of origin.

More recently, the Government has contracted with a local company with the main objective being the establishment of emissions testing for all motorised vehicles. This has been a long time in the making, but we are now almost to the point where this will become a reality. Many motorists and pedestrians equate pollution to what they can see; however the absence of visible pollutants from a vehicle's exhaust doesn't guarantee that the vehicle is operating according to the manufacturer's emissions standards. Therefore all vehicles will be tested for emissions to sustain our air quality and preserve our environment. This prime example regarding emissions relates not only to global warming, but also to the health of all Bermudians, especially our most vulnerable, our children and our seniors.

The Government has also worked hard over the past several years to:

- Encourage carpooling;
- Encourage the use of school buses to get more cars off of the road; and
- Improve public transportation through the introduction of several fast ferries and mini-buses, which have reduced the public's reliance on driving to work;

The Government is keeping abreast of international expertise and knowledge on climate change; however Bermuda cannot only rely on international research because it is quite likely that global warming will have unique impacts on Bermuda. In regards to monitoring climate change, the Government continues to support the Bermuda Underwater Exploration Institute and the Bermuda Institute of Ocean Sciences' work on sea-level trends in Bermuda.

The Government of Bermuda keenly recognises the words of the Seychelles UN Ambassador that in the context of climate change, "No Island is an Island." As such, Bermuda will continue to develop measures locally to counter the effects and impacts of global warming, while simultaneously entering the world's stage through the ratification of the Kyoto Protocol, following the path of a number of small island states that are effectively having their voices heard in the international arena.

Appendix 4: Summary of Research on Sea Level Rise in Bermuda

Sea level rise is a topic of increasing global concern. Particularly for coastal jurisdictions and islands like Bermuda, the threat may have significant implications. Sea level rise is tied to climate change, whereby warming temperatures cause expansion of the oceans as well as melting of the ice caps, glaciers and ice sheets. A report currently being prepared by the Bermuda National Trust is assessing the impact of climate change on Bermuda and one key focus is how rising sea level will affect us. The following summary draws on information compiled for this report.

Sea level changes are not new to Bermuda; scientific research has documented significant changes in sea level around the Island over its geological history tied to the various ice ages. We know, for example, that over the past 1 million years sea level has fluctuated enormously (see Figure 1) and Sterrer et al. (2004) note that the Bermuda Platform has been alternately flooded and exposed approximately every 100,000 years or so, significantly changing the size of the land mass.

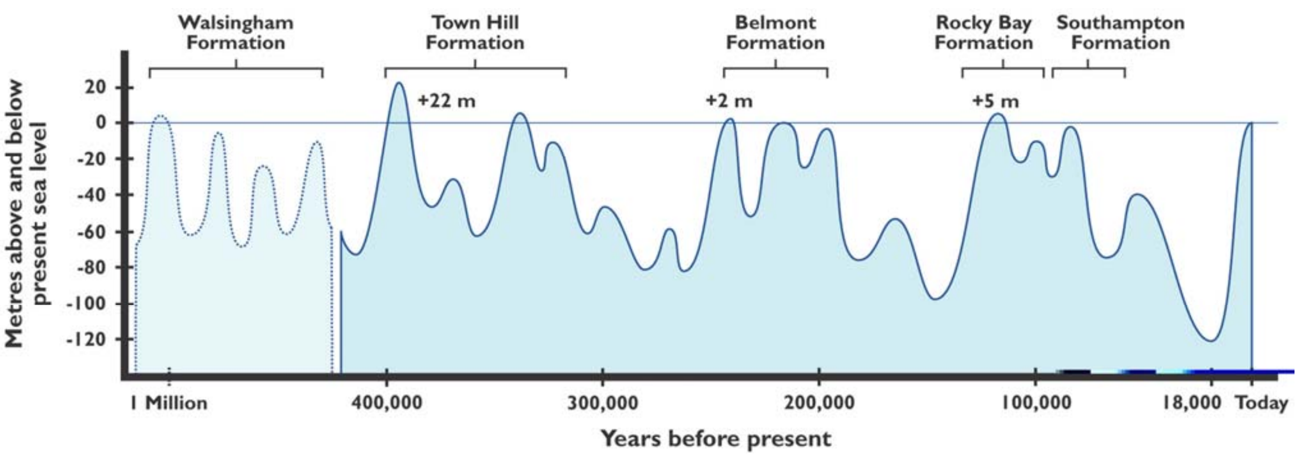

Figure 1. Sea level rise during the Pleistocene showing highest sea level stand recorded at +22m, approximately 400,000 years ago. (From BAMZ collection).

The highest sea levels stands documented locally from marine conglomerates are at 28 m above present (Land et al., 1967) and 20 ± 3m above present (Hearty et al., 1999), occurring about 400,000 years ago. The latter study concluded that sea level could only have reached such peaks if the Greenland and Western Antarctic ice sheets, as well as a portion of the East Antarctic ice sheet, melted. In contrast, during the last Ice Age approximately 18,000 years ago sea level was as much as 120 m below present.

Since that time global sea levels have been rising, initially quite rapidly at about 15-20 mm/year for the first 6,000 years. Then the rate slowed and according to the IPCC (2007), from 3,000 years ago to the start of the 19th century sea level rise was almost constant at 0.1 to 0.2 mm/yr. In the 1900's the average global rate of rise accelerated to 1 to 2 mm/yr, and from 1993 to the present satellite altimetry has indicated a rate of rise of about 3 mm/yr. Of this rise, most is due to thermal expansion of ocean water due to warming temperatures, followed by melting of glaciers and ice caps, as well as melting of the Greenland and Antarctic Ice Sheets IPCC, 2007).

However, sea level changes are not consistent across the globe. Variation resulting from regional differences in temperature, salinity, winds and ocean circulation, all influence sea level. According to the IPCC (2007), regional sea level rise for Bermuda is currently modelled at 2mm/year. However, Bermuda has been the site of an ongoing study on sea level rise which is being conducted by the Geological Survey of Canada, the Bermuda Underwater Exploration Institute and the Department of Conservation Services. In a multi-pronged approach this team has firstly been analysing data published by 10 different authors between 1965 and 1996 on sea level rise in Bermuda over the past 8,000 years (Blasco et al., 2008). They note that the data show considerable variation in rates from one study to the next.

By focusing on the past 2000 years, Blasco and his team have integrated this data and plotted it to reveal an average rate of sea level rise over this period of 2mm/year. Meanwhile, tide data collected in Ferry Reach since 1932 suggest that in the last 74 years sea level has risen at an average rate of 2.04 mm +/- 0.47 mm/year (see Figure 2). However, separate analysis by Blasco et al. (2008) reveals that historic data derived from photographs of the seawall built at the British Naval Dockyard in 1835 and photographed in 1876 indicates that sea level has risen 40.6 cm over the past 131 years, or about 3.1 mm/year.

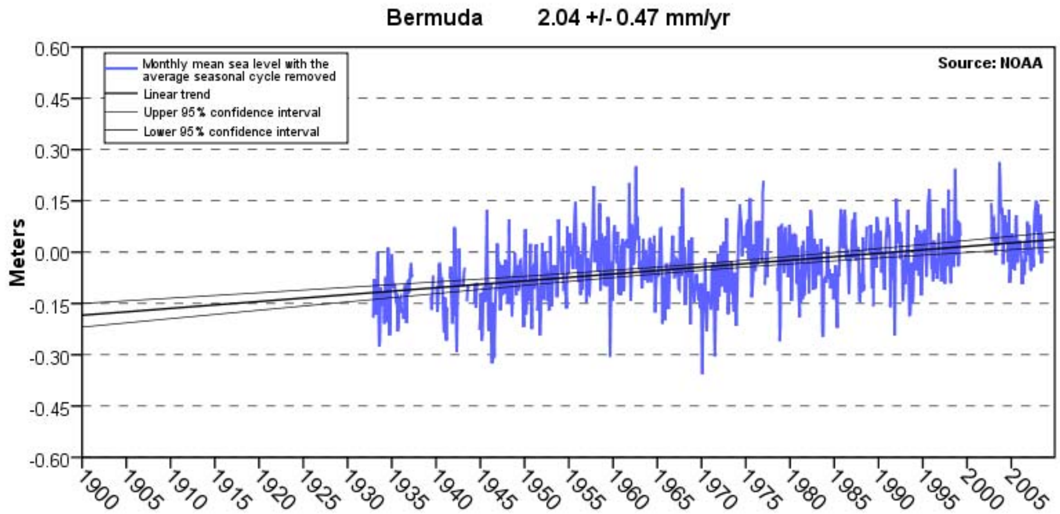

Figure 2. Showing NOAA sea level data for Bermuda, and a mean sea level trend of 2.04 mm/year +/- 0.47 mm/year based on monthly data collected from 1932 to 2006 at Ferry Reach. (Source: NOAA http://tidesandcurrents.noaa.gov).

Clearly the picture is not entirely straightforward and coupled to the actual rate of sea level rise may be the issue of island subsidence. Although widely considered to be extremely stable, satellite GPS vertical motion velocity data derived from the vertical motion sensor positioned at the Bermuda Institute of Ocean Sciences and published by the Jet Propulsion Laboratory in the US indicates that the Island has been subsiding at the rate of 0.9 mm/year since 1993, but this data needs further validation. Blasco et al. are continuing their sea level studies to try and ensure that Bermuda has the most accurate data on which to build future projections.

So what of the future? According to various potential future scenarios developed by the IPCC (2007) and based on the level and speed of the global response to reducing carbon emissions, sea level could rise by between 0.18 m and 0.59 m by the end of this century. However, it is now widely recognised that these estimates are overly conservative and fail to take into account the speed at which the ice sheets are melting. More recently, Pfeffer et al. (2008) performed gross calculations to assess the maximum sea level rise that can reasonably be expected taking into consideration the dynamic effect of ice not just melting but of being pushed straight into the ocean. They concluded that a rise of 0.8 m to 2 m is physically possible by 2100.

In trying to determine the future impact of sea level rise on Bermuda (and adopting the precautionary principle it would make sense to consider both a 0.59 m rise and a 2 m rise), it is important to remember that there is also considerable annual background variation about the mean. Lunar affects on tides and a local steric anomaly affect the actual sea level on an annual basis. To fully consider the impact of rising sea level, taking account of these additional affects is critical.

Local tides give us a tidal range of 0.8 – 1.2 m between low and high tides, depending on the moon. Additionally, there is a seasonal fluctuation related to water temperatures in the ocean that needs to be superimposed on the high tide during the fall. This is due to the fact that in the early summer, an upper "mixed layer" of warm water develops in the ocean around Bermuda, with temperatures often exceeding 25^{o} C by late summer and extending down to 100m depth or more. As a result, from April to November the surface ocean waters around Bermuda heat up and expand causing a related sea level rise of about 0.25 m. Known as a “steric anomaly” this is responsible for the very high tides typically observed towards the end of the calendar year (Rowe, pers. comm).

Taking these fluctuations (which add 0.865 m to the charted mean sea level mark) into consideration, preliminary projections across Bermuda for a 0.59 m sea level rise show that at least 158 Ha of land would be inundated at high tide during the summer months (Shailer, pers. comm.). A 2 m rise would impact at least 766 Ha during summer high tides (or about 14% of Bermuda’s land area).

One additional factor that will also amplify the impact of sea level around Bermuda are meso-scale eddies of warm and cold water. Generated in deep water, these can either depress sea level (cold eddies) or increase it (warm eddies). They may persist in the local area for many months. One in November 2003 raised sea level by an additional about 0.25 m (Government of Bermuda, 2005). Storm surge during hurricanes will also cause elevated sea levels. With storm intensity predicted to increase in the Atlantic as a result of climate change, Category 1 hurricanes might be expected to produce a surge of 1.2 – 1.5 m on top of the above projections. A Category 3 storm may add an additional 2.7 – 3.6 m whilst a Category 5 storm may produce a 5.5 m or greater storm surge (National Hurricane Center, 2007).

It is perhaps worth noting that compared with many islands, Bermuda is fortunate to have a shoreline that for the most part rises quite steeply, sparing us the impacts from sea level rise that may be felt more dramatically in other jurisdictions.

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Appendix 5: Non-Exhaustive Energy Related Questions

The Government invites comments on some of the issues raised in the Green Paper and to stimulate debate and effective input, the Department of Energy puts forward a range of questions for your study and response.

1. Regarding energy, “What’s wrong”?

2. What is your understanding on the issues of Climate Change?

3. Do you think it would be helpful if the ‘Private’ sector and the ‘Public’ sector formed an alliance, this new organization would stimulate investments in energy conservation/efficiency and alternative/renewable technologies?

4. What link(s) should be made between economic competitiveness and a greater emphasis on energy conservation/efficiency and alternative/renewable technologies? Would it be useful to require set annual targets on these technologies? To ensure a continued spread of best practice, what benchmarks should be put in place?

5. Fiscal policy is an important tool to encourage changes in behaviour towards energy conservation and new habits toward the use of energy efficiency products that use less energy. How could energy conservation/efficiency measures be implemented in a manner that does not result in any adverse taxation consequences?

6. Most Governments are looking to energy efficiency/conservation programs to make significant public energy sayings. State some of the measures the Department of Energy should adopt as part of a National Energy Plan?

7. Smart Meter/Dual Metering Policy; Electric Grid Access & Load Policy; Wholesale and Retail Electrical Rates etc. are some of the topics that will be debated for legislation. What challenges to Stakeholders and the greater participation by the general public can be expected?

8. Public authorities are often looked upon to lead by example. Should legislation place specific obligations on public authorities, for example, to meet the measures that have been recommended in this paper? Regarding public procurement, could or should public authorities develop rules and regulations that will help build viable markets for certain products and new technologies? How could this implementation promote the adoption of new technologies and provide incentives for industry to research new energy efficient products and processes? How can this be done in a manner that would save money for public authorities?

9. In addition to reinforcing the importation of “Energy Star” or equivalent energy reduction products, “What significant new initiatives could be taken to increase energy efficiency across the economy and in particular among households, businesses, the public sector, the transport sector and the build environment?

10. Public information and education campaigns on energy conservation, efficiency; alternative and renewable technologies have shown success in some countries, what more can be done in Bermuda?

11. Encouraging importers to bring new energy efficient products to Bermuda represents a major challenge. How can they be stimulated to change their product mix?

12. In order to improve energy conservation/efficiency, it may be necessary to complete certain infrastructure projects. Do you have any ideas on how and what funding sources could be used to raise the investment?

13. Sustainable Energy Utilities have been created in many communities around the world in an effort to phase away from fossil fuel price volatility, lack of energy competition, and dependence on energy sources that are environmentally risky. Should the Department of energy take similar action toward Sustainable Energy Utilities or equivalent as stated above?

14. The U.S. Energy Information Administration reported that buildings are responsible for almost 50% of all greenhouse gas emissions and, let us assume that in Bermuda the percentage is the same. In Bermuda, although some hotels and guest-houses have back-up generation capacity most commercial buildings draw their electricity from the electric utility which is 98% dependent on fossil fuels. Should the Government require that new and existing commercial buildings be responsible to meet strict guidelines on their use of electricity that were generated from fossil fuels?

15. Implementing energy conservation/efficiency and alternatives/renewable technologies in buildings is an area where large electricity savings can be made. What practical measures could be taken to ensure that the existing community buildings would be in compliance? There is a product balance that could be achieved and impressive savings on the electrical bill that could be made. Is this really possible? How could the appropriate balance between generating energy-efficiency gains and the objective of limiting new administrative burdens be minimized?

16. Establishing incentives to improve energy conservation/efficiency and encouraging alternative/renewable technologies in rented accommodation is a difficult task because most building owners do not pay electric bills and thus have no economic interest in investing in energy-efficiency improvements such as insulating for air-conditioning, double glazing etc. How best could this challenge be addressed?

17. Reducing energy consumption and the carbon footprint is one of the most important goals for green buildings. Any green building rating system, such as the Leadership in Energy and Environmental Design green building rating system give energy efficiency/conservation the highest priority. Should Bermuda adopt the Leadership in Energy and Environmental Design green building rating system or develop a green building rating system of our own? Should Bermuda put in place building energy codes, labelling, audit programs, energy management schemes, financial incentives and set up mandatory or volunteer efficiency standard guidelines?

18. Among the measures that could be adopted in the transportation sector, which has the greatest potential, and should technological innovations e.g. tires, certain engine parts, lighting and fuels etc. be taken into consideration?

19. A major challenge to the Government is to ensure that automobile importers import energy efficient vehicles. To what extent should import measures be voluntary in nature and to what extent should the Government use incentives and disincentives to encourage importer's voluntary vehicle models, makes, size, electric, hybrid, flex-fuel etc?

20. Like Bermuda, the Hawai'i County Energy Sustainability Plan reported in 2007 that they are about 98% dependent on oil for their electricity supply. The *Analysis and Recommendations for the Hawai'i County Energy Sustainability Plan report* states that they plan to reduce dependency on oil to about 30% by 2030. Should Bermuda support and adopt the Hawaiian plan? If so, Why?

21. Cap-and-trade is part of an agreement that allows large buildings and the electric utility that emit greenhouse gases to buy and sell energy credits. Businesses that cannot make sufficient cuts can buy the right to pollute from cleaner companies. This emission trading mechanism is a key tool in developing a market–based response to meeting the goals of the Kyoto protocol and climate change. What are your thoughts toward the cap-and-trade business?

22. The Intergovernmental Panel on Climate Change has forecast a possible rise in sea levels of 0.59 meters by the end of the century and that this figure could rise to over 2 meters if the effects of the melting Greenland an Antarctic ice sheets continue to rise. Contrast this phenomenon with the last interglacial period, about 125,000 years ago, when sea levels were 4 to 6 meters higher than today. See Appendix 4. that describes the damage sea level increases would cause in Bermuda. Provide your thoughts?

23. Bermuda's Energy prices are determined by International oil and gasoline and other fuel prices, "What actions should be taken to reduce the cost of electricity, gasoline and other fuels to Bermudian consumers"?

24. In the context of liberalization of the Bermuda Energy market, what actions could be taken to develop more fully competitive electricity and fuels (gasoline etc.) market and what specific barriers will need to be overcome?

25. What are the key questions that would address a fully cohesive Bermudian Biofuel industry? Biofuel feedstock from: (i) Spent cooking oil; and (ii) Micro-Algae.

ANNEX X

Hawaiian Clean Energy Initiative

Timetable

Energy Agreement
Between Government and Utility Companies.

Draft Legislation
A Bill for an Act Relating to Hawaii's Clean Energy Initiative.

January 2009

Hawaiian Clean Energy Initiative

HECO TIMELINE

HAWAIIAN ELECTRIC COMPANY, INC. (HECO)

	Cumulative Target Goal (MW by year-end)				
Renewable Energy Commitments	2010	2015	2020	2025	2030
RENEWABLE GENERATION					
IPP Projects (info based on IPP proposals)					
Kahuku Wind	30.0	30.0	30.0	30.0	30.0
Sea Solar OTEC		25.0	100.0	100.0	100.0
Lockheed Martin OTEC		10.0	10.0	10.0	10.0
Molokai and/or Lanai Wind		400.0	400.0	400.0	400.0
Honua Waste-to-Energy		6.0	6.0	6.0	6.0
C&C Waste-to-Energy		11.0	11.0	11.0	27.0
RFP Non-firm RE		100.0	100.0	100.0	100.0
Utility Projects					
Airport DSG (Bio-fuel)	8.0	8.0	8.0	8.0	8.0
DG at substations (Bio-fuel)		30.0	30.0	30.0	30.0
CIP CT-1 (Bio-fuel)	110.0	110.0	110.0	110.0	110.0
CIP CT-2 (Bio-fuel)		110.0	110.0	110.0	110.0
Military DG (Biofuel)		50.0	62.5	75.0	75.0
Total RE Generation	148.0	890.0	977.5	990.0	1,006.0
ENERGY EFFICIENCY/CUSTOMER SITED GENERATION					
PV (through feed-in tariff or PPA)	6.5	23.0	65.0	108.0	140.0
Solar Opportunity					
Mandatory Solar Roofing, SB644	1.0	3.0	6.0	9.0	11.0
Pay-As-You-Save Solar Program	2.0	6.0	10.0	15.0	19.0
PV Host Program	2.0	12.0	22.0	32.0	42.0
Net Energy Metering	5.0	23.0	57.0	97.0	127.0
Distributed Generation & Distributed Energy Resources	0.0	8.0	15.5	23.0	35.0
Seawater Air Conditioning	0.0	16.0	16.0	16.0	16.0
Total EE/DG	16.5	91.0	191.5	300.0	390.0
TOTAL RE & EE/DG	168.5	1,015.0	1,220.0	1,358.0	1,481.0
PEAK REDUCTION/PEAK SHIFTING					
Demand Response Program & Load Management	60.0	73.0	89.0	103.0	116.0
Pricing Programs					
Residential TOU Rates Commercial TOU Rates Industrial TOU Rates	2.0	10.0	20.0	31.0	41.0
Critical Peak Pricing	2.0	24.0	31.0	37.0	44.0
TRANSPORTATION ELECTRIFICATION					
Plug-In Hybrid Cars (# of Cars, Oahu Only)	600	36,000	66,000	96,000	126,000

HAWAII ELECTRIC LIGHT COMPANY, INC. (HELCO)

Renewable Energy Commitments	Cumulative Target Goal (MW by year-end) 2010	2015	2020	2025	2030
RENEWABLE GENERATION					
IPP Projects (info based on IPP proposals)					
PGV Geothermal	8.0	8.0	8.0	30.0	30.0
Hamakua Biomass or Hu Honua		25.0	25.0	25.0	25.0
Hawaii County Waste-To-Energy		4.0	4.0	4.0	4.0
Sopogy Solar	0.5	0.5	0.5	0.5	0.5
Na Makani Wind and PSH		4.5	4.5	4.5	4.5
Total RE Generation	8.5	42.0	42.0	64.0	64.0
ENERGY EFFICIENCY/CUSTOMER SITED GENERATION					
PV (through feed-in tariff or PPA)	1.8	7.8	18.0	30.0	39.0
Solar Opportunity					
Mandatory Solar Roofing, SB644	1.0	4.0	8.0	12.0	15.0
Pay-As-You-Save Solar Program	0.2	1.0	3.0	4.0	5.0
PV Host Program	2.0	7.0	12.0	17.0	22.0
Net Energy Metering	1.3	6.0	14.0	24.0	32.0
Distributed Generation & Distributed Energy Resources	2.7	6.6	10.0	12.6	12.5
Total EE/DG	9.0	32.4	65.0	99.6	125.5
TOTAL RE & EE/DG	17.9	80.4	115.0	172.6	202.5
PEAK REDUCTION/PEAK SHIFTING					
Demand Response Program & Load Management	0.0	1.0	4.0	4.0	4.0
Pricing Programs					
Residential TOU Rates Commercial TOU Rates Industrial TOU Rates	0.2	2.0	3.0	3.0	5.0
Critical Peak Pricing	0.2	4.0	5.0	6.0	8.0
TRANSPORTATION ELECTRIFICATION					
Plug-In Hybrid Cars (# of Cars, Hawaii Only)	1,200	7,200	13,200	19,200	25,200

MAUI ELECTRIC COMPANY, LTD (MECO)

Renewable Energy Commitments	Cumulative Target Goal (MW by year-end) 2010	2015	2020	2025	2030
RENEWABLE GENERATION					
IPP Projects (info based on IPP proposals)					
Shell Wind		21.0	21.0	21.0	21.0
Lanai Solar	1.2	1.2	1.2	1.2	1.2
Oceanlinx Wave		2.7	2.7	2.7	2.7
Pulehu Biomass		6.0	6.0	6.0	6.0
Landfill gas (Waste-to-Energy)		Unknown status.			
KWP II		21.0	21.0	21.0	21.0
Total RE Generation	1.2	51.9	51.9	51.9	51.9
ENERGY EFFICIENCY/CUSTOMER SITED GENERATION					
PV (through feed-in tariff or PPA)	1.8	7.8	18.0	30.0	39.0
Solar Opportunity					
Mandatory Solar Roofing, SB644	1.0	3.0	6.0	9.0	11.0
Pay-As-You-Save Solar Program	0.1	2.0	3.0	5.0	6.0
PV Host Program	2.0	7.0	12.0	17.0	22.0
Net Energy Metering	2.2	10.0	24.0	42.0	54.0
Distributed Generation & Distributed Energy Resources	1.8	4.8	7.8	10.8	12.0
Total EE/DG	8.9	34.6	70.8	113.8	144.0
TOTAL RE & EE/DG	10.5	92.5	131.7	177.7	209.9
PEAK REDUCTION/PEAK SHIFTING					
Demand Response Program & Load Management	4.0	8.0	9.0	10.0	10.0
Pricing Programs					
Residential TOU Rates / Commercial TOU Rates / Industrial TOU Rates	0.2	2.0	3.0	5.0	6.0
Critical Peak Pricing	0.2	4.0	6.0	7.0	8.0
TRANSPORTATION ELECTRIFICATION					
Plug-In Hybrid Cars (# of Cars, Maui Only)	1,200	7,200	13,200	19,200	25,200

ENERGY AGREEMENT AMONG THE STATE OF HAWAII, DIVISION OF CONSUMER ADVOCACY, DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS, AND THE HAWAIIAN ELECTRIC COMPANIES

The signatories to this agreement are the Governor of the State of Hawaii; the State Department of Business, Economic Development and Tourism; Hawaiian Electric Company, Hawaii Electric Light Company, Maui Electric Company ("Hawaiian Electric Companies"); and the Consumer Advocate of the State of Hawaii.

On behalf of the people of Hawaii, we believe that the future of Hawaii requires that we move more decisively and irreversibly away from imported fossil fuel for electricity and transportation and towards indigenously produced renewable energy and an ethic of energy efficiency. The very future of our land, our economy and our quality of life is at risk if we do not make this move and we do so for the future of Hawaii and of the generations to come.

The islands of Hawaii have abundant natural resources, including wind, sunshine, ocean and geothermal sources for electricity generation, and land for energy crops that can be refined into biofuels to address electricity and transportation needs. Economic and culturally sensitive use of natural resources can achieve energy supply security and price stability for the people of Hawaii, as well as significant environmental and economic opportunities and benefits. Successfully developing Hawaii's energy economy will make the State a global model for achieving a sustainable, clean, flexible, and economically vibrant energy future.

We commit to being open and truthful with our community about the investment necessary to transition to a clean energy future, the importance of making it, and the time it will take to be successful. We accept that the transition to this clean energy future will require significant public and private investment with impacts on Hawaii's ratepayers and taxpayers and, we expect to achieve long-term benefits that outweigh the costs of such investments.

As we move from central-station, oil-based firm power to a much more renewable and distributed and intermittent powered system, we accept that the operating risks of the Hawaiian Electric Companies will increase which may potentially affect customers. Thus, we recognize the need to assure that Hawaii preserves a stable electric grid to minimize disruption to service quality and reliability. In addition, we recognize the need for a financially sound electric utility. Both are vital components for our achievement of an independent renewable energy future.

We commit to take steps to reduce the demand for electricity and increase the efficiency of energy that we do use both to reduce the costs to the public and to reduce the level of electrical generation. At the same time, we recognize that a system of utility regulation will be needed to assure that Hawaii preserves a stable electric grid and a financially sound electric utility as vital components of our renewable energy future.

We will strive to assure that this process to achieve the HCEI goals and objectives will be directed towards providing ratepayer benefits, including long term price stability, and ultimately lower cost than would be incurred using imported fossil fuels.

We also commit to incorporate new metrics for measurement and oversight systems that monitor our progress in reducing our use of imported fossil fuel, while increasing our efficiency and our use of renewable energy to meet Hawaii's electrical energy demand.

We commit ourselves to a system of utility regulation that will transform our major utility from a traditional sales-based company to an energy services provider that retains its obligation to serve our public with reliable energy, strives to source and integrate greener and lower cost generation, and moves us to an energy independent future.

And finally, we commit to working together in good faith, openness and in the spirit of cooperation and collaboration to achieve the objectives and goals set forth in this agreement.

____
Linda Lingle
Governor
State of Hawaii

____
Constance H. Lau
President & Chief Executive Officer
Hawaiian Electric Industries, Inc.

____
Theodore E. Liu
Director
Department of Business Economic
Development and Tourism

____
Robert A. Alm
Executive Vice President
Hawaiian Electric Company, Inc.

____
Catherine P. Awakuni
Consumer Advocate
Department of Commerce and
Consumer Affairs

Witnessed By:

____
William Parks
U.S. Department of Energy

____
Maurice H. Kaya
Technical Director
Hawaii Renewable Energy Development
Venture

1 Wind Power for Hawaii

The Hawaiian Electric Companies are committed to integrating the maximum attainable amount of wind energy on their systems.

Furthermore, the Hawaiian Electric Companies are committed to prudently negotiate purchase power agreements and evaluate integration investment costs for the benefit of the Hawaiian Electric Companies' ratepayers.

To accelerate the addition of clean renewable energy resources for the residents of Oahu, Hawaiian Electric is negotiating Power Purchase Agreements ("PPA") with several independent power producers ("IPP") totaling up to approximately 135 MW of renewable energy (collectively the "Grandfathered Projects"), which includes a 30 MW wind farm located on the north shore of Oahu.

In addition to pursuing these Grandfathered Projects, Hawaiian Electric has also issued a Request for Proposals for Renewable Energy Projects ("RE RFP") seeking to contract for an additional 100 MW of renewable energy for Oahu. The RE RFP is part of a structured competitive procurement process established by the Commission ("Competitive Bidding Framework") with the intent to enable Hawaiian Electric to obtain viable renewable energy generation at a competitive and reasonable cost for the benefit of all ratepayers. Hawaiian Electric believes that much of the developable wind energy resources located on Oahu (understood to be in the range of approximately 100 MW) has the opportunity to be realized in the near term as a direct result of the Grandfathered Projects and the RE RFP activities.

Wind power is a commercially proven source of renewable energy today that, while limited on Oahu, is abundant on the neighbor islands with combined resource potential across the State thought to be in excess of 1,000 MW. To achieve substantially greater use of wind power on Oahu where most of the electric power in the State is consumed, it is necessary to transmit the wind power produced on the other islands by undersea cable systems[1] to Oahu. Several developers proposing large-scale wind farm projects located on the islands of Lanai and Molokai, ranging in size of up to roughly 400 MW each, have notified Hawaiian Electric of their intent to submit a proposal in response to the RE RFP.

In order to facilitate a future in which the abundant, sustainable and indigenous wind resources of our islands supply a significant portion of the total energy demand on Oahu, the parties commit to the following:

[1] Undersea cable systems are comprised of all facilities between the Oahu and the neighbor islands' AC transmission systems to transfer power between each island's grids.

1. Hawaiian Electric commits to integrate, with the assistance of the State to accelerate the commitment, up to 400 MW of wind power into the Oahu electrical system that is produced by one or more wind farms located on either the island of Lanai or Molokai and transmitted to Oahu via undersea cable systems (the “Big Wind” projects). This accelerated process shall in no way limit the longer term incorporation of additional neighbor island renewable energy projects should those future projects and cost of integration prove feasible and prudent to ratepayers.

2. Hawaiian Electric and the State commit to accelerate the addition of new clean renewable energy resources on Oahu. To that end, the parties recognize that the ongoing efforts related to the Grandfathered Projects and the Oahu RE RFP currently in progress provide the best near-term opportunity to add up to 235 MW of new clean renewable energy resources located on Oahu. Hawaiian Electric commits to continue negotiations for the purchase of renewable energy from Grandfathered Projects and to efficiently complete the Oahu RE RFP. The State commits to support, facilitate and help expedite these ongoing Oahu or Oahu related activities and processes, including the successful development of the resulting Oahu or Oahu related renewable energy projects.

3. To facilitate the early adoption of both the Oahu projects and one or more of the neighbor island wind farm, Hawaiian Electric, with support from the State, commits to work together with the developers of these Big Wind projects and the Commission to bifurcate their project proposals from the ongoing Oahu RE RFP. The bifurcated RFP process to evaluate and select the best Big Wind project or projects, will be led by Hawaiian Electric, with support from the State. Selection is contemplated to be conducted in conformance with the Competitive Bidding Framework using data submitted by developers in September 2008. The State will support Hawaiian Electric in the wind farm evaluation and selection process.

4. Hawaiian Electric also agrees to provide $100,000 in funding to model the Molokai grid and to make efficiency recommendations to the island residents. (A similar program is already underway on Lanai through the Department of Energy.)

5. All necessary engineering, technical and financial studies and analyses to identify Big Wind project integration and performance requirements, undersea cable systems requirements, and Hawaiian Electric system modifications, infrastructure additions and operating solutions (“Implementation Studies”) will be conducted in a comprehensive but expedited manner. (See “Technology of Inter-Island Renewables” section.)

6. The developer of the selected Big Wind project is responsible for all matters related to the implementation of its wind farm facilities. These responsibilities include: (a) securing all land rights, permits and approvals (e.g. environmental, land use and construction) that are necessary for the efficient and effective development of its wind farm; (b) all related infrastructure and equipment that may be identified and required for the project pursuant to the Implementation Studies, and (c) any requirements, such as energy storage to meet performance standards, that may arise from a subsequent interconnection requirements study (“IRS”) conducted by Hawaiian Electric, and as embodied in a PPA between Hawaiian

Electric and the developers. The costs of fulfilling the aforementioned responsibilities shall be borne by the developer(s). Hawaiian Electric shall provide for appropriate additional storage capacity investments, grid upgrade additions, and grid operation management procedures to support the integration of the project with the overall grid.

7. Understanding the complexity of large scale infrastructure siting and investment in an Inter-Island Electric Cable, the State shall accept primary responsibility and shall serve as lead, while coordinating with developers, contractors, and/or Hawaiian Electric as the circumstances merit, on all matters related to the siting and permitting of the undersea cable systems consistent with the Implementation Studies. These responsibilities include but are not limited to conducting or having contractors and advisors conduct the appropriate engineering and design of the undersea cable systems, acquisition of all necessary off-shore and on-shore land rights, permits and approvals (including the Environmental Impact Statement), and construction, operation and maintenance of the undersea cable systems. The undersea cable systems shall be considered State owned infrastructure unless alternatives are discovered as part of the Implementation Studies and agreed to by relevant affected Parties. The State can also consider the option of bringing in a third-party independent transmission company to fund and build the inter-island cables.

Hawaiian Electric may enter into an agreement as a contractor with the State for the operation and maintenance of the undersea cable systems under such terms and conditions as the parties decide. Should Hawaiian Electric enter into any such operating and maintenance contract with the State, all reasonably incurred costs and expenses of Hawaiian Electric arising thereunder shall be recovered through the Clean Energy Infrastructure Surcharge (CEIS) mechanism.

8. The State shall first seek, with Hawaiian Electric's and/or developer(s) reasonable assistance, federal grant or loan assistance to pay for the undersea cable systems. In the event that effort fails, the State will employ its best effort to fund the undersea cable systems through a prudent combination of taxpayer paid sources and ratepayer sources with acceptance that the cable system finance may have an effect on Hawaiian Electric and that a financially sound electric utility are vital components of our renewable energy future. In the event Hawaiian Electric funds any part of the cost to develop the undersea cable systems such that Hawaiian Electric has part ownership in the cable systems, all reasonably incurred capital cost and expense of Hawaiian Electric arising thereunder shall be recovered through the CEIS mechanism. However, nothing in this paragraph shall be construed as creating an obligation on Hawaiian Electric’s part to fund any part of the undersea cable systems costs.

9. The State and the selected wind farm developer shall work together, in consultation with Hawaiian Electric and other appropriate advisors and stakeholders as set forth in the conclusions of the Implementation Studies, to interconnect the undersea cable systems to the developer’s wind farm facilities located on Lanai or Molokai. Hawaiian Electric will be responsible for all required utility system connections or interfaces on Lanai or Molokai, if any, with the State’s undersea cable systems and/or the wind farm facilities. All necessary

Hawaiian Electric capital improvements will be proposed to the PUC for approval including its recovery supported by the State and the wind farm developer, and recovered, through the CEIS mechanism, until the next rate case, at which time such costs will be reflected in the test year rate base.

10. Hawaiian Electric is responsible for funding, constructing, operating and maintaining all land-based connections and infrastructure improvements to the existing Hawaiian Electric system up to the interconnection point located at the on-shore termination of the State owned undersea cable systems on Oahu. Hawaiian Electric will consult with, and seek agreement with the State on the selected route to the appropriate substation. The State will support, facilitate and expedite all required land use, environmental and regulatory permits and approvals associated with Hawaiian Electric's land-based connections and infrastructure improvements. In the event Hawaiian Electric is unable after reasonable effort to secure the necessary permits and approvals or is delayed in its completion of the required land-based connections and infrastructure on Oahu, Hawaiian Electric is not responsible for the cost, expense, and any purported lost opportunity of the Big Wind project developer and the State related to their efforts toward the development of this renewable energy undertaking. All necessary Hawaiian Electric capital improvements will be proposed to the PUC, supported by the State and wind farm developer, and recovered through the CEIS mechanism, until the next rate case, at which time such costs will be reflected in the test year rate base.

11. In addition to the integration of Grandfathered Projects and possible projects resulting from the RE RFP, and the commitment to integrate up to 400 MW of wind power in Hawaiian Electric's renewable energy commitments set forth in this agreement, an assessment will be conducted as a part of the Implementation Studies of the capability of the Oahu system to integrate additional wind energy from the neighbor islands in future years. Upon completion of the assessment and assuming it is possible, Hawaiian Electric agrees to integrate additional wind energy following the successful integration and commercial operation of the first large-scale wind farm. The Parties will review the process for the implementation of additional renewable energy and storage project opportunities from the neighbor islands and the Parties may agree to follow the same process identified in this section for the first neighbor island wind farm(s) to ensure that the proposal is in the best interest of the Parties and the ratepayers.

2 Renewable Energy Commitments

The parties are all committed to the rapid development of as much renewable energy as possible. To that end, the parties are looking to the development of a series of projects including, but not limited, to the listed projects.

Hawaiian Electric and the State commit to accelerate the addition of new clean energy resources on Oahu. To that end, the Parties recognize that Hawaiian Electric's independent, ongoing efforts related to the Grandfathered Projects and the Oahu RE RFP currently in progress may provide a reasonable near-term opportunity to add up to 235 MWs of new clean energy resources located on Oahu. Hawaiian Electric commits to continue independent negotiations for the purchase of renewable energy from the Grandfathered Projects and to efficiently complete the Oahu RE RFP. Should these projects prove feasible and demonstrate rate payer benefits as shown in information made available to the State and in the State's sole opinion, the State commits to support, facilitate and help expedite these ongoing activities and processes, including the successful development of the resulting renewable energy projects.

It is understood that these projects must still be put before the Commission through PPA and that other new projects may come along as well. Hawaiian Electric will work to streamline PPA development for these projects in order to meet the commitment timeline set forth in Exhibit B of this agreement.

It is also understood that Hawaiian Electric's move to biofuels is not intended to slow the implementation of these or other renewable energy projects.

It is understood that the Hawaiian Electric utilities will not add any new utility owned biofuel central-station generating units without equivalent retirements in terms of megawatthour energy generation of existing units. The utilities will not be allowed any cost recovery for any new utility biofuel generation units without the aforementioned equivalent retirement of existing units.

It is also understood that the Hawaiian Electric utilities shall not themselves add any new fossil-based generation over 2 MW beyond those already approved by the Commission or under construction without equivalent megawatthour retirements.

The parties do note that specific renewable energy projects may or may not result in power purchase agreements for reasons outside the control of the parties negotiating such agreements.

Hawaiian Electric will encourage and explore the development of the following project proposals known today, with the goal of bringing the maximum number of projects and renewable MW on-line as quickly as possible subject to Commission approval, contract negotiations, and grid integration feasibility.

Hawaiian Electric Company, Inc.

- RFP (Competitive Bid for Non-firm Renewable Energy) (100 MW)
- NorthShore Wind (30 MW) as-available with batteries for smoothing
- Honua (6MW) Waste-to-Energy
- C&C (21 MW) Waste-to-Energy
- Sea Solar (25 MW to 100 MW) Ocean Thermal
- Lockheed Martin (10 MW) Ocean Thermal

- CIP CT-1 (110 MW) Biofuel Simple Cycle Gas Turbine
- Airport DG (8 MW) Biofuel
- DG at substations to Biofuel (30 MW)
- Molokai or Lanai Wind (400 MW)
- CIP CT-2 (100 MW) Biofuel
- Military DG (100 MW) Mixed renewables
- Waiau 3 and/or 4 Retirement (after CT-2 or Hawaiian Electric-Military DG on line)
- RFP (Competitive Bid for Renewable Energy) Additional and Replacement Power (MW TBD)

Maui Electric Company, Ltd.

- Shell Wind (21 MW) Wind
- Lanai Solar (1.2 MW) Solar
- Pulehu (6 MW) Biomass
- Oceanlinx (2.7 MW) Wave
- Landfill Gas (2 MW) Waste-to-Energy
- KWPII (21 MW) Wind
- HC&S extension Biomass
- RFP (Competitive Bid for Firm Renewable Energy) Additional and Replacement Power (MW TBD)

Hawaii Electric Light Company, Inc.

- Up to 40 MW of generation resources with full ancillary services, economic dispatch, energy payments only. Current possibilities are:
    - PGV Geothermal additional 8 MW
    - Hamakua Biomass (25 MW) or Hu Honua Biomass (22 MW)
    - Hi County Waste-to-Energy (4 MW)
- Up to 5 MW of variable/intermittent generation resources with energy only payments. Current possibilities are:
    - SOPOGY (0.5 MW) Solar
    - Na Makani (4.5 MW) Wind with pumped hydro for “firming” and “smoothing”

If the above happens, HELCO’s fossil fuel generation will be displaced; depending upon how much of the above development occurs, the following may be possible:

- Reduction in energy purchases from Hamakua Energy Partners

- Reduction in energy production from HELCO fossil fuel units
- Shipman (15 MW) Retired (after Biomass and PGV on line and bio-fueling not feasible)
- Diesel-11 (2 MW) Retired
- Puna Steam (15 MW) converted to Biomass
- RFP (Competitive Bid for Firm and/or As-Available Renewables – due 2023) (MW TBD)

Energy storage, such as pumped storage hydro and battery energy storage as well as transmission and distribution facilities are considered as utility integrating technologies for generation resources. Energy storage and other technologies which provide ancillary services may be utility-owned or may be acquired with PPAs with appropriate prices, terms and conditions designed specifically for grid integration and ancillary services.

3 The Technology of Inter-Island Renewables

The Parties are all committed to the integration of non-fossil fuel, renewable energy, sourced first from the Renewables for Oahu Project(s). Over the long term, integration of renewable energy from neighbor islands may also occur should the results the Inter-Island Cable Study and additional Implementation Studies show that the resulting energy generation, delivery and grid integration costs provide true cost/benefit (in the face of imported oil and its associated price and supply risks) to the State and to Hawaiian Electric Companies' ratepayers.

In conjunction with the analyses to integrate the Renewables for Oahu Project(s), the Parties agree to assess the potential of an expanded undersea cable system to Maui County and to facilitate additional, near term, balanced, renewable energy resources based on the study results, where such results and additional potential projects are found to be cost effective and prudently incorporated in the near term without interference with the Renewables for Oahu Project(s). The Parties understand that the economies of scale and the timing of capacity utilization of any proposed undersea cable configuration may materially affect the overall benefit to ratepayers and will work to facilitate utilization of the cable or renewable resources, while maintaining system reliability in accordance with the rest of this section.

The parties agree to utilize an experienced technical resource, such as the National Laboratories to independently validate and review the appropriateness of the scope and depth of analyses envisioned for the Implementation Studies below.

To successfully accomplish the objective of integrating renewable energy from the neighboring islands, minimize curtailment of as-available energy, and extract the most value of a Big Wind project, subject to confirmation in the independent validation above, the parties agree to work together on a set of Implementation Studies to identify:

The technical requirements of and configuration for the inter-island undersea cable systems to ensure their high availability in order to facilitate the transfer of all available energy from the wind farm.

The modifications and additions needed for existing Oahu and neighbor island AC transmission grids to reliably interconnect power from the inter-island high-voltage DC cables and transmit the wind farm energy to Oahu's distribution system.

The energy storage or flexible generation (providing ancillary services and other attributes such as load following, frequency response, regulation, quick start, fast ramping, etc.) needed to offset the variable nature of the wind energy and to minimize the curtailment of wind or other intermittent energy projects.

The modifications needed on existing generating units (such as cycling conversion, etc.) to offset the variable nature of the wind energy and to minimize the "spilling" of wind.

The changes to operational practices and procedures needed to operate the island grids and integrate their operations with the wind farm.

The parties agree that the Oahu Implementation Studies will be based upon existing generation resources and transmission and distribution systems and will take into account projects identified in the Renewable Energy Commitments section above.

Using all available system, meteorological, and performance data of the island systems, the parties agree to conduct these Implementation Studies in a collaborative fashion to support a timely implementation of the neighbor island wind farm, the undersea cable systems, and the on-island transmission, generation, energy storage, and all other infrastructure necessary for the effective integration of the wind farm energy.

The parties agree that technical and operating requirements (including the design of the undersea cable systems, the modifications and additions to the Oahu transmission system, the amount of energy storage or flexible generation required, the kind of modifications needed to existing generating units, and the changes to operational practices) determined in the Implementation Studies should be based upon a robust infrastructure design that maintains reliability levels consistent with industry practices, customer expectations, and requirements of the PUC and strives to achieve a high fuel efficiency for the system.

The parties agree that these Implementation Studies involve the technical resources of the parties, and the technical assistance of leveraged resources such as the U.S. Department of Energy and its National Laboratories, the Hawaii Natural Energy Institute, and other appropriate technology advisors, both public and private, such as General Electric and other industry experts.

The parties agree to base the design and development of a neighbor island wind farm, the undersea cable systems, and the on-island transmission, generation, energy storage, and all other infrastructure necessary for the effective integration of the wind farm, on the results of these Implementation Studies.

The parties agree to assess the ability of the Oahu, Maui, and Big Island grids to incorporate additional amounts of non-firm, variable renewable generation, such as significant amounts of distributed PV generation and a subsequent neighbor island wind farm.

The parties agree to analyze the expansion of the undersea cable system to the Island of Hawaii and to assess the potential of the expanded undersea cable to facilitate the development of additional renewable energy resources on the Island of Hawaii.

The intent of this effort is to identify the ability to utilize wind, solar, ocean, geothermal and other renewable resources to meet the electricity needs of the ratepayers of the Hawaiian Electric Companies. It is understood that actual build-out of the inter-island cables will probably happen in stages. Based on current knowledge the installation of the shallow cables from Maui County to Oahu are likely to happen first.

The parties agree that the cost of the Implementation Studies will be recovered through the CEIP surcharge.

The parties also agree to examine the impact that interconnection may have on revenue bond financing and to take appropriate follow up action. Appropriate follow up actions could include seeking changes to IRS regulations or the redemption of the revenue bonds and related capital structure costs.

4 The Solar Opportunity

Solar opportunities for Hawaii include solar water heating (SWH), photovoltaics (PV), and concentrated solar power (CSP).

The parties believe that solar energy represents an immediate and substantial renewable energy opportunity for Hawaii. In order to fully use that energy, the parties commit to the following:

1. A measure to address issues encompassed in the Governor’s June 26, 2008 press release on her signing of the mandatory solar roofing law enacted in 2008 will be submitted to the 2008- 2009 Legislative session, and will be supported by all parties.

2. The tax credits and rebates for the conversion of existing homes to solar water heating will be continued. The Hawaiian Electric Companies may bid to continue implementation of this program once responsibility for energy efficiency programs is transferred to the third-party administrator.

3. The Hawaiian Electric Companies will propose a full "pay as you save" style program under which the ratepayer (property owner or renter) requests solar water heating, the utility

provides the unit installed by a licensed solar dealer, and the unit is paid for through a "shared savings" approach using the ratepayer's bill. The utility may outsource portions of the program administration. The utility will recover all prudently incurred costs related to this program. By the end of 2008, the Hawaiian Electric Companies will file an application with the PUC seeking approval to implement the program, with a goal of no less than 2,500 annual installations. Once the application is approved by the Commission, the Hawaiian Electric Companies shall be ready to implement the program. (This program is in addition to the ongoing solar water heating and pilot “pay as you save” programs that are currently authorized by the PUC.)

4. The Hawaiian Electric Utilities are responsible for expeditiously integrating customer-sited PV and CSP energy into the utility system via the Rule 14H tariff as modified in May, 2008. In addition, the Hawaiian Electric Companies shall incorporate the integration of PV systems in their Clean Energy Scenario Planning (“CESP”).

5. The Hawaiian Electric Companies agree to address and mitigate the system integration issues at the distribution and system level for PV technologies.

6. Support the installation of third-party and customer PV systems through feed-in tariffs that offer known, stable pricing terms and standardized interconnections (See Feed-in Tariff section).

7. Support customer energy payment options through modification of Hawaii’s Net Metering option to include provisions for the sale of excess energy produced by the customer’s net metered system on an annual basis and payment for such energy at the feed-in tariff rate or at a somewhat lower fixed rate to fairly balance the option risks available in all customer options. New net metered installations shall be required to incorporate time-of-use metering equipment and, when time-of-use rates are implemented on a full scale basis in Hawaii or the applicable area, the net metered customer shall move to time of use net metering and sale of excess energy. The Parties agree that net metering installations benefit from system ancillary services, but that the long term commodity risks accepted by installation owners and excess energy payments contemplated herein, adequately compensate for the use of ancillary services that are unique to small island systems.

8. In order to provide customers a third option, the Hawaiian Electric Companies shall facilitate the development of photovoltaic (PV) energy by submitting an application to the PUC for a "PV Host Program" by March 31, 2009 of this agreement being signed. This PV Host program will consist of the following elements:

a. Contracting to use a customer site, both commercial and residential, for the installation of a PV system. The site owner may be a part owner of the system. As consideration for providing a PV generation site, the site owner may receive a site rental payment and/or use a portion of the PV energy generated at their site.

b. The Hawaiian Electric Companies will competitively procure the installation of the systems, which can be owned by a third party and/or the utility.

c. In the case of third party-owned systems, the utility may purchase PV energy at a standard rate. That rate shall not be linked to avoided cost and is intended to provide long-term stable pricing. The initial rate shall be set based on a competitive solicitation done by the utility before the submission of the PV Host program application. The standard rate may be changed, subject to PUC approval, based on changes in tax laws and rebates, changes in PV system costs, and other developments in PV services.

d. The Hawaiian Electric Companies may purchase the PV system and add the system cost to the utility's rate base, as long as the cost of the system is at or below the level established by the PUC.

e. The Hawaiian Electric Companies shall structure the program to acquire PV energy as efficiently as possible, with priority given to sites, which accommodate large amounts of PV. Attributes of these sites as well as relevant information from known candidate sites will be identified in the program design and in the PV Host program application that will be filed with the PUC.

f. Should federal legislation be altered so that the utilities may claim tax credits, the value of such tax credits shall be passed through to ratepayers in the form of lower rate based asset costs or other mechanism.

g. In these PV Host installations, the Hawaiian Electric Companies are responsible for integrating the energy into the utility's system.

h. Such PV Host systems can be targeted toward customers, such as the Department of Education facilities and other State buildings and properties.

9. Once the program is approved by the Commission, the cost of acquiring PV energy, including but not limited to site rental payments, site improvements, interconnection, purchased energy, and PV Host program administration shall be paid for by all ratepayers. The estimated program costs and cost recovery mechanism will be provided in the program design and application that will be filed for Commission approval.

10. Hawaiian Electric will review utility property such as Kahe Valley for use as a PV and/or CSP site by March 31, 2009, and the results of such review will be shared with the State and the Commission. Hawaiian Electric will also present the process in by which development may be implemented at each site.

11. The Hawaiian Electric Companies agree to facilitate the development of CSP through PPA.

12. The Hawaiian Electric Companies agree to address and mitigate the system integration issues at the distribution and system level for PV and CSP technologies through the Rule 14H tariff, as amended in May 2008.

13. All utility PV systems and projects shall be subject to the same circuit limits as all non-utility customer sited DG resources.

5 Biofueling

The majority of electric power generated in Hawaii is produced through the burning of imported liquid fossil fuels. Significant activity is taking place both in Hawaii and around the world to produce biofuels, which can be substituted for liquid fossil fuels.

The use of sustainable, renewable biofuels in existing firm power units (utility and non-utility) will provide substantial levels of renewable energy, reduce greenhouse gas emissions, avoid the need to construct expensive replacement generation, and allow for the integration of intermittent resources such as wind and solar energy.

The demand created by the use of biofuels in Hawaiian Electric's units will provide a strong basis for investment in the local biofuel industry, which, in turn, will bolster Hawaii's agriculture sector and increase our energy independence and security, and retain dollars in the State.

In order to facilitate the use of biofuels in Hawaii, the parties commit and agree to the following:

1. The Hawaiian Electric utilities will affirm the technical feasibility of biofuel (and/or blends of biofuels with fossil fuels) use in their generating units via operational test burns beginning in 2009. Such testing will include:

a. Procurement, transport, and storage of biofuels.

b. Design, procurement, and installation of new equipment and instrumentation.

c. State Department of Health approval of test burns. No individual test burn period shall be longer than three months, consistent with the Department of Health’s administrative rules.

2. The State will support, facilitate and expedite all permitting and approvals associated with the Hawaiian Electric utilities’ testing of biofuels in their generating units.

3. The State will provide the Hawaiian Electric utilities with maximum air permit flexibility during the test burns. If during testing, emissions approach permitted emission limits, the Hawaiian Electric utilities will terminate the tests. The Hawaiian Electric utilities may request temporary approval of higher emission limits to allow completion of the test burn. The State will facilitate and expedite the Department of Health’s approval of temporary emission limits. In no case shall a violation of State or federal ambient air quality standards be allowed to occur.

4. The Hawaiian Electric utilities will competitively procure sustainable biofuels to be used for the tests, and request expedited PUC approval of the test biofuel procurement contract(s) and the inclusion of the test biofuel, sustainability audit, tracing, and certification costs, and transportation, terminaling, throughput and related costs in the energy cost adjustment clause. The parties agree on the Hawaiian Electric utilities’ need to conduct biofuel tests and the appropriateness of including reasonable biofuel testing, audit, tracing, certification,

and transportation, terminaling, throughput and related costs in the energy cost adjustment clause or other appropriate surcharge mechanism that will allow for timely cost recovery. The parties agree to support utility recovery of all reasonable non-fuel related biofuel testing expenses that are not included in Hawaiian Electric's existing base rates.

5. The results of the tests will be shared with the parties.

6. Subsequent to testing, implementation of long-term biofuel use in the Hawaiian Electric utilities' power generating units may require air permit modifications and fuel infrastructure changes. The State and U.S. Department of Energy (DOE) will facilitate and expedite the State's Department of Health's and Federal Environmental Protection Agency's approval of such permit modifications, and advocate for maximum regulatory discretion including possible exemption from New Source Review. Hawaiian Electric will be allowed full cost recovery for all prudent and reasonable fuel infrastructure changes deemed necessary to support the implementation of long-term biofuel use, upon commission review and approval.

7. Assuming technical feasibility and the ability to modify permits are confirmed, the Hawaiian Electric utilities will implement use of sustainable biofuels (and/or blends of biofuels with fossil fuels) in their generating units, subject to acceptable biofuel pricing and sufficient biofuel availability. The Hawaiian Electric utilities will maintain flexibility in their equipment and permits and will be allowed to use alternative fuels should significant biofuel supply or price disruptions occur.

8. Hawaiian Electric will convert generating units using liquid fossil fuels to using biofuels, to the extent reasonable and necessary to achieve RPS goals and to facilitate integration of other forms of renewable energy.

9. The Hawaiian Electric utilities will procure sustainably-produced biofuels in accordance with its NRDC environmental sourcing policy. The parties agree in principle that paying a reasonable cost premium to ensure sustainability is acceptable.

10. The Hawaiian Electric utilities will preferentially purchase biofuels that are locally grown and produced in Hawaii. The parties agree in principle that paying a reasonable cost premium for locally-produced biofuels is acceptable.

11. The State, via its State Biofuels Master Plan, will identify and implement financial incentives and land use and employment policies to encourage the development of a local biocrop and biofuel production industry.

12. The Hawaiian Electric utilities will consider and pursue options to actively incent or partner in local biofuel development projects either as a regulated utility or as an unregulated affiliate. The State agrees to support the utilities' involvement in these projects subject to a showing of avoidance of conflicts of interest, and, if done as a regulated utility, reasonable ratepayer benefits.

13. The Hawaiian Electric utilities, as part of their ongoing research and development activity will provide financial support for research and development of locally-grown vegetable oils, research and development of algae and other next generation feedstocks, and local feedstock production and processing facilities. Currently, these activities are being conducted by the University of Hawaii and the Hawaii Agricultural Research Center.

14. The parties will support continued federal tax support for biofuels and will seek their extension to cover the full range of biofuel products including crude palm oil (CPO).

15. If there is a disruption of supply or delivery of biofuels or any technical or other similar biofuel related emergency situation, PUC approval must be sought by the utility before it can substitute fossil fuels for biofuels in operating new biofuel fired generating units beyond what is required for unit testing or startups/shutdowns.

6 Avoided Energy Cost Contracts

The parties regard avoided energy cost based on fossil fuel prices for renewable energy contracts as a vestige of the past. The Hawaiian Electric utilities will make a request of all existing independent power producers in which PPA are based on fossil fuel prices to renegotiate those contracts to delink their energy payment rates from oil costs and provide ratepayers with stable, long-term and predictably priced contracts. If such requests are not accepted, as opportunities arise, the Hawaiian Electric utilities will negotiate new contracts or extensions of existing contracts to delink their energy payment rates from oil costs. See Exhibit B for a list of existing PPA prices based on fossil fuel prices, and information on contract expiration dates.

All new renewable energy contracts are to be delinked from fossil fuel oil costs.

The utility will determine what ancillary services are needed to integrate proposed energy providers into the system and make appropriate investments to ensure grid reliability and performance. The utility will pay appropriate value for ancillary services provided by third parties.

7 Feed-in Tariffs

The parties agree that feed-in tariffs are beneficial for the development of renewable energy, as they provide predictability and certainty with respect to the future prices to be paid for renewable energy and how much of such energy the utility will acquire. The parties agree that feed-in tariffs should be designed to cover the renewable energy producer's costs of energy production plus some reasonable profit, and that the benefits to Hawaii from using a feed-in tariff to accelerate renewable energy development (from lowering oil imports, increasing energy security, and increasing both jobs and tax base for the state), exceed the potential incremental rents paid to the renewable providers in the short term. To that end, the parties agree to the following:

- The parties will respectfully request that by March, 2009, the Commission will conclude an investigative proceeding to determine the best design for feed-in tariffs that support the Hawaii Clean Energy Initiative, considering such factors as categories of renewables, size or locational limits for projects qualifying for the feed-in tariff, how to manage and identify project development milestones relative to the queue of projects wishing to take the feed-in tariff terms, what annual limits should apply to the amount of renewables allowed to take the feed-in tariff terms, what factors to incorporate into the prices set for feed-in tariff payments, and the terms, conditions, and duration of the feed-in tariff that shall be offered to all qualifying renewable projects, and the continuing role of the Competitive Bidding Framework;
- In addition, the parties will respectfully request that by July, 2009, the Commission will adopt a set of feed-in tariffs and prices that implement the conclusions of the feed-in tariff investigation;
- Utility PPA of renewable energy made using the Commission-approved feed-in tariff shall be deemed to be prudent and their costs shall be approved for rate recovery;
- Utility purchases of renewable energy under the feed-in tariff shall be counted toward the utility's Renewable Portfolio Standard requirements;

The parties agree in principle that 10% of the utility's energy purchases under feed-in tariff PPA will be included in the utility's rate base through January 2015.

With the parties' agreement to implement feed-in tariffs as a method for accelerating the acquisition of renewable energy and Hawaiian Electric's implementation plan set forth in Exhibit B, towards the integration of the renewable energy commitments, the achievement of the utility renewable energy program goals, as well as the other commitments offered in this document as identified and summarized in Exhibit A, the parties further agree to request Commission suspension of the current intra-governmental wheeling docket (i.e., Docket No. 2007-0176) and the Schedule Q investigation (i.e., Docket No. 2008-0069) for a period of 12 months, with a goal of having parties review necessity of the docket.

8 Coal

The parties agree that new generators fueled, whole or in part, by coal are not in the best interests of the people of Hawaii. Any attempts to add new coal based generation in Hawaii will be opposed by the parties.

9 Renewable Portfolio Standard (RPS)

The parties agree that a Renewable Portfolio Standard is a desirable way to articulate and structure Hawaii's electric utilities' renewable energy acquisition obligations. To that end, the parties agree to the following:

- Energy savings from such technologies as energy efficiency, demand response, and renewable displacement shall not count toward the utilities' RPS goals after 2014, but shall be fully counted with respect to achievement of the goals of the Hawaii Clean Energy Initiative.
- In addition to a 10% RPS goal in 2010, a 15% RPS goal in 2015, and a 25% RPS goal in 2020, Hawaii's RPS goals shall be modified to require that 40% of the Hawaiian Electric utilities' total RPS must be provided from renewable sources by 2030, and that through 2015 no more than 30% of the Hawaiian Electric utilities' total RPS may come from imported biofuels consumed in utility-owned units.
- The Hawaiian Electric utilities will support the State and/or the PUC in incorporating these changes in the HRS §269-92, or in the exercise of the PUC authority. The parties understand that the PUC will impose penalties for non-compliance with the RPS.
- Electricity generation from refuse-derived fuels shall count toward the RPS because the energy produced by such generation is sustainable and avoids the social costs of landfill disposal.
- To the degree that liquid or solid fuels are burned in a mixture of renewable or sustainable and fossil fuels, only that portion which is renewable or sustainable (measured on a per BTU input basis) shall count toward the satisfaction of the RPS requirements.
- The Hawaiian Electric utilities may aggregate the renewable and sustainable generation and purchases across all islands in their service territory on a calendar year basis to meet their collective RPS requirements.
- All grid-connected renewable energy generation, both central-station and distributed, shall count towards the RPS goal.
- The RPS goals will be reevaluated every five years beginning in 2013 to determine whether they remain achievable, taking into account changes in technology, the status of the projects contemplated in this agreement, and necessary regulatory support. The reevaluation will also consider the status of biofuels and its ability to contribute to the RPS, as well as increase in sales for use in EV/PHEVs.
- If any renewable energy generated or purchased by the Utility on DOD installations, and feeding power to the grid, cannot be considered in the calculation of the utility contribution to the RPS, the RPS goals will be adjusted accordingly.

10 Greening Transportation

For the Hawaii Clean Energy Initiative to reach its ambitious goal of 70 percent clean, renewable energy for electricity and transportation by 2030, a significant shift in the way we travel around Hawaii, and especially Oahu, is essential. While the State needs to pursue a broad range of solutions for transportation, the parties agree to the following:

Addressing transportation issues will require a combination of solutions including:

1. Increased mass transit (more buses and some kind of fixed guide-way);
2. More fuel-efficient internal combustion vehicles;
3. Alternative fuels for vehicles;
4. Improved personal mobility (e.g., walking and bicycling); and
5. Behavioral changes (tele-commuting, car pool and van pool use, etc).

The most promising alternative fuel, by far, available today is electricity. Electrification of transportation can offer consumers a lower-cost alternative to gasoline. It also decreases greenhouse gas emissions from the transportation sector dramatically, while only slightly increasing emissions from the power sector.

A variety of electric vehicles are in various stages of use and development.

1. Present hybrids use only gasoline for fuel but run much of the time on electricity generated by the vehicle;

2. Plug-in hybrids will charge from the grid and run most of the time on electricity, seamlessly converting to small gasoline-powered internal combustion engines only as the battery charge runs out; and

3. "Pure" electric vehicles will run exclusively on electricity, either from direct recharging or a combination of recharging and battery swapping to extend their range.

Whatever combination of technologies ultimately succeeds, moving from gasoline-fired engines to electric engines makes sense now. Electric utilities have significant idle capacity overnight that could be used to re-charge vehicles (and swappable batteries) during off peak hours. Increasing off-peak loads also can allow greater use of renewable energy during these off-peak times.

The impact of pure EV/PHEVs upon the utility girds will be carefully studied, and PHEV adoption strategies will be designed to complement and leverage the utility grids and will note be pushed beyond the point where they become potentially harmful or costly to the electric grid or uneconomic on a pure BTU-in, transportation miles-out basis.

Therefore, it is agreed that the parties will make 'greening' of ground transportation in Hawaii a priority.

Under this agreement, the State will:

- Encourage adoption of 'gas-optional' electric vehicles (hybrids, PHEVs, and EVs) through a "tool box" of incentives, including but not limited to

- Tax credits and/or deductions;
- Preferential parking and HOV lane use;
- Waived or reduced registration/license fees;
- Incentives/rebates for multi-family buildings to wire or re-wire for electric vehicle charging;
- Preferred insurance rates;
- Incentives for rental car fleet conversion to "gas optional" vehicles; and
- Support for:

Dealer offerings (preferred financing, discounts, rebates);

Utility offerings (preferred rates, rebates, new meters);

Employer support (stipends, vehicle-sharing, parking); and

Web-based information center.

- Assist utilities in making necessary changes (described below) to adapt to a transportation electricity market, including installation of a smart grid and potentially modifying the existing time-of-use rates to establish a rate that encourages the recharging of batteries during the off peak periods, thereby enabling the utility to reduce the amount of renewable energy that may be curtailed during such periods, and supporting greenhouse gas measures, which consider the overall decreased greenhouse gas impacts of converting from gasoline-powered vehicles to cleaner gas-optional vehicles (i.e., not penalizing the utility for possible increased electricity generation to help achieve cleaner transportation objectives).
- For pure EVs, conduct a study to assess whether the additional charging stations and other custom infrastructure needs dictate that one specific EV program (e.g., A Better Place) must be chosen over others (this does not preclude also supporting hybrid EVs and PHEVs).
- Work with all parties to develop charging stations in high traffic areas.
- Lead by example and help develop the 'gas optional' vehicle market by becoming an early adopter of electric vehicles for its fleets.

Similarly, it is the responsibility of the electric utilities to:

- Lead by example and help develop the 'gas optional' vehicle market by becoming an early adopter of electric vehicles for its fleets.
- Speed installation of Advanced Metering Infrastructure including the meters and computerized control technology.
- Adopt time-of-use rates to encourage off-peak recharging and the computerized technology to monitor and control such recharging.
- Encourage adoption of renewable energy as the primary source of recharging power.

11 Displacement of Fossil Fuel Energy and "Retirements"

As a key part of the transition of the Hawaiian Electric Companies' systems to a renewable energy future, the utilities will "retire" the older and less efficient fossil-fired firm capacity generating units by removing such units from normal daily operating service as expeditiously as possible. For purposes of this agreement retire means (1) to decommission and shutdown the unit; or (2) to place on "reserve standby status."

The utility generating units affected, the relative timing of such change in operating status, and the association of such operating status with the implementation of other envisioned projects is described in the Renewable Energy Commitments section of this agreement.

Re-permitting older generation will take years, and cannot be done fast enough to meet an urgent need. At the same time, the ratepayers have made a substantial investment in these units. Being able to bring units out of reserve standby status is expected to save ratepayers millions of dollars, the utility years of time to obtain approval to operate the unit and can avoid sustained outages resulting from unforeseen events.

A generating unit placed on reserve standby status will retain its current operating permits to provide for energy supply to customers as called for by the utility based on system needs. These units will be placed in cold storage and cannot be placed on the utilities daily commitment schedule except under emergency circumstances. When the unit is brought out of standby status, the utility shall notify the Commission, the Consumer Advocate, the Federal Environmental Protection Agency (EPA), and the State Department of Health (DOH). The utility's capital, operations and maintenance expenses related to placing and maintaining its units on standby status and to run the units under emergency conditions shall be subject to recovery through the rate process.

The utility with support of the parties will meet with the EPA and DOH to ensure that it is understood (1) that it is not intended that the reserve standby status is a permanent shutdown; (2) that the unit remains on State or federal emission inventories; (3) that the units will continue to be maintained; (4) that the unit can be brought back on line within six to eight weeks; and (5) that the unit's status will be reexamined as part of the Clean Energy Scenario Planning process and its annual updates.

12 Energy Efficiency

It is the goal of all parties to ensure that Hawaii achieves the maximum possible levels of energy efficiency as it represents the most effective use of resources possible, including conservation by not using resources at all. To that end, the parties agree to the following:

- The parties will support the development of an Energy Efficiency Portfolio Standard (EEPS) for the State of Hawaii. The Hawaiian Electric utilities will support the State's effort in incorporating such EEPS in State statute, and will use its best efforts to achieve the energy efficiency goals established in the EEPS.

- By April 1, 2009, the Hawaiian Electric utilities will initiate a load research program to obtain detailed energy usage information about Hawaii energy customers' electricity and gas appliance age and efficiency, energy use patterns, building energy use and efficiency characteristics, so this information can be used to develop energy efficiency and mass market renewables program designs and for future energy planning efforts.
- Beginning on April 1, 2009, the utilities will lead, in collaboration with the State and third-party administrator, new studies to determine the technical and economic potential for a broad variety of energy efficiency, demand response, and renewable substitution measures within Hawaii. The cost of such studies will be recovered through an appropriate surcharge mechanism.
- The third party administrator will take over the administration of all energy efficiency programs as ordered by the Commission. The parties believe that the utilities should be allowed to apply for and will support the utilities continued provision of energy efficiency programs to commercial and industrial customers, upon the administrator's and Commission's review and approval, for a three-year period while the third-party administrator gets established and defines the overall program direction;
- The third-party administrator, utilities and stakeholders (such as the IRP Advisory Group and C&I customers) will work together in a collaborative process to design effective, high-impact energy efficiency and renewable substitution programs that are expressed in five-year program plans.
- The State and utilities will work with the third-party administrator and stakeholders to identify and deliver a set of energy efficiency measures that are specifically targeted to benefit low income electric and gas users, and fund delivery of those measures through the Public Benefits Fund.
- By June 2009, the Commission, State and utilities will identify no fewer than six energy efficiency measures or sets of measures that can achieve high penetration and high savings impact quickly and cost-effectively, and develop a plan to begin delivering those measures to Hawaii electric customers beginning no later than September 2009. These programs can be funded by eliminating other efficiency programs that have been found to have less impact at higher cost, and will be implemented by the third-party administrator.
- The parties also agree that Hawaiian Electric may apply to implement the Residential New Construction (RNC) program, Residential Customer Energy Awareness (RCEA) program and the Residential Solar Water Heating (RSWH) program but that the State will not necessarily support their applications.
- The energy efficiency programs shall not provide incentives to encourage customers to switch to other fossil fuels.
- The parties agree to support the enactment of an energy efficiency portfolio standard at the 2009 session of the Legislature.

Upon approval of the programs by the Commission and the program responsibility is transferred to the third-party administrator, the utilities and the third-party administrator will have budget flexibility to use the resources available to achieve the stated goals and energy use reduction targets and program goals within broad guidelines that permit the pursuit of market opportunities, but preserve the ability of customer segments to have equitable access to program participation.

13 Demand Response Programs

Demand Response programs, including load management programs, are a critical component of the reduction of electrical energy use. These programs allow specific customer loads to serve the interests of all ratepayers by allowing those loads to be controlled for grid reliability and cost management. In order to achieve the maximum potential of these programs, the parties agree to the following:

1. Administration of demand response should remain with the utilities because of the need to monitor electrical system status while deciding when and to what degree to invoke the demand reductions available through demand response programs.

2. The utilities should update direct load control programs to enable use of the programs as an emergency grid management option. MECO and HELCO will propose the implementation of new demand response programs and submit an application seeking Commission approval of such programs by June 30, 2009. Hawaiian Electric will determine the modifications deemed necessary to the existing direct load control programs currently authorized by the Commission. A well-designed demand response program is beneficial because the program enables the utility to maintain reliability during grid emergencies and defer generation additions.

3. The utilities will also explore the use of demand response as a mechanism to accommodate more renewable energy and to manage frequency fluctuations resulting from intermittent renewable resources connected to the grid and provide a recommendation for such use to the Commission by December 31, 2009, including a request for Commission approval for implementation.

4. Third-party demand response or load curtailment aggregators have demonstrated the ability to develop a variety of price-responsive event and responsive demand response options. Hawaiian Electric will work with these firms to insure the maximum use of this resource and propose an initial plan of action by June 30, 2009. In addition, Hawaiian Electric may conduct pilot projects with aggregators, which will provide an opportunity to demonstrate the value of their programs. Proposals seeking Commission approval for such pilot projects will be submitted by December 31, 2009.

5. Demand response pilots are a low risk approach to test new concepts, and test new communication technologies and hardware in island salt-spray environments separated by mountain ranges, valleys and ridges. Demand response pilots can also test software that will interface with existing customer information systems and test customer response to

demand response program designs and delivery. Thus, pilot programs may be an appropriate avenue to implement demand response in Hawaii. The Hawaiian Electric Companies will provide the Commission with an evaluation of the initial proposed pilot projects together with a proposed implementation date by December 31, 2009.

6. The Hawaiian Electric utilities will explore enabling technologies, and if appropriate, will add them to the system to make it easier for customers to receive energy pricing or event information and change or manage their energy use based on this new information. An assessment of such technologies will be incorporated into the Hawaiian Electric Companies' Clean Energy Scenario Planning process.

7. The utilities will also allow demand response to provide a variety of ancillary services and encourage those demand-side ancillary services if they can be provided more precisely than supply-side resources. An assessment of the benefits of using demand response to provide ancillary services will be incorporated into the Hawaiian Electric Companies' Clean Energy Scenario Planning process.

8. Program costs for existing and any new demand response programs shall be recovered through DSM surcharge.

14 Advanced Metering Infrastructure (AMI)

Advanced Metering Infrastructure is a critical component of a number of important aspects of the Clean Energy Initiative. The parties believe that AMI will help customers manage their energy use more effectively. To that end, the parties agree on the following:

1. Hawaiian Electric will apply to the Commission by November 30, 2008, for immediate approval to begin installing, on a first-come, first-served basis, advanced meters for all customers that request them. The application will also seek expedited approval to fully implement time-of-use rates on an interim basis for the customers requesting the installation of advanced meters. Unless the Commission identifies a compelling reason to do otherwise, all customers having advanced meters will be given the utility time-of-use or dynamic rate options and shall have to affirmatively opt out of the rate option.

2. The meters and associated costs will be paid for through the CEIS, until such costs are embedded and recovered in the utilities' base rates in future rate cases.

3. By December 31, 2008, Hawaiian Electric will file a full application to install advanced meters to remaining customers and the communication and meter data management system, including the necessary software and appropriate pricing programs. The PUC application will identify the desired goals, business purposes, functionality and cost for advanced meters and the identification of a meter data management system with associated costs to purchase and install that will achieve the desired goals and purposes, including a

schedule for acquisition and installation of remaining meters and the customers to be served.

4. Upon Commission approval, AMI will be implemented as quickly as possible, along with proposals for time-of-use rates and customer electricity pricing information that facilitate substantive customer understanding and energy use management.

5. Hawaiian Electric will minimize the financial impacts on low income and disadvantaged customers who have limited options through a combination of tiered rates and lifeline rates.

6. The Hawaiian Electric utilities working with external experts will submit to the Commission an evaluation of the effectiveness of the utilities' time-of-use rates and shall determine whether any changes are needed to the energy information communications and time-of-use rates to improve customers' energy responsiveness. The utilities will complete this evaluation by December 31, 2009 and will submit a second report 1 year after the full deployment of AMI.

7. Beginning January 1, 2009, the utility will submit an annual report to the Commission on the number of customers currently served, number who opted out, customer load response, impact of time-of-use rates on customer's monthly bills and feedback received from customers.

15 Pricing Principles and Programs

The pricing of electrical services can be used to motivate changes in customer electrical usage and allow customers who choose to take advantage of specific pricing programs to manage their electric bills. The parties agree that rates must recover the basic costs of utility service and further agree to the following:

The parties believe that rates should reflect the Bonbright principles, which promote fairness in cost allocation, promote efficient resource use, are practical to implement, easy to interpret, provide bill stability for the customers, avoid undue discrimination between customers, and provide adequate and stable revenues to Hawaiian Electric. Rates must reflect the basic cost of service.

The parties also believe that participation in pricing programs should generally be on an opt-out basis.

With those principles in mind, the parties agree that the Hawaiian Electric utilities will continue to convert the residential rates to inclining block rate structure to encourage energy conservation and efficient use of energy. The utilities will complete this conversion of the residential rates as part of the current rate cases before the Commission.

In the case of commercial and industrial customers, the current declining block rate structure will be replaced with mandatory time-of-use for all C&I customers. The utilities will complete the implementation of mandatory time-of-use rates to commercial and industrial customers by class as AMI is implemented. Demand response options, parallel with AMI deployment, will be offered to all C&I customers. Hawaiian Electric will, on a continuing basis, evaluate the effectiveness of the program and customer response.

16 Meeting the Military's Needs

The parties understand that the military services have specific objectives to improve energy efficiency in existing and new facilities, reduce dependence on fossil fuels, and improve military installation energy security while containing costs. The parties agree to support the military's energy goals, and agree to allow the utilities to meet the military energy service needs through competitive or other service contracting methods as long as the utilities can provide such services in a way that benefits rather than compromises other ratepayers.

In order to meet the military service needs, various requests for proposals are being prepared that will seek specific technologies and resources through mechanisms such as Energy Savings Performance Contracts, Utility Energy Service Contracts, and Enhanced Use Leasing. Possible services the Utility could provide include Distributed or On Site Generation, Energy Efficiency Programs, Advanced Metering, Smart Grid technology, Load Control programs and Renewable Energy delivery.

Hawaiian Electric Company will actively participate in these processes and believes that retaining military service customers is in the best interests of all residents in the state of Hawaii. The State agrees to support the military processes and decisions.

17 Seawater Air Conditioning (SWAC)

Seawater Air Conditioning is an established energy displacement technology and is considered an important resource that all parties strongly support. Therefore the parties agree to support rebates for individual buildings or customers that choose SWAC and expedited SWAC permit review and approval by all State and County agencies, starting with the downtown Honolulu SWAC project.

All parties agree to support:

1. Rebates that incent individual buildings to sign up for these projects;
2. Adoption by individual customers in the affected areas;
3. Expedited permit and approval review and action by all State and County agencies.

The parties support the initial project, the downtown Honolulu Seawater Air Conditioning (HSWAC) to be installed by 2010, with other projects to follow.

18 Distributed Generation (DG) and Distributed Energy Storage (DES)

Distributed generation, including biofueled and fossil facilities, combined heat and power, and small renewable technologies such as wind and photovoltaics, can help replace central station generation and improve local grid operations and reliability. Similarly, DES (such as batteries, ice storage systems, flywheels and super-capacitors) can aid in firming intermittent renewables and provide load shifting and peak-shaving capabilities. To support and accelerate the adoption of DG and DES (termed broadly, distributed energy resources), the parties agree to the following:

1. The Hawaiian Electric Companies will facilitate planning for distributed energy resources through the Clean Energy Scenario Planning process and Locational Value Maps, to identify areas where these resources have system benefits and can be reasonably accommodated. The Locational Value Maps will be completed and become publicly available by December 31, 2009.

2. The utilities will support non-utility DG and DES by improving the process and procedure for interconnecting non-utility DG and DES to make it faster, efficient, and more transparent. By June 30, 2009, the Hawaiian Electric utilities will submit a review of the implementation of the Rule14H tariffs, as amended in May, 2008.

3. All parties will support reconsideration of the Commission's ban on utility-owned DG where it is proven that utility ownership and dispatch clearly benefits grid reliability and ratepayers' interests, and the equipment is competitively procured.

4. If Hawaiian Electric owns any DG, it will power those units using sustainable biofuels or other renewable technologies and fuels.

5. The utilities may contract with third parties to aggregate fleets of DG or standby generators for utility dispatch or under PPA, or may undertake such aggregation itself if no third parties respond to a solicitation for such services.

6. To the degree that transmission and distribution automation and other smart grid technology investments are needed to facilitate distributed energy resource utilization, those investments will be recovered through the Clean Energy Infrastructure Surcharge and later placed in rate base in the next rate case proceeding.

7. The Hawaiian Electric Companies will support DES either customer-owned or utility-owned.

8. All parties will support Hawaiian Electric dispatchable standby generation (DSG) units upon showing reasonable ratepayer benefits.

9. In order to accept higher levels of DG on the utility grid, significant investment in smart grid technologies and changes in grid operations may be needed. These investments, if

demonstrated to be prudent and reasonable in cost, will be recovered through the Clean Energy Infrastructure Surcharge or through the general rate case recovery process.

19 Net Energy Metering (NEM)

The parties are in agreement that there should be no system-wide caps on net energy metering at any of the Hawaiian Electric utilities. Instead, the parties agree to the following:

- Distributed generation interconnection will be limited on a per-circuit basis, where generation (including PV, micro wind, internal combustion engines, and net metered generation) feeding into the circuit shall be limited to no more than 15% of peak circuit demand for all distribution-level circuits of 12kV or lower;
- New DG requests shall be processed and interconnected on a first-come, first-served basis unless the Commission specifies some other method;
- For those circuits where interconnection requests (particularly for PV) approach the 15% limit, the utility will perform and complete within 60-days after receipt of an interconnection request, a circuit-specific analysis to determine whether the limit can be increased. For non inverter-based DGs, the analysis to determine whether the limit can be increased will be performed on a case-by-case basis based on the specifics of the DG project(s) proposed;
- If the utility believes a specific DG installation poses a significant risk to circuit reliability and safety or grid stability, it will notify the applicant, the Consumer Advocate and the Commission, within 30 days from receipt of the completion of a circuit analysis and the identification of the need to defer the installation until further analysis can be conducted, and shall conduct that analysis within no more than three months from the date of the application request.

NEM currently provides an interim measure to encourage the installation of and pay for renewable energy generated from customer-sited systems, generally PV systems. The parties agree that NEM will be replaced with an appropriate feed-in tariff and new net metered installations shall be required to incorporate time-of-use metering equipment and, when time-of-use rates are implemented on a full scale basis in Hawaii or the applicable area, the net metered customer shall move to time of use net metering and sale of excess energy.

As part of the Clean Energy Scenario Planning ("CESP") process, Locational Value Maps ("LVM") identified in the CESP process can trigger an engineering review by the Hawaiian Electric Utilities to determine whether circuit limits can be safely raised above the threshold for the specific circuits in the LVM and if distribution circuit modifications can be made to increase the level of DG/NEM within the LVM.

Current provisions relating to interconnection requirements will remain in force.

20 Lifeline Rates

The Hawaiian Electric Companies and Consumer Advocate agree to explore by April 2009, the possibility of establishing "lifeline rates", which are designed to provide a cap on rates for those who are unable to pay the full cost of electricity and submit a proposal for Commission approval by April 2009.

21 The Gas Company

The Hawaiian Electric Companies and The Gas Company are energy providers to a common group of customers and their collaboration can accelerate the success of the HCEI. Hawaiian Electric welcomes The Gas Company's interest in producing renewable and sustainable fuels and will make every effort to use these renewable fuels in its existing and future power plants.

22 Green Contracting

Because select ratepayers of the utilities have renewable energy obligations or otherwise have a desire to obtain green attributes, and because renewable energy in Hawaii, unlike on the mainland, is cost competitive with and often cheaper than non renewable energy, the parties agree that green attributes should be separated from green energy pricing, and that the price benefits of green energy and the price stability to it provides, should be shared by all ratepayers. However, the best method to achieve this goal requires further evaluation, so the parties agree to help the Commission evaluate options for green contracting and RECs by May 2009 and recommend a preferred path forward to the Commission.

23 Resource Attributes: The Loading Order

The parties agree that the maximum possible use must be made of energy efficiency, demand response and renewable energy. The utilities shall apply this loading order in the CESP process in determining the utilities' resource plans to supply the total system load.

24 Public Benefits Fund ("PBF")

The parties agree that energy efficiency resources should be funded using a Public Benefit Fund. The parties agree to the following:

- Respectfully request that the Commission establish a PBF that is funded by collecting 1% of each Hawaiian Electric utility's total revenues in years one and two; 1.5% in years three and four; and 2% thereafter. Once sufficient load research and potential studies allow more precise identification of the cost-effective and achievable levels of energy efficiency, the PBF collection amount will be based upon the desired level of such investments;

- The Commission may adjust the PBF funding levels on a year-to-year basis. The monies shall be dedicated to the support of programs for the utility and ratepayers from whom the funds were collected, except for studies which can benefit the ratepayers of all of the Hawaiian Electric utilities;
- Funds not spent in one year can be rolled over to another year and shall not be available to meet any current or past obligation of the State;
- PBF monies will be spent for energy efficiency programs measures, incentives, market transformation, technical assistance, program administration, customer education, potential studies, and measurement and evaluation, as expended by the third-party administrator or program contractors, which may include the utilities;
- PBF monies for incentives and subsidy payments shall be allocated among programs, measures, and customer groups at the discretion of the Commission with input from the utility, third-party administrator, and other stakeholders;
- Criteria for fund allocation shall include program cost-effectiveness, likelihood of achieving high levels of energy savings and measure saturation, and equity between customer classes. Allocations and incentive levels that are set by the Commission should remain stable for a period necessary to allow for program certainty and continuity for utility customer and service providers. Adjustments based on market conditions and program evaluations are appropriate;
- Program funding should remain stable long enough to create program certainty and continuity for program providers and utility customers;
- At least 10% of each Hawaiian Electric utility's PBF shall be spent on programs that serve low-income customers. The Commission has the discretion to adjust the amount after review of relevant potential studies and input from the utility and other stakeholders.

The Hawaiian Electric utilities shall encourage its customers whose bills are in arrears to take advantage of available energy efficiency programs and provide timely information and assistance on the programs available to them.

25 Investment in the Infrastructure

The parties agree in principle that maintaining the basic infrastructure of the current electrical system is a critical foundation to all other aspects of the Hawaii Clean Energy Initiative.

Furthermore, the parties also agree that it may be necessary to make additional investments in transmission, distribution, and generation to facilitate and integrate high levels of renewable energy production, and that those investments will be determined through the Clean Energy Scenario Planning process. The parties specifically reject deferred maintenance as an operating philosophy and commit to supporting reasonable and prudent investment in the ongoing maintenance and upgrade of the existing generation, transmission, and distribution systems, unless the CESP process determines whether specific investments previously identified as being needed are subsequently rendered unnecessary through the implementation of effective energy efficiency, demand response, and distributed energy resources or non-utility generation.

26 The Smart Grid

The parties agree in principle that a "smart grid" is a critical component of Hawaii's energy future. A smart grid builds upon existing utility generation, transmission and distribution, using automation, communications, analytics and controls to operate the grid more efficiently, reliably, and safely, and improve the integration and use of intermittent renewables, demand-side and decentralized resources. The parties agree to the following:

1. Increased levels of SCADA may be necessary for the Hawaiian Electric Companies' distribution system. Evaluating and prioritizing which circuits to implement SCADA will include reviewing the levels of distributed generation by circuit and in total on each utility system, as well as the levels of monitoring, control systems, protection systems, and communications systems required to maintain system stability. The level of SCADA additions to the distribution system will be a significant consideration in evaluating system changes and upgrades required to maintain system reliability as each utility adds more renewable distributed generation to its system. Hawaiian Electric utilities will complete this evaluation and review of its circuits by December 31, 2009, and will submit a report of the results and recommendations to the Commission by such date.

2. As wind and solar systems are added to the grid, particularly at the distribution level, the utilities shall increase their real-time monitoring of the transmission and distribution system capability that includes monitoring of environmental factors such as wind speed, sunlight intensity and temperature.

3. In conjunction with an increased data collection capability as noted above, it may be necessary to install and implement forecasting and monitoring systems to better predict the wind and cloud patterns that affect variable renewable generation.

4. There is a need to develop an increased capability to remotely and automatically control transmission and distribution systems through the use of remote switching devices, voltage regulations devices, protective relaying, and individual distributed generation installations and individual loads.

5. In distribution circuits where DG penetration approaches levels which impact the effectiveness of static protective relaying, it may be necessary to upgrade the relay system to accommodate dynamic settings and higher penetration levels of distributed generation.

6. It may be necessary to implement distribution automation; transmission and distribution technologies and microgrids which address self-healing, resistance to attacks, power quality,

and accommodation of non-renewable generation. These technologies are intended to open new markets and increase grid efficiency and should be implemented if demonstrated to be cost effective.

7. Prudent and cost effective investment in smart grid technologies may be recovered through the Clean Energy Infrastructure Program or the general rate case process.

27 Transmission Planning

Transmission remains a key responsibility of the Hawaiian Electric Companies and a critical element of a clean energy future. To that end, the parties agree to the following:

1. The Hawaiian Electric Companies will perform and complete the planning analysis required to evaluate several scenarios under the Clean Energy Scenario Planning (CESP) process.

2. The CESP will identify new transmission projects for which the Hawaiian Electric Companies will then pursue PUC approval to proceed with the construction of the projects.

3. Transmission investments made to fulfill Clean Energy Scenario plans or renewable energy development zone commitments will, to the greatest extent possible, be supported by all parties including requests for the expeditious processing of the applications filed with the PUC.

4. Integration of generation (renewable, variable, or firm) is a complex process and the Hawaiian Electric Companies' transmission and distribution planning analyses are necessary for evaluating generation interconnection proposals. The utilities will conduct the required evaluations within 6 months after receipt of a bona fide generation interconnection request. The utility may request additional information if it believes data received is incomplete or if additional data is required to complete an IRS, but cannot use a series of additional data requests to delay the process. The burden is on the utility to demonstrate that the additional data requests are necessary, or else the time to respond to data requests cannot be used to extend the 6-month deadline.

28 Decoupling from Sales

The transition to Hawaii’s clean energy future can be facilitated by modifying utility ratemaking with a decoupling mechanism that fits the unique characteristics of Hawaii's service territory and cost structure, and removes the barriers for the utilities to pursue aggressive demand-response and load management programs, and customer-owned or third-party-owned renewable energy systems, and gives the utilities an opportunity to achieve fair rates of return. The parties agree in principle that it is appropriate to adopt a decoupling mechanism that closely tracks the mechanisms in place for several California electric utilities, as follows:

1. The revenues of the utility will be fully decoupled from sales/revenues beginning with the interim decision in the 2009 Hawaiian Electric Company Rate Case (most likely in the summer of 2009).

The utility will use a revenue adjustment mechanism based on cost tracking indices such as those used by the California regulators for their larger utilities or its equivalent and not based on customer count. Such a decoupling mechanism would, on an ongoing basis, provide revenue adjustments for the differences between the amount determined in the last rate case and:

(a) The current cost of operating the utility that is deemed reasonable and approved by the PUC;

(b) Return on and return of ongoing capital investment (excluding those projects included in the Clean Energy Infrastructure Surcharge); and

(c) Any changes in State or federal tax rates.

Adjustments shall occur on a quarterly basis, semi-annual, or annual based or the availability of the indices utilized. The adjustments will continue until such time that they are incorporated in the utility's base rates.

2. The parties agree that the decoupling mechanism that will be implemented will be subject to review and approval by the PUC.

3. The utility will continue to use tracking mechanisms for Commission-approved pension and other post-retirement benefits to ensure that the expenses are evened out for the ratepayer and are not subject to sudden and dramatic swing.

4. The Commission may review the decoupling mechanism at any time if it determines that the mechanism is not operating in the interests of the ratepayers.

5. The utility or the Consumer Advocate may also file a request to review the impact of the decoupling mechanism.

6. The Commission may unilaterally discontinue the decoupling mechanism if it finds that the public interest requires such action.

7. In order to implement the decoupling mechanism, the parties agree that HELCO and MECO will file for a 2009 test year rate case.

29 Clean Energy Infrastructure Surcharge (CEIS)

The Clean Energy Infrastructure Surcharge is designed to expedite cost recovery for infrastructure that supports greater use of renewable energy or grid efficiency within the utility systems. The parties agree to support the following:

1. The establishment of a CEIS to recover the reasonable costs of new transmission and other infrastructure investment needed to facilitate new clean energy investments by the utility or by IPPs. Subject to Commission approval, the CEIS may also be used to recover costs that would normally be expensed in the year incurred and may be used to accelerate cost recovery.

2. Capital costs eligible for recovery through the CEIS include the allowed return on investment based on the rate of return from the last rate case, AFUDC as appropriate, depreciation, applicable taxes, other costs as approved by the Commission.

3. The reasonable costs of infrastructure investments will be eligible for cost recovery through the CEIS if it can be demonstrated that the investments facilitate greater grid efficiency as determined and approved by the Commission, such as advanced meters and grid automation.

4. The reasonable costs of infrastructure investments that may be recovered through the CEIS, as determined by the Commission, include transmission lines built, in significant part, to facilitate renewable energy development, inter-connection equipment, advanced metering infrastructure, battery storage, and other equipment to facilitate increased use of renewable energy whether utility or third-party owned.

5. The CEIS may also be used to recover costs stranded by clean energy initiatives when approved by the Commission.

6. The CEIS is a mechanism to timely recover: (a) costs that would be expensed in the year incurred; and (b) a return on and of the costs of specific capital projects deemed necessary for the achievement of the HCEI objectives. The CEIS is not a financing vehicle for the Hawaiian Electric Companies.

7. If the utility is conducting a very costly capital investment project and receives Commission pre-approval for Construction Work in Progress (CWIP) rate base treatment, the utility can use the CEIS to recover the return on the CWIP asset. If the CWIP investment is given rate base treatment, it shall not earn AFUDC.

8. The CEIS will be implemented as a separate surcharge.

9. Cost recovery under the CEIS will terminate when and to the extent that the costs are incorporated in the utility's base rates.

10. The CEIS surcharge will be reset on an annual basis to recover: (1) the capital and other related costs (as noted in paragraph 2 above) incurred by the utilities relating to the

adoption and integration of the renewable energy resources commitments identified in Exhibit A; (2) the change in the return on investment resulting from the change in the unrecovered cost of the projects completed in years prior to the immediately preceding year; and (3) the true up resulting from the reconciliation of the estimated and actual collections for the immediately preceding year. The new CEIS will take effect on March 1 of each year to allow for consideration of the Commission approved: (1) final costs of capital projects completed ; (2) changes in the return on the net book value of the capital asset at the end of the immediately preceding year; (3) the results of the reconciliation to be performed by January 31 of each year of the estimated and actual costs to be recovered in the CEIS for the preceding year; and (4) any costs that should be expensed in the prior year, but are approved for recovery in the CEIS. The Hawaiian Electric utilities, the State, and the Consumer Advocate shall work in collaborative fashion in developing the implementation procedure of the CEIS recovery mechanism, for submission for PUC approval by November 30, 2008.

11. It is probable that it will be easier to achieve higher levels of renewable energy generation on islands other than Oahu. Subject to Commission approval, the CEIS may be used as a mechanism to have Oahu's ratepayers pay for some of the cost burden of new renewable energy developments on the MECO and HELCO systems.

The utility has a Renewable Energy Infrastructure Program (REIP) pending at the Commission. The parties have no objection to the use of this docket after approval of the REIP to change the REIP to incorporate the CEIS mechanism changes, provided public notice is given to the ratepayers of the Hawaiian Electric Companies of the substitution changes and public hearings are held regarding the change, consistent with the requirements of HRS § 269-12.

30 Energy Cost Adjustment Clause (ECAC)

The parties agree that the goal of utility resource purchases is to maximize the purchase of renewable energy (and particularly locally-produced renewable energy), to de-link the renewable energy contracts from oil prices, and to stabilize, to the extent possible, ongoing fuel prices, in that order. To that end, the parties agree to the following:

- The Hawaiian Electric Companies may engage in limited hedging and forward contracting for both energy and fuel using guidelines and practices to manage both cost and risk, as approved by the Commission;
- The Commission will periodically review and approve the prudence and effectiveness of the Hawaiian Electric Companies' utility's fuel and energy procurement practices to ensure that the requirements of the energy cost adjustment clause are met. The Commission will examine whether there is renewable energy which the utility did not purchase or whether alternate purchase strategies were appropriately used or not used; and

- The Hawaiian Electric Companies will be allowed to pass through reasonably incurred purchase power contract costs, including all capacity, O&M and other non-energy payments approved by the Commission (including those acquired under the feed-in tariff) through a separate surcharge.
    - If approved, these costs will be moved from base rates to the new surcharge.
    - The surcharge will be adjusted monthly and reconciled quarterly.

31 Preferred Stock / Hybrid Securities Offering

The utility must raise sufficient capital to fund the necessary infrastructure required for the Hawaii Clean Energy Initiative, and will do so in part by issuing a preferred stock/hybrid securities offering. Preferred stock/hybrid securities represent a less expensive form of financing than equity, but does not negatively impact the utility's debt ratio as much as debt issuance would. The parties agree to support a reasonable preferred stock/hybrid securities offering proposal made by the Hawaiian Electric utilities to the Commission.

32 Clean Energy Scenario Planning (CESP)

To improve analysis and guidance for Hawaii's clean energy future, the parties agree to replace the current Integrated Resource Planning (IRP) process with a new Clean Energy Scenario Planning (CESP) process. The parties agree to the following:

- The CESP process will provide high level guidance on long term (10-20 years) direction and an Action Plan for near term initiatives (5 years), balancing how the utility will meet its customers' expected energy needs as modified by planned energy efficiency, renewables substitution and demand response, encouraging high levels of renewable and clean energy with distributed resources, while protecting reliability at reasonable costs.
- The CESP process will be conducted on an on-going basis with a new Clean Energy Scenario Plan developed in three-year cycles. The CESP process will include exploring alternative energy scenarios, risks and uncertainties, to develop a base case and variations for a 20-year planning horizon.
- Since clean energy actions and choices on one island may affect the entire State, all Hawaiian Electric utilities shall conduct the CESP process in parallel or as one CESP process for all three utilities, using common economic and other assumptions and common scenarios for technology, economic, and development paths and options, while maintaining the option to also develop island-specific scenarios.
- The Hawaiian Electric utilities shall conduct a comprehensive generation and transmission analysis every three years to support the evaluation of several planning scenarios to be considered in developing the new base case. In addition, the Hawaiian Electric utilities shall provide Locational Value Maps that will guide the identification of geographic areas of distribution system growth for potential application of new energy

efficiency, demand response, and distributed generation and storage within Clean Energy Investment Zones.

- The CESP process will incorporate an Advisory Committee and a public review process;

Hawaiian Electric Company will complete and submit the Hawaiian Electric IRP-4 to the Public Utilities Commission by September 30, 2008. The Commission will receive the Hawaiian Electric IRP-4 and will be requested to close the docket and suspend HELCO's and MECO's IRP-4 dockets.

Hawaiian Electric Company shall request Commission approval to implement items in the Action Plan that otherwise require approval through the IRP-4 process.

The parties will request that the Commission open a new docket to establish the CESP process.

Pending the Decision and Order establishing the CESP process, each Hawaiian Electric utility will continue to meet with its Advisory Committees and file annual updates to its respective IRPs.

The parties agree that the specifics of the CESP Process, including the new CESP objectives and framework, are subject to Commission review and approval. Some of the specifics as may be proposed by the Hawaiian Electric utilities are described below.

33 Clean Energy Scenario Plan

Each utility will conduct a comprehensive generation and transmission analysis every three years to support the evaluation of several planning scenarios under consideration in the development of the new base case and will provide Locational Value Maps that will guide the identification of geographic areas of distribution system growth for potential new energy efficiency (EE), distributed response (DR), distributed generation (DG) and renewable substitution.

The Clean Energy Scenario Plan will take into consideration greenhouse gas emissions, impacts to local natural resources and to the local economy. The Clean Energy Scenario Plan will also identify, understand and characterize the risks and uncertainties that can make a significant difference to the utilities' resource selection. As Hawaii transitions to greater integration of new renewable resources, it will increase the factors to manage the electric system, and the level of reliability may at times be impacted.

The Clean Energy Scenario Plan should define a manageable scope for the process, which includes annual updates (such as changes to the plan resulting from changes in sales and peak forecasts, fuel prices forecasts, new or changes in timing of generation resources, changes in penetration of DSM and other demand-side resources, etc.) to keep plans "fresh" with updated assumptions and to address/account for new issues (such as NEM limits). The

Clean Energy Scenario Plan must comply with requirements of the Competitive Bidding for New Generation Framework.

The Clean Energy Scenario Plan will include the following components subject to Commission review and approval:

a. **Scenarios** - The Clean Energy Scenario Plan should focus on higher level planning, such as scenario analyses and a preferred portfolio of energy sources/types, rather than identifying specific details on individual resources of the plan. These scenarios may feature different policy backdrops, such as major increases or decreases in oil prices, policy changes such as federal or international carbon regulation or the accelerated adoption of plug-in hybrid electric vehicles, as well as different resource policies that the PUC can influence or direct, such as higher levels of energy efficiency, demand response, and renewable substitution (e.g., solar water heating and seawater-cooled air conditioning). A reasonable number of Clean Energy Scenario Plan scenarios should be developed in consultation with the State, PUC and stakeholders to reflect a range of the possible energy-related policy choices and risks facing the State, its utilities and citizens.

b. **Base case and variations** - The Clean Energy Scenario Plan should start with a base case of the current IRP or Clean Energy Scenario Plan that incorporates current and forecast loads, demographics, economic conditions, fuel availability and prices, existing and planned resources (supply- and demand-side) and their capital and operating costs, and more other relevant information.

c. **Analysis** - The Clean Energy Scenario Plan should be supported by quantitative and qualitative tools to process data. Analysis tools may include production simulation models, load flow models, and resource screening models that employ, among several methods, probabilistic and Monte Carlo techniques to derive probability based results.

The Clean Energy Scenario Plan will use production simulation and resource screening models to identify the preferred energy contributions from various resources, taking into account the differing renewable energy impact, emissions, fossil fuel usage and cost into consideration. Existing contractual and forward looking operational requirements and constraints on the mix of generation types (such dispatch and curtailment requirements) will be factored into the analysis.

In addition to scenario analysis, technical analyses will need to be performed to determine the extent to which renewable resources with certain types of characteristics (e.g. intermittent, as-available resources, or fixed dispatch resources) can be integrated into the system while maintaining a stable and reliable electrical grid.

d. **Scope** - Clean Energy Scenario Plan includes an assessment of supply-side additions, supply-side retirements (or purchase power contract terminations) and demand-side resources as well as transmission requirements. Clean Energy Scenario Plan excludes an analysis of the distribution system, but should be coordinated with distribution planning to reflect the value and influence of distributed resources (energy efficiency, demand response, renewable substitution and distributed generation) and to identify technical or operational issues that may arise if customer resources (especially customer-side distributed generation) develops into a high percentage of circuit or system demand.

e. **CESP process Advisory Committee** - At the start of the CESP process, the utility should form an advisory committee composed of key stakeholders (including the third-party energy efficiency program administrator), policymakers and customers to help the utility shape the scenarios and business cases, resource options, analysis, interpretation and public review processes.

f. **Renewable Energy Zones (REZ)** - REZ identification will be performed in coordination with the utility CESP process. The utility may request input from consultants and/or national agencies, such as NREL, who understand the potential areas of renewable energy development. With the support of these consultants, existing transmission facilities could be overlaid onto Geographic Information System (GIS) maps with the identified renewable resource locations.

g. **System analysis** - The utility should conduct a thorough, load flow transmission system analysis building on the base case assumptions and forecasts (including any known and measurable changes), evaluating grid conditions and flows for no less than a three-year period. That analysis, informed by relevant economic, load, and demand-side resource cases and scenarios, should be the basis for utility planning. The Clean Energy Scenario Plan would evaluate system level distributed generation and demand-side management (DSM) impact, taking into account the aggregate system impact to load and load flows on the transmission system to determine transmission and generation system benefits. Localized impacts to system loads will be taken into account in the transmission analysis as they are realized during the development of the base case model.

h. **The CESP process identifies fossil needs** - The CESP process will identify if new fossil fueled units are needed. These should be justified primarily by the need to balance and integrate variable renewable energy generation sources for overall grid reliability.

i. **Locational Value Map** - The utility will identify “geographic areas of distribution system growth” within the next 3-5 years where distributed resources and energy efficiency could be beneficial within the existing transmission and distribution system limits. The utility would identify “geographic areas” rather than individual circuits (i.e., today for Oahu, could identify the West side from Ocean Pointe to Ko ‘Olina; for the Big Island, various areas in West Hawaii and North Hawaii; for Maui, areas of Kihei and Lahaina) to maximize benefits and incorporate back up system needs. The information from the Locational Value Maps would be provided to parties such as the PBF Administrator so that EE DSM can be focused into geographic areas that would most benefit from energy efficiency. Determining value or price in the CESP process will be difficult because the potential to avoid distribution would depend on how much EE was being installed, the amount and type of renewable distributed generation being installed, and the planned operations of the DG resources.

j. **Clean Energy Investment Zones** - The utility should use the Locational Value Map to identify geographic areas where there is a high value to incremental investment in distributed generation, demand response, energy efficiency, or CHP. Such areas will be clearly delineated and termed “Clean Energy Investment Zones.” The utility will publicize the existence of these zones, focus efforts to sign up customers, and evaluate the need for an RFP for firm renewable distributed generation in the Clean Energy Investment Zones areas after considering factors such as the ability to meet renewable goals, cost effectiveness of renewable firm distributed generation, lack of proposals for renewable firm generation in the Clean Energy Zones or difficulty in attaining distribution assets within the needed time-frame. The utility will develop a streamlined procedure to help customers, third-party aggregators, and energy service companies contract with the utility to bring new clean energy resources into service in these Clean Energy Investment Zones. All of this information should be publicized in conjunction with the utility’s educational efforts following completion of the Clean Energy Scenario Plan.

k. **Cost** - The utility should purchase renewable energy at prices that are increasingly de-linked from oil prices. Avoided costs may be determined from the costs the utility would incur if it installed a renewable resource.

l. **No-regrets resources** - Upon completion of the Clean Energy Scenario Plan analyses, the utility should look for common themes, assets and strategies that demonstrate robust value to balance costs and risks across many of the scenarios and cases examined. These are likely to be “no-regrets” resources and strategies that will give the utility and State the greatest value and flexibility across a wide range of potential futures and uncertainties.

m. **PUC Application for Transmission Assets** - From the CESP process new transmission assets that require PUC approval will be identified. Hawaiian Electric will typically initiate more detailed studies in order to evaluate the appropriate asset to install. The detailed studies will be incorporated into the application for the new transmission asset that Hawaiian Electric submits for PUC approval. Transmission investments made to fulfill Commission-approved Clean Energy Scenario Plans or renewable energy development zone commitments shall require PUC approval pursuant to the requirements of the Commission’s administrative rules. Applications for approval submitted by the utility should receive expedited handling and the Hawaiian Electric Companies shall demonstrate the necessity of the project in application filed with the PUC. Upon Commission approval, the project costs may be recovered through either the CEIS or through a general rate case proceeding.

n. **Public review** – For the public review process of the Clean Energy Scenario Plan the Hawaiian Electric Companies shall provide information to policymakers, active stakeholders and the general public about future resource needs, opportunities and costs. The utility should seek feedback from citizens, consumers and policymakers in the State to assure that the Clean Energy Scenario Plan is reflecting the public interest. The process of review should be long enough to communicate effectively the information in the Clean Energy

Scenario Plan to the public audience, and to receive effectively public responses that can be integrated into subsequent planning work.

o. **Regulatory review of the Clean Energy Scenario Plan** - Regulators should review and evaluate the plan to see that it can accomplish its purposes and that it provides the strategic guidance for future utility planning decisions. This approval should elevate the status of the preferred resources identified in the Clean Energy Scenario Plan Action Plan to give them a presumption of need in any subsequent siting proceeding.

p. **Timing of the CESP process** - The utility will submit the new Clean Energy Scenario Plan to the Commission every three years, after a public review process. It is suggested that there should be an expedited time period for the Commission to complete its review and issue an order approving or denying the plan within six (6) months. If the Commission rejects all or parts of the CESP, there should be an explanation for non-approval and the implications of that non-approval on the utility's asset investment and strategic choices for the upcoming three-year period. In order to continually reassess the CESP plan on a regular and timely basis, it is suggested that if the PUC has not issued a decision within a defined period, the plan is automatically deemed "approved." The utility can continue public education about the Plan while it is under review at the Commission.

34 Federal Law and Rules

The energy picture in Hawaii is very different from the energy picture in other states. There are, however, certain Federal laws, which can either assist or hamper the Clean Energy Initiative.

The parties agree to support the following:

PURPA

- Exempt Hawaii from PURPA
    - Adding an exemption that would cover Hawaii so that the utilities would be authorized to consider independent power producer (IPP) proposals under the State's Competitive Bidding Framework when capacity or energy is needed rather than being compelled to consider purchase power proposals from qualifying IPPs as and when proposed, or to purchase power subject to all the terms and conditions in PURPA. RENEWABLES
- Extend expiration of Biofuels Blender's Tax Credit.
    - This tax credit will expire on December 31, 2008, before Hawaiian Electric's CIP CT-1 is in service or MECO potentially purchases any biodiesel for its Maalaea units. The tax credit should reduce biodiesel costs for the utilities, and, thus, their ratepayers. The tax credit should also extend to all biofuels.
- Expand PTC for Electric Generation from Biofuels

- This credit is available for electric generation from biofuels, but only for units placed in service after 1992 and before 2006. That timeframe excludes Hawaiian Electric's CIP CT-1 and several MECO Maalaea units.

ENVIRONMENTAL ISSUES

- Include Volcano National Park volcanic air emissions in the background baseline for the Regional Haze Program.
    - EPA's Regional Haze Rules, designed to protect visibility in National Parks, are ambiguous as to the effect of naturally occurring haze. Controlling visibility impairing emissions from Company units would be fruitless and very expensive.
- Allow electrical generation units to switch to green fuels (biofuels) without triggering New Source Review (NSR).
    - Fuel switching could result in increased emissions (primarily NOx), potentially triggering NSR. Costs of NOx control on existing units switching to biofuels would be exorbitant with no appreciable benefit since we do not have a NOx problem in Hawaii.

35 Greenhouse Gas (GHG) Issues

Transforming the state's energy dependence on oil to higher levels of efficiency and renewable energy will substantially reduce Hawaii's Greenhouse Gas (GHG) emissions. Therefore, the parties agree:

- All parties will support a policy for non-carbon or low carbon alternatives in future energy resource planning and selection (i.e. no coal);
- The parties will support and select alternatives which help the State and utility meet the GHG requirements;
- Guiding principles in GHG reduction measures include freedom of choice for energy consumers, a preference for incentives and market-based measures over regulatory penalties, and a balancing of the climate change mitigation burden fairly across all GHG emitters;
- The parties will work collaboratively on State and federal GHG legislation to support the HCEI agreements and measures that take Hawaii's unique conditions into account (e.g., HPOWER, potential federal exemptions, etc.);
- Because of the uncertainties of GHG legislation at the State and federal level, the parties agree to suspend any decision to implement a State REC system until such time when these legislative actions become clear;
- The State shall support and expedite approvals of necessary infrastructure and rate structures, including smart metering, which enable and accelerate measures designed to reduce GHG emissions;
- As a goal during the renewal of power purchase contracts, the parties agree to move the Independent Power Producers to "green" alternatives and GHG compliance.

36 Telling the Energy Story

Public understanding of the Hawaii Clean Energy Initiative's long-term energy security benefits for the State of Hawaii is critical for its success. Taking real action to achieve a clean energy future for our State requires commitment from all stakeholders – State government (including administration, legislature and regulators), utilities, other businesses (including transportation), communities, environmental groups and others. To that end, the parties agree to the following:

The State will take the lead in educating its citizens and businesses on the value of the Hawaii Clean Energy Initiative.

The State, with inputs from the utilities, and other stakeholders, will develop a common set of messages about the importance, rationale for and scope of the Hawaii Clean Energy Initiative. These may include:

- As an island state, without interconnections to a mainland grid, developing clean local energy sources and fully embracing energy efficiency is critical to increase Hawaii's energy security.
- Many solutions for our islands will be different than elsewhere and must take into account the unique conditions of our small, remote, independent utility grids.
- Reducing our dependence on imported oil must address both electricity and transportation.
- Maintaining and upgrading the electric grid is essential to supporting reliable, renewable energy and to using technologies (such as advanced metering) that give customer options for better managing energy use.
- Variable renewable sources -- such as wind, solar, ocean and hydro -- must be an important part of our energy mix. To reliably add large amounts of intermittent renewable energy sources to our small island grids, we need proper planning, new and developing technologies, a mix of fuel-flexible generation resources, and new operational practices.
- Substantial investment will be necessary to develop local renewable energy fuel sources. Energy costs may be higher at first, but in the long run can be more stable than with current volatile oil pricing. In addition, future greenhouse gas or carbon taxes will increase the cost of fossil fuels even further.

These are investments in Hawaii’s future we must be willing to make. These are benefits, including energy security and protecting the environment, which we cannot put a price on. By ensuring energy security and protecting Hawaii’s special environment, we are creating a more responsible, cleaner future for our families, our communities and our islands. The utility and the State will work together to communicate these key messages to the public.

To maximize public awareness and understanding of this big picture, the communications campaign should utilize a full range of communication vehicles including utility advertising, free media and person-to-person communications with interested groups. Resources for such communications shall be authorized and recoverable.

37 How We Stay on Track

With the Hawaii Clean Energy Initiative, the State, the Consumer Advocate and Hawaiian Electric Company have reached a series of agreements that are critical to shaping Hawaii's energy future. We are each committed to doing our respective parts to carry out our agreements. To that end, the parties agree that:

- The State and utilities will identify a set of metrics that capture and quantify the important elements of the HCEI, and will set up a program to collect that information, calculate the metrics, and regularly report to citizens and stakeholders on the accomplishments of the HCEI relative to its goals;
- The Hawaiian Electric utilities commit to integrate the renewable energy resources, and our responsibilities for achieving the target goals of the programs specified in the Hawaiian Electric's Renewable Energy Commitments provided in Exhibit A;
- The Hawaiian Electric utilities' implementation plan and activities are detailed in Exhibit B. The Parties will meet quarterly and work collaboratively to ensure and monitor the performance and progress in achieving these commitments;
- If one party feels another is not living up to their obligations, they will first raise that issue directly with the other party;
- If there is a substantive breach of this agreement by a party(ies), the other party(ies) is not bound by any provisions that remain unexecuted of this agreement, and may change their position on any dockets already pending before the Commission; and
- Any amendment or modification of this agreement shall not be valid unless it is in writing and signed by the parties. Any waiver hereunder shall not be valid unless it is written and signed by the party against whom waiver is asserted.

Report Title:
Hawaii Clean Energy Initiative (HCEI)

Description:
Establishes initiatives necessary for and sufficient to the transition of Hawaii's energy sector from almost completely dependent on petroleum to 70% dependent on efficient, stable, secure, renewable, non-petroleum energy sources by 2030.

REVISED: January 5, 2009
1st DRAFT DATE: December17, 2008

__.B. NO._____

A BILL FOR AN ACT

RELATING TO HAWAII'S CLEAN ENERGY INITIATIVE.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

PART I

SECTION 1. Attaining independence from our detrimental reliance on fossil fuels has been a long-standing objective for the State.

Hawaii is the most petroleum dependent State in the use of petroleum for its energy needs. It pays the highest electricity prices in the U.S., and its gasoline costs are among the highest in the country. Fuel surcharges that pass the increases in fuel costs to consumers have significantly increased the cost of over 80% of the goods and services sold in Hawaii. Household fuels and utilities costs rose 36.4%, from the previous year, as reflected in the Honolulu Consumer Price Index during the second quarter of 2008. Hawaii's energy costs approaches 11% of its Gross Domestic Product (GDP), whereas in most states energy costs are 4% of GDP. Between 2005 and 2008, state government consumption of electricity increased 3.9%, but expenditures increased 56.8%.

Reducing our oil dependence and its consequent price volatility and attaining a measure of energy security is critical. More than 96% of petroleum in Hawaii now comes from foreign sources. Clean energy from indigenous renewable resources, as an alternative have the potential to provide an estimated 150% of current installed electrical capacity.

On January 28, 2008, the signing of a Memorandum of Understanding between the State of Hawaii and the U.S. Department of Energy (U.S. DOE) launched the Hawaii Clean Energy Initiative (HCEI). This initiative and long-term partnership between Hawaii and U.S. DOE is aimed at accelerating the use and development of energy efficiency and renewable energy technologies; allow Hawaii to serve as a model and demonstration test bed for the U.S. and other island communities; and develop a national partnership to accelerate system transformation, whereby the following goals are attained:

(1) Achieve a 70% clean energy economy for Hawaii within a generation.

(2) Increase Hawaii’s energy security.

(3) Capture economic benefits of clean energy for all levels of society.

(4) Contribute to Green House Gas reduction.

(5) Foster and demonstrate innovation.

(6) Build the workforce of the future.

(7) Serve as a national model.

The purpose of this Act is to provide a first step in aligning Hawaii's energy policy rules with the State's energy goals. For Hawaii to realize energy independence and economic stability the transformation of its energy system must encompass changes to:

(1) Hawaii's policy/regulatory framework;

(2) System-level technology development and integration;

(3) Financing/capital investment; and

(4) Institutional system planning.

To enable energy efficiency and renewable energy resources to meet 70% of Hawaii's energy demand by 2030, the Hawaii Clean Energy Initiative set goals for energy efficiency; renewable and indigenous electricity production; energy delivery and improvements to the electrical grid; and diversification of energy sources for transportation. The initiatives to achieve these goals were developed by the U.S. Department of Energy; the Department of Business, Economic Development and Tourism; and members of the five Hawaii Clean Energy Initiative working groups over the course of 2008. It presents a range of measures—some proven elsewhere, some innovative—to reach aggressive energy goals while balancing the interests of various stakeholders.

PART II

RENEWABLE PORTFOLIO STANDARDS

SECTION 2. Section 269-91, Hawaii Revised Statutes, is amended to read as follows:

§269-91 [Definitions.] For the purposes of this [part]:

"Biofuels" means liquid or gaseous fuels produced from organic sources such as biomass crops, agricultural residues and oil crops, such as palm oil, canola oil, soybean oil, waste cooking oil, grease, and food wastes, animal residues and wastes, and sewage and landfill wastes.

"Cost-effective" means the ability to produce or purchase electric energy or firm capacity, or both, from renewable energy resources at or below avoided costs consistent with the methodology set by the public utilities commission in accordance with section 269-27.2.

"Electric utility company" means a public utility as defined under section 269-1, for the production, conveyance, transmission, delivery, or furnishing of power.

"Renewable electrical energy" means:

(1) Electrical energy generated using renewable energy as the source;

(2) Electrical energy savings brought about by the use of renewable displacement or off-set technologies, including solar water heating, seawater air-conditioning district cooling systems, solar air conditioning, and customer-sited, grid-connected renewable energy systems[~~;~~],provided that such electrical energy savings will not count towards the renewable portfolio standards beginning in 2015; or

(3) Electrical energy savings brought about by the use of energy efficiency technologies, including heat pump water heating, ice storage, ratepayer-funded energy efficiency programs, and use of rejected heat from co-generation and combined heat and power systems, excluding fossil-fueled qualifying facilities that sell electricity to electric utility companies and central station power projects[~~;~~], provided that such electrical energy savings will not count towards the renewable portfolio standards beginning in 2015.

"Renewable energy" means energy generated or produced utilizing the following sources:

(1) Wind;

(2) The sun;

(3) Falling water;

(4) Biogas, including landfill and sewage-based digester gas;

(5) Geothermal;

(6) Ocean water, currents and waves;

(7) Biomass, including biomass crops, agricultural and animal residues and wastes, and [~~municipal~~] solid waste;

(8) Biofuels; and

(9) Hydrogen produced from renewable energy sources.

"Renewable portfolio standard" means the percentage of electrical energy sales that is represented by renewable electrical energy.

SECTION 3. Section 269-92(a) and section 269-92(b), Hawaii Revised Statutes, are amended to read as follows:

"**§269-92 Renewable portfolio standards.** (a) Each electric utility company that sells electricity for consumption in the State shall establish a renewable portfolio standard of:

(1) Ten per cent of its net electricity sales by December 31, 2010;

(2) Fifteen per cent of its net electricity sales by December 31, 2015; [~~and~~]

(3) [~~Twenty~~] Twenty-five per cent of its net electricity sales by December 31, 2020[~~.~~]; and

(4) Forty per cent of its net electricity sales by December 31, 2030.

(b) The public utilities commission may establish standards for each utility that prescribe what portion of the renewable portfolio standards shall be met by specific types of renewable electrical energy resources; provided that:

(1) Before 2015, [~~A~~]at least fifty per cent of the renewable portfolio standards shall be met by electrical energy generated using renewable energy as the source, and beginning 2015, the entire renewable portfolio standards shall be met by electrical generation from renewable energy sources;

(2) Where electrical energy is generated or displaced by a combination of renewable and nonrenewable means, the proportion attributable to the renewable means shall be credited as renewable energy; [~~and~~]

(3) Where fossil and renewable fuels are co-fired in the same generating unit, the unit shall be considered to

generate renewable electrical energy (electricity) in direct proportion to the percentage of the total heat input value represented by the heat input value of the renewable fuels[~~.~~]; and

(4) The public utilities commission shall not approve applications to build new additional fossil-based electric generation units with rated capacity greater than 2 megawatts."

SECTION 4. Section 269-95, Hawaii Revised Statutes, is amended to read as follows:

"**§269-95 Renewable portfolio standards study.** The public utilities commission shall:

(1) By December 31, 2007, develop and implement a utility ratemaking structure, which may include performance-based ratemaking, to provide incentives that encourage Hawaii's electric utility companies to use cost-effective renewable energy resources found in Hawaii to meet the renewable portfolio standards established in section 269-92, while allowing for deviation from the standards in the event that the standards cannot be met in a cost-effective manner or as a result of events or circumstances, such as described in section

269-92(d), beyond the control of the utility that could not have been reasonably anticipated or ameliorated;

(2) Gather, review, and analyze empirical data to determine the extent to which any proposed utility ratemaking structure would impact electric utility companies' profit margins, and to ensure that these profit margins do not decrease as a result of the implementation of the proposed ratemaking structure;

(3) Using funds from the public utilities special fund, contract with the Hawaii natural energy institute of the University of Hawaii to conduct independent studies to be reviewed by a panel of experts from entities such as the United States Department of Energy, National Renewable Energy Laboratory, Electric Power Research Institute, Hawaii electric utility companies, and other similar institutes with the required expertise. These studies shall include findings and recommendations regarding:

(A) The capability of Hawaii's electric utility companies to achieve renewable portfolio standards in a cost-effective manner and shall assess factors such as the impact on consumer rates, utility system reliability and stability, costs and availability of appropriate renewable energy resources and technologies, permitting approvals, effects on the economy, balance of trade, culture, community, environment, land and water, climate change policies, demographics, and other factors deemed appropriate by the commission; and

(B) Projected renewable portfolio standards to be set five and ten years beyond the then current standards;

(4) Evaluate the renewable portfolio standards every five years beginning in 2013, and may [~~R~~]revise the standards based on the best information available at the time [~~if the results of the studies conflict with~~] to determine if the renewable portfolio standards established by section 269-92 remain achievable; and

(5) Report its findings and revisions to the renewable portfolio standards, based on its own studies and other information [~~those contracted under paragraph (3)~~], to the legislature no later than twenty days

before the convening of the regular session of [~~2009~~] 2014, and every five years thereafter."

PART III

NET ENERGY METERING

SECTION 5. Section 269-101.5, Hawaii Revised Statutes, relating to Net Energy Metering, shall be amended to read as follows:

[§269-101.5] Maximum capacity of eligible customer-generator. The eligible customer-generator shall have a capacity of not more than fifty kilowatts; provided that the public utilities commission may by rule or order, [~~increase~~] modify the maximum allowable capacity that eligible customer-generators may have [~~to an amount greater than fifty kilowatts by rule or order.~~], or eliminate and replace it with a limit on a per-circuit basis for some electric utility companies, which will require such electric utility companies to perform a circuit-specific analysis to determine how the limit can be increased or mitigated for those circuits where the interconnection requests are approaching the specified limit.

SECTION 6. Section 269-102(b), Hawaii Revised Statutes, relating to Net Energy Metering, shall be amended to read as follows:

"(b)Each net energy metering contract or tariff shall be identical, with respect to rate structure, to the contract or tariff to which the same customer would be assigned if the customer was not an eligible customer-generator, provided that the public utilities commission may, by rule or order, allow some electric utility companies to assign eligible customer-generators to other applicable rates, tariffs or contracts determined reasonable by the public utilities commission to encourage the increased use and development of renewable energy systems in Hawaii. The charges for all retail rate components for eligible customer-generators shall be based exclusively on the eligible customer-generator's net kilowatt-hour consumption over a monthly billing period. Any new or additional demand charge, standby charge, customer charge, minimum monthly charge, interconnection charge, or other charge that would increase an eligible customer-generator's costs beyond those of other customers in the rate class to which the eligible customer-generator would otherwise be assigned are contrary to the intent of this section, and shall not form a part of net energy metering contracts or tariffs."

SECTION 7. Section 269-104, Hawaii Revised Statutes, relating to Net Energy Metering, shall be amended to read as follows:

"**§269-104 Additional customer-generators.** Notwithstanding section 269-102, an electric utility is not obligated to provide net energy metering to additional customer-generators in its service area when the combined total peak generating capacity of all eligible customer-generators served by all the electric utilities in that service area furnishing net energy metering to eligible customer-generators equals .5 per cent of the system peak demand of those electric utilities; provided that the public utilities commission may, by rule or order, increase or eliminate the limit to [~~by rule or order,~~] the allowable percentage of the electric utility's system peak demand produced from eligible customer-generators in the electric utility's service area, whereupon the electric utility will be obligated to provide net energy metering to additional eligible customer-generators in that service area [~~up to the increased percentage amount~~]."

PART IV

ENERGY RESOURCES COORDINATOR

SECTION 8. Section 196-4, Hawaii Revised Statutes, is amended to read as follows:

"**§196-4 Powers and duties.** Subject to the approval of the governor, the coordinator shall:

(1) Formulate plans, including objectives, criteria to measure accomplishment of objectives, programs through which the objectives are to be attained, and financial requirements for the optimum development of Hawaii's energy resources;

(2) Conduct systematic analysis of existing and proposed energy resource programs, evaluate the analysis conducted by government agencies and other organizations and recommend to the governor and to the legislature programs which represent the most effective allocation of resources for the development of energy sources;

(3) Formulate and recommend specific proposals, as necessary, for conserving energy and fuel, including the allocation and distribution thereof, to the governor and to the legislature;

(4) Assist public and private agencies in implementing energy conservation and related measures;

(5) Coordinate the State’s energy conservation and allocation programs with that of the federal government, other state governments, governments of nations with interest in common energy resources, and the political subdivisions of the State;

(6) Develop programs to encourage private and public exploration and research of alternative energy resources which will benefit the State;

(7) Conduct public education programs to inform the public of the energy situation as may exist from time to time and of the government actions taken thereto;

(8) Serve as consultant to the governor, public agencies and private industry on matters related to the acquisition, utilization and conservation of energy resources;

(9) Contract for services when required for implementation of this chapter;

(10) Review proposed state actions which the coordinator finds to have significant effect on energy consumption and report to the governor their effect on the energy

conservation program, and perform such other services as may be required by the governor and the legislature;

(11) Prepare and submit an annual report and such other reports as may be requested to the governor and to the legislature on the implementation of this chapter and all matters related to energy resources; [~~and~~]

(12) Formulate a systematic process including the development of requirements, to identify geographic areas that are rich with renewable energy resource potential which can be developed in cost-effective and environmentally benign manner, and designate such areas as Renewable Energy Zones (REZ);

(13) Develop and recommend incentives plans and programs to encourage the development of renewable energy resource projects within the renewable energy zones;

(14) Assist public and private agencies in identifying the utility transmission projects or infrastructure that are required to accommodate and facilitate the development of renewable energy resources;

(15) Assist public and private agencies in coordination with department of budget and finance in accessing use

of special purpose revenue bonds to finance the engineering, design, and construction of transmission projects and infrastructure that are deemed critical to the development of renewable energy resources;

(16) Develop the criteria or requirements for identifying and qualifying specific transmission projects or infrastructure that are critical to the development of renewable energy resources, and which the energy resources coordinator will assist in accessing the use of special purpose revenue bonds to finance such projects or infrastructure; and

[~~(12)~~](17)Adopt rules for the administration of this chapter pursuant to chapter 91, provided that the rules shall be submitted to the legislature for review."

PART V

RENEWABLE ENERGY RESOURCES

SECTION 9. The definition of "Qualified business" in Section 209E-2, Hawaii Revised Statutes, is amended to read as follows:

"Qualified business" means any corporation, partnership, or sole proprietorship authorized to do business in the State that is qualified under section 209E-9, subject to the state corporate or individual income tax under chapter 235, and is:

(1) Engaged in manufacturing, the wholesale sale of tangible personal property as defined in Section 237-4, or a service business as defined in this chapter;

(2) Engaged in producing agricultural products where the business is a producer as defined in section 237-5, or engaged in processing agricultural products, all or some of which were grown within an enterprise zone;

(3) Engaged in research, development, sale, or production of all types of genetically-engineered medical, agricultural, or maritime biotechnology products; or

(4) Engaged in development or production of [~~producing electric power from wind energy for sale primarily to a public utility company for resale to the public.~~] fuels or thermal energy or electrical energy from renewable resources, including:

i. Wind;

ii. The sun;

iii. Falling water;

iv. Biogas, including landfill and sewage-based digester gas;

v. Geothermal;

vi. Ocean water, currents and waves;

vii. Biomass, including biomass crops, agriculture and animal residues and wastes, and solid waste;

viii. Biofuels; and

ix. Hydrogen produced from renewable energy sources.

PART VI

RENEWABLE ENERGY FACILITATOR

SECTION 10. Section 201-12.5(b) shall be amended to read as follows:

"(b) The renewable energy facilitator shall have the following duties:

(1) Facilitate the efficient permitting of renewable energy projects which include the land parcel on which the facility is situated, any renewable energy production structure or equipment, any energy transmission line from the facility to a public utility's electricity system, and any on-site infrastructure necessary for the production of electricity or biofuel from the renewable energy site;

(2) Initiate the implementation of key renewable energy projects by permitting various efficiency improvement strategies identified by the department;

(3) Administer the day-to-day coordination for renewable energy projects on behalf of the department and the day-to-day operations of the renewable energy facility siting process established in [Act 207, Session Laws of Hawaii 2008]; and

(4) Submit periodic reports to the legislature on renewable energy facilitation activities and the progress of the renewable energy facility siting process."

PART VII

RENEWABLE ENERGY PERMITTING

SECTION 11. Section 201N-1 relating to the definition 'renewable energy facility' shall be amended to read as follows:

"Renewable energy facility" or "facility" means a new facility located in the State with the capacity to produce from renewable energy at least two hundred megawatts of electricity; <u>provided that biofuel production facilities and electricity production facilities with capacities between 5 and 200 megawatts may apply to the coordinator for designation as</u>

renewable energy facilities, with such designation to be at the sole discretion of the coordinator. The term includes any of the following associated with the initial permitting and construction of the facility:

(1) The land parcel on which the facility is situated;

(2) Any renewable energy production structure or equipment;

(3) Any energy transmission line from the facility to a public utility's electricity transmission or distribution system;

(4) Any on-site infrastructure; and

(5) Any on-site building, structure, other improvement, or equipment necessary for the production of electricity or biofuel from the renewable energy site, transmission of the electricity or biofuel, or any accommodation for employees of the facility.

SECTION 12. Section 201N-4(g) shall be amended to read as follow:

"(g) Each appropriate state and county agency shall diligently endeavor to process and approve or deny any permit in the permit plan no later than twelve months after a completed permit plan application is approved by the coordinator. If a permit is not approved or denied within twelve months after approval of a completed permit plan application, the permitting agency shall, within thirty days following the twelve month period, provide the coordinator with a report identifying diligent measures that are being taken by the agency to complete processing and action as soon as practicable[~~, and unless the coordinator expressly disapproves the permit in writing within five months after receipt of the report from the permitting agency~~]. If no further processing and action are reported by the permitting agency within five months, the permit shall be deemed approved. If a permitting agency fails to provide this report and if the permit has not been approved or denied within eighteen months following the approval of a completed permit plan application by the coordinator, the permit shall be deemed approved."

SECTION 13. There is appropriated out of the renewable energy facility siting special fund the sum of $1,000,000 or so much thereof as may be necessary for each year of the fiscal biennium 2009-2011. The sum appropriated by this Act shall be expended by the department of business, economic development, and tourism for the purposes of the fund created in section 201N-11, Hawaii Revised Statutes.

PART VIII

ENERGY EFFICIENCY

SECTION 14. Chapter _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

§______ Energy Efficiency Portfolio Standard. The State will set an Energy Efficiency Portfolio Standard with the goal of off-setting forecasted load growth in the electricity sector from 2009 to 2030.

The statewide target shall be 4300 Gigawatt-hours of electricity savings by 2030. The interim targets, and any island by island targets, shall be set by the Public Utilities Commission.

The Public Utilities Commission shall identify the parties who are responsible for each element of the standard and set incentives and penalties based on performance by each entity.

Renewable substitution, including but not limited to solar water heating and sea water air conditioning, shall count toward this standard.

The Administrator of the Public Benefits Fund, whether the utility or a third party, will be responsible for reaching this level of energy efficiency by instituting efficiency programs across all end use sectors. The Administrator will submit annual reports to the Public Utilities Commission by March 1 of each year, beginning March 1, 2010, reporting energy efficiency savings achieved during the previous calendar year. The Public Utilities Commission will monitor and evaluate progress against this standard.

Penalties for not meeting the standard shall be established by the Public Utilities Commission.

SECTION 15. Chapter _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

§______ Energy efficiency studies and planning. The Public Benefits Fee Administrator shall be authorized $500,000 from the Public Utilities Commission special fund to conduct energy efficiency assessments to identify current energy use patterns in Hawaii and areas of greatest potential for energy efficiency savings. The assessments shall include end use research regarding Hawaii's homes, businesses, and other utility customers. The energy potential assessments will identify and recommend energy efficiency programs to target.

The assessments shall be forwarded to the Legislature, the Public Utilities Commission, the Energy Resources Coordinator, and the utilities.

The assessments must be completed by December 31, 2010.

The Public Benefits Fee Administrator will establish aggressive Efficiency Plans with the provision that efficiency will be the first loaded resource in all cases where it is cost effective. Cost effectiveness shall be defined as all resources deemed to effectively cover the incremental cost of investment within 15 years when measured against average electricity rates for residential, small commercial, large commercial, industrial, and agricultural customers.

To the extent that the building code changes between Efficiency Plans, the net impact of the code should be netted out of the requirements.

Until the full energy efficiency plan is available, the Public Utilities Commission, department of business, economic development, and tourism, utilities and the Public Benefits Fee Administrator should work with stakeholders to identify a small set of cost-effective energy efficiency measures that will have high energy-saving impact and can be implemented in significant volumes with high penetration goals, so the state can begin realizing energy savings immediately.

SECTION 16. Section _______, Hawaii Revised Statutes, is amended to read as follows:

§ _____ **Building Codes.** The Public Benefits Fee Administrator shall be funded $600,000 from the Public Utilities Commission special fund to implement following responsibilities.

The Public Benefits Fee Administrator will set up procedures for and conduct measurement and verification of buildings and homes constructed under the code to assess code compliance and building performance. The results will help inform necessary changes to code and code training delivery in subsequent amendments.

The counties will also work with the Public Benefits Fee Administrator to conduct an analysis of the energy intensity of residential and commercial buildings built to code compared to baseline homes.

The Public Benefits Fee Administrator shall conduct surveys of builders to determine actual costs associated with meeting code for residential and commercial buildings.

Results of these analyses and surveys must be delivered to the Legislature in annual reports 20 days prior the convening of each legislative session. The report shall include recommendations for code updates, which can be adopted by the state building code council on a biennial basis.

The Public Benefits Fee Administrator shall assess the feasibility of implementing a net zero energy building code for residential and commercial construction.

Residential building codes will apply to all single family homes, duplexes, and low-rise residential buildings less than three stories for both new construction and major renovation projects.

The Public Benefits Fee Administrator will determine technical code amendments to complement the International Energy Conservation Code residential building code in order to take advantage of Hawaii's climate.

Building code analysis should also consider the costs and benefits of requiring advanced meters and energy 'dashboard' technologies that improve the ability of the occupant to monitor and improve building performance, cool roof requirements; requirement that the roofs of new homes to be solar-ready; requirement that all homes built or rehabilitated in Hawaii have and present an energy label; and any other measures that can improve the ability of the homeowner to better understand and manage their energy use.

Commercial code compliance must include on the building permit application a designated commissioning agent who has experience related to energy and buildings. In order to be eligible for an occupancy certificate, the building owner must submit to the appropriate agency a building commissioning report completed by the designated commissioning agent. Builders shall remedy any deficiencies found in the commissioning report within 60 days of receipt of the report to ensure that the building operates as designed under code. The counties are authorized to set and assess fines on any building that does not provide proof of having remedied the building's deficiencies within 60 days.

The Public Benefits Fee Administrator shall create commissioning guidelines appropriate for building practices in Hawaii by January 1, 2010.

SECTION 17. **Section 107-28, Hawaii Revised Statutes, is amended to read as follows:**

"[§107-28] County building code authority to amend the state model building code without state approval. (a) The governing body of each county shall amend the state building code as it applies within its respective jurisdiction, in accordance with section 46-1.5(13), without approval of the council. Each county shall use the model codes and standards listed in section 107-25, as the referenced model building codes and standards for its respective county building code ordinance, no later than two years after the adoption of the state building code.

(b) If a county does not amend the statewide model code within the [~~two-year~~] one year timeframe, the state building code shall become applicable as an interim county building code until the county adopts the amendments.

(c) State Building Code Council shall adapt and adopt the latest International Code Council and International Energy Conservation Code updates within 6 months of adoption by the International Code Council; each county shall adapt and adopt the updates within 6 months of the State Building Codes Council adoption or the State Building Codes Council update shall become county code if not adopted within 6 months."

SECTION 18. Section 196-6.5, Hawaii Revised States, is amended to read as follows:

"[§196-6.5] **Solar water heater system required for new single-family residential construction.** (a) On or after January 1, 2010, [~~no building permit shall be issued for~~] a new single-family dwelling [~~that does not~~] shall include a solar water heater system that meets the standards established pursuant to section 269-44, unless the [~~energy resources coordinator~~] Public Benefits Fee Administrator approves a variance. A variance shall only be approved if an architect or engineer licensed under chapter 464 attests that:

(1) Installation is impracticable due to poor solar resource;

(2) Installation is cost-prohibitive based upon a life cycle cost-benefit analysis that incorporates the average residential utility bill and the cost of the new solar water heater system with a life cycle that does not exceed fifteen years;

(3) A substitute renewable energy technology system, as defined in section 235-12.5, is used as the primary energy source for heating water; or

(4) A demand water heater device approved by Underwriters Laboratories, Inc., is installed; provided that at least one other gas appliance is installed in the dwelling. For the purposes of this paragraph, "demand water heater" means a gas-tankless instantaneous water heater that provides hot water only as it is needed.

(b) A request for a variance shall be submitted to the [~~energy resources coordinator~~] Public Benefits Fee Administrator on an application prescribed by the [~~energy resources coordinator~~] Public Benefits Fee Administrator and shall include, but not be limited to, a description of the location of the property and justification for the approval of a variance using the criteria established in subsection (a). A variance shall be deemed approved if not denied within thirty working days after receipt of the variance application.

(c) Nothing in this section shall preclude any county from establishing procedures and standards required to implement this section.

(d) Nothing in this section shall preclude participation in any utility demand-side management program or public benefits fund under part VII of chapter 269."

SECTION 19. Section _______, Hawaii Revised Statutes, is amended to read as follows:

"§ _____ **Public buildings.** (a) The public sector should be a leader in energy efficiency for buildings. Public buildings can serve as a training ground for contractors and building professionals to design and construct buildings with excellent energy performance that goes beyond code. The government also has a greater level of certainty about the duration that it will occupy a building, so the lifecycle savings realized from low operating costs are more assured for public sector investments than for private investments. (b) Each state department with responsibilities for the design and construction of buildings and facilities shall benchmark every existing public building that is either larger than 5000 square feet or uses more than 8000 kWh per year by December 31, 2010, and use the results to determine the state's investment in improving the efficiency of its own building stock. Benchmarking shall be conducted using the ENERGY STAR portfolio management tool or an equivalent tool, as determined by the Public Benefits Fee Administrator. The Public Benefits Fee Administrator shall provide training to affected departments on the ENERGY STAR portfolio management tool or an equivalent tool.

Public buildings must be retro-commissioned not less than every five years. The Public Benefits Fee Administrator shall create retro-commissioning guidelines by January 1, 2010.

The performance target for energy efficiency in existing public buildings, including schools, universities, community colleges, hospitals, and public housing, will be 30% better than the most recent building code for the building type.

Departments may enter into energy savings performance contracts with a third party to cover the capital costs of energy efficiency measures and distributed generation as long as the terms of the energy savings performance contracts conform to this standard. The comptroller may review and exempt specific projects as appropriate to take into account cost-effectiveness.

Energy savings performance contracts will be executed according to state guidelines issued by the Comptroller and reviewed by the Comptroller. To expedite energy saving performance contracting for public buildings, the department of accounting and general services will develop a master energy savings performance contracts agreement that any department may use to contract with an energy savings performance contracts provider for energy efficiency and renewable energy services.

Departments, schools, and other public facilities that validate the amount of money they save with energy efficiency measures can keep at least 50% of the energy savings achieved through those upgrades for programmatic activities. Agencies which are allowed to keep at least 50% of the energy savings shall not have their budgets comparably reduced in subsequent years.

Existing public buildings that undergo a major retrofit or renovation must achieve a level of energy efficiency that is 30% better than code, provided that the cost of the measures can be recouped within 20 years."

SECTION 20. Chapter _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§_____ **On-bill financing for energy efficiency and renewable energy.** By December 31, 2009, the Public Utilities Commission will institute a rule governing the on-bill financing program, to be administered by the Public Benefits Fee Administrator.

The program's goal is to change out inefficient refrigerators, install solar water heaters, and install photovoltaic systems. The Public Utilities Commission will establish the details of this program.

Residential and small commercial customers will make no upfront payments, and will pay the cost of the system over time on their electric bill at an interest rate to be determined by the Public Utilities Commission.

The program will provide the customer with 1) an ENERGY STAR refrigerator in exchange for their existing one if the existing refrigerator was purchased before a certain date or uses a certain amount of energy per month, with guidelines and qualifications to be determined by the Public Utilities Commission, 2) install a solar water heating system on the customer’s roof if the system will pay back in a time period to be determined by the Public Utilities Commission, and 3) install a photovoltaic system on the roof, with limitations and payback period to be determined by the Public Utilities Commission.

Customers who take advantage of this program will receive an energy audit partially paid for by the Public Benefits Fee Administrator; the Public Utilities Commission will determine the level of cost-share, if any, that consumers must provide for the energy audit.

The Public Benefits Fee Administrator may contract to appropriately licensed contractors or installers to install the systems and conduct the necessary follow-up in the form of energy audits, measurement, and verification.

The Public Benefits Fee Administrator shall ensure that the old appliances are decommissioned so that they are not returned to service, and that they are disposed of in a manner that complies with all environmental requirements.

The Public Benefits Fee Administrator must provide a program report to the Public Utilities Commission eight months and 14 months after the start of the program. After the first full year of the program, and at any time thereafter, the Public Utilities Commission may conduct independent evaluation of the program effectiveness. The Public Utilities Commission shall forward these reports to the Energy Resources Coordinator.

The responsibility and execution for customer billing shall remain with the utility."

SECTION 21. Chapter _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§_____ **Appliances and equipment.** The Public Benefits Fee Administrator will offer a cash incentive to Hawaii residents to turn in their air-conditioners made before 2000 and replace them with and ENERGY STAR model. The Public Benefits Fee Administrator's goal will be to replace at least 50% of the State's qualifying appliances within 5 years of the program's start. The program will include a certification that the inefficient appliances are scrapped and disposed of in an environmentally appropriate manner. The Public Benefits Fee Administrator may add other appliances if analysis and evaluation show that such additions are warranted. In addition, the Public Benefits Fee Administrator may offer a cash incentive for homeowners to retire any second refrigerators. Resources to administer the program may come out of the Public Benefits Funds."

SECTION 22. Section _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§ 235-_____ **Tax credit for a net zero energy building.** (a) There shall be allowed to each taxpayer who owns a net zero energy building fixed to real property located in the state an income tax credit which shall be deductible from the taxpayer's net income tax liability, if any, imposed by this chapter only for the first taxable year in which the building meets the definition of net zero energy building.

(b) The amount of the credit shall be:

(1) For a building that is up to 1000 square feet, the tax credit shall be $9.00 per square foot;

(2) For a building that is more than 1000 square feet but less than 4,000 square feet, the tax credit shall be $6.00 per square foot;

(3) For a building that is more than 4,000 square feet, the tax credit shall be $3.00 per square foot for a maximum credit of $50,000.

(c) In the case of a partnership, S corporation, estate, or trust, the tax credit allowable is for every net zero energy building owned by the entity. Distribution and share of the credit shall be determined pursuant to section 235-110.7(a).

In the case of a building owned by more than one person, the tax credit shall be determined as if owned by one person, and then apportioned among the various owners in proportion to their ownership interest in the building.

(d) For purposes of this section:

"Net zero energy building" means any building that produces more electricity from renewable energy technology systems than it consumes from all sources on a monthly basis during any 9 months of the tax year.

"Renewable energy technology system" means a system that captures and converts a renewable source of energy into electricity.

(e) The director of taxation shall prepare any forms that may be necessary to claim a tax credit under this section. The director of taxation may require the taxpayer to furnish reasonable information to ascertain the validity of the claim for credit made under this section and may adopt rules necessary to effectuate the purposes of this section pursuant to chapter 91.

(f) If the tax credit under this section exceeds the taxpayer's income tax liability, the excess of the credit over liability may be used as a credit against the taxpayer's income tax liability in subsequent years until exhausted. All claims for the tax credit under this section, including amended claims, shall be filed on or before the end of the twelfth month following the close of the taxable year for which the credit may be claimed. Failure to comply with this subsection shall constitute a waiver of the right to claim the credit.

(g) This section shall apply to taxable years beginning after December 31, 2009, and shall not apply to taxable years after December 31, 2019.

(h) Taxpayers claiming tax credits for renewable energy systems under this section are not eligible for tax credits under section 235-12.5.

(i)(1) If, during any taxable year, a net zero energy building ceases to be a net zero energy building and is owned by the taxpayer who claimed the tax credit, then the tax credit shall be recaptured. To recapture, the taxpayer must add to taxable income for the taxable year in which the building ceases to be a net zero energy building, the amount of the recapture percentage of the the credits allowed and claimed under this section.

(2) For purposes of subsection (1), the recapture percentage shall be determined in accordance with the following table:

If the property ceases to be the recapture percentage is: a net zero energy building within:

(i) One full year after the taxable year in which the credit is claimed: 100 percent.

(ii) One full year after the close of the period described in clause (i) 80 percent.

(iii) One full year after the close of the period described in clause (ii) 60 percent.

(iv) One full year after the close of the period described in clause (iii) 40 percent.

(v) One full year after the close of the period described in clause (iv) 20 percent.

(j) If a deduction is taken under section 179 of the Internal Revenue Code, no tax credit shall be allowed for that portion of the cost for which the deduction is taken.

(k) The basis of eligible property for depreciation or accelerated cost recovery system purposes for state income taxes shall be reduced by the amount of credit allowable and claimed. In the alternative, the taxpayer shall treat the amount of the credit allowable and claimed as a taxable income item for the taxable year in which it is properly recognized under the method of accounting used to compute taxable income."

SECTION 23. Chapter _______, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§_____ **Consumer Information.** Energy consumption information shall be required in sale/lease of property. Financial institutions and new occupant consumers shall be provided energy information before lease/sale.

The Public Benefits Fee Administrator shall develop rules for reporting energy information to consumers at the time of sale or rental of commercial/residential buildings.

The Public Benefits Fee Administrator shall develop programs and information to educate financial institutions, mortgage brokers, and consumers on the economics of energy efficient properties, including savings over the life-cycle of such properties.

The Public Benefits Fee Administrator will establish a web-based model showing data and publicize to realtors and others."

PART IX

RENEWABLE ENERGY INCOME TAX CREDITS

SECTION 24. Section 235-12.5, Hawaii Revised Statutes, is amended to read as follows:

"**§235-12.5 Renewable energy technologies; income tax credit.** (a) When the requirements of subsection [~~(c)~~] (d) are met, each individual or corporate taxpayer that files an individual or corporate net income tax return for a taxable year may claim a tax credit under this section against the Hawaii state individual or corporate net income tax. The tax credit may be claimed for every eligible renewable energy technology system that is installed and placed in service in the [~~State~~] state by a taxpayer during the taxable year. [~~This credit shall be available for systems installed and placed in service in the State after June 30, 2003.~~] The tax credit may be claimed as follows:

(1) [~~Solar thermal energy systems for:~~] For each solar energy system: Thirty-five per cent of the actual cost or the cap amount determined in subsection (b), whichever is less; or

[~~(A) Single-family residential property for which a building permit was issued prior to January 1, 2010: thirty-five per cent of the actual cost or $2,250, whichever is less;~~

~~(B) Multi-family residential property: thirty-five per cent of the actual cost or $350 per unit, whichever is less; and~~

~~(C) Commercial property: thirty-five per cent of the actual cost or $250,000, whichever is less;~~]

(2) [~~Wind-powered energy systems for:~~] For each wind-powered energy system: Twenty per cent of the actual cost or the cap amount determined in subsection (b), whichever is less;

[~~(A) Single-family residential property: twenty per cent of the actual cost or $1,500, whichever is less;~~

~~(B) Multi-family residential property: twenty per cent of the actual cost or $200 per unit, which is less; and~~

~~(C) Commercial property: twenty per cent of the actual cost or $500,000, whichever is less; and~~

~~(3) Photovoltaic energy systems for:~~

~~(A) Single-family residential property: thirty-five per cent of the actual cost or $5,000, whichever is less;~~

~~(B) Multi-family residential property: thirty-five per cent of the actual cost or $350 per unit, whichever is less; and~~

~~(C) Commercial property: thirty-five per cent of the actual cost or $500,000, whichever is less;~~]

provided that multiple owners of a single system shall be entitled to a single tax credit; and provided further that the tax credit shall be apportioned between the owners in proportion to their contribution to the cost of the system.

In the case of a partnership, S corporation, estate, or trust, the tax credit allowable is for every eligible renewable energy technology system that is installed and placed in service in the State by the entity. The cost upon which the tax credit is computed shall be determined at the entity level. Distribution and share of credit shall be determined pursuant to section 235-110.7(a).

(b) The amount of credit allowed for each eligible renewable energy technology system shall not exceed the applicable cap amount, which is determined as follows:

(1) If the primary purpose of the solar energy system is to use energy from the sun to heat water for household use, then the cap amounts shall be:

(A) $2,250 per system for single-family residential property;

(B) $350 per unit per system for multi-family residential property; and

(C) $250,000 per system for commercial property.

(2) For all other solar energy systems, the cap amounts shall be:

(A) $5,000 per system for single-family residential property;

(B) $350 per unit per system for multi-family residential property; and

(C) $500,000 per system for commercial property.

(3) For all wind-power energy systems, the cap amounts that apply shall be:

(A) $1,500 per system for single-family residential property;

(B) $200 per unit per system for multi-family residential property; and

(C) $500,000 per system for commercial property.

[~~(b)~~] (c) For the purposes of this section:

"Actual cost" means costs related to the renewable energy technology systems under subsection (a), including accessories and installation, but not including the cost of consumer incentive premiums unrelated to the operation of the system or offered with the sale of the system and costs for which another credit is claimed under this chapter.

"Household use" means any use that heated water is commonly put to in a residential setting, including commercial application of those uses.

"Renewable energy technology system" means a system that captures and converts a renewable source of energy, such as [~~wind, heat (solar thermal), or light (photovoltaic) from the sun~~] sun or wind energy, into:

(1) A usable source of thermal or mechanical energy;

(2) Electricity; or

(3) Fuel.

"Solar or wind energy system" means any identifiable facility, equipment, apparatus, or the like that converts [~~insolation~~] sun or wind energy to useful thermal or electrical energy for heating, cooling, or reducing the use of other types of energy that are dependent upon fossil fuel for their generation.

[~~(c)~~] (d) For taxable years beginning after December 31, 2005, the dollar amount of any utility rebate shall be deducted from the cost of the qualifying system and its installation before applying the state tax credit.

[~~(d)~~] (e) The director of taxation shall prepare any forms that may be necessary to claim a tax credit under this section, including forms identifying the technology type of each tax credit claimed under this section, whether for [~~solar thermal, photovoltaic from the sun,~~] solar or wind. The director may also require the taxpayer to furnish reasonable information to ascertain the validity of the claim for credit made under this section and may adopt rules necessary to effectuate the purposes of this section pursuant to chapter 91.

[~~(e)~~] (f) If the tax credit under this section exceeds the taxpayer's income tax liability, the excess of the credit over liability may be used as a credit against the taxpayer's income tax liability in subsequent years until exhausted[~~.~~], unless otherwise elected by the taxpayer pursuant to subsection (g) or (h).

All claims for the tax credit under this section, including amended claims, shall be filed on or before the end of the twelfth month following the close of the taxable year for which the credit may be claimed. Failure to comply with this subsection shall constitute a waiver of the right to claim the credit.

(g) For solar energy systems, a taxpayer may elect to reduce the eligible credit amount by 30% and if this reduced tax credit exceeds the amount of income tax payment due from the taxpayer, the excess of the credit over payments due shall be refunded to the taxpayer; provided that tax credits properly claimed by a taxpayer who has no income tax liability shall be paid to the taxpayer; and provided further that no refund on account of the tax credit allowed by this section shall be made for amounts less than $1.

The election required by this subsection shall be made in a manner prescribed by the director on the taxpayer's return for the taxable year in which the system is installed and placed in service. A separate election may be made for each separate system that generates a credit. An election once made is irrevocable.

(h) For any renewable energy technology system, an individual taxpayer may elect to have any excess of the credit over payments due refunded to the taxpayer, if:

(1) All of the taxpayer's income is exempt from taxation under section 235-7(a)(2) or section 235-7(a)(3); or

(2) The taxpayer's adjusted gross income is $20,000 or less (or $40,000 or less if filing a tax return as married filing jointly);

provided that tax credits properly claimed by a taxpayer who has no income tax liability shall be paid to the taxpayer; and provided further that no refund on account of the tax credit allowed by this section shall be made for amounts less than $1. A husband and wife who do not file a joint tax return shall only be entitled to make this election to the extent that they would have been entitled to make the election had they filed a joint tax return.

The election required by this subsection shall be made in a manner prescribed by the director on the taxpayer's return for the taxable year in which the system is installed and placed in service. A separate election may be made for each separate system that generates a credit. An election once made is irrevocable.

[~~(f) By or before December, 2005, to the extent feasible, using existing resources to assist the energy-efficiency policy review and evaluation, the department shall assist with data collection on the following:~~

~~(1) The number of renewable energy technology systems that have qualified for a tax credit during the past year by:~~

~~(A) Technology type (solar thermal, photovoltaic from the sun, and wind); and~~

~~(B) Taxpayer type (corporate and individual); and~~

~~(2) The total cost of the tax credit to the State during the past year by:~~

~~(A) Technology type; and~~

~~(B) Taxpayer type.~~]

[~~(g For systems installed and placed in service in 2009, no residential home developer shall be entitled to claim the credit under subsections (a)(1)(A), (a)(2)(A), and (a)(3)(A). A residential home developer is defined as a person who holds more than one residential dwelling for sale as inventory.~~]

(i) No taxpayer shall be allowed a credit under this section for a solar water heater system required by section 196-6.5 that is installed and placed in service on any newly constructed residence authorized by a building permit issued on or after January 1, 2010."

SECTION 25. This Act shall apply to eligible renewable energy technology systems that are installed and placed in service on or after January 1, 2010.

PART X

TRANSPORTATION ENERGY INFRASTRUCTURE

SECTION 26. Section 226-18, Hawaii Revised Statutes, is amended to read as follows:

"**§226-18 Objectives and policies for facility systems--energy.** (a) Planning for the State's facility systems with regard to energy shall be directed toward the achievement of the following objectives, giving due consideration to all:

(1) Dependable, efficient, and economical statewide energy systems capable of supporting the needs of the people;

(2) Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased;

(3) Greater energy security <u>and diversification</u> in the face of threats to Hawaii's energy supplies and systems; and

(4) Reduction, avoidance, or sequestration of greenhouse gas emissions from energy supply and use.

(b) To achieve the energy objectives, it shall be the policy of this State to ensure the <u>short- and long-term</u> provision of adequate, reasonably priced, and dependable energy services to accommodate demand.

(c) To further achieve the energy objectives, it shall be the policy of this State to:

(1) Support research and development as well as promote the use of renewable energy sources;

(2) Ensure that the combination of energy supplies and energy-saving systems is sufficient to support the demands of growth;

(3) Base decisions of least-cost supply-side and demand-side energy resource options on a comparison of their

total costs and benefits when a least-cost is determined by a reasonably comprehensive, quantitative, and qualitative accounting of their long-term, direct and indirect economic, environmental, social, cultural, and public health costs and benefits;

(4) Promote all cost-effective conservation of power and fuel supplies through measures, including:

(A) Development of cost-effective demand-side management programs;

(B) Education; and

(C) Adoption of energy-efficient practices and technologies;

(5) Ensure, to the extent that new supply-side resources are needed, that the development or expansion of energy systems uses the least-cost energy supply option and maximizes efficient technologies;

(6) Support research, development, [~~and~~] demonstration and utilization of energy efficiency, load management, and other demand-side management programs, practices, and technologies;

(7) Promote alternate fuels and transportation energy efficiency[~~ by encouraging diversification of transportation modes and infrastructure~~];

(8) Support actions that reduce, avoid, or sequester greenhouse gases in utility, transportation, and industrial sector applications;

(9) Support actions that reduce, avoid, or sequester Hawaii's greenhouse gas emissions through agriculture and forestry initiatives; and

(10) Provide priority handling and processing for all state and county permits required for renewable energy projects."

SECTION 27. Chapter 235, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§235- Electric vehicle charging; income tax credit.** (a) There shall be allowed to each taxpayer subject to the taxes imposed by this chapter a tax credit for code compliant electric vehicle charging infrastructure installed and placed in service in the State that shall be deductible from the taxpayer's net income tax liability. The tax credit may be claimed for the taxable year in which the code compliant electric vehicle charging system is placed in service in the State.

(b) The amount of the credit shall be 70% of the cost of the electric vehicle charging system or $500 per electric vehicle charge point of the system, whichever is less. The cost of the electric vehicle charging system includes all costs to acquire, construct and install the electric vehicle charging system that are required to be capitalized under section 263 of the Internal Revenue Code to the electric vehicle charging system. The cost of the electric vehicle charging system does not include costs that are properly allocable to land or to a building and its structural components, including, but not limited to costs related to the acquisition of land on which the electric vehicle charging system is located, expenses for permits, legal fees, project management, or engineering to the extent such expenses are related to the land.

(c) If a deduction is taken under section 179 of the Internal Revenue Code, no tax credit shall be allowed for that portion of the cost for which the deduction is taken.

(d) The basis of eligible property for depreciation or accelerated cost recovery system purposes for state income taxes shall be reduced by the amount of credit allowable and claimed.

In the alternative, the taxpayer shall treat the amount of the credit allowable and claimed as a taxable income item for the taxable year in which it is properly recognized under the method of accounting used to compute taxable income.

(e) The costs used to compute this tax credit may not be used to compute any other tax credit.

(f) For the purposes of this section:

"Electric vehicle charge point" means the part of the electric vehicle charging system that delivers electricity from a source outside an electric vehicle into one electric vehicle.

"Electric vehicle charging system" means a system that is designed in compliance with Article 625 of the National Electrical Code and delivers electricity from a source outside an electric vehicle into one or more electric vehicles. An electric vehicle charging system may include several charge points simultaneously connecting several electric vehicles to the system.

(g) The director of taxation shall prepare any forms that may be necessary to claim a tax credit under this section. The director may also require the taxpayer to furnish reasonable information to ascertain the validity of the claim for credit made under this section and may adopt rules necessary to effectuate the purposes of this section pursuant to chapter 91.

(h) If the tax credit under this section exceeds the taxpayer's income tax liability, the excess of the credit over liability may be used as a credit against the taxpayer's income tax liability in subsequent years until exhausted. Every claim, including amended claims, for a tax credit under this section shall be filed on or before the end of the twelfth month following the close of the taxable year for which the credit may be claimed. Failure to comply with the foregoing provision shall constitute a waiver of the right to claim the credit.

(i) This tax credit applies to electric vehicle charging systems placed in service after July 1, 2009 and before January 1, 2016."

SECTION 28. Chapter 235, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§235- Alternative fuel refueling; income tax credit.** (a) There shall be allowed to each taxpayer subject to the taxes imposed by this chapter a tax credit for any alternative fuel refueling infrastructure installed and placed in service in the State that shall be deductible from the taxpayer's net income tax liability. The tax credit may be claimed for the taxable year in which the alternative fuel refueling infrastructure is placed in service.

(b) The amount of the credit shall be 30% of the cost of the alternative fuel refueling infrastructure or $10,000, whichever is less. The cost of the alternative fuel refueling infrastructure includes all costs to acquire, construct and install the alternative fuel refueling infrastructure that are required to be capitalized under section 263 of the Internal Revenue Code to the alternative fuel refueling infrastructure. The cost of the alternative fuel refueling infrastructure does not include costs that are properly allocable to land or to a building and its structural components, including, but not limited to costs related to the acquisition of land on which the alternative fuel refueling infrastructure is located, expenses for permits, legal fees, project management, or engineering to the extent such expenses are related to the land.

(c) If a deduction is taken under section 179 of the Internal Revenue Code, no tax credit shall be allowed for that portion of the cost for which the deduction is taken.

(d) The basis of eligible property for depreciation or accelerated cost recovery system purposes for state income taxes shall be reduced by the amount of credit allowable and claimed. In the alternative, the taxpayer shall treat the amount of the credit allowable and claimed as a taxable income item for the taxable year in which it is properly recognized under the method of accounting used to compute taxable income.

(e) The costs used to compute this tax credit may not be used to compute any other tax credit.

(f) Recapture provisions shall conform with the recapture provisions applied to "alternative fuel refueling property" credits described in section 30C of the Internal Revenue Code.

(g) For the purposes of this section:

"Alternative fuel refueling infrastructure" means equipment for the storage and dispensing of alternative fuels for the refueling of alternative fuel vehicles, and shall conform with the definition of "alternative fuel refueling property" contained in section 30C of the Internal Revenue Code.

(h) The director of taxation shall prepare any forms that may be necessary to claim a tax credit under this section. The director may also require the taxpayer to furnish reasonable information to ascertain the validity of the claim for credit made under this section and may adopt rules necessary to effectuate the purposes of this section pursuant to chapter 91.

(i) If the tax credit under this section exceeds the taxpayer's income tax liability, the excess of the credit over liability may be used as a credit against the taxpayer's income tax liability in subsequent years until exhausted. Every claim, including amended claims, for a tax credit under this section shall be filed on or before the end of the twelfth month following the close of the taxable year for which the credit may be claimed. Failure to comply with the foregoing provision shall constitute a waiver of the right to claim the credit.

(j) This tax credit applies to alternative fuel refueling infrastructure placed in service after July 1, 2009 and before January 1, 2016."

SECTION 29. Chapter ___, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§ - Designation of parking spaces for electric vehicles.** All commercial and public parking lots with at least 100 parking spaces shall designate at least one prime (near the entrance) spot exclusively for electric vehicles. An additional electric vehicle parking location shall be required for each additional 100 parking spaces in the lot; the additional spaces shall be located either near the building entrance or near electrical service, at the discretion of the facility manager. Such spaces shall be designated, clearly marked, and enforced by December 31, 2010.

For the purposes of this section, "electric vehicle" means an electric vehicle or neighborhood electric vehicle with an electric vehicle ("EV") license plate."

SECTION 30. Chapter 291, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§291- Parking spaces reserved for electric vehicles; penalties.** (a) Beginning January 1, 2011, any person who parks a non-electric vehicle in a space designated and marked as reserved for electric vehicles shall receive a warning. (b) Beginning July 1, 2011, any person who parks a non-electric vehicle in a space designated and marked as reserved for electric vehicles shall be guilty of a traffic infraction under chapter 291D and shall be fined not less than $50 nor more than $100 and pay any costs incurred by the court related to assessing the fine.

(b) Any citation issued under this chapter may be mailed to the violator pursuant to section 291C-165(b)."

SECTION 31. Chapter ___, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"Electric vehicle charging capability will be required on all new single family housing units constructed after January 1, 2015. Charging capability shall follow standards adopted by SAE International."

SECTION 32. Section 269-1, Hawaii Revised Statutes, subparagraph (2)(G) under the definition of "Public Utility" is modified to read as follows:

"(G) Any person who:

(i) Controls, operates, or manages plants or facilities for the production, transmission, or furnishing of power primarily or entirely from non-fossil fuel sources; [~~and~~]

(ii) Provides, sells, or transmits all of that power, except such power as is used in its own internal operations, directly to a public utility for transmission to the public;

(iii) Any person or business who owns, controls, operates or manages plants or facilities primarily used to charge or discharge a vehicle battery, the purpose of which is to provide the power for vehicle propulsion;"

PART XI

TRANSPORTATION ENERGY INCENTIVES

SECTION 33. Chapter 237, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§237- Exemption of sale or lease of certain vehicles.** (a) Beginning January 1, 2010 and expiring December 31, 2015, there shall be exempted from and excluded from the measure of the taxes imposed by this chapter all of the gross proceeds arising from the sale or lease of new or used light duty vehicles classified as alternative fuel vehicles and fuel economy leader vehicles.

(b) As used in this section:

"Alternative fuel" means alcohol fuels; mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; biodiesel; mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels; other fuels derived from biological materials; and electricity provided by off-board energy sources.

"Alternative fuel vehicle" means a vehicle capable of operating on an alternative fuel.

"Fuel economy leader vehicle" means a vehicle that is identified by the United States Environmental Protection Agency as a "Fuel Economy Leader" in its class and model year.

"Light duty vehicle" means a light duty truck or light duty vehicle, as such terms are defined under section 216(7) of the Clean Air Act (42 U.S.C. §7550(7)), having a gross vehicle weight rating of 8,500 pounds or less."

SECTION 34. Section 238-9.5, Hawaii Revised Statutes, is amended to read as follows:

"**§238-9.5 Motor vehicle importation; report by dealers; proof of payment.** (a) Every dealer, as defined in section 437-1.1, shall submit a report to the director, on or before the last day of each calendar month, for all motor vehicles delivered by the dealer in the prior month as a courtesy delivery. The report shall contain the name and address of the dealer making the courtesy delivery, name and address of the seller of the vehicle, type of motor vehicle, the landed value of the vehicle, the name and address of the purchaser or importer, the date of importation, and other information relevant to the courtesy delivery as requested by the director.

As used in this section, "courtesy delivery" means the preparation for delivery and the delivery by a dealer of a motor vehicle imported into the State by a person who purchased the motor vehicle from an out-of-state motor vehicle manufacturer or an out-of-state dealer and does not apply to motor vehicles sold by the in-state dealer.

(b) The director of taxation shall prepare forms necessary for individuals importing motor vehicles into the State to prove payment of the use tax necessary to register the motor vehicle.

(c) The tax imposed by this chapter shall not apply to any alternative fuel vehicles and fuel economy leader vehicles exempted under chapter 237."

SECTION 35. Section 286-41, Hawaii Revised Statutes, is amended to read as follows:

"§286-41 Application for registration; full faith and credit to current certificates; this part not applicable to certain equipment. (a) Every owner of a motor vehicle which is to be operated upon the public highways shall, for each vehicle owned, except as herein otherwise provided, apply to the director of finance of the county where the vehicle is to be operated, for the registration thereof. If a vehicle is moved to another county and is to be operated upon the public highways of that county, the existing certificate of registration shall be valid until its expiration date, at which time the owner shall apply to the director of finance of the county in which the vehicle is then located for the registration of the vehicle, whether or not the owner is domiciled in the county or the owner's principal place of business is in that county, except that this provision shall not apply to vehicles which are temporarily transferred to another county for a period of not more than three months.

(b) Application for the registration of a vehicle shall be made upon the appropriate form furnished by the director of finance and shall contain the name, occupation, and address of the owner and legal owner; and, if the applicant is a member of the United States naval or military forces, the applicant shall give the organization and station. All applications shall also contain a description of the vehicle, including the name of the maker, the type of fuel for the use of which it is adapted (e.g., gasoline, diesel oil, liquefied petroleum gas), the serial or motor number, and the date first sold by the manufacturer or dealer, and such further description of the vehicle as is called for in the form, and such other information as may be required by the director of finance, to establish legal ownership. A person applying for initial registration of a neighborhood electric vehicle shall certify in writing that a notice of the operational restrictions applying to the vehicle as provided in section 291C-134 are contained on a permanent notice attached to or painted on the vehicle in a location that is in clear view of the driver.

(c) If the vehicle to be registered is specially constructed, reconstructed, or rebuilt; is a special interest vehicle; or is an imported vehicle, this fact shall be stated in the application and upon the registration of the special interest motor vehicle and imported motor vehicle, which has been registered until that time in any other state or county, and the owner shall surrender to the director of finance the certificates of registration or other evidence of such form of registration as may be in the applicant's possession or control. The director of finance shall grant full faith and credit to the currently valid certificates of title and registration describing the vehicle, the ownership thereof, and any liens noted thereon, issued by any title state or county in which the vehicle was last registered. The acceptance by the director of finance of a certificate of title or of registration issued by another state or county, as provided in this subsection, in the absence of knowledge that the certificate is forged, fraudulent, or void, shall be a sufficient determination of the genuineness and regularity of the certificate and of the truth of the recitals therein, and no liability shall be incurred by any officer or employee of the director of finance by reason of so accepting the certificate.

(d) The owner of every motor vehicle of the current, previous, and subsequent year model bought out-of-state, subsequently brought into the State, and subject to the use tax under chapter 238 shall provide with the application for registration proof of payment of the use tax pursuant to requirements established by the department of taxation. No registration certificate shall be issued without proof of payment of the use tax unless the vehicle is an alternative fuel vehicle or fuel economy leader vehicle exempt from the use tax as provided in chapter 238.

(e) Notwithstanding any other law to the contrary, the director of finance of the county in which the application for registration is sought shall not require proof of insurance as a condition to satisfy the requirements of this part. This subsection shall apply only to the initial registration of any motor vehicle.

(f) The provisions of this part requiring the registration of motor vehicles shall not apply to:

(1) Special mobile equipment;

(2) Implements of husbandry temporarily drawn, moved, or otherwise propelled upon the public highways; and

(3) Aircraft servicing vehicles which are being used exclusively on lands set aside to the department of transportation for airport purposes.

(g) Beginning January 1, 2010 and expiring December 31, 2015, the motor vehicle registration fee and other fees, if any, assessed upon or associated with the registration of an electric vehicle in this State, including any fees associated with the issuance of an electric vehicle license plate, shall be waived."

SECTION 36. Chapter ___, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"§ - Transportation energy transformation grant fund. (a) There is established a special fund to be designated as the transportation energy transformation grant fund. Moneys transferred to the transportation energy transformation grant fund may be expended by the director to carry out the director's duties and obligations under this article. Disbursements from the transportation energy transformation grant fund shall not be subject to chapter 42F or 103D.

(b) As used in this article:

"Director" means the director of ___.

"Electric vehicle" has the same meaning as contained in Title 26, Section 30, of the Internal Revenue Code, for 'new qualified plug-in electric drive motor vehicle,' and means a motor vehicle, including a plug-in hybrid electric vehicle:

(1) which draws propulsion using a traction battery with at least 4 kilowatt hours of capacity;

(2) which uses an off-board source of energy to recharge such battery;

(4) the original use of which commences with the taxpayer; and

(5) which is acquired for use or lease by the taxpayer and not for resale.

"Fleet" means more than fifty light duty vehicles in the state owned or operated by related entities.

"Integrated intelligently with the electrical grid" means that the demand of the vehicle for electricity from the grid is controlled, to reduce the electrical demand on the grid during peak demand times and maximize the use of renewable energy sources or use of renewable energy potentially available off peak that would otherwise be curtailed.

(c) The transportation energy transformation grant fund may be used by the director to make transportation energy transformation grants authorized under this article. The transportation energy transformation grant fund shall also be used by the director to pay for any administrative and operational costs, including personnel costs and marketing costs, associated with a transportation energy transformation grant program. Any law to the contrary notwithstanding, the director may use the moneys in the transportation energy transformation grant fund to employ or retain, by contract or otherwise, without regard to chapters 76 and 78, necessary professional, expert, managerial, technical, and support personnel to implement and carry out the purposes of this article.

(d) Before June 30 of each calendar year, fifty per cent of the grants shall be reserved for non fleet vehicles and no more than ten per cent of the grants may be provided to any one fleet.

(e) Subject to the availability of funds and the standards in this chapter, grants for approved electric vehicles shall be provided to purchasers of electric vehicles intended to be integrated intelligently with the electrical grid and licensed for use on Hawaii's highways, as follows:

(1) Beginning January 1, 2010 and expiring December 31, 2010: up to $4000 per vehicle; limited to the first 500 vehicles.

(2) Beginning January 1, 2011 and expiring December 31, 2011: up to $3500 per vehicle; limited to the first 1000 vehicles.

(3) Beginning January 1, 2012 and expiring December 31, 2013: up to $2500 per vehicle; limited to the first 2000 vehicles per year.

(4) Beginning January 1, 2014 and expiring December 31, 2015: up to $2000 per vehicle; limited to the first 2500 vehicles per year.

(5) Beginning January 1, 2016 and expiring December 31, 2021: up to $500 per vehicle; limited to the first 10000 vehicles per year.

(g) The description, specifications, guidelines, and requirements for intelligent integration with the electrical grid shall be further developed and determined by the director at the director's sole discretion. The director may amend, narrow, or expand the definitions, description, specifications, and requirements of intelligent integration.

(h) A grant may be made to an applicant only if the applicant:

(1) Has met the descriptions, specifications, guidelines, and requirements established by the director for the grant program;

(2) Has filed a completed application form, as determined solely by the director, together with all supporting documentation required by the director;

(3) Has, in the case of a fleet, filed together completed grant applications for all vehicles in the fleet;

(4) Has completed the purchase or lease, licensing, and registration of the vehicle, prior to applying for the grant;

(5) Has provided any other information deemed necessary by the director; and

(6) Has met all additional requirements needed to implement the grant program as determined by the director.

<u>(i) The director shall include information on the transportation energy transformation grant fund and statistical information on program participation in the department's annual report to the governor and the legislature.</u>

SECTION 37. There is appropriated out of the general revenues of the State of Hawaii the sum of $3,750,000 to develop and implement transportation energy transformation grant fund. The sum appropriated shall be expended by the department of ______. The appropriation shall not lapse at the end of the fiscal biennium for which the appropriation is made; such unexpended appropriation, if any, shall be carried forward to the next calendar year and used to provide additional grants at the new rate; provided that all moneys from the appropriation unencumbered as of December 31, 2021, shall lapse as of that date.

SECTION 38. Section 235-110.3, Hawaii Revised Statutes, is amended to read as follows:

"**§235-110.3 [~~Ethanol~~] <u>Biofuel</u> facility tax credit.** (a) Each year during the credit period, there shall be allowed to each taxpayer subject to the taxes imposed by this chapter, [~~an ethanol~~] a biofuel facility tax credit that shall be applied to the taxpayer's net income tax liability, if any, imposed by this chapter for the taxable year in which the credit is properly claimed.

For each qualified [~~ethanol~~] biofuel production facility, the annual dollar amount of the [~~ethanol~~] biofuel facility tax credit during the eight-year period shall be equal to thirty per cent of its nameplate capacity if the nameplate capacity is greater than five hundred thousand [~~but less than fifteen million~~] gallons. A taxpayer may claim this credit for the first fifteen million gallons of capacity of each qualifying [~~ethanol~~] biofuel facility; provided that:

(1) The claim for this credit by any taxpayer of a qualifying [~~ethanol~~] biofuel production facility shall not exceed one hundred per cent of the total of all investments made by the taxpayer in the qualifying [~~ethanol~~] biofuel production facility prior to and during the credit period;

(2) The qualifying [~~ethanol~~] biofuel production facility operated at a level of production of at least seventy-five per cent of its nameplate capacity on an annualized basis;

(3) The qualifying [~~ethanol~~] biofuel production facility is in production on or before January 1, 2017; and

(4) No taxpayer that claims the credit under this section shall claim any other tax credit under this chapter for the same taxable year.

(b) As used in this section:

"Biofuel" means ethanol, biodiesel, diesel, jet fuel, or other liquid fuel meeting the relevant fuel specifications of ASTM International (formerly ASTM, the American Society for Testing and Materials).

"Credit period" means a maximum period of eight years beginning from the first taxable year in which the qualifying [~~ethanol~~] biofuel production facility begins production even if actual production is not at seventy-five per cent of nameplate capacity.

"Investment" means a nonrefundable capital expenditure related to the development and construction of any qualifying [~~ethanol~~] biofuel production facility, including processing equipment, waste treatment systems, pipelines, and liquid storage tanks at the facility or remote locations, including expansions or modifications. Capital expenditures shall be those direct and certain indirect costs determined in accordance with section 263A of the Internal Revenue Code, relating to uniform capitalization costs, but shall not include expenses for compensation paid to officers of the taxpayer, pension and other related costs, rent for land, the costs of repairing and maintaining the equipment or facilities, training of operating personnel, utility costs during construction, property taxes, costs relating to negotiation of commercial agreements not related to development or construction, or service costs that can be identified specifically with a service department or function or that directly benefit or are incurred by reason of a service department or function. For the purposes of determining a capital expenditure under this section, the provisions of section 263A of the Internal Revenue Code shall apply as it read on March 1, 2004. For purposes of this section, investment excludes land costs and includes any investment for which the taxpayer is at risk, as that term is used in section 465 of the Internal Revenue Code (with respect to deductions limited to amount at risk).

"Nameplate capacity" means the qualifying [~~ethanol~~] biofuel production facility's production design capacity, in gallons of motor fuel grade ethanol per year.

"Net income tax liability" means net income tax liability reduced by all other credits allowed under this chapter.

"Qualifying [~~ethanol~~] biofuel production" means [~~ethanol~~] biofuel produced from renewable, organic feedstocks, or waste materials, including municipal solid waste. All qualifying production shall be fermented, distilled, gasified, or produced by physical chemical conversion methods such as reformation and catalytic conversion and dehydrated at the facility.

"Qualifying [~~ethanol~~] biofuel production facility" or "facility" means a facility located in Hawaii which produces [~~motor~~] fuel grade [~~ethanol meeting the minimum specifications by the American Society of Testing and Materials standard D-4806, as amended~~] biofuel.

(c) In the case of a taxable year in which the cumulative claims for the credit by the taxpayer of a qualifying [~~ethanol~~] biofuel production facility exceeds the cumulative investment made in the qualifying [~~ethanol~~] biofuel production facility by the taxpayer, only that portion that does not exceed the cumulative investment shall be claimed and allowed.

(d) The department of business, economic development, and tourism shall:

(1) Maintain records of the total amount of investment made by each taxpayer in a facility;

(2) Verify the amount of the qualifying investment;

(3) Total all qualifying and cumulative investments that the department of business, economic development, and tourism certifies; and

(4) Certify the total amount of the tax credit for each taxable year and the cumulative amount of the tax credit during the credit period.

Upon each determination, the department of business, economic development, and tourism shall issue a certificate to the taxpayer verifying the qualifying investment amounts, the credit amount certified for each taxable year, and the cumulative amount of the tax credit during the credit period. The taxpayer shall file the certificate with the taxpayer's tax return with the department of taxation. Notwithstanding the department of business, economic development, and tourism's certification authority under this section, the director of taxation may audit and adjust certification to conform to the facts.

If in any year, the annual amount of certified credits reaches $12,000,000 in the aggregate, the department of business, economic development, and tourism shall immediately discontinue certifying credits and notify the department of taxation. In no instance shall the total amount of certified credits exceed $12,000,000 per year. Notwithstanding any other law to the contrary, this information shall be available for public inspection and dissemination under chapter 92F.

(e) If the credit under this section exceeds the taxpayer's income tax liability, the excess of credit over liability shall be refunded to the taxpayer; provided that no refunds or payments on account of the tax credit allowed by this section shall be made for amounts less than $1. All claims for a credit under this section must be properly filed on or before the end of the twelfth month following the close of the taxable year for which the credit may be claimed. Failure to comply with the foregoing provision shall constitute a waiver of the right to claim the credit.

(f) If a qualifying [~~ethanol~~] biofuel production facility or an interest therein is acquired by a taxpayer prior to the expiration of the credit period, the credit allowable under subsection (a) for any period after such acquisition shall be equal to the credit that would have been allowable under subsection (a) to the prior taxpayer had the taxpayer not disposed of the interest. If an interest is disposed of during any year for which the credit is allowable under subsection (a), the credit shall be allowable between the parties on the basis of the number of days during the year the interest was held by each taxpayer. In no case shall the credit allowed under subsection (a) be allowed after the expiration of the credit period.

[~~(g) Once the total nameplate capacities of qualifying ethanol production facilities built within the State reaches or exceeds a level of forty million gallons per year, credits under this section shall not be allowed for new ethanol production facilities. If a new facility's production capacity would cause the statewide ethanol production capacity to exceed forty million gallons per year, only the ethanol production capacity that does not exceed the statewide forty million gallon per year level shall be eligible for the credit.~~]

[~~(h)~~] (g) Prior to construction of any new qualifying [~~ethanol~~] biofuel production facility, the taxpayer shall provide written notice of the taxpayer's intention to begin construction of a qualifying [~~ethanol~~] biofuel production facility. The information shall be provided to the department of taxation and the department of business, economic development, and tourism on forms provided by the department of business, economic development, and tourism, and shall include information on the taxpayer, facility location, facility production capacity, anticipated production start date, and the taxpayer's contact information. Notwithstanding any other law to the contrary, this information shall be available for public inspection and dissemination under chapter 92F.

[~~(i)~~] (h) The taxpayer shall provide written notice to the director of taxation and the director of business, economic development, and tourism within thirty days following the start of production. The notice shall include the production start date and expected [~~ethanol~~] biofuel fuel production for the next twenty-four months. Notwithstanding any other law to the contrary, this information shall be available for public inspection and dissemination under chapter 92F.

[~~(j)~~] (i) If a qualifying [~~ethanol~~] biofuel production facility fails to achieve an average annual production of at least seventy-five per cent of its nameplate capacity for two consecutive years, the stated capacity of that facility may be revised by the director of business, economic development, and tourism to reflect actual production for the purposes of determining [~~statewide production capacity under subsection (g) and~~] allowable credits for that facility under subsection (a). Notwithstanding any other law to the contrary, this information shall be available for public inspection and dissemination under chapter 92F.

[~~(k)~~](j) Each calendar year during the credit period, the taxpayer shall provide information to the director of business, economic development, and tourism on the [~~number of~~] gallons [~~of ethanol~~] and type of biofuel produced and sold during the previous calendar year, how much was sold in Hawaii versus overseas, percentage of Hawaii-grown feedstocks and other feedstocks used for [~~ethanol~~] biofuel production, the number of employees of the facility, and the projected [~~number of~~] gallons [~~of ethanol~~] and type of biofuel production for the succeeding year.

[~~(l)~~](k) In the case of a partnership, S corporation, estate, or trust, the tax credit allowable is for every qualifying [~~ethanol~~] biofuel production facility. The cost upon which the tax credit is computed shall be determined at the entity level. Distribution and share of credit shall be determined pursuant to section 235-110.7(a).

[~~(m)~~](l) Following each year in which a credit under this section has been claimed, the director of business, economic development, and tourism shall [~~submit a written~~] include in its annual report to the governor and legislature [~~regarding the~~

~~production and sale of ethanol. The report shall include~~] the following:

(1) The number, location, and nameplate capacities of qualifying [~~ethanol~~] biofuel production facilities in the State;

(2) The total number of gallons of [~~ethanol~~] biofuel produced and sold during the previous year; and

(3) The projected number of gallons of [~~ethanol~~] biofuel production for the succeeding year.

[~~(n)~~] (m) The director of taxation shall prepare forms that may be necessary to claim a credit under this section. Notwithstanding the department of business, economic development, and tourism's certification authority under this section, the director may audit and adjust certification to conform to the facts. The director may also require the taxpayer to furnish information to ascertain the validity of the claim for credit made under this section and may adopt rules necessary to effectuate the purposes of this section pursuant to chapter 91."

SECTION 39. Section 251-2, Hawaii Revised Statutes, is amended to read as follows:

"§251-2 **Rental motor vehicle and tour vehicle surcharge tax.** (a) There is levied and shall be assessed and collected each month a rental motor vehicle surcharge tax of $2 a day, except that for the period of September 1, 1999, to August 31, 2011, the tax shall be $3 a day, or any portion of a day that a rental motor vehicle is rented or leased. The rental motor vehicle surcharge tax shall be levied upon the lessor; provided that the tax shall not be levied on the lessor if:

(1) The lessor is renting the vehicle to replace a vehicle of the lessee that is being repaired; and

(2) A record of the repair order for the vehicle is retained either by the lessor for two years for verification purposes or by a motor vehicle repair dealer for two years as provided in section 437B-16.

(b) There is levied and shall be assessed and collected each month a tour vehicle surcharge tax of:

(1) $65 for each tour vehicle used or partially used during the month that falls into the over twenty-five passenger seat category; and

(2) $15 for each tour vehicle used or partially used during the month that falls into the eight to twenty-five passenger seat category.

The tour vehicle surcharge tax shall be levied upon the tour vehicle operator.

(c) For the period of January 1, 2010 through December 31, 2015, up to two hundred alternative fueled light duty vehicles per rental car fleet shall be exempt from the rental motor vehicle surcharge tax.

(d) For the purposes of this section:

"Alternative fuel" means alcohol fuels; mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; biodiesel; mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels; other fuels derived from biological materials; and electricity provided by off-board energy sources.

"Alternative fuel vehicle" means a vehicle capable of operating on an alternative fuel.

"Light duty vehicle" means a light duty truck or light duty vehicle, as such terms are defined under section 216(7) of the Clean Air Act (42 U.S.C. §7550(7)), having a gross vehicle weight rating of 8,500 pounds or less."

"Rental car fleet" refers to all vehicles in the state owned or operated by related entities."

PART XII

TRANSPORTATION ENERGY REQUIREMENTS

SECTION 40. Section 103D-412, Hawaii Revised Statutes, is amended to read as follows:

"**§103D-412 [~~Energy-efficient vehicles~~] Light-duty vehicle requirements.** (a) The procurement policy for all agencies purchasing or leasing [~~motor~~] light duty vehicles shall be to [~~obtain energy-efficient vehicles~~] reduce dependence on petroleum for transportation energy. [~~All covered fleets are directed to procure increasing percentages of energy-efficient vehicles as part of their annual vehicle acquisition plans, which shall be as follows~~]

[~~(1) In the fiscal year beginning July 1, 2006, at least twenty per cent of newly purchased light-duty vehicles acquired by each covered fleet shall be energy-efficient vehicles;~~

~~(2) In the fiscal year beginning July 1, 2007, at least thirty per cent of newly purchased light-duty vehicles acquired by each covered fleet shall be energy-efficient vehicles;~~

~~(3) In the fiscal year beginning July 1, 2008, at least forty per cent of newly purchased light-duty vehicles acquired by each covered fleet shall be energy-efficient vehicles; and~~

~~(4) For each subsequent fiscal year, the percentage of energy-efficient vehicles newly purchased shall be five percentage points higher than the previous year, until at least seventy-five per cent of each covered fleet's newly purchased, light-duty vehicles are energy-efficient vehicles.~~]

Beginning January 1, 2010, all State and County entities shall, when purchasing new vehicles, seek vehicles with reduced dependence on petroleum-based fuels, in the following descending order of priority:

(1) The agency shall first evaluate any available electric or plug-in hybrid electric vehicle and, if it meets the needs of the agency, such vehicle shall be selected.

(2) If an electric or plug-in hybrid electric vehicle that meets the needs of the agency is not available, the agency may select a hydrogen or fuel cell vehicle.

(3) If a hydrogen or fuel cell vehicle that meets the needs of the agency is not available, the agency may select a flexible fuel vehicle.

(4) If a flexible fuel vehicle that meets the needs of the agency is not available, the agency may select a hybrid electric vehicle.

(5) If a hybrid electric vehicle that meets the needs of the agency is not available, the agency shall select a vehicle that is identified by the United States Environmental Protection Agency in its annual "Fuel Economy Leaders" report as being among the top performers for fuel economy in its class.

(b) For the purposes of this section:

"Agency" means a state agency, office, or department.

"Alternative fuel" [has the same meaning as contained in 10 Code of Federal Regulations Part 490] means alcohol fuels; mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; biodiesel; mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels; other fuels derived from biological materials; and electricity provided by off-board energy sources.

"Covered fleet" has the same meaning as contained in 10 Code of Federal Regulations Part 490 Subpart C.

[~~"Energy-efficient vehicle" means a vehicle that:~~

~~(1) Is capable of using an alternative fuel;~~

~~(2) Is powered primarily through the use of an electric battery or battery pack that stores energy produced by an electric motor through regenerative braking to assist in vehicle operation;~~

~~(3) Is propelled by power derived from one or more cells converting chemical energy directly into electricity by combining oxygen with hydrogen fuel that is stored on board the vehicle in any form;~~

~~(4) Draws propulsion energy from onboard sources of stored energy generated from an internal combustion or heat engine using combustible fuel and a rechargeable energy storage system; or~~

~~(5) Is on the list of "Most Energy Efficient Vehicles" in its class or is in the top one-fifth of the most energy-efficient vehicles in its class available in Hawaii as shown by vehicle fuel efficiency lists, rankings, or reports maintained by the United States Environmental Protection Agency.~~]

"Excluded vehicles" has the same meaning as provided in 10 Code of Federal Regulations Section 490.3.

"Light-duty vehicle" has the same meaning as contained in 10 Code of Federal Regulations Part 490. It does not include any vehicle incapable of traveling on highways or any vehicle with a gross vehicle weight rating greater than 8,500 pounds.

[~~(c) Agencies may offset energy-efficient vehicle purchase requirements by successfully demonstrating percentage improvements in overall light-duty vehicle fleet mileage economy. The offsets shall be measured against the fleet average miles per gallon of petroleum-based gasoline and diesel fuel, using the fiscal year beginning July 1, 2006, as a baseline, on a percentage-by-percentage basis.~~

~~(d) Agencies that use biodiesel fuel may offset the vehicle purchase requirements of this section at the rate of one vehicle for each four hundred fifty gallons of neat biodiesel fuel used. Neat biodiesel fuel is one hundred per cent biodiesel (B100) by volume.~~]

[~~(e)~~](c) Agencies may apply to the chief procurement officer for exemptions from the requirements of this section to the extent that the vehicles required by this section are not available or do not meet the specific needs of the agency. Life cycle vehicle and fuel costs may be included in the determination of whether a particular vehicle meets the needs of the agency. Estimates of future fuel prices shall be based on projections from the United States Energy Information Administration.

[~~(f)~~](d) Vehicles acquired from another state agency and excluded vehicles are exempt from the requirements of this section.

[~~(g)~~](e) Nothing in this section is intended to interfere with [~~an agency's~~] the ability of a covered fleet to comply with the [~~federally-imposed~~] vehicle purchase mandates [~~such as those~~] required by 10 Code of Federal Regulations Part 490 Subpart C."

SECTION 41. Section 196-9(c), Hawaii Revised Statutes, is amended to read as follows:

"(c) With regard to motor vehicles and transportation fuel, each agency shall:

(1) Comply with Title 10, Code of Federal Regulations, Part 490, Subpart C, "Mandatory State Fleet Program", if applicable;

(2) Comply with all applicable state laws regarding vehicle purchases;

(3) Once federal and state vehicle purchase mandates have been satisfied, purchase the most fuel-efficient vehicles that meet the needs of their programs; provided that life cycle cost-benefit analysis of vehicle purchases shall include projected fuel costs;

(4) Purchase alternative fuels and ethanol blended gasoline when available;

(5) [~~Evaluate a purchase preference for~~] Purchase biodiesel blends, [~~as applicable to agencies with diesel fuel purchases~~] in accordance with Chapter 103D;

(6) Promote efficient operation of vehicles;

(7) Use the most appropriate minimum octane fuel; [~~provided that~~] vehicles shall use 87-octane fuel unless the owner's manual for the vehicle states otherwise or the engine experiences knocking or pinging;

(8) [~~Beginning with fiscal year 2005-2006 as the baseline, collect~~] Collect and maintain, for [~~the life of~~] each vehicle acquired, the following data:

(A) Vehicle acquisition cost;

(B) United States Environmental Protection Agency rated fuel economy;

(C) Vehicle fuel configuration, such as gasoline, diesel, flex-fuel gasoline/E85, and dedicated propane;

(D) Actual in-use vehicle mileage;

(E) Actual in-use vehicle fuel consumption; and

(F) Actual in-use annual average vehicle fuel economy[~~; and~~].

(9) [~~Beginning with fiscal year 2005-2006 as the baseline with respect to each~~] Each agency that operates a fleet of thirty or more vehicles[~~,~~] shall collect and maintain, in addition to the data in paragraph (8), the following:

(A) Information on the vehicles in the fleet, including vehicle year, make, model, gross vehicle weight rating, and vehicle fuel configuration;

(B) Fleet fuel usage, by fuel;

(C) Fleet mileage; and

(D) Overall annual average fleet fuel economy and average miles per gallon of gasoline and diesel."

SECTION 42. Section 103D-1012, Hawaii Revised Statutes, is amended to read as follows:

"**§103D-1012 Biofuel preference.** (a) Notwithstanding any other law to the contrary, contracts for the purchase of diesel fuel or boiler fuel shall be awarded to the lowest responsible and responsive bidders, with preference given to bids for biofuels or blends of biofuel and petroleum fuel.

(b) When purchasing fuel for use in diesel engines, the preference shall be [~~five cents~~] twenty per cent per gallon of one hundred per cent [~~biodiesel~~] biomass-based diesel. For blends containing both [~~biodiesel~~] biomass-based diesel and petroleum-based diesel, the preference shall be applied only to the [~~biodiesel~~] biomass-based diesel portion of the blend.

(c) When purchasing fuel for use in boilers, the preference shall be [~~five cents~~] twenty per cent per gallon of one hundred per cent biofuel. For blends containing both biofuel and petroleum-based boiler fuel, the preference shall be applied only to the biofuel portion of the blend.

(d) As used in this section, "biodiesel" means a vegetable oil-based fuel that meets ASTM International standard D6751, "Standard Specification for Biodiesel (B100) Fuel Blend Stock for Distillate Fuels", as amended.

(e) As used in this section, "biofuel" means fuel from non-petroleum plant or animal based sources that can be used for the generation of heat or power.

(f) As used in this section, “biomass-based diesel” means biodiesel or diesel fuel substitute produced in Hawaii from biomass, provided that the fuel is registered with the Environmental Protection Agency for use in on-road engines and meets ASTM International fuel specifications for use in diesel engines.

(g) Beginning January 1, 2012, all State-owned diesel vehicles and equipment are required to be fueled with blends of biomass-based diesel, subject to the availability of the fuel and so long as the price is no greater than 20% more per gallon than the price of conventional diesel."

SECTION 43. Chapter 196, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§196- Alternative fuel vehicle requirement for fleets.** (a) Beginning January 1, 2012, each fleet operator controlling more than fifty light duty vehicles in the state shall, when replacing its light duty vehicles or expanding its fleet, acquire increasing percentages of vehicles capable of operating on non-petroleum energy sources, including electric vehicles, flexible fuel vehicles, or other alternative fuel vehicles.

(b) At least 4% of all new light duty vehicles acquired by a fleet operator in the state during the calendar year of 2012 shall be alternative fuel vehicles. This percentage shall increase by four per cent per year, reaching seventy-six per cent in the calendar year 2030.

(c) For the purposes of this section:

"Acquire" means to take into possession or control, whether by lease, purchase, or other arrangement.

"Alternative fuel" means alcohol fuels; mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; biodiesel; mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels; other fuels derived from biological materials; and electricity provided by off-board energy sources.

"Alternative fuel vehicle" means a vehicle capable of operating on an alternative fuel.

"Electric vehicle" means a vehicle powered by electricity. It does not include a neighborhood electric vehicle or any vehicle that is not designed to obtain electricity from sources outside the vehicle.

"Fleet operator" means an entity controlling more than fifty light duty vehicles for use in a business enterprise, including vehicle rental, but does not include vehicles held for retail sale.

"Light-duty vehicle" has the same meaning as contained in 10 Code of Federal Regulations Part 490. It does not include any vehicle incapable of traveling on highways or any vehicle with a gross vehicle weight rating greater than 8,500 pounds.

(d) A fleet operator and its affiliates may aggregate their vehicle purchases.

(e) Fleet operators acquiring vehicles earlier than the program start date or in excess of the number of vehicles required will be able to accumulate alternative fuel vehicle credits, which may be traded, sold, or banked for later use in meeting vehicle acquisition requirements.

(f) Fleet operators shall file annual reports with the energy resources coordinator. Reports shall be for each calendar year, and shall conform to the format, content, and reporting requirements specified by the energy resources coordinator.

Reports shall be filed by June 30 following the close of the calendar year of the report.

(g) Fleet operators may apply to the energy resources coordinator for exemptions from the requirements of this section to the extent that the vehicles required by this section are not available or do not meet the specific needs of the fleet. To be eligible for an exemption, a fleet operator must be able to demonstrate having made a good faith effort to comply with the requirements.

(h) Any fleet operator or any other person violating the requirements of this section may be subject to a fine of up to $1000 per nonconforming vehicle and up to $50 per day per annual report.

(i) The energy resources coordinator, in accordance with chapter 91, shall adopt rules for the administration and enforcement of this section."

SECTION 44. Chapter 196, Hawaii Revised Statutes, is amended by adding a new section to be appropriately designated and to read as follows:

"**§196- Alternative fuel light duty vehicle sales requirement.** (a) Beginning January 1, 2015, each motor vehicle dealer with sales of more than fifty light duty vehicles per year in Hawaii shall increase the percentages of new and used light duty vehicle sales represented by vehicles capable of operating on non-petroleum energy sources, including electric vehicles, flexible fuel vehicles, or other alternative fuel vehicles, as follows:

(1) Ten per cent of its annual light duty vehicle sales for each calendar year between January 1, 2015 and December 31, 2019;

(2) Twenty per cent of its annual light duty vehicle sales for each calendar year between January 1, 2020 and December 31, 2024;

(3) Fifty per cent of its annual light duty vehicle sales for each calendar year between January 1, 2025 and December 31, 2029; and

(4) Seventy-five per cent of its annual light duty vehicle sales for each calendar year after January 1, 2030.

(b) For the purposes of this section:

"Alternative fuel" means alcohol fuels; mixtures containing eighty-five per cent or more by volume of alcohols with gasoline or other fuels; natural gas; liquefied petroleum gas; hydrogen; biodiesel; mixtures containing twenty per cent or more by volume of biodiesel with diesel or other fuels; other fuels derived from biological materials; and electricity provided by off-board energy sources.

"Alternative fuel vehicle" means a vehicle capable of operating on an alternative fuel.

“Electric vehicle” means a vehicle powered by electricity. It does not include a neighborhood electric vehicle or any vehicle that is not designed to obtain electricity from sources outside the vehicle.

"Light-duty vehicle" has the same meaning as contained in 10 Code of Federal Regulations Part 490. It does not include any vehicle incapable of traveling on highways or any vehicle with a gross vehicle weight rating greater than 8500 pounds.

"Motor vehicle dealer" means a new motor vehicle dealer or a used motor vehicle dealer, as such terms are defined in Chapter 437 of the Hawaii Revised Statutes.

"Sale" means the transfer of control, whether by lease, sale, or other arrangement, for a period greater than six months.

(c) Dealers may acquire credits for alternative fuel vehicle sales earlier than or in excess of the required amounts. These credits may be banked, sold, or transferred to the dealer’s affiliates or other motor vehicle dealers in the state.

Such credits may be used to offset an equivalent number of required vehicle sales.

(d) Each dealer shall file an annual report with the energy resources coordinator reporting on number and type of alternative fuel vehicles and non alternative fuel light duty vehicles sold during the previous calendar year, as well as any vehicle credits sold, purchased, traded, or banked. Reports shall be for each calendar year, and shall conform with the format, content, and reporting requirements specified by the energy resources coordinator. Reports shall be filed by June 30 following the close of the calendar year of the report.

(e) Any vehicle dealer not meeting the alternative fuel vehicle percentage requirement shall include in its report an explanation for not meeting the requirement.

(f) Motor vehicle dealers may apply to the energy resources coordinator for exemptions from the requirements of this section to the extent that the vehicles or credits required by this section were not available. To be eligible for an exemption, a motor vehicle dealer must be able to demonstrate having made a good faith effort to comply with the requirements.

(g) Any motor vehicle dealer or any other person violating the requirements of this section may be subject to a fine of up to $1000 per nonconforming vehicle and up to $50 per day per annual report.

(h) Failure to file the required reports or to comply with the vehicle sales requirements of this section may be grounds for referral to the motor vehicle industry board for disciplinary action.

(i) The energy resources coordinator, in accordance with chapter 91, shall adopt rules for the administration and enforcement of this section."

SECTION 45. Chapter 437-28, Hawaii Revised Statutes, is amended by amending paragraph (a)(2) to read as follows:

"(2) Has failed to comply with, observe, or adhere to any provision of this chapter or any other law relating to the sale, taxing, or licensing of motor vehicles or any rule or order made pursuant to this chapter[~~;~~], or has been referred to the board by the state energy resources coordinator for failing to comply with state alternative fuel vehicle requirements;"

PART XIII

TRANSPORTATION ENERGY PLANS AND STUDIES

SECTION 46. The Department of Accounting and General Services shall develop an implementation plan for installation of electric vehicle charging stations at State owned parking facilities.

SECTION 47. Section 286-172, Hawaii Revised Statutes, is amended to read as follows:

"**§286-172 Furnishing of information.** (a) Subject to authorization granted by the chief justice with respect to the traffic records of the violations bureaus of the district courts and of the circuit courts, the director of transportation shall furnish information contained in the statewide traffic records system in response to:

(1) Any request from a state, a political subdivision of a state, or a federal department or agency, or any other authorized person pursuant to rules adopted by the director of transportation under chapter 91;

(2) Any request from a person having a legitimate reason, as determined by the director, as provided under the rules adopted by the director under paragraph (1), to obtain the information for verification of vehicle ownership, traffic safety programs, or for research or statistical reports;

<u>(3) the Energy Resources Coordinator, to track the number and type of vehicles in use and the effectiveness of</u>

efforts to increase the efficiency and diversify the fuel needs of Hawaii's transportation sector; or

[~~(3)~~](4) Any request from a person required or authorized by law to give written notice by mail to owners of vehicles.

(b) Any person requesting information contained in the statewide traffic records system under subsection (a)(2) shall file an affidavit with the director stating the reasons for obtaining the information and making assurances that the information will be used only for such reasons, that individual identities will be properly protected, and that the information will not be used to compile a list of individuals for the purposes of any commercial solicitation by mail or otherwise, or the collection of delinquent accounts or any other purpose not allowed or provided for by the rules.

(c) The information provided to any person qualifying to receive information under subsection (a)(2) shall be provided for a fee and under such conditions as set by the director pursuant to rules adopted by the director under chapter 91. The director shall require the person receiving the information to file with the director a corporate surety bond in favor of the State in the penal sum of not more than $70,000, conditioned upon the full and faithful compliance of the person receiving the information with the terms and conditions of the affidavit and the conditions set by the director. Any person otherwise qualified to receive information under subsection (a)(2) and who complies with the provisions of this section may receive all the information in the motor vehicle registration file if the person either provides information to or performs recalls on behalf of manufacturers of motor vehicles as authorized by the federal government or as deemed necessary by a manufacturer in order to protect the public health, safety, and welfare or to make a free correction of a manufacturing deficiency.

(d) Any person receiving information pursuant to subsection (a)(2) or (3) shall hold harmless the State and any agency thereof from all claims for improper use or release of such information."

SECTION 48. Section 92F-19, Hawaii Revised Statutes, is amended to read as follows:

"**§92F-19 Limitations on disclosure of government records to other agencies.** (a) No agency may disclose or authorize disclosure of government records to any other agency unless the disclosure is:

(1) Necessary for the performance of the requesting agency's duties and functions and is also:

(A) Compatible with the purpose for which the information was collected or obtained; or

(B) Consistent with the conditions or reasonable expectations of use and disclosure under which the information was provided;

(2) To the state archives for the purposes of historical preservation, administrative maintenance, or destruction;

(3) To another agency, another state, or the federal government, or foreign law enforcement agency or authority, if the disclosure is:

(A) For the purpose of a civil or criminal law enforcement activity authorized by law; and

(B) Pursuant to:

(i) A written agreement or written request, or

(ii) A verbal request, made under exigent circumstances, by an officer or employee of the requesting agency whose identity has been verified, provided that such request is promptly confirmed in writing;

(4) To a criminal law enforcement agency of this State, another state, or the federal government, or a foreign criminal law enforcement agency or authority, if the information is limited to an individual's name and other identifying particulars, including present and past places of employment;

(5) To a foreign government pursuant to an executive agreement, compact, treaty, or statute;

(6) To the legislature, or a county council, or any committee or subcommittee thereof;

(7) Pursuant to an order of a court of competent jurisdiction;

(8) To authorized officials of another agency, another state, or the federal government for the purpose of auditing or monitoring an agency program that receives federal, state, or county funding;

(9) To the offices of the legislative auditor, the legislative reference bureau, or the ombudsman of this

State for the performance of their respective functions;

(10) To the department of human resources development, county personnel agencies, or line agency personnel offices for the performance of their respective duties and functions, including employee recruitment and examination, classification and compensation reviews, the administration and auditing of personnel transactions, the administration of training and safety, workers' compensation, and employee benefits and assistance programs, and for labor relations purposes;

(11) To the department of business, economic development, and tourism for the performance of their statutory responsibilities; or

[~~(11)~~](12) Otherwise subject to disclosure under this chapter.

(b) An agency receiving government records pursuant to subsection (a) shall be subject to the same restrictions on disclosure of the records as the originating agency."

SECTION 49. Section 226-17, Hawaii Revised Statutes, is amended to read as follows:

"§226-17 **Objectives and policies for facility systems--transportation.** (a) Planning for the State's facility systems with regard to transportation shall be directed towards the achievement of the following objectives:

(1) An integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe, and convenient movement of people and goods.

(2) A statewide transportation system that is consistent with and will accommodate planned growth objectives throughout the State.

(b) To achieve the transportation objectives, it shall be the policy of this State to:

(1) Design, program, and develop a multi-modal system in conformance with desired growth and physical development as stated in this chapter;

(2) Coordinate state, county, federal, and private transportation activities and programs toward the achievement of statewide objectives;

(3) Encourage a reasonable distribution of financial responsibilities for transportation among participating governmental and private parties;

(4) Provide for improved accessibility to shipping, docking, and storage facilities;

(5) Promote a reasonable level and variety of mass transportation services that adequately meet statewide and community needs;

(6) Encourage transportation systems that serve to accommodate present and future development needs of communities;

(7) Encourage a variety of carriers to offer increased opportunities and advantages to interisland movement of people and goods;

(8) Increase the capacities of airport and harbor systems and support facilities to effectively accommodate transshipment and storage needs;

(9) Encourage the development of transportation systems and programs which would assist statewide economic growth and diversification;

(10) Encourage the design and development of transportation systems sensitive to the needs of affected communities and the quality of Hawaii's natural environment;

(11) Encourage safe and convenient use of low-cost, energy-efficient, non-polluting means of transportation;

(12) Coordinate intergovernmental land use and transportation planning activities to ensure the timely delivery of supporting transportation infrastructure in order to accommodate planned growth objectives; and

(13) [~~Encourage diversification of transportation modes and infrastructure~~] Include transportation energy demand estimates in State-wide and County-wide long-range land transportation plans that utilize travel demand forecasting models in order to promote alternate fuels and energy efficiency."

SECTION 50. Statutory material to be repealed is bracketed and stricken. New statutory material is underscored.

SECTION 51. This Act shall take effect upon its approval.

INTRODUCED BY:______________________________

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Backgrounder

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New Nuclear Plant Designs

Background

The NRC has long sought standardization of nuclear power plant designs, and the enhanced safety and licensing reform that standardization could make possible. The Commission expects advanced reactors to be safer and use simplified, passive or other innovative means to accomplish their safety functions. The NRC's regulation (Part 52 to Title 10 of the Code of Federal Regulations) provides a predictable licensing process including certification of new nuclear plant designs. This process reflects decades of experience and research involving reactor design and operation. The design certification process provides for early public participation and resolution of safety issues prior to an application to construct a nuclear power plant.

Pre-Application Review Process

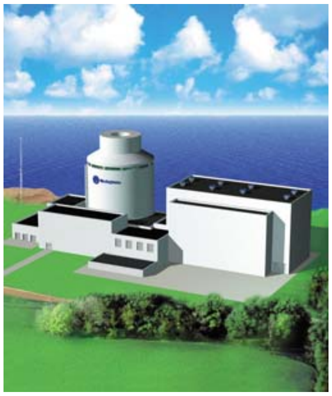
The NRC's "Statement of Policy for Regulation of Advanced Nuclear Power Plants," dated July 8, 1986, encourages early discussions, before a license application is submitted, between NRC and reactor designers to provide licensing guidance. In June 1988, the NRC issued NUREG-1226, "Development and Utilization of the NRC Policy Statement on the Regulation of Advanced Nuclear Power Plants." This document provides guidance on the implementation of the policy and describes the approach used by NRC in its review of advanced reactor design concepts.

In general, the NRC conducts pre-application reviews of advanced reactor designs to indentify:

- major safety issues that could require Commission policy guidance to the staff,
- major technical issues that could be resolved under existing NRC regulations on policy, and
- research needed to resolve identified issues.

Design Certification Review Process

The review process for new reactor designs involves certifying standard reactor designs, independent of a specific site, through a rulemaking (Subpart B of Part 52). This rulemaking can certify a reactor design for 15 years. Design certification applicants must provide the technical information necessary to demonstrate compliance with the safety standards set forth in applicable NRC regulations (10 CFR Parts 20, 50, 73, and 100). Applicants must also provide information to close out unresolved and generic safety issues, as well as issues that arose after the Three Mile Island accident. The application must include a detailed analysis of the design's vulnerability to certain accidents or events, and inspections, tests, analyses, and acceptance criteria to verify the key design features. The NRC is considering a new rule that would require design certification applicants to assess their plant's level of built-in protection for avoiding or mitigating the effects of a large commercial aircraft impact, reducing the need for human intervention to protect public health and safety.



Currently there are four certified reactor designs that can be referenced in an application for a combined license (COL) to build and operate a nuclear power plant. They are:

1. **Advanced Boiling Water Reactor** design by GE Nuclear Energy (May 1997);
2. **System 80+** design by Westinghouse (formerly ABB-Combustion Engineering) (May 1997);
3. **AP600** design by Westinghouse (December 1999); and
4. **AP1000** design (pictured at left) by Westinghouse (January 2006).

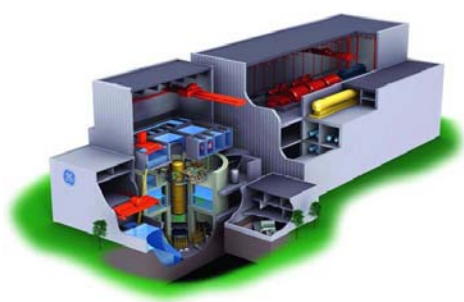
Reactor Design Review Status

The status of advanced reactor applications for both active and inactive design reviews is provided below in alphabetical order. A description of each design follows.

Active Reviews

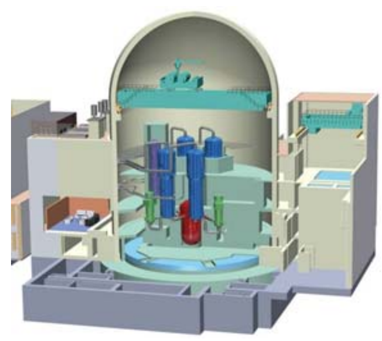
- **AP1000 (Amendment) –** Westinghouse submitted an application to amend the AP1000 design in July 2007, in order to: 1) address several "open items" that would otherwise be dealt with in a COL application, 2) voluntarily comply with the intent of the proposed aircraft impact assessment rule, and 3) modify the reactor's pressurizer design. The staff accepted the amendment for review in January 2008 and expects to complete its review in 2009. The rulemaking is tentatively scheduled for completion in 2010.

- **ESBWR** - General Electric submitted its ESBWR (pictured at right) certification application on Aug. 24, 2005. The staff accepted the application for review in a letter dated Dec. 1, 2005, and expects the certification process to continue through 2010.



- **EPR -** Areva submitted its EPR certification application on Dec. 11, 2007. The staff expects the certification process to continue through 2011.

- **US-APWR -** Mitsubishi Heavy Industries (MHI), a Japanese firm, submitted a design certification application for the U.S.-specific version of its Advanced Pressurized Water Reactor (pictured at right) on Dec. 31, 2007. The staff expects the certification process to continue through 2011.



Pre-Application Reviews

- **PBMR -** A South African firm, Pebble Bed Modular Reactor (PBMR) Pty. Limited notified the NRC in a letter dated Feb. 18, 2004, that it intended to apply for design certification in the near future and requested discussions with the NRC to plan the scope and content of the preapplication review. NRC staff have held several public meetings with PBMR to discuss its activities and plans to submit pre-application information. PBMR has continued to submit pre-application information through 2007 and expects to submit a design certification application in late 2009.

- **Toshiba 4S** - On Feb. 2, 2005, the NRC staff met with the city manager and vice mayor of Galena, Alaska to discuss and answer questions on the city's plans to build a Toshiba 4S reactor to provide its electricity. Toshiba began pre-application discussions with NRC staff in Oct. 2007, and the company expects to submit a design approval application in 2009.

Inactive Reviews

- **IRIS** - In May 2006, Westinghouse and the NRC staff discussed the current status of the International Reactor Innovative and Secure (IRIS). The planned submittal of a design certification application for IRIS has been changed from 2008 to 2010. Westinghouse has submitted topical reports related to the planned test programs and plans to submit additional reportes in support of preapplication interactions. The IRIS design is sometimes mentioned in the context of a grid-appropriate reactor under the Global Nuclear Energy Partnership.

Regulatory Structure for New Plant Licensing

In the longer term, the NRC may be called on to review reactor designs that use a broader range of technology than those currently under review. Therefore, the NRC staff may develop technology-neutral guidelines for plant licensing in the future. These guidelines are intended to encourage future designs to incorporate additional safety and security where possible. The staff issued in Dec. 2007 a "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing" (NUREG-1860).

Design Descriptions

ABWR: The U.S. Advanced Boiling Water Reactor (pictured at left) uses a single-cycle, forced circulation design with a rated power of 1,300 megawatts electric (MWe). The design incorporates features of the BWR designs in Europe, Japan, and the United States, and uses improved electronics, computer, turbine, and fuel technology. Improvements include the use of internal recirculation pumps, control rod drives that can be controlled by a screw mechanism rather than a step process, microprocessor-based digital control and logic systems, and digital safety systems. The design also includes safety enhancements such as protection against overpressurizing the containment, passive core debris flooding capability, an independent water makeup system, three emergency diesels, and a combustion turbine as an alternate power source.

AP600: The Advanced Passive 600 is a 600 MWe advanced pressurized water reactor that incorporates passive safety systems and simplified system designs. The passive systems use natural driving forces without active pumps, diesels, and other support systems after actuation. Use of redundant, non-safety-related, active equipment and systems minimizes unnecessary use of safety-related systems.

AP1000: The Advanced Passive 1000 is a larger version of the previously approved AP600 design. This 1,100 MWe advanced pressurized water reactor incorporates passive safety systems and simplified system designs. It is similar to the AP600 design but uses a longer reactor vessel to accommodate longer fuel, and also includes larger steam generators and a larger pressurizer.

EPR: The Evolutionary Power Reactor (pictured at right) is a 1,600 MWe pressurized water reactor of evolutionary design. Design features include four 100% capacity trains of engineered safety features, a double-walled containment, and a "core catcher" for containment and cooling of core materials for severe accidents resulting in reactor vessel failure. The design does not rely on passive safety features. The first EPR is under construction at the Olkiluoto site in Finland, with another planned for the Flammanville site in France.

ESBWR: The Economic and Simplified Boiling Water Reactor is a 1,500 MWe, natural circulation boiling water reactor that incorporates passive safety features. This design is based on its predecessor, the 670 MWe Simplified BWR (SBWR) and also utilizes features of the certified ABWR. The ESBWR enhances natural circulation by using a taller vessel, a shorter core, and by reducing the flow restrictions. The design utilizes an isolation condenser system for high-pressure water level control and decay heat removal during isolated conditions. After the automatic depressurization system operates, a gravity-driven cooling system provides low-pressure water level control. Containment cooling is provided by a passive system.

IRIS: The International Reactor Innovative and Secure is a pressurized light water cooled, medium-power (335 MWe) reactor that has been under development for several years by an international consortium. The IRIS design utilizes an integral reactor coolant system layout. The IRIS reactor vessel houses not only the nuclear fuel, control rods and neutron reflector, but also all the major reactor coolant system components including pumps, steam generators and pressurizer. The IRIS integral vessel is larger than a traditional PWR pressure vessel, but the size of the IRIS containment is a fraction of the size of corresponding loop reactors.

PBMR: The Pebble Bed Modular Reactor (pictured at left) is a modular high-temperature gas reactor that uses helium as its coolant. PBMR design consists of eight reactor modules, 165

MWe per module, with capacity to store 10 years of spent fuel in the plant (there is additional storage capability in onsite concrete silos). The PBMR core is based on German high-temperature gas-cooled reactor technology and uses spherical graphite elements containing ceramic-coated fuel particles.

System 80+: This standard plant design uses a 1,300 MWe pressurized water reactor. It is based upon evolutionary improvements to the standard CE System 80 nuclear steam supply system and a balance-of-plant design developed by Duke Power Co. The System 80+ design has safety systems that provide emergency core cooling, feedwater and decay heat removal. The new design also has a safety depressurization system for the reactor, a combustion turbine as an alternate AC power source, and an in-containment refueling water storage tank to enhance the safety and reliability of the reactor system.

Toshiba 4S: The Toshiba 4S reactor design has an output of about 10 MWe. The reactor has a compact core design, with steel-clad metal-alloy fuel. The core design does not require refueling over the 30-year lifetime of the plant. A three-loop configuration is used: primary system (sodium-cooled), an intermediate sodium loop between the radioactive primary system and the steam generators, and the water loop used to generate steam for the turbine. The basic layout is a “pool” configuration, with the pumps and intermediate heat exchanger inside the primary vessel.

US-APWR: The Mitsubishi Heavy Industry US-APWR design is an evolutionary 1,700 MWe pressurized water reactor currently being licensed and built in Japan. The design includes high-performance steam generators, a neutron reflector around the core to increase fuel economy, redundant core cooling systems and refueling water storage inside the containment building, and fully digital instrumentation and control systems.

June 2008

New Commercial Reactor Designs

Release Date: November 2006
Next Release Date: November 2007

New Reactor Designs

Reactor Design	Vendor	Approximate Capacity (MWe)	Reactor Type	Certification Status	Target Certification
AP600	Westinghouse	650	PWR	Certified	Certified
AP1000*	Westinghouse	1117	PWR	Certified	Certified
ABWR*	GE et al	1371	BWR	Certified	Certified
System 80+	Westinghouse	1300	PWR	Certified	Certified
ESBWR*	GE	1550	BWR	Undergoing certification	2007
EPR*	AREVA NP	1600	PWR	Pre-certification	2009
PBMR	Westinghouse, Eskom	180	HTGR	Pre-certification	Not Available
IRIS	Westinghouse et al	360	PWR	Pre-certification	2010
US APWR	Mitsubishi	1600	PWR	Undergoing certification	2011
ACR Series	AECL	700-1200	Modified PHWR	Pre-certification	Not Available
GT-MHR	General Atomics	325	HTGR	Research prototype planned	Not Available
4S*	Toshiba	10-50	Sodium-cooled	Potential construction	Not Available

Note: Data are approximate targets which may change. Reactor types are defined below. Designs marked with an asterisk (*) are also supported by electricity generating firms or organizations publicly investigating possible construction in the U.S. AECL is Atomic Energy of Canada Limited.

This document supersedes an earlier publication entitled "New Reactor Designs". Criteria for inclusion on the preceding table are:
Design certification issued by the Nuclear Regulatory Commission (AP600, AP1000, APWR, System 80+)

1. Submission to the Nuclear Regulatory Commission (NRC) of an application for design certification (ESBWR, USAPR)
2. Recent pre-design certification activities with the NRC or public announcement of such intentions (EPR, PBMR, IRIS, ACR series reactors)
3. A research reactor design that has been discussed with the NRC that might lead to a commercial prototype (GT-MHR)
4. Selected additional designs that appear to be intended for eventual construction in the US. (4S)

Excluded are:

1. Reactors that do not appear to be intended for the US market.
2. Reactors that are components of US government programs that have not yet been identified for targeted design certification. This excluded list includes many designs associated with Generation IV (Gen IV) reactor designs (included in the previous edition

of "New Reactor Designs"), the Next Generation Nuclear Power (NGNP) program, and the Global Nuclear Energy Partnership (GNEP). Such reactor designs will be included after the designs are publicly identified for design certification. Gen IV reactors are summarized on http://nuclear.inl.gov/gen4/index.shtml.

Reactor Types

1. **Pressurized Water Reactors (PWR)**: PWRs use nuclear-fission to heat water under pressure within the reactor. This water is then circulated through a heat exchanger (called a "steam generator") where steam is produced to drive an electric generator. The water used as a coolant in the reactor and the water used to provide steam to the electric turbines exists in separate closed loops that involve no substantial discharges to the environment. Of the 104 fully licensed reactors in the United States, 69 are PWRs. Westinghouse, Babcock and Wilcox, and Combustion Engineering designed the designed the nuclear steam supply systems (NSSS) for these reactors. After these reactors were built, Westinghouse and Combustion Engineering nuclear assets were combined. The French-German owned firm Areva NP has acquired many of Babcock and Wilcox's nuclear technology rights, though portions of the original Babcock and Wilcox firm still exist and possess some nuclear technology rights as well. Other major makers of PWR reactors, including Areva, Mitsubishi, and Russia's Atomstroyexport, have not yet sold their reactors in the U.S. www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/pwr.html
2. **Boiling Water Reactors (BWR)**: The remaining 35 operable reactors in the United States are BWRs. BWRs allow fission-based heat from the reactor core to boil the reactor's coolant water into the steam that is used to generate electricity. General Electric built all boiling water reactors now operational in the United States. Areva NP and Westinghouse BNFL have each designed BWRs.www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/bwr.html
3. **Pressurized Heavy Water Reactors (PHWR)**: PHWRs have been promoted primarily in Canada and India, with additional commercial reactors operating in South Korea, China, Romania, Pakistan, and Argentina. Canadian-designed PHWRs are often called "CANDU" reactors. Siemens, ABB (now part of Westinghouse), and Indian firms have also built commercial PHWR reactors. Heavy water reactors now in commercial operation use heavy water as moderators and coolants. The Canadian firm, Atomic Energy of Canada Limited (AECL), has also recently proposed a modified PHWR (the ACR series) which would only use heavy water as a moderator. Light water would cool these reactors. No successful effort has been made to license commercial PHWRs in the United States. PHWRs have been popular in several countries because they use less expensive natural (not enriched) uranium fuels and can be built and operated at competitive costs. The continuous refueling process used in PHWRs has raised some proliferation concerns because it is difficult for international inspectors to monitor. Additionally, the relatively high Pu-239 content of PHWR spent fuel has also raised proliferation concerns. The importance of these claims is challenged by their manufacturers. PHWRs, like most reactors, can use fuels other than uranium and the ACR series of reactors is intended to use slightly enriched fuels. Particular interest has been shown in India in thorium-based fuel cycles. http://www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/china/candu.html
4. **High Temperature Gas-cooled Reactors (HTGR)**: HTGRs are distinguished from other gas-cooled reactors by the higher temperatures attained within the reactor. Such higher temperatures might permit the reactor to be used as an industrial heat source in addition to generating electricity. Among the future uses for which HTGRs are being considered is the commercial generation of hydrogen from water. In some cases, HTGR turbines run directly by the gas that is used as a coolant. In other cases, steam or alternative hot gases such as nitrogen are produced in a heat exchanger to run the power generators. Recent proposals have favored helium as the gas used as an HTGR coolant. The most famous U.S. HTGR example was the Fort Saint Vrain reactor that operated between 1974 and 1989. Other HTGRs have operated elsewhere, notably in Germany. Small research HTGR prototypes presently exist in Japan and China. Commercial HTGR designs are now promoted in China, South Africa, the United States, the Netherlands, and France though none of these is yet commercially marketed. The proposed Next Generation

Nuclear Plant (NGNP) in the U.S. will most likely be a helium-based HTGR, if it is funded to completion. http://www.nuc.berkeley.edu/designs/mhtgr/mhtgr.GIF

5. **Sodium-cooled reactors reactors**: Sodium-cooled reactors are included on this list primarily because of proposals to build a Toshiba 4S reactor in Alaska. Sodium-cooled reactors use the molten (liquid) metal sodium as a coolant to transfer reactor generated heat to an electricity generation unit. Sodium-cooled reactors are often associated with "fast breeder reactors (FBRs)" though this is technically not the case in the 4S design.

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AP600

(Westinghouse)
Synonyms: Advance Passive 600
Approximate Capacity (electric): 600 MWe
Reactor Type: Pressurized Water Reactor
NRC Design Certification Status: Certified December 1999
Supporting Generating Companies (potential site): None
The AP600 is a 600 MW PWR certified by the NRC. While based on previous PWR designs, the AP600 has innovative passive safety features that permit a greatly simplified reactor design. Simplification has reduced plant components and should reduce construction costs. The AP600 has been bid overseas but has never been built. Westinghouse has deemphasized the AP600 in favor of the larger, though potentially even less expensive (on a cost per kilowatt or capacity basis) AP1000 design.
Further Information: http://www.ap600.westinghousenuclear.com/ http://www.nei.org/index.asp?catnum=3&catid=704

AP1000

(Westinghouse)
Synonyms: Advanced Passive 1000
Approximate Capacity (electric): 1117-1154 MWe
Reactor Type: Pressurized Water Reactor
NRC Design Certification Status: Certified after December 2005, though amendments have since been proposed.
Supporting Generating Companies (potential site): Duke Power (Cherokee County), Progress Energy (Harris), Southern Company (Vogtle), NuStart Energy-Tennessee Valley Authority (Bellefonte)
The AP1000 design is favored for construction at five to six potential sites (ten to twelve reactors) in the United States. The AP1000 is an enlargement of the AP600, designed to almost double the reactor's target electricity output without proportionately increasing the total cost of building the reactor. Westinghouse anticipates that operating costs should be below the average of reactors now operating in the United States. While Westinghouse owns rights to several other designs, the AP1000 is the principal product that the company now promotes in the United States for near term deployment. The AP1000 includes innovative, passive safety features and a much simplified design intended to reduce the reactor's material and construction costs while improving operational safety. During 2007 or 2008 it is anticipated that the AP1000 will be the subject of combined license (COL) applications to build and operate new reactors in the United States. In early 2005 Westinghouse submitted a bid to build a version of the AP1000 to build as many as four AP1000s at two sites in China.
Further Information: http://www.nrc.gov/reactors/new-licensing/design-cert/ap1000.html http://www.ap1000.westinghousenuclear.com/ http://en.wikipedia.org/wiki/AP1000 http://www.nei.org/doc.asp?docid=770

ABWR

(General Electric and others)
Synonyms: Advanced Boiling Water Reactor
Approximate Capacity (electric): 1371-1465 MWe
Reactor Type: Boiling Water Reactor
NRC Design Certification Status: Certified May 1997. Design amendments are possible but have not been publicly announced.
Supporting Generating Companies (potential site): NRG Energy (South Texas Project); Amarillo Power
Four ABWRs operate in Japan and more are planned there. Two additional ABWRs are under construction in Taiwan and two units are being considered for the South Texas Project site in the United States. While the ABWR design is usually associated in the United States with General Electric, variations on the design have also been built by Toshiba and Hitachi. Hitachi also hopes to associate with General Electric for building additional ABWRs at the South Texas Project. The Tennessee Valley Authority (TVA) published a study of the costs of building an ABWR reactor in the United States in September 2005 (below). Vendors now claim costs for building the ABWR that are low enough that they have attracted some customer interest.
Further Information:
http://www.gepower.com/prod_serv/products/nuclear_energy/en/new_reactors/abwr.htm
http://en.wikipedia.org/wiki/ABWR http://www.nei.org/doc.asp?catnum=&catid=&docid=110&format=print
http://np2010.ne.doe.gov/reports/Main%20Report%20All5.pdf
http://www.nuc.berkeley.edu/designs/abwr/abwr.html

System 80+

(Westinghouse)
Synonyms: None
Approximate Capacity (electric): 1300 MWe plus
Reactor Type: Pressurized Water Reactor
NRC Design Certification Status: Certified May 1997.
Supporting Generating Companies (potential site): A modified version of the design is being promoted for development in South Korea
The System 80+ reactor is a PWR designed by Combustion Engineering (CE) and by CE's successor owners ABB and Westinghouse. The NRC has certified the System 80+ for the U.S. market, but Westinghouse no longer actively promotes the design for domestic sale. The System 80+ provides a basis for the APR1400 design that has been developed in Korea for future deployment and possible export.
Further Information: http://www.nei.org/index.asp?catnum=3&catid=703
http://www.nuc.berkeley.edu/designs/sys80/sys80.html

ESBWR

(General Electric)
Synonyms: Sometimes called Economic Simplified Boiling Water Reactor or European Simplified Boiling Water Reactor though General Electric does not frequently use the name.
Reactor Type: Boiling Water Reactor
Approximate Capacity (electric): 1550 MWe plus
NRC Design Certification Status: Undergoing certification
Supporting Generating Companies (potential site): Entergy (Grand Gulf, River Bend), Dominion Energy (North Anna)

The ESBWR is a new simplified BWR design promoted by General Electric and some allied firms. The ESBWR constitutes an evolution and merging of several earlier designs including the ABWR. The ESBWR, which includes new passive safety features, is intended to cut construction and operating costs significantly from earlier ABWR designs. GE and others have invested heavily in the ESBWR though the design and two US utilities, Dominion and Entergy have expressed an interest in possibly building the design at three sites. These utilities have stated that they might apply for a combined license (COL) to build and operate new ESBWR reactors during 2007 or 2008. The two utilities have also applied for Early Site Permits (ESPs) for the designs which the anticipate receiving during 2007. The ESBWR is presently undergoing design certification with the NRC.
Further Information: http://www.nrc.gov/reactors/new-licensing/design-cert/esbwr.html http://www.gepower.com/prod_serv/products/nuclear_energy/en/new_reactors/esbwr.htm http://en.wikipedia.org/wiki/ESBWR http://www.nei.org/index.asp?catnum=4&catid=907 www.ans.org/pubs/magazines/nn/docs/2006-1-3.pdf

EPR

(Areva NP)
Synonyms: Evolutionary Pressurized Water Reactor, the name European Pressurized Water Reactor does not apply to the US design
Approximate Capacity (electric): 1600 MWe
Reactor Type: Pressurized Water Reactor
NRC Design Certification Status: Pre-application review
Supporting Generating Companies (potential site): UniStar Nuclear-Constellation-Areva (Calvert Cliffs, Nine Mile Point)
Areva NP announced in early 2005 that it would market its EPR design in the United States and has recently begun pre-certification activities. The U.S.-market version is called the Evolutionary Pressurized Water Reactor. The EPR is a conventional, though advanced, PWR in which components have been simplified and considerable emphasis is placed on reactor safety. The design is now being built in Finland with a target commercialization during 2010. The French government has also authorized building an EPR at Flamanville 3 in France. Additional EPRs might replace additional commercial reactors now operating in France starting in the late 2010s and EPRs have been bid, in China and elsewhere. The proposed size for the EPR has varied over time, but is most frequently placed around 1600 MWe. Earlier designs were as large as 1750 MWe. The EPR is promoted in the United States by UniStar Nuclear, a joint venture of Constellation Energy and AREVA NP. UniStar is presently looking at the possibility of building EPRs at Constellation-owned sites at Nine Mile Point and Calvert Cliffs and has had discussions with other firms. Areva NP anticipates submitting a design certification application to the Nuclear Regulatory Commission during late 2007.
Further Information: http://www.nrc.gov/reactors/new-licensing/design-cert/epr.html http://en.wikipedia.org/wiki/European_Pressurized_Reactor http://unistarnuclear.com/

PBMR

(Westinghouse, PBMR Ltd.)
Synonyms: Pebble Bed Modular Reactor
Approximate Capacity (electric): 165 MWe
Reactor Type: High temperature gas-cooled reactor (HTGR)
NRC Design Certification Status: Pre-application review
Supporting Generating Companies (potential site): The design has no U.S. generating company sponsor. The PBMR is supported by the South African utility Eskom for development in South Africa The PBMR uses helium as a coolant and is part of the HTGR family of reactors. PBMR development is thus a product of a lengthy history of research, notably in Germany and the United States. More recently the design has been promoted and revised by PBMR Ltd., an affiliate of the South African utility Eskom. Westinghouse is a minority investor in PBMR Ltd. and has taken a leading role in U.S.

design certification. The PBMR design is presently in a "pre-certification" status with the NRC. Prototype variations on the PBMR design now operate in China and Japan. Eskom has also received administrative approval to build a prototype PBMR in South Africa. If the prototype is successful, Eskom has stated it intends to build several follow on units. There is no U.S. generating company sponsor of the design. At around 165 MWe the PBMR would be one of the smaller reactors now proposed for the commercial market. This is considered a marketing advantage by some because small reactors require lower initial capital investments than larger new units. Several PBMRs could be built at a single site as local power demand requires. The NRC also does not claim the same familiarity with the PBMR design that it has with light water reactors (PWR and BWR). Fuels used in the PBMR would be more highly enriched than the uranium is now used in light water reactor designs. China and South Africa have also discussed cooperation in PBMR efforts.
Further Information: http://www.nrc.gov/reactors/new-licensing/design-cert/pbmr.html
http://www.pbmr.com/ http://en.wikipedia.org/wiki/Pebble_bed_modular_reactor
http://www.nei.org/index.asp?catnum=3&catid=707

IRIS

(Westinghouse-led consortium)
Synonyms: International Reactor Innovative and Secure
Approximate Capacity (electric): 100-300 MWe
Reactor Type: Pressurized Water Reactor (advanced design)
NRC Design Certification Status (potential site): Pre-application review
Supporting Generating Companies: None, though international generating companies are part of the international consortium developing the design.
Westinghouse has promoted the IRIS reactor design as a significant simplification and innovation in PWR technology. While the IRIS is a PWR, several components, notably steam generators, are internal to the reactor vessel. The reactor design is smaller than most operating PWRs and is asserted to be much simplified. Fuel for the IRIS would be more enriched (5-9% U-235 compared to 3-5%) than is presently used in U.S. PWR. This might allow for longer periods between reactor refueling. The IRIS reactor includes features intended to avoid loss of coolant accidents. Pre-certification is proceeding though IRIS might show its potential during the next decade (2010s). Certification activities as now scheduled could precede commercial availability. IRIS sponsors have a targeted 2010 certification completion date with commercial deployment to follow.
Further Information: http://hulk.cesnef.polimi.it/ http://www.nei.org/index.asp?catnum=3&catid=712

US-APWR

(Mitsubishi Heavy Industries)
Synonyms: International Advanced Pressurized Water Reactor, the name Advanced Pressurized Water Reactor (APWR) usually refers to the design in Japan
Approximate Capacity (electric): 1700 MWe in the United States
Reactor Type: Pressurized Water Reactor
NRC Design Certification Status: Pre-application review. Application targeted for March 2008.
Supporting Generating Companies (potential site): Support exists for the related APWR design among Japanese generating companies.
The US-APWR is a U.S.-marketed variation on APWR design sold in Japan by Mitsubishi Heavy Industries. The 1538 MW APWR has been selected by Japan Atomic Power Company for two units to be located at Tsuruga in Japan with the first unit slated for completion in 2014. Other Japanese generating companies are also interested in the APWR design. The 1700 MW US-APWR was only recently (June 2006) announced for the U.S. market and is not presently being certified in any other international markets. The US-APWR has not yet received publicized support from any U.S. generating company. Pre-application design certification activities before the U.S. Nuclear Regulatory Commission began during July 2006. Mitsubishi targets a design certification application for March

2008 and hopes complete the process during 2011. Mitsubishi also wants to have the reactor available for construction in the U.S. as early as 2011. Mitsubishi is also investigating certifying a second, smaller reactor design at a capacity of 1200 MW.
Further Information: http://en.wikipedia.org/wiki/Advanced_Pressurized_Water_Reactor
http://www.mhi-ir.jp/english/new/sec1/200607031122.html

ACR Series

(Atomic Energy of Canada Limited)
Synonyms: Advanced CANDU Reactor, ACR700, ACR1000
Approximate Capacity (electric): 700-1200 MWe
Reactor Type: Modified Pressurized Heavy Water Reactor
NRC Design Certification Status: Pre-application review apparently on hold.
Supporting Generating Companies(potential site): None, though it is among the designs being considered for eventual development in Ontario, Canada.
AECL's ACR series of reactors is considered by its vendor to be an evolution from the internationally successful CANDU line of PHWRs. Original pre-application design certification procedures in the U.S. had been for the 700 MW ACR700 design. More recent discussions have focused on the 1200 MW ACR1000. CANDU reactors and their Indian derivatives have had more success than any family of commercial power reactors except the LWRs. One of the innovations in the ACR series of reactors, compared to earlier CANDU designs, is that heavy water is used only as a moderator in the reactor. Light water is used as the coolant. Earlier CANDU designs used heavy water both as a moderator and as a coolant. This change makes it debatable whether the ACR design series are true PHWRs, PWRs, or a hybrid between the two designs. Fueling procedures for the ACR follow the earlier CANDU designs in that it occurs while the reactors are in service rather than during refueling outages. AECL has aggressively marketed the ACR series offering low prices, short construction periods, and favorable financial terms. As is the case for most non-LWR reactors, U.S. generating companies, nuclear engineers, and regulators have only limited familiarity with the design. Interest in the ACR series by Dominion Resources in Virginia and by United Kingdom generating companies has not been sustained. AECL has subsequently delayed its efforts to certify the design in the United States. The ACR series has been mentioned as a possible contender for construction in Ontario, the earliest possible reactor construction there might be either earlier CANDU designs or non-Canadian designs.
Further Information: http://www.nrc.gov/reactors/new-licensing/design-cert/acr-700.html
http://www.aecl.ca/Reactors/ACR-1000.htm http://www.aecl.ca/AssetFactory.aspx?did=88
http://en.wikipedia.org/wiki/Advanced_CANDU_Reactor

GT-MHR

(General Atomics)
Synonyms: Gas Turbine Modular Helium Reactor, Freedom Reactor (Entergy trademark)
Approximate Capacity (electric): 285 MWe
Reactor Type: High temperature gas-cooled reactor (HTGR)
NRC Design Certification Status: Pre-application review.
Supporting Generating Companies: Entergy (development only)
The GT-MHR is an HTGR developed by the U.S. firm, General Atomic. The most advanced plans for GT-MHR development relate to building reactors in Russia to assist in the disposal of surplus plutonium supplies. Parallel plans for commercial power reactors would use uranium-based fuels enriched to as high as 19.9 percent U-235 content. This would keep the fuel a fraction below the 20 percent U-235 enrichment that defines highly-enriched uranium. The U.S. utility, Entergy, has participated in GT-MHR development and promotion and uses the name "Freedom Reactor" for the design. A proposed research version of the reactor has been proposed for the University of Texas Permian Basin and affiliated institutions for Andrews County, Texas. Because coolant temperatures arising from HTGRs are much higher than from light water reactors, the design is viewed as a

potential source of commercial heat. Particular attention has been paid to the design's potential to produce of hydrogen from water. The GT-MHR is considered, among many other designs, as a potential contender for the US Department of Energy's Next Generation Nuclear Plant (NGNP) program.
Further Information: http://gt-mhr.ga.com/ http://en.wikipedia.org/wiki/GT-MHR http://www.nei.org/doc.asp?catnum=3&catid=711

4S

(Toshiba)
Synonyms: Super Safe, Small, and Simple
Approximate Capacity (electric): 10 MWe, larger possible
Reactor Type: Sodium-cooled
NRC Design Certification Status: Manufacturer and sponsor are developing a pre-application approach.
Supporting Generating Companies (potential site): Town of Galena, Alaska
The 4S is a very small molten sodium-cooled reactor designed by Toshiba. The reactor presently being considered is 10 MWe though larger and smaller versions exist. The 4S is intended for use in remote locations and to operate without refueling during its 30-year life. The 4S has been compared with a nuclear "battery" because it does not require refueling. The lack of refueling would mean that the reactor's fuel supply would be a capital cost rather than an operating cost. It has been suggested that the fuel might be relatively low cost, reprocessed spent fuels originating from more conventional power reactors. Other potential fuels are uranium or uranium-plutonium alloys. If uranium is the fuel in the United States, plans call for 19.9 percent fuel enrichment, just below the 20 percent definition of highly enriched uranium. The use of molten-sodium as a coolant is not new, having been used in many fast breeder reactors. Toward the end of 2004 the town of Galena, Alaska granted initial approval for Toshiba to investigate building a 4S reactor in that remote location. The design is also under consideration for other locations in Alaska. Most recent discussions target completion around 2013, though the schedule is not firm. Galena and Toshiba officials discussed their plans with the NRC in early February 2005 and plan additional filings over the coming years. The NRC indicated that it was not familiar with the 4S design and that design certification (at vendor expense) might be costly and prolonged. Design certification can be incorporated in the COL process thus it is unclear if a separate design certification will be pursued, if the project continues.
Further Information: http://en.wikipedia.org/wiki/Toshiba_4S http://www.atomicinsights.com/AI_03-20-05print.html http://www.iser.uaa.alaska.edu/Publications/Galena_power_draftfinal_15Dec2004.pdf#search='Toshiba 4S'

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Galena Electric Power – a Situational Analysis

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DRAFT Final Report
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EXECUTIVE SUMMARY

Purpose

The purpose of the investigation is to compare the economics of various electrical power generation options for the City of Galena. Options were assessed over a 30-year project period, beginning in 2010, and the final results were compared on the basis of residential customer electric rates ($/kWh).

Galena's electric utility currently generates power using internal combustion diesel engines and generator sets. Nearby, there is an exposed coal seam, which might provide fuel for a power plant. Contributions to the energy mix might come from solar, municipal solid waste, or wood. The City has also been approached by Toshiba, Inc., as a demonstration site for a small (Model 4S) nuclear reactor power plant. The Yukon River is possibly a site for in-river turbines for hydroelectric power. This report summarizes the comparative economics of various energy supply options.

This report covers:

- thermal and electric load profiles for Galena
- technologies and resources available to meet or exceed those loads
- uses for any extra power produced by these options
- environmental and permitting issues and then
- the overall economics of each of the primary energy options.

Loads

Currently, the city buildings, school, swimming pool, and health clinic space heating needs are met by capturing the heat rejected by the diesel electric generators (DEGs) and transferring the hot water to the buildings (all close to the power plant). We have assumed an existing average cogeneration load of 400 K Btu/hr for 8 months per year plus a 300 K Btu/hr [commercial/residential boiler load] for other buildings in town for eight months. This gives a total yearly cogeneration thermal load [CTLoad] projected for the future of about 4 B Btu. (Northern Resource Group, 2004). We have distributed these over a year using Fairbanks heating degree days [HDD] data. Analysis shows that allowing for expansion and additional customers for heat (the Air Station), the heat delivered annually could be about 8 B Btu in the future.

In **Figure ES.1**, we see the monthly electric energy generated. This results in an annual load slightly under 10 M kWh. The average monthly load was around 800 kW in July and over 1 MW in January.

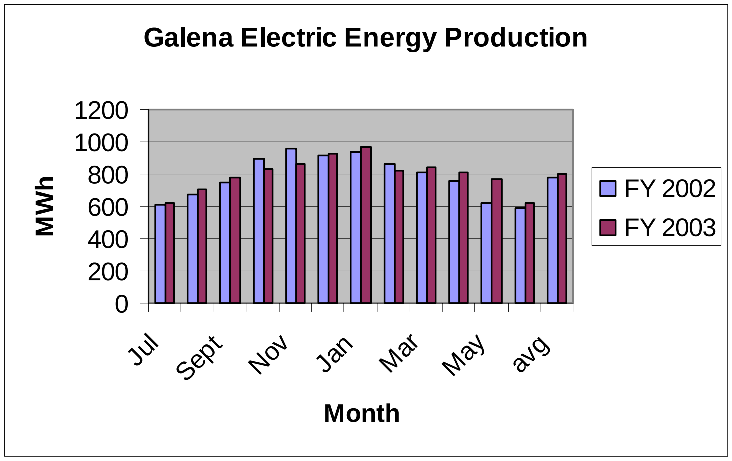

Figure ES.1. Monthly electric generation for Galena

Taking the equivalent projected heating loads and adding the electric loads over the year yields the load requirements displayed in **Figure ES.2.** for the year 2010.

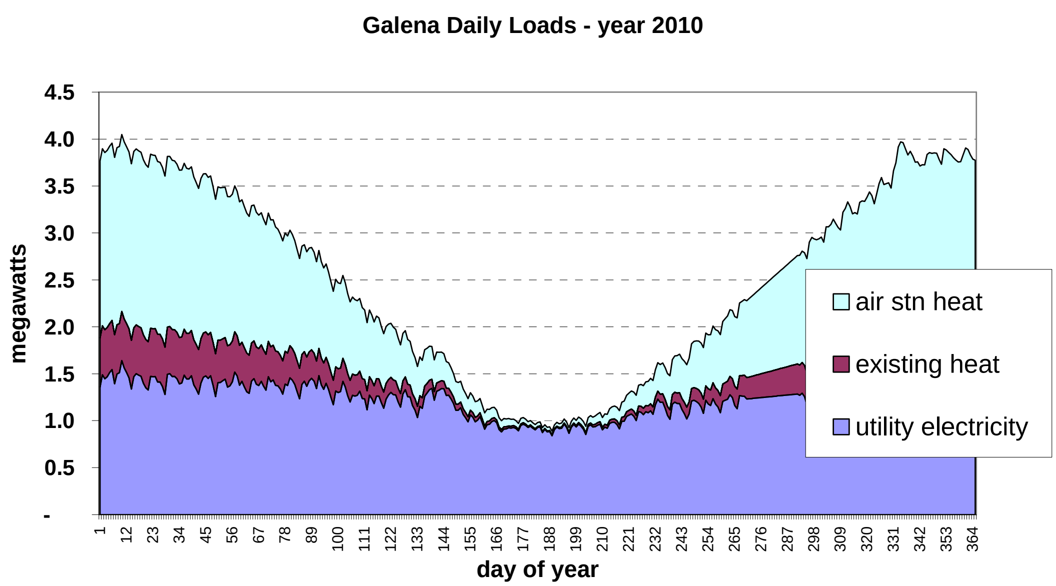

Figure ES.2. Combined heating and electrical loads based on current use in Galena

The various generation options available have different output capacities. For example, the Toshiba 4S system has a generation capacity of 10 MW. Thus, extra power would be available. If the rates were sufficiently low, residential space heating might be an option, as would commercial activities including greenhouses and aquaculture. **Figure ES.3.** illustrates a possible profile using the base loads from **Figure ES.2** with the addition of some of these options for the year 2039. The power requirements are about 8 MW. This would still leave extra power for other uses.

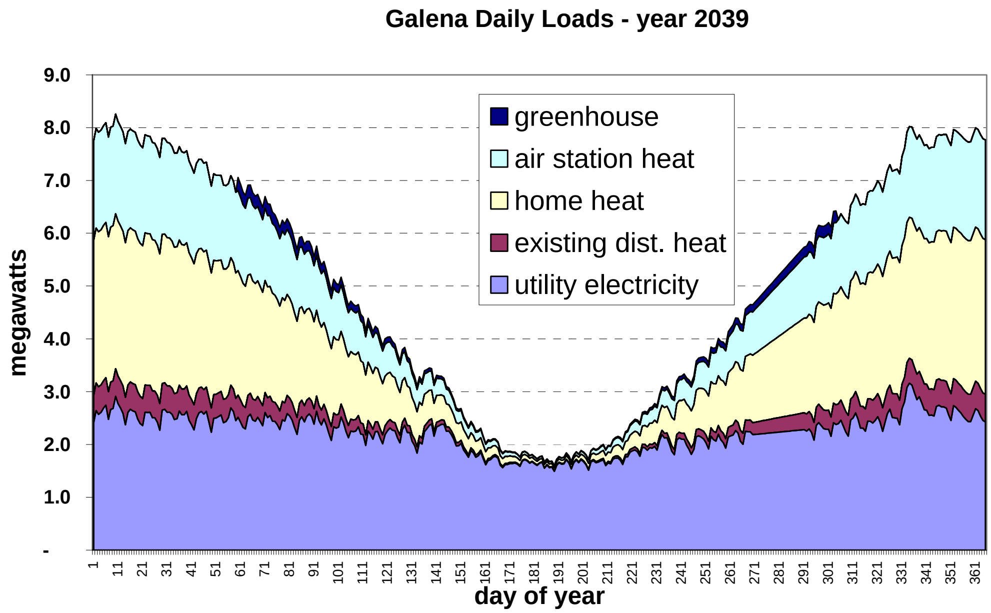

Figure ES.3. Projected combined loads for 2039 with residential space heating and one 2000 ft^2 greenhouse.

Power Generation Options

The three systems assessed in depth were enhanced diesel, coal (mine and power plant), and the Toshiba 4S nuclear reactor. In the later two cases, backup diesel generators were retained to provide power during any time the primary system was down for repairs or maintenance. All economic analyses included the cost of the backup diesel system.

Enhanced Diesel. According to the Rural Alaska Energy Plan (MAFAa, 2002), the most efficient village sized DEGs available today are capable of achieving peak efficiencies in the 15.8 kWh/gal range. With a fuel oil having a heating value of 135 K Btu/gal, this is equivalent to converting 40% of the energy in the fuel to electric power. For the past two years, the Galena average monthly electrical generation efficiency varied from about 13.2 to 14.8 kWh/gal and averaged 13.76 kWh/gal. For this analysis, we assumed that the units currently in use will continue to perform at 14 kWh/gal and any upgraded or new units will operate at 15 kWh/gal.

Coal (Mine & Power Plant). Exposed coal seams are about 18 road miles upriver from Galena near the Louden town site. This deposit is not well-understood. Before much further analysis is attempted, the deposit must be explored to determine its size and very importantly its depth below the surface. Samples have been analyzed and have shown an estimated heating value averaging 9.4 K Btu/lb (18.6 M Btu/ton), sulfur content less than 0.5%, ash averaging 9 % [range 2 – 16 %], and moisture content averaging 19% [14 to 28%]. One exposed seam is about 9 feet high and 2,000 feet across. [Phillips and Denton, 1990]. If a 1-MW coal-fired plant were to operate with an efficiency of 25%, it would require about 0.68 tons/hr of coal or about 12,000 ft^3/month. If a 100-foot width were taken from this 9-foot-high coal seam, 13 ft/month or 166 feet/yr would have to be excavated. This coal might be delivered to Galena for an estimated $100 to $128/ton.

Atmospheric fluidized-bed combustion (AFBC) boilers are now well-established as a mature power generation technology with more than 620 AFBC units in operation worldwide in the size range 20 to 300 MW. Current operating experience shows that AFBC boilers meet high environmental standards and are commercially viable and economically attractive. For more information on AFBCs see http://www.epri.com/journal/details.asp?id=627&doctype=features

These plants burn a range of fuels, including bituminous and subbituminous coal, coal waste, lignite, petroleum coke, biomass, and a variety of waste fuels. In many instances, units are designed to fire several fuels (including biomass fuels), which emphasizes one of the technology's major advantages: its inherent fuel flexibility.

While no AFBC coal power plants in the small size range required at Galena have been built and operated at this time, small AFBC boilers have been used to provide heat for industrial processes. Adaptation to power production requires the addition of a steam turbine and ancillary equipment.

The U.S. Department of Energy (DOE) initiated a study in 1998 (Northern Economics, 2001) to investigate the capital and operating costs of small coal-fired power plants [600 kW to 2 MW]. The installed capital costs were estimated at from $3.0K to $4.3K/kW and an electricity cost of $0.22 to $0.77/kWh.

A 2003 feasibility study on a barge-mounted 5-MW AFBC power plant (Bonk, 2004) estimated capital costs from $20M to $25M and electricity costs of $0.20/kWh minus a credit for heat delivered using Galena coal.

J.S. Strandberg (1997) did a feasibility analysis of an 800 kW AFBC coal plant in McGrath plus a 125 kW DEG. The analysis estimated a total project budget of about $14 million, which included the power plant, coal mine development, haul road, and an expanded district heating system. The estimated electricity cost was $0.176/kWh, which included a $ 0.077/kWh credit for heat delivered. Over half the total cost was for coal and limestone. A major issue was the high parasitic power required [over 155 kW], and the estimate for it was increased as the study was completed.

Phillips and Denton (1900) calculated costs for a 483 kW coal-fired model cogeneration facility producing 6.8 M Btu/hr of heat. The costs of electricity ranged from $0.11 to $0.22/kWh for a base load plant to as much as $0.80/kWh for a lightly loaded plant. Of the 21 M Btu/hr fuel input, 46% went to the production of electricity. Of the total capital cost of $7.5 M, $2.0 M was allocated to electrical and +$5.5 M to heat. For a plant in Galena using Louden coal, the electricity costs were estimated to range from $0.26 to $0.36/kWh.

A coal-fired plant should be a base-load plant sized to run near its capacity all of the time except for planned shutdowns for maintenance and repair.

Toshiba 4S Nuclear Plant. The 4S Model power plant concept is based on a design for a Small Innovative Reactor (SIR), which is a sealed unit. Unlike conventional reactors, the 4S concept is for the sealed reactor to be delivered at the site, installed with the generator system, operated for the prescribed design life, removed, and replaced with the sealed assembly intact. Thus, there would be no emissions (other than steam), no release of radioactivity, and minimum chance of radiation exposure when the reactor assembly is buried. Toshiba has approached the City with the offer to provide the reactor and power plant at no capital cost so that the 4S can have a reference site and operation experience. Some expense may be incurred by the City for site preparation and installation.

The 4S has no mechanical systems internal to the sealed assembly. Electromagnetic pumps move the cooling fluid. The reflecting shield that controls the reaction is also moved electromagnetically. This greatly reduces the potential for mechanical and equipment problems. Cooling and heat transfer is accomplished using liquid sodium metal. Heat is transferred to a steam generation loop and the resulting steam drives the turbine to generate electricity with rejected heat in the condensed water available for district heating or other uses. For district heating, the steam can be used directly. Problems that have occurred in sodium-cooled plants design have been in sections of the plant other than the reactor.

In this concept, the nuclear reactor is planned to be installed up to 100 feet below grade and capped with reinforced concrete. This provides a nearly impenetrable barrier that cannot be lifted by any heavy equipment available in Galena. The 4S also uses a nonproliferation fuel that cannot be used to produce a nuclear weapon without first undergoing isotopic enrichment, an extremely costly and technologically challenging process.

The projected 4S capital cost, if commercialized, is projected to be $2,500/kW or $25 million for a 10 MW unit. A 50-MW model is also in development. If fully utilized, electric power from the 50-MW unit is estimated by the vendor to be $0.065/kWh. Our economic analysis proved to be highly sensitive to the number of plant personnel required. A reasonable number of operations personnel are required for efficiency and safety, but it is not known how many security personnel may be required. A detailed safety and security risk assessment, required by the Nuclear Regulatory Commission licensing process, will determine the necessary staffing levels. The time required for the NRC licensing process is not known at this time. It may add a significant period before the plant can be started, but for purposes of this analysis, we assumed a start date in 2010. The experience gained from the Galena project will be used to refine capital and installation cost estimates for future installations.

Other Generation Modules

Although, other options for power were considered, they were not viable for large-scale deployment by the utility. These include solar, wind, in-river turbines, biomass, fuels cells, and coal bed methane.

In-river Turbines. Prototype turbines have been developed but have not been demonstrated in arctic settings. Calculations of the power output from candidate models indicate the output would be relatively low at Galena (22.5 kW for a unit with two 3m diameter turbines). For these reasons, we did not pursue or recommend installation of in-river turbines at this time.

Solar. Much of interior Alaska has a good solar resource for as much as eight months of the year, including the springtime when there is a large need for both heat and electricity. A downside to using solar energy is the intermittent nature of the resource.

Hence, as with any intermittent resource, storage can be a key issue. Solar technologies take two forms, solar-electric (photovoltaic) and solar thermal. Photovoltaic devices convert sunlight directly to electricity at efficiencies as high as 25%, although 10% is typical. Installation of a 100 kW module in a Galena setting could cost $2M. Solar thermal technologies use the heat in sunlight to produce hot water, heat for buildings, or electric power. In Galena, solar technology would best serve individual home or business owners. Its impact on the utility was determined to be limited.

Biomass. Biomass can be wood from trees as well as plant residue, animal waste, and the paper portion of municipal solid waste (MSW). The dispersed nature of this resource makes the energy and time involved in harvesting an important issue. We determined the contribution from this source to be too small for a stand-alone unit. However, MSW could be burned in the AFBC of the coal power plant.

Wind. Galena is located in a low wind resource region – Class 1. For wind turbines to work efficiently and contribute significantly to a utility, they must operate in a Class 5, 6, or 7 region. Thus, wind was not considered.

Fuel Cells. This technology is under intense development but has not been commercialized. While some demonstrations are underway, fuel cells are not available for utility applications at this time.

Coal Bed Methane. Gas has been produced commercially from coal beds in the lower 48. Development of resources in other parts of Alaska is in a preliminary stage. Because information to develop CBM in arctic conditions is insufficient, CBM cannot be considered for Galena. If considered for development, extensive work is required to delineate local reserves before development could occur.

Conservation

Conserving energy can reduce loads for utilities and reduce consumer power bills. Utilities have a role in providing information on conservation to their customers. This report discusses measures that can be taken by end-users to conserve.

Uses of Extra Power

Some power plant options have optimum sizes that would provide power over and above current and projected electrical consumption. For those cases, possible uses studied included district heating, residential electric baseboard heating, transmission to nearby villages, production of hydrogen, and horticulture/aquaculture. Use of all energy produced by generation options is essential to realize the full economic potential of generation systems.

District Heating/Heat Sales. Currently, DEGs provide heat to City buildings, the school, and swimming pool. This is assumed to continue in all of the scenarios considered. Some expansion is assumed. Also considered is the sale of heat through a hot water pipeline to the Air Station. To provide space heating, the Air Station consumes about the same volume of fuel oil each year as the electric utility. The value of the heat supplied is equivalent to the value of the displaced fuel oil.

Electric Space Heating to Residences. If electric rates can be lowered sufficiently, residents will begin to use more electricity in their homes. With sufficiently low rates, many will convert to electric baseboard heating systems. The only reasonable option here is the 4S nuclear plant. If this situation were to be realized, retrofitting the homes and upgrading the distribution system would result in economies of scale, increased convenience, and enhancement of in-door air quality. In considering the economics of the 4S option, the costs of retrofitting and installation were included in the capital cost to the utility.

Hydrogen Production. Projected electric and heat loads over the 30-year life of this analysis indicate that extra power will still be available. In considering other potential uses, we assessed the production of hydrogen for fuel. Transportation of hydrogen for sale outside the City was determined to not be economical. However, under certain conditions, converting City vehicles, school district buses, and Air Station heavy equipment may be economically feasible. It might also provide the City the opportunity to be a test-bed for production and use of hydrogen in remote arctic settings. Hydrogen production may be feasible but not economically viable without subsidies. No credit was taken for the oxygen that is coproduced, but it could be captured and compressed for local use.

Transmission to other villages. An analysis of estimated construction costs of transmission lines to the villages nearest to Galena revealed that the capital costs were several million dollars greater than the revenue that could be collected over the 30-year period. This option is therefore not considered feasible from an economic standpoint.

Greenhouses and Aquaculture. The extra heat produced by new power plants may give rise to private entrepreneurial activities. We briefly looked at the potential of greenhouses and aquaculture. Many other activities may be viable. If the cost for the heat (in the form of heated water) were low enough, these ventures appear to have merit.

Environmental Issues and Permitting

Issues related to permitting were surveyed for the generation options considered viable. The critical considerations are

- Air pollution control
- Water pollution control
- Waste management
- Disturbance of lands/habitat

After considering all issues and potential emissions, the 4S option appears to be the least problematic (this depends on the Nuclear Regulatory Commission) from the standpoint of ease of gaining new permits. Opening a coal mine and building a coal-fired power plant appears to be the most difficult.

Economic Analyses

Estimating the cost of power to the consumer is the primary objective of this project. We considered the three options: improved diesel, coal (mine & power plant), and the Toshiba 4S nuclear power plant. In all cases, the base case was taken as the continuation and improvement of the diesel-based system now in place. The most critical parameters for each option are shown below.

In the base case, two extremes were taken. First, the continuation of diesel generation with a fuel cost of $1.50/gal at a flat rate (no escalation). The second case took the cost of fuel at $2.15/gal and escalated it at 2%/year. These cases were used to compare all the others. For the coal option, the delivered cost of the fuel and the conversion efficiency of the plant were the variables on which the power cost most depends. For the 4S option, the staffing levels (the plant operation staff was held constant, but the number of security personnel was varied) required were the most important.

Table ES.1. Most critical parameters for each option considered.

	units	low value	high value
Diesel fuel price in 2010	$/gallon	1.50	2.15
Diesel fuel price increase (over and above general inflation)	% per year	0.0%	2.0%
Coal price (delivered to Galena)	$/ton	100	125
Coal plant average efficiency		30%	40%
Nuclear plant security staff	positions	4	34

Numerous scenarios were run showing the effect of various assumptions. The power plant sizes, optimized for the various technologies, were taken with the load and energy uses, and the total project cost, as well as the electricity cost to the consumer, was calculated. The figures below show the results for various scenarios beginning in 2010. The coal and nuclear systems assumed that DEGs would be employed as back-up for maintenance and emergency shutdowns. Therefore, the price of diesel fuel affects the economics of those systems.

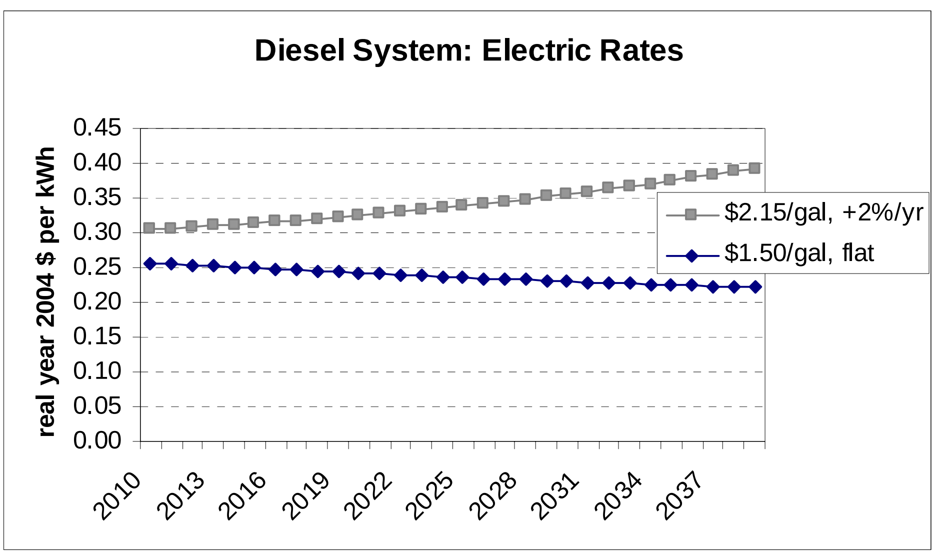

Figure ES.4. Projected future electric rates with a diesel system.

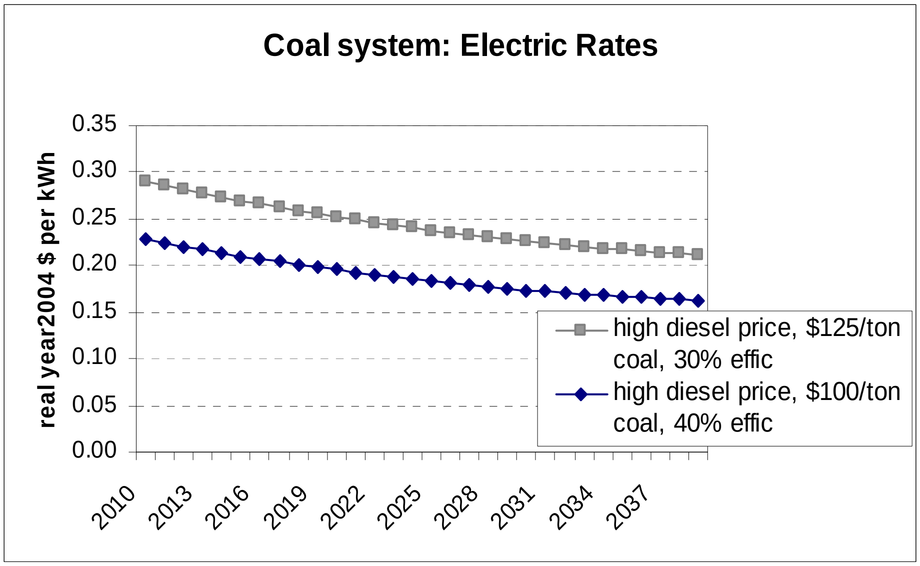

Figure ES.5. Projected future electric with rates with coal system.

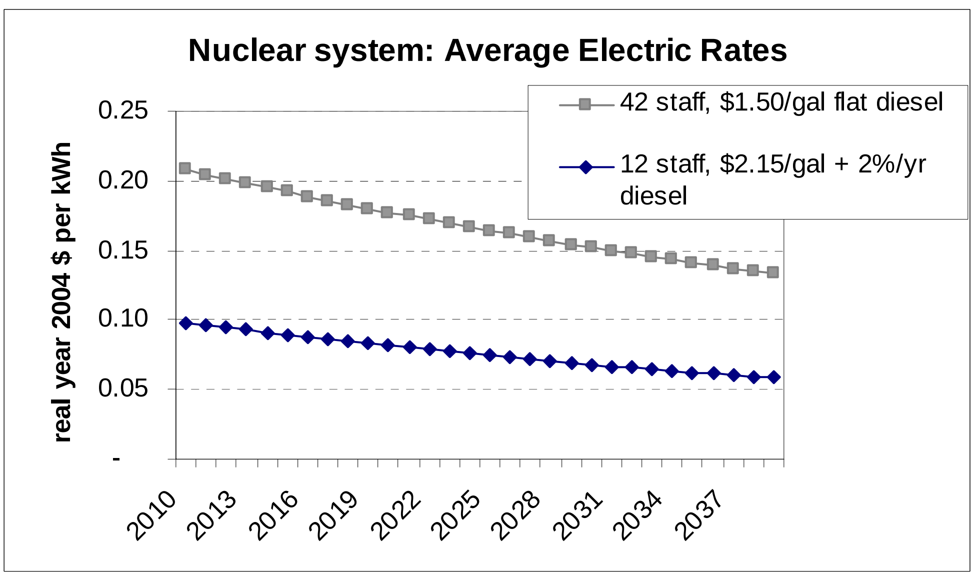

Figure ES.6. Projected future electric rates with nuclear system.

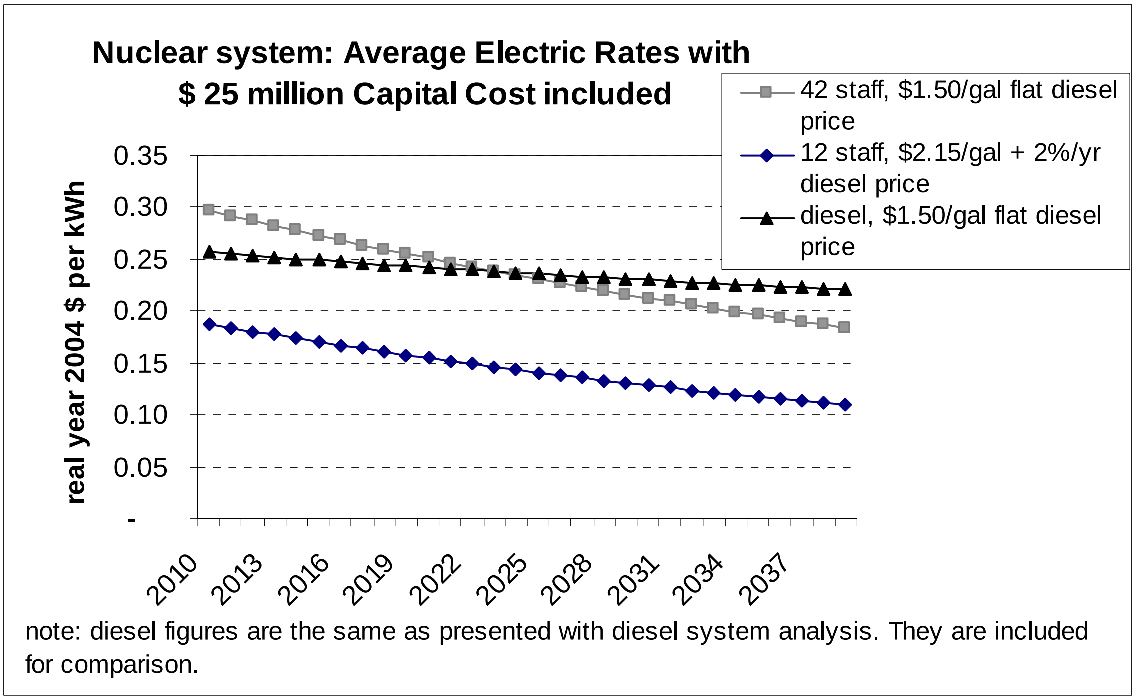

Figure ES.7. Projected future electric rates with nuclear capital costs included in rates.

ES.2. Summary of results of the economic evaluations

	Diesel	Nuclear	Coal
Loads served:			
utility electricity	X	X	X
existing district heat	X	X	X
residential electric space heat		X	
greenhouse		X	
air station district heat		X	[sometimes]
Life-cycle total cost ($million)			
low value	38	(7)	23
high value	59	35	36
Net benefits compared to diesel ($million)			
low value		3	3
high value		67	36
Average electric rate in 2010 ($/kWh)			
low value	0.26	0.10	0.23
high value	0.30	0.21	0.29
Average electric rate in 2030 ($/kWh)			
low value	0.23	0.07	0.17
high value	0.36	0.15	0.23

The economic evaluations included the costs of diesel backup generators for coal and nuclear.

In all cases, the nuclear system will provide the lowest cost power to the consumer. The coal option will beat the diesel option in some scenarios.

Conclusions and Recommendations

On the basis of environmental permitting, the nuclear plant appears to be a clear winner. Obtaining permits for the coal plant appears to be the most difficult. The validity of this conclusion depends on the process and length of time required to gain a license from the NRC. All assumptions regarding costs and timing require validation.

The economic analysis reveals that the 4S option will provide the lowest cost power if the assumptions hold. In the Galena case, the assumption is that capital cost will be borne by an outside party and that reasonable staffing levels will result from the licensing process. The coal option may be economic in some scenarios compared to enhanced diesel systems, so the coal option should not be entirely dismissed.

Even though installation of the 4S nuclear plant presents a potential long-term solution to Galena's critical energy issues from economic and environmental permitting standpoints, other aspects, such as safety analyses, remain to be performed as part of the licensing process. Ultimately, the selection of the best energy option must consider these analyses and other factors. Specifically, regarding the 4S nuclear plant option, safety relating to potential accidents involving the reactor core and the use of liquid sodium as a heat transfer medium must be adequately addressed. If this technology is successfully deployed in Galena, its economic viability in other Alaska villages and elsewhere depends on the actual life cycle costs yet to be quantified.

Benefits associated with adoption of one or more of the technologies discussed in this report go beyond their ability to meet Galena's thermal and electric energy loads.

We see the potential for Galena to serve as a training center for rural Alaskans interested in using similar technologies in their villages. We also see the potential for use of additional cogeneration leading to economic development such as the development of horticulture and aquaculture. Enhancement of local employment associated with these activities is another benefit. With today's uncertain energy situation, many communities are diversifying their energy options. This includes adding renewably based technologies to lessen dependence on fossil fuels. Adding a few tens of kW of PV arrays, for example, could help Galena insulate itself against fluctuations in the price and supply of diesel fuel.

Therefore, the recommendations are:

- Proceed with refining the 4S evaluation process in conjunction with the NRC
    - It may be advantageous for Galena to enlist an independent organization to estimate the time required for licensing and permitting
    - Toshiba and Galena should consider partnering with a U.S. organization or National Laboratory to assist in the process
- Retain the current diesel systems (with scheduled upgrades) until a decision is made regarding the installation of a replacement by about 2010.

- ♦ Retain the option of a coal mine and power plant until it is determined if the 4S system can be permitted and licensed. If the 4S cannot be realized, then the coal option appears feasible (with a favorable coal resource assessment result).

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABREVIATIONS

ACMCRA	Alaska Surface Coal Mining Control and Reclamation Act
AFBC	atmospheric fluidized bed combustor
AVEC	Alaska Village Electric Cooperative
B	billion
Btu	British thermal unit
CGP	Construction General Permit
CFR	Code of Federal Regulations
CTLoad	cogeneration thermal load
DEG	Diesel Electric Generator
DEC	Alaska Department of Environmental Conservation
DOE	U.S. Department of Energy
DNR	Alaska Department of Natural Resources
DMLW	DNR Division of Mining, Land and Water Management
EPA	U.S. Environmental Protection Agency
Gal	gallon
GVEA	Golden Valley Electric Association
HDD	heating degree day
HDH	heating degree hour
HHL	hourly heat load
INEEL	Idaho National Engineering and Environmental Laboratory
K	thousand
kW	kilo-watt
kWh	kilo-watt hour
kWp	kilo-watt peak
M	million
MW	mega-watt
MWh	mega-watt hour
NRC	Nuclear Regulatory Commission
SIR	small innovative reactor
SMCRA	Surface Mining Control and Reclamation Act of 1977
NETL	National Energy Technology Laboratory
NPDES	National Pollutant Discharge Elimination Permit
NREL	National Renewable Energy Laboratory
MSW	municipal solid waste
PAFC	phosphoric acid fuel cell
PEM	proton exchange membrane
RCRA	Resource Conservation and Recovery Act
SMCRA	Surface Mining Control and Reclamation Act

1. INTRODUCTION

1.1 Purpose

The purpose of the investigation is to compare the future power generation options available to the City of Galena. The cost for power ($/kWh) is the parameter used as the basis for this comparison.

Galena's electric utility currently generates power using internal combustion diesel engines and generator sets (DEG). An exposed coal seam nearby might provide fuel for a power plant. The City has been approached by Toshiba, Inc., as a demonstration site for a small 10-MW (Model 4S) nuclear reactor power plant. The Yukon River is possibly a site for in-river turbines for hydroelectric power. Additional contributions to the energy mix might come from solar, municipal solid waste, or wood. This report summarizes the comparative economics of various energy supply options.

This report will first discuss;

- thermal and electric load profiles for Galena
- technologies and resources available to meet or exceed those loads
- uses for any extra power produced by these options
- environmental and permitting issues and
- the overall economics of them.

The bottom-line conclusions will compare the consumer cost of power on a $/kWh basis.

1.2 Setting

The City of Galena is a community of about 800 people situated on the north shore of the Yukon River in the interior of Alaska 270 air miles from Fairbanks. Galena experiences a cold continental climate with extreme temperature differences (-64 to 92 ^{o}F). Temperatures of -40^{o}F are common during the winter. Annual precipitation is 12.7 inches, with 60 inches of snowfall. The River is ice-free from mid-May through mid-October. The climate is important to power use projections. For more information, see the State's community information web site for Galena; (www.dced.state.ak.us/dca/commdb/CB.cfm)

The City has three distinct districts: "Old Town," "New Town," and the Air Station. The community was formerly established in 1918 near an Athabascan fish camp (Henry's Point) and became a supply and transshipment point for nearby lead mines. In 1920, Athabascans from the village of Louden began moving to Galena to find employment selling wood to steam ships and hauling freight to the regional mines. The Galena airfield was established during World War II as a refueling point for planes being ferried to Russia as part of military operations (Lend-Lease Program). During the 1950s the military installations were expanded. Due to a severe flood in 1971, a new community site was developed 1 ½ miles east of the original town site. "New Town" is the site of the City offices, health clinic, schools, washeteria, store, and more than 150 homes. The Air Force Station was closed in 1993. It is maintained by the Chugach Development Corporation and is used as a backup Air National Guard facility. It is also the site of Galena School District Boarding School and Vocational Training programs. (www.dced.state.ak.us/dca/commdb/CB.cfm).

Galena's current energy requirements are met by DEG-produced electricity, fuel oil-fired boilers, and oil- or wood-fired stoves. All economic analyses will compare considered options to those currently in widespread use.

1.3 The Galena Situational Analysis Project

1.3.1 Scope

The project scope is to assess the electric power generation/distribution options and compare their economics for the City of Galena. Conceptual plant designs from previous investigations were used. Current loads and projected uses for energy were considered in developing the projections. The final product is the comparison of consumer electric rates projected through a 30-year period (2010 through 2039).

Key issues to be addressed in choosing future energy options for any community include (1) available resources, (2) loads [electrical and thermal], (3) suitable technologies, (4) uses for extra power, (5) environmental and permitting issues and (6) economics. Uncertainties in the future price of imported fuel underlie all economic calculations. Additional considerations are possible linkages with neighboring villages and the potential for economic stimulation are presented in appropriate sections.

The Project Team visited the City twice. The first visit was April 1 and 2, 2004, to kick off the project, gather background information, and make presentations at both a town meeting and at the "Breakfast Club." During the second visit, June 15-16, presentations of our preliminary results were made to the City Council (in open meeting), at the "Breakfast Club," and to the staff of the Louden Tribal Council . During these visits, options were discussed with many and we gained valuable insight and information.

1.3.2 Limitations

An investigation of this type has several constraints placed on it by time, resources, and the availability of data. Limitations specific to this project include:

- Coal resource data for the Louden deposit is limited, therefore it was assumed to be sufficient to support the coal mine and power plant option. Detailed resource evaluation is needed.
- Detailed designs for power plants for the various fuel options, heat transfer systems, and extra power-use facilities were outside the scope of this project. Previous work cited was used for this analysis.
- The use of the Toshiba 4S reactor system will require extensive technical design, operations, safety, risk, and environmental analyses. The results of these analyses will determine the feasibility of the installation.
- The economic analysis is based on the comparison of scenarios for change occurring 30 years into the future. While scenario analysis is a useful tool for examining long-range feasibility, it does have several limitations.

- First, the validity of the analysis depends on the validity of the scenarios and the assumptions that are used to generate the scenarios.
- Second, the analytical model does not contain internal "feedbacks" such as an explicit link between higher electricity prices and reduced electricity consumption.
- Third, we have not attached probabilities to any of the assumptions or scenarios. Therefore the model cannot produce estimates of a single "most likely" or "best" estimate for any of the results.
- Finally, no attempt has been made to explicitly evaluate the degree to which any of the options may increase or decrease economic and financial risk. In summary, our scenario-based analysis requires readers of the report to make their own judgments about which scenarios and assumptions are more likely to occur. Although this can be viewed as a limitation of our method, it can also be viewed as a strength, since there is a clear link between assumptions and conclusions for each scenario examined.

Another uncertainty is the magnitude of any future carbon or other emissions taxes. Even a modest carbon tax such as that being proposed in some European countries can have a significant effect on the costs of using fossil fuels – in this study, the tax would have application in all options because either they are based on fossil fuels (coal and enhanced diesel) or employ diesel generation as a backup (coal and nuclear).

1.4 Acknowledgements

This study was conducted over a three-month period beginning in April 2004. Funding was provided by the U.S. Department of Energy's Arctic Energy Office. Assistance and support was received from many sources. Specifically, the authors thank: the members of the Advisory Committee (See Section 1.5) for input and guidance; the Galena City Council, City Manager, and "The Breakfast Club" for important background and operational information; the Loudon Tribal Council for insight into its perspective on development; the citizens of Galena for their hospitality; the Alaska Village Electric Cooperative (AVEC) for providing electric load data; and vendors of related systems and products for helping us understand system possibilities; and Ashish Agrawal of UAF for helping with the electric load calculations

1.5 Advisory Committee

An Advisory Committee was formed to review the project plans and progress through the study. The primary functions of the committee were to make sure the most critical issues were addressed and that reasonable assumptions were made. The Advisory Committee met on April 22, 2004, June 8, 2004, and July 21, 2004. The Committee members are

Peter Crimp, Alaska Energy Authority
Brent Petrie, AVEC
Kathy Prentki, Denali Commission
Tyg Skywatcher, Louden Tribal Council
Marvin Yoder, City Manager, City of Galena

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2. POWER GENERATION OPTIONS

Essential in determining the most appropriate power generation options to consider is an understanding of the community's loads. After loads are assessed, then options are considered.

Note that for any system option, there is a requirement to provide for backup generation capacity, which is accomplished by retaining some level of diesel generation capacity.

2.1 Loads

2.1.1 Heating Load for Cogenerated Heat

Currently, the city buildings, school, swimming pool and health clinic space heating needs are met by capturing the heat rejected by the diesel electric generators (DEGs) and transferring the hot water to the buildings (all close to the power plant). We have assumed a existing average cogeneration load of 400,000 Btu/hr for eight months per year plus an 300,000 Btu/hr [commercial/residential boiler load] for other buildings in town for eight months. This gives a total yearly cogeneration thermal load [CTLoad] projected for the future of about 4 B Btu. The 400,000 and 300,000 Btu/hr were obtained from the 2004 Galena Energy Assessment (Northern Resource Group, 2004). These were distributed over a year using Fairbanks heating degree days [HDD] data. This gives a maximum heating load of 900,000 BTU/hr. However, in his response to the Denali Commission Screening Report (Northern Economics*, 2001)*, city manager Marvin Yoder said the city uses 50% of DEGs BTUs in winter. With an average load of ~ 900 kW in winter, we can assume the heat rejected to the jacket water is ~900 kW. Using half of this results in 450 kW ~ 1.5 mm Btu/hr as the maximum cogenerated heat delivered. Allowing for expansion, the maximum cogenerated heat delivered is about 1.8 M Btu/hr. This results in the upper curve in the plot shown in **Figure 2.1** below and a yearly total of about 8 B Btu.

These HDDs were found using 1958 to 1993 data for the average daily temperature in Fairbanks and noting that each English unit HDD is 24 hours with the average ambient temperature 1^{o}F below 65^{o}F. A curve fit for average daily temperature was used.

T = 27.5 +36.*sin(pi.*(d-96)/182) where day [d] 0 is on Jan 1.

The minimum of this plot occurs on Jan 5.

Then HHD = (65 – T) gives the distribution of HDD over the year. The corresponding equation for heating degree hours [HDH] is

HDH = 65 –T1 where

T1 = 27.5 + 36*sin(pi*(hr/24-96)./182).

Using HDH total = sum(HDH), one can calculate the hourly heat load (HHL),

HHL = CTLoad*HDH/HDHtotal

This results in curves shown in **Figure 2.1**, below. The yearly total HDD resulting from this curve fit is 13793, which is the average for the 35 years beginning in 1958.

Note: The Fairbanks average monthly minimum and maximum T over the 11-year period beginning with 1980 correlated with Tanana with an R^2 > 0.99. Since Tanana is 100 miles upriver from Galena, using Fairbanks temperature data to produce HDD is a good approximation for Galena.

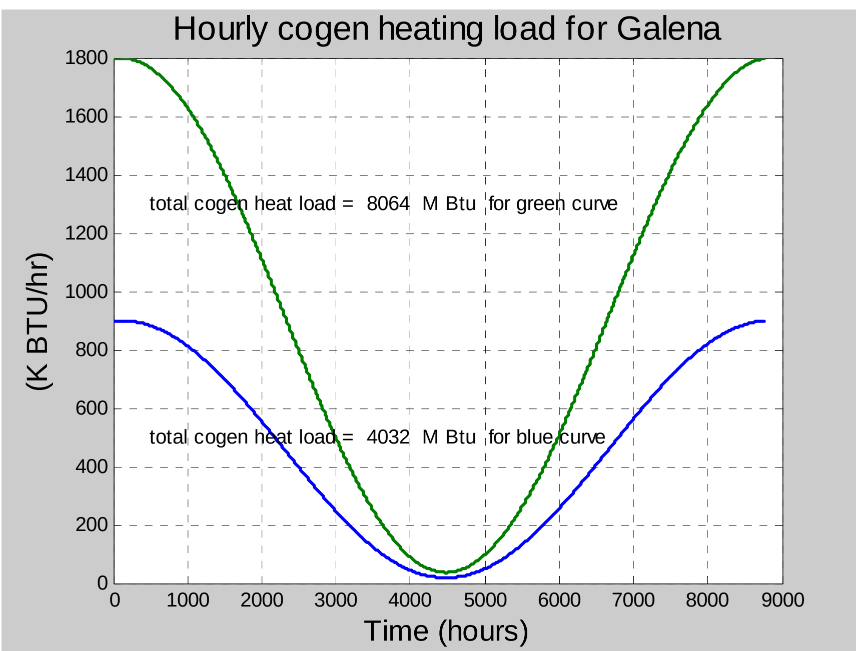


Figure 2.1. Galena heating load for cogeneration

2.1.2 Electric Loading Profile.

To generate an electric load profile with data at 15-minute intervals for Galena, we started with the actual data for monthly kWh generated [Galena Energy Assessment, 2004], the data for winter and summer peaks from the Denali Commission Screening Report (Northern Economics, 2001) [1.6 MW and 0.9 MW], and used 15-minute load information from an interior Alaska Village Electric Cooperative (AVEC) village (Petrie, 2004) with a similar climate to provide profiles for diurnal and weekly variations for Galena. These 15-minute data were comparable with 1-hour data collected in Galena for the 1st quarter of 2004. In **Figure 2.2**, we see the monthly electric energy generated. This results in an annual load slightly under 10 M kWh. The average monthly load was about 800 kW in July and over 1 MW in January.

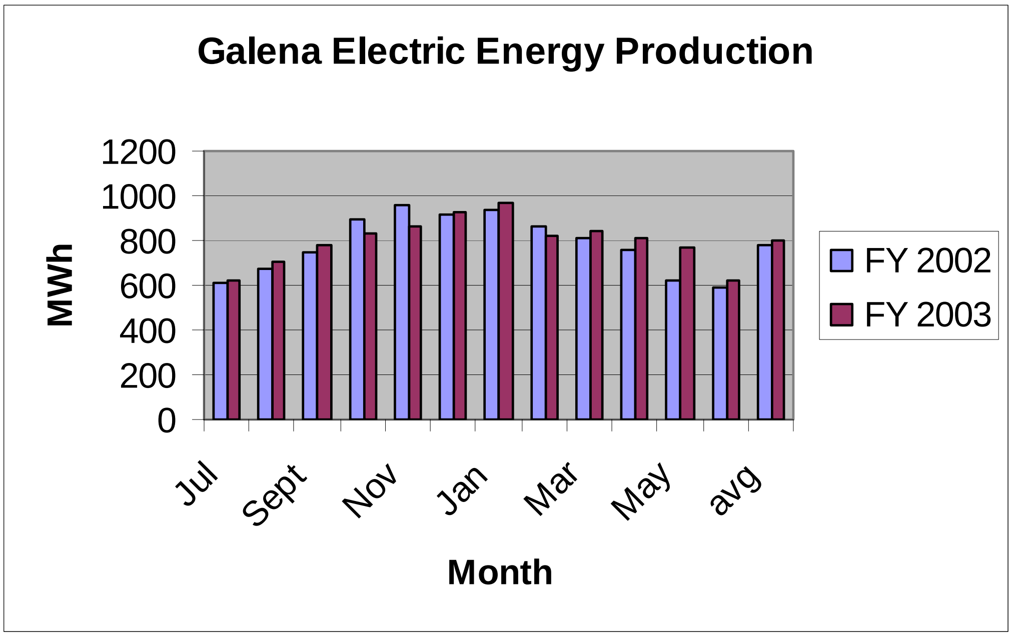


Figure 2.2. Monthly electric generation for Galena

By scaling the data for a northern AVEC village, we generated a map of yearly load excursions for Galena such that the yearly and monthly totals match the actual Galena data. The results are shown in **Figure 2.3**. Here, if we zoomed in on, for example, a 1- or 2-day time period, we would see the details of the loads for that particular period with the load being greater at 6 p.m. than 2 a.m. Such details can be extracted from the MATLAB ™ program used to generate this plot and are shown in **Figure 2.4**.

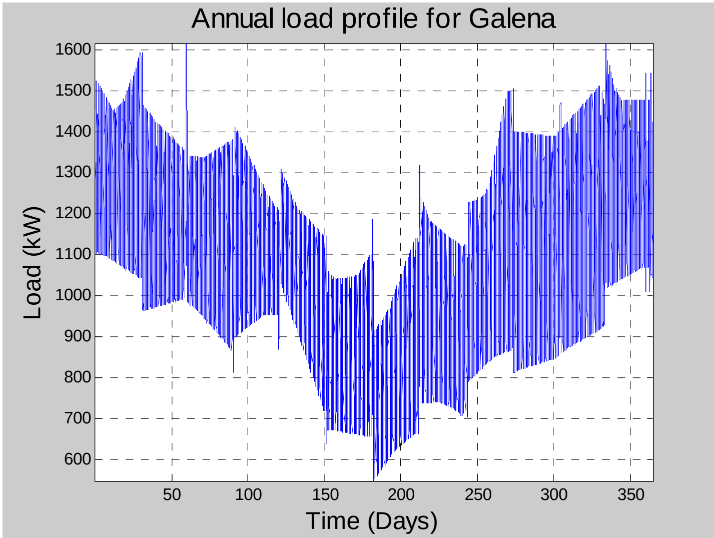


Figure 2.3. Hypothetical electric load for Galena for one-year period

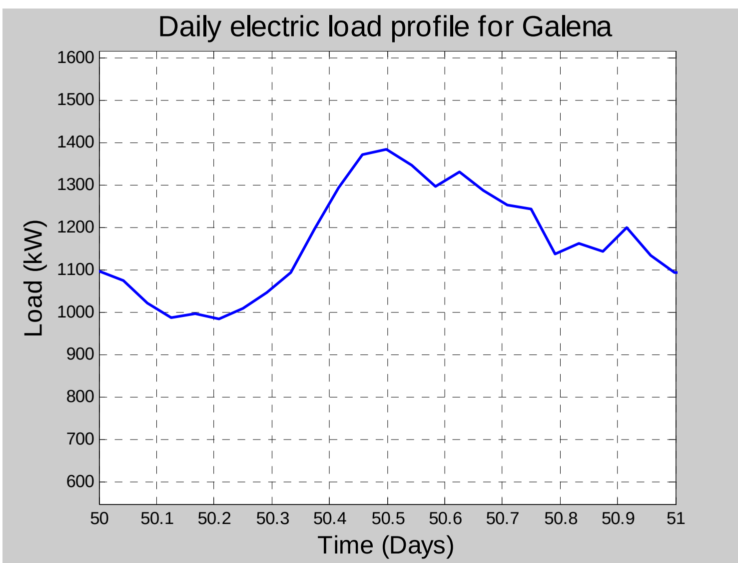


Figure 2.4. Hypothetical electric load for Galena for Day 50. The maximum is 1380 kW and the minimum is 990 kW.

2.2 Enhanced Diesel

According to the Rural Alaska Energy Plan (MAFA, 2002a), the most efficient village-sized DEGs available today are capable of achieving peak efficiencies in the 15.8 kWh/gal range. With a fuel oil having a heating value of 135 K Btu/gal, this is equivalent to converting 40% of the energy in the fuel to electric power. Technology improvements such as those associated with electronic fuel injection have reduced air pollution and noise due to more efficient combustion processes. The enhanced diesel scenario will assume an efficiency, for electric power production, of 15 kWh/gal as long as each generator operating is at least 50% load. At the same time, we will assume that the captured heat from the jacket water and after-cooler [if applicable] is at least 50% of the electric power output.

We also estimate the cogenerated heat available in the jacket water is in the range of the electric power generated. Hence, the difference between these two will be proportional to the parasitic fan power needed for heat rejection when cogeneration is not sufficient for heat rejection requirements.

We can define three kinds of efficiency with

(1) η_{el} = Wel/Qdoth

(2) η_{cogen} = [Wel + Qdotcogen]/Qdoth, and

(3) η_{econ} = [Wel + αQdotcogen]/Qdoth

where Wel = the electric power produced (kW)
Qdoth = the rate of energy input in the fuel (kW)
Qdotcogen = the heat recovery rate (kW), and
α = an energy quality factor

α accounts for the lower quality of thermal compared with electric energy. An approximate figure for α may be 1/3.

Note: to convert heat rate into units associated with electric power, it is convenient to use 1 kW = 3,412 Btu/hr.

Figure 2.5 shows that the average monthly electrical generation efficiency varies from about 13.2 to 14.8 kWh/gal with an average of 13.76. If we assume the fuel has a heating value of 134K Btu/gal and uses 1 kWh = 3,412 Btu, the above corresponds to an actual Galena efficiency range of 33.5 to 37.6%. If we assume we can capture heat equivalent to one-half Wel, then each of these efficiencies increases by 50% according to Equation (2). From Equation (3), if α = 1/3, each η increases by about 17%.

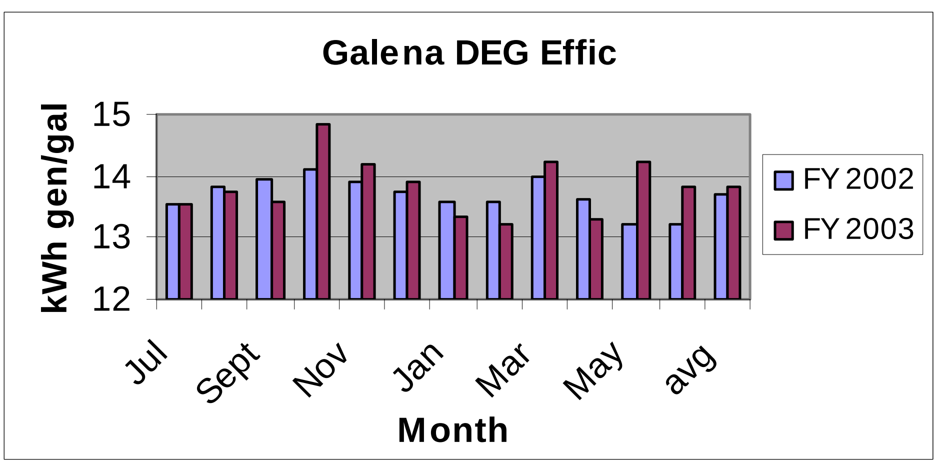


Figure 2.5. Performance of DEG system at Galena

By assuming enhanced utilization of cogenerated heat together with more efficient production of electric power, we can calculate the reduction in diesel fuel used annually compared with a baseline case. By amortizing the cost of buying new improved diesels and expanding district heating, we can calculate if the benefit cost ratio is greater than one.

2.3 Coal (Mine & Power Plant)

2.3.1 Coal Mine

An exposed coal seam about 18 road miles upriver from Galena has coal having an estimated heating value averaging 9.4 K Btu/lb (18.6 M Btu/ton). Its sulfur content is less than 0.5%, ash averages 9% [range 2 to 16%], and moisture content averages 19% [14 to 28%]. One exposed seam is about 9 feet high and 2,000 feet across. [Phillips and Denton, 1990]. If a 1-MW coal-fired plant were to operate with an efficiency of 25%, it would require 13.6 Btu/hr of fuel energy or about 0.68 tons/hr (6,000 tons/yr) of coal. At a density of ~ 80 lb/ft^3, the required volume is about 17 ft^3/hr or 12K ft^3/month. If a 100-foot width were taken from this 9-foot-high coal seam and used, 13 ft/month or 166 feet/yr would have to be excavated.

The coal resource estimate was based only on the extent of the exposed seams. A detailed drilling program is required to delineate and define the magnitude of the coal resource contained in this bed.

A cost estimation for hauling 5K tons/yr of coal 10 miles is $123/ton for a “model” mine with $35 of this for hauling, $35 for permitting and engineering, and $25 for stripping (Phillips and Denton, 1990). This is slightly lower than the $128/ton estimate for coal delivered from the Louden prospect to Galena (Northern Economics, 2001).

2.3.2 Power Plant with AFBC and a Steam Turbine

Atmospheric fluidized-bed combustion (AFBC) boilers are now well-established as a mature power generation technology with more than 620 AFBC units in operation worldwide in the size range 20 to 300 megawatts (MW). Current operating experience shows that AFBC boilers meet high environmental standards and are commercially viable and economically attractive.
http://www.epri.com/journal/details.asp?id=627&doctype=features

Two commercial units are operating in Ohio at sizes < 5 MW. One (Johnson) unit has operated for about 20 years. A DOE-supported 8.5 M Btu/hr unit at Cedar Farms, Ohio, has completed four months of unattended computer operation of the combustor by April 2004. Furthermore, it received certification for long-term commercial operation from Ohio having met emissions requirements for sulfur and particulates. It provides hot water at 14 psia and 185^{o}F for a commercial greenhouse operation. Since the greenhouse now operates with natural gas (NG) costing $8.30/MBtu, the payback period is about four years accounting for combustor’s the installed cost. This period is estimated to be six years if this unit were modified to produce electric power (Bonk, 2004). To do this, a turbine/generator, more heat transfer area, plus auxiliary equipment must be added. The latter would include additional controls as well as transformers and a distribution system.

These plants burn a range of fuels, including bituminous and subbituminous coal, coal waste, lignite, petroleum coke, biomass, and a variety of waste fuels. In many instances, units are designed to fire several fuels, which emphasizes one of the technology's major advantages: its inherent fuel flexibility. AFBC boilers also can more readily handle fuels that are problematic in pulverized coal (PC) boilers (i.e., biomass and waste). The principle of operation involves tiny particles of combustible material such as coal being kept in suspension by upward flowing air. The bed of hot coals surrounds water-filled tubes to which heat is very efficiently transferred to make steam. The steam expands through a steam turbine that is coupled to an electric generator to produce electric power.

The U.S. DOE initiated a study in 1998 (Northern Economics, 2001) to investigate the capital and operating costs of small coal-fired power plants [600 kW to 2 MW]. For 50 and 85% load factors, fuel costs ranging from $2.25 to $12.00/MBtu, and efficiencies from 20 to 26 K Btu/kWh, the electricity costs ranged from $0.22 to $0.77/kWh. The installed costs ranged from $3.0K to $4.3K/kW and the total annual non-fuel costs ranged from $1.0M to $2.6M. Galena coal was mentioned to have a delivered cost of $7.06/MBtu in that report. This is close to the $6.15/M Btu derived from the 1990 study cited above. At the other end of the spectrum, the Royal Academy of Engineering (2004) calculated the electricity costs from large [>100 MW] coal-fired CFB power plants to be $0.063/kWh with about 90% of that being approximately equally distributed among fuel, capital, and carbon emissions. These costs were slightly lower than those for plants using pulverized coal.

A 2003 feasibility study on a barge-mounted 5-MW AFBC power plant (Bonk, 2004) estimated capital costs from $20M to $25M and electricity costs of $0.20/kWh minus a credit for heat delivered. This is for 11K Btu/lb coal delivered for $100/ton [estimates for Galena]. These last two numbers are equivalent to $4.54/MBtu delivered cost.

J.S. Strandberg (1997) did a feasibility analysis of an 800 kW AFBC coal plant in McGrath, Alaska, plus a 125 kW DEG. He estimated a total project budget of about $14 million, which included the power plant, coal mine development, haul road, and an expanded district heating system. The coal had a heating value of about 6700 Btu/lb and was assumed to cost $52/ton delivered. The district net output was 9 M Btu/hr and water was supplied at 240^{o}F and 75 psig. The estimated electricity cost was $0.176/kWh, which included a $ 0.077/kWh credit for heat delivered. Over half of the total cost was for coal and limestone. A major issue was the system's high parasitic power required [over 155 kW], and the estimate for it was increased as the study was completed.

Phillips and Denton (1900) calculated costs for a 483 kW coal-fired model cogeneration facility producing 6.8 M Btu/hr of heat. The costs of electricity ranged from $0.11 to $0.22/kWh for a base load plant to as much as $0.80/kWh for a lightly loaded plant. The corresponding heat costs ranged from $16 - $28/M Btu on the low end to as much as $110 on the high. Of the 21 M Btu/hr fuel input, 46% went to the production of electricity. Of the total capital cost of $7.5 M, $2.0 M was allocated to electrical and >$5.5 M to heat. Almost half of the latter was for 12,000 feet of distribution piping at $200/ft. For a plant in Galena using Louden coal, the electricity costs were estimated to range from $0.26 to $0.36/kWh and heat from $24 to $36/M Btu.

A comparison of the four Alaskan studies appears in **Table 2.1.**

Table 2.1. Key parameters for four Alaska coal-power plant studies

Study/Parameters	Size for We	Capital Cost	Est. Rate ($/kWh)
Phillips & Denton, 1990	483 kW + 6.8 M Btu/hr heat	$ 7.5 M [$ 2M for elec. Rest for heat	0.11 to 0.80 [base load to lightly loaded
USDOE, 1998	600 kW to 2 MW	$ 2.5 .. $ 6M	0.22 to 0.77 [various fuel costs & loading]
Strandberg, 1997	800 kW + 9 M Btu/hr heat	$ 14M [including coal mine + district heat]	0.18
Bonk, 2004	5 MW [barge mounted]	$ 20 - $25 M	0.20

For comparison, according to Colt et al. (2001), the true cost of rural electric utility service for 90% of rural Alaska villages runs less than $0.45/kWh. The range is from $0.17/kWh for larger regional center communities (Naknek) up to around $1.80/kWh for small remote communities like Pedro Bay.

A coal fired-plant should be a base-load plant sized to run near its capacity all the time except for planned shutdowns for maintenance and repair.

2.3 Toshiba 4S Nuclear Power Plant

2.3.1 4S System Characteristics

This discussion of the proposed nuclear reactor is a summary and more details are enclosed in the Appendices. First, the characteristics of the design are presented. Then, sections are included describing the safety of the design and the security issues.

The nuclear reaction which occurs in the reactor core produces heat. This heat is conveyed by heat transfer fluids or coolants to the exterior of the reactor where the energy is used for electric power generation or for other purposes. Existing commercial plants in the United States employ water as the coolant and produce hot pressurized water from the energy released by radioactive decay in the nuclear core contained within a pressure vessel. This water, in turn, transfers heat to water in the secondary water system to vaporize it into steam. All this occurs within a thick concrete containment structure. The pressurized steam is transferred outside the containment vessel where it drives a steam turbine coupled to an electrical generator. Control rods in the core are used to moderate the reaction. Currently, the United States produces about 17% of its electricity from 109 nuclear power plants of up to 1000 MW capacity. Worldwide, there are over 400 nuclear plants; France generates 77% of its electricity from nuclear reactors . There are no commercial nuclear power plants in Alaska (McKinney and Schoch, 1998)

Figure 2.6 shows the large containment structure in which the reactor and steam generator are housed. Note the parabolic-shaped cooling tower in which water is sprayed to allow heat to be rejected to the ambient air. This heat rejection provides a heat sink to condense the steam leaving the turbine. The pump feeding the working fluid to the steam generator requires water in the liquid form to work effectively. Hence, the steam must be condensed upstream of the pump. The pump pressurizes the water to allow proper operation of the pressurized water reactor.

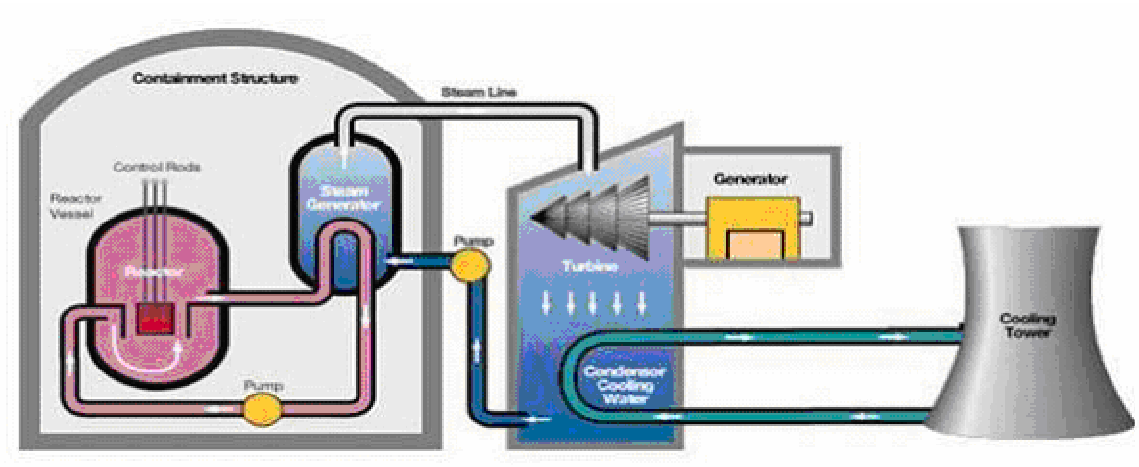


Figure 2.6. Schematic of Nuclear Power Plant: Photo courtesy of TVA

The 10 MW Toshiba 4 S nuclear power plant is an example of new small innovative reactor [SIR] designs that are under active development today. Most of the components of this system have been extensively tested and many have been licensed by the Nuclear Regulatory Commission (NRC). Toshiba currently is conducting engineering work to complete the reactor and plant designs. Therefore, if the first operational unit is installed at a site such as Galena, it would be considered a "reference" rather than a "prototype" or "demonstration" plant. Reactor development proceeds in several steps.

- *Experimental* reactors are the first stage to test the concept (research)
- *Demonstration* reactors use refined designs and test integrated systems (engineering)
- *Prototype* reactors are the first of several reactors of the fully engineered design
- *Reference* plants establish the design basis for licensing and serve as a model for the construction and licensing of additional commercial plants. (Rosinski, May 24, 2004, private communication)

The assumption that the 4S would be a reference plant is subject to some question by U.S. National Laboratory staff (Brown, 2004, Sackett, 2004). Further, caution should be taken in the estimated development time needed to bring this design to an operational state. In this study we assumed the plant would be ready in 2010, but it may require 3 to 5 years longer.

The 4S is schematically shown in **Figure 2.7**. These modular reactors are designed to require minimum field assembly and minimal maintenance by allowing spent or defective modules to be removed and repaired at a central facility. Unlike commercial power reactors, the 4S is designed as a totally enclosed unit. The core and the primary coolant loops are sealed in the cylindrical structure. The heat released by the fission process and radioactive decay in the core is transferred to a liquid metal [sodium] in a primary heating loop. This, in turn, heats sodium in a secondary loop that transfers heat to water to make steam in a second heat exchanger which in turn drives a steam generator. The sodium is maintained at about 1 atmosphere pressure and 500^{o}C. There is no design capability to open the reactor vessel, for any purpose, other than at the factory. The coolant is circulated by electromagnetic pumps which have no moving parts. Coolant pumps and reservoirs are located above the core so that the structure design is kept long and narrow. This design also means that there are no emissions, except steam, throughout the lifetime of the plant.

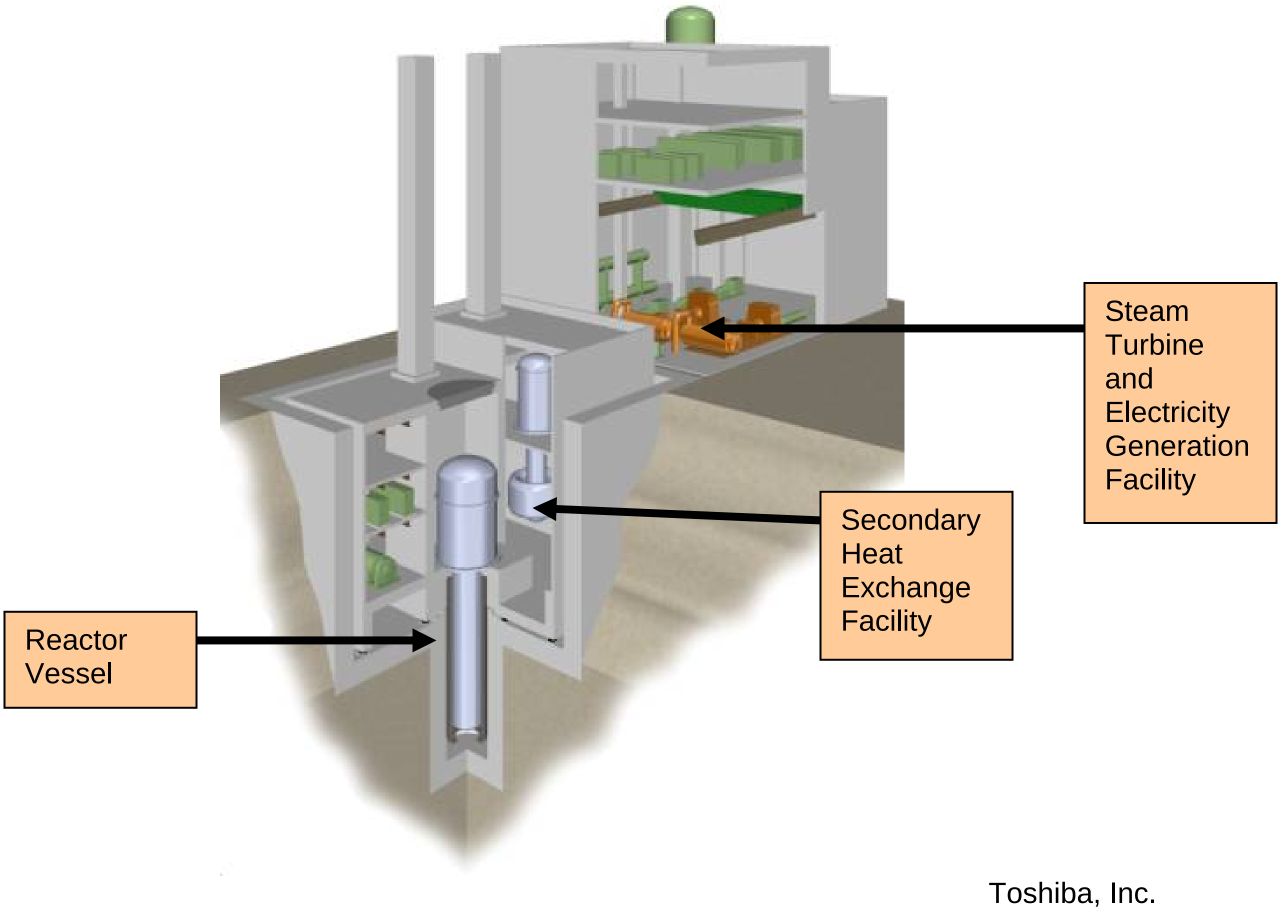


Figure 2.7. Schematic diagram of the 4S installation. Note that it is proposed that the Reactor Vessel be installed up to 100 feet below grade.

In the 4S design, the radioactive core is 2.0 m high and 0.7 m in diameter with the fuel composition of enriched uranium alloyed with zirconium. The fuel is less than 20% uranium. A cylindrical steel reflector shield rising from the bottom at a rate of around 5 cm/yr by means of an electromagnetic drive mechanism maintains the proper reaction rate by reflecting neutrons back into the core. The reflectors are moving upward slowly in order to compensate the reactivity loss during 30 years burn-up. In the event of a shutdown for whatever reason, gravity will cause the shield to fall back down, slowing the reaction rate. Moreover, the reactivity temperature coefficient is negative, meaning that the reaction will slow down if the core temperature gets too high. If an accident occurred, power would be lost, the reflector would stop its ascent, and it would move down to make core sub-critical, terminating the fission reaction.

The projected design life of the sealed 4S reactor is 30 years. The intent is that refueling on site would not be necessary. The reactor is intended to be returned to the factory and a replacement unit installed at the end of the unit's life. For a first-of-a-kind installation in Galena, licensing requirements may include extensive analysis of the reactor after a short run-time (i.e. 1 to 5 years). In this case the reactor would be changed out at that interval and returned to Toshiba for analysis. Extensive technical design evaluations are underway at Argonne National Laboratory – West, in conjunction with Toshiba, to improve and refine features of the 4S, but the current design is a sound basic design with low technical risk. (Sackett, 2004)

Load following is achieved by controlling the water flow to the steam generator causing changes in the coolant temperature, which affects the core inlet temperature and hence alters the reaction rates in the core. Since the core reactivity has a negative temperature coefficient, the lower water flow rate [lower load] lowers the core thermal output [consistent with lower load] by raising the core temperature. This feature greatly simplifies operation of the 4S power plant. (USDOE, 2001)

A cost estimate provided by Toshiba in 2003 was a capital of $2,500/kWe and electricity at $0.05 to $0.07/kWh assuming mass production of such plants. Experts may assert that this is a low value and does not include all of the development costs (Brown, 2004, Sackett, 2004)

Prior to the installation of any nuclear plant in the US, the Nuclear Regulatory Commission (NRC) conducts an extensive licensing process. This process includes extensive safety, security, and siting reviews. Detailed risk assessments are required; Safety and Security are critical elements of the process. The time required is not known precisely at this time.

2.3.2 Safety

The 4S is a pool type of reactor – not a breeder reactor- that has an "inherently" safe design so that it shuts itself down if coolant is lost. If that occurs, the reflector falls to the bottom of the reactor vessel, no longer performing its function, and the nuclear reaction slows down. This has been tested in the laboratory and will be verified as part of the Toshiba development work prior to NRC licensing and approval. The concept was also demonstrated at the Experimental Breeder Reactor II (EBR II) at the Argonne National Laboratory-West facility at the Idaho National Engineering Laboratory in 1988 when a large-scale reactor of this design was tested to failure, and the tests proved the reactor would shut down with no adverse effects.

The fact that there are no moving parts in the vessel adds to safety of the plant. The coolant is pumped using the electromagnetic properties of the sodium. Designed so that there is no refueling during its design-life, the 4S requires very low maintenance and reduces the risk of mechanical failure.

The possibility of sodium-water reactions is a serious consideration, and concerns about handling of sodium have resulted in extensive design consideration of the coolant loops in the 4S. Water and sodium react with the release of a large amount of energy, and the 4S is consequently designed with double-walled piping to contain the sodium and prevent leaks (Sakashita, 2004). Advanced leak detection systems sense the void between the walls of the pipe for sodium vapor. If detected at levels of 0.1 gram per second, the sodium circulation system is shut down. This contains the sodium within the piping, which is in turn contained inside the vessel or the secondary cooling loop housing. In the event of a leak, there are double and triple containment features. Leak detection systems monitor in each of the containment levels. This significantly reduces the risk of leaked sodium coming in contact with water.

Sodium cooled reactors throughout the world have been run for thousands of hours without incidents involving the reactor core. According to Neil Brown, a nuclear engineer at the Lawrence Livermore National Laboratory, there are 21 sodium-cooled fast reactors worldwide, including Japan's MONJU. This 280-MW plant operated for about one year starting in 1994 before being shut down after an accidental sodium leak and fire. No radioactivity leaked, but community concerns have kept MONJU shut down. (FDNM, 2004).

Another example of long-term operation is a 140-MW liquid metal reactor (JOYO), which has operated in Japan since 1977. It is a breeder reactor designed to produce more fuel than it consumes. It had operated for over 50,000 hours by the time it was shut down in 1994 and produced over 4,000,000 MWh of thermal energy.

(http://www.iaea.org/inis/aws/fnss/fulltext/0791_4.pdf)
During a period when the reactor was shut down, there was a fire lasting 3 hours in a maintenance facility 50m from the reactor in Oct. 2001. The fire may have been caused by spontaneous combustion of sodium on some of the equipment (Japan Times, Nov. 2, 2001).

In another example of long-term operation, the Experimental Breeder Reactor-II (EBR-II) generated over 2 B kWh of electricity while operating at Argonne National Laboratory from 1964 to 1994.
(http://www.anlw.anl.gov/anlw_history/reactors/ebr_ii.html).
It successfully passed a series of safety tests including those involving loss of coolant flow. Even with the normal shutdown systems disabled, the reactor safely stopped operating without reaching excessive temperatures.

The 4S vessel is expected to be installed up to 100 feet below grade. With the nature of the vessel's walls, placing it in a concrete structure at this depth will help reduce safety issues.

2.3.3 Security

Since questions of security are foremost in our minds, the NRC-required risk assessment will consider this in depth. Installing the vessel deep underground with a large, heavy, reinforced concrete cap adds to the secure nature of the 4S installation. The core is designed so that the material is below the proliferation treaty limits. If it were to fall into the wrong hands, it cannot be easily converted or enriched to weapons-grade fuel.

No heavy equipment in Galena is capable of lifting/removing the cap. The cap would need to be broken and removed in pieces. Due to Galen's isolation, no group of insurgents could accomplish this without detection long before they could breach the vessel. Even if they did, the material in a core of this design would not be easily extracted.

In its economic analysis based on the current practices at large nuclear power plants in suburban areas of the lower 48 states and Japan, Toshiba conservatively estimated a security guard force of 34 would be required. Because of the design, isolation, and inaccessibility of the vessel or cooling loops, it is suggested that this level of surveillance may not be required. A detailed risk assessment will determine what level is needed. With remote monitoring from the City/State law enforcement offices, only one guard may be necessary on-site at all times. This would significantly reduce the manpower requirements and effect the economic assessment. Thus, in the economic section, we used four guards as a minimum and 34 guards as the upper level for security staffing.

2.4 Other Power and Heat Generation Modules

In addition to those technological options for electricity generation discussed above, others can be used and are briefly described below. It was determined that these options would not contribute a significant enough amount of affordable energy to the utility for the utility to justify a major investment in them. However, Galena may want to consider implementing these technologies on a pilot scale within the next 10 years. If they might be proven feasible or reduced in price in the future, these technologies can be added to the utility as modules. Included are in-river turbines, solar, biomass, fuel cells, and coal bed methane. Therefore, these options are briefly discussed below – further details for some are provided in the Appendices.

2.4.1 Hydro In-river Turbines

Galena is on the north bank of the Yukon River, one of the largest in the country. A tremendous amount of water passes the site each day – winter and summer - and it seems to be a logical place to install in-river turbines for electric power generation. However, compared to the load requirements of the City, this may not be a valid conclusion. From the discussion presented in Appendix 1, a variety of turbines are being developed, but none has been proven in arctic environments. The one apparently best suited to the Galena site is under development by UEK Corporation. It is proposed to be installed in rivers, anchored to the bottom, and operated year-around – even under ice. A project to demonstrate it at the village of Eagle on the upper Yukon River has been approved but is awaiting U.S. DOE funding. This turbine design has dual 3-meter diameter blades. To estimate the power output of such a unit at Galena, a look at the power density is in order.

The power density in a flowing fluid is

$$Pmax = 0.5\rho V^3$$

For water flowing at V = 2 m/sec (characteristic of the Yukon at Galena) and density ρ = 1000 kg/m^3, this corresponds to 4 kW/m^3. For reasons related to mass conservation and efficiency, one may only be able to capture 40% of this or less with a

conventional turbine. For a water turbine with two 3-meter turbines or area of 14.1 m^2, this results in power generation of 22.5 kW – much less than that required by the City's load. Ten units would have to be installed to make even a marginal contribution and the cost may be too great for the benefit. UEK estimates $1,000/kW capacity for a 10-MW plant yet to be built.
(http://www.delawareonline.com/newsjournal/local/2003/09/06tidalpowerplant.html)

On the other hand, an operational 300 kW tidal turbine in Norway costs $23,000/kW capacity. (http://www.eere.energy.gov/RE/ocean.html)

2.4.2 Solar

Much of interior Alaska has a good solar resource for as much as eight months of the year. The National Renewable Energy Lab [NREL, 2004] has 30-year solar insolation data for hundreds of U.S. locations. Although there is no data for Galena, the plot shown in **Figure 2.8** below for Fairbanks probably provides a fair representation. Note, the data shows a substantial resource, even in the springtime, when both heat and electrical demands are high.

A downside to using solar energy is the intermittent nature of the resource. Hence, as with any intermittent resource, storage can be a key issue.

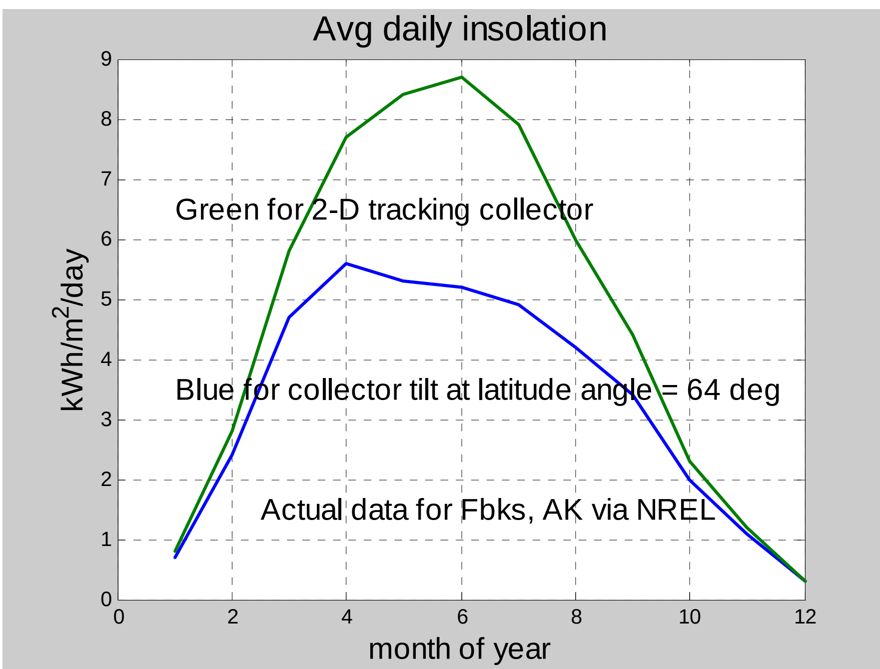


Figure 2.8. Solar insolation data for Fairbanks, Alaska

2.4.2.1 Solar-electric

Photovoltaic devices convert sunlight directly to electricity at efficiencies as high as 25%, although 10% is typical. Applications include residential both on and off grid, commercial buildings, remote systems for telecommunication, cathodic protection, pumping and irrigation, and land-based navigation aids. With output power densities around 125 W/m^2, a 1-square-meter panel may produce a kW-hr each 8-hour day. Brown (1999) estimated electric power can be produced for $0.20/kW-hr. Obvious shortcomings in northern Alaskan applications are associated with the lack of solar input during the winter when the demand for electrical power is the greatest. But the solar resource is still significant for two-thirds of the year in much of the state.

According to a study done in Arizona (McChesney, 2003), the average installed system costs in Arizona varied from ~ $6/peak watt for grid-tied facilities to over $20/peak W (or $20,000/kWp) for off grid systems. The latter would include battery storage. Installation of a 100 kW module in a Galena setting could cost $2M.

2.4.2.2 Solar Thermal

Solar thermal technologies use the heat in sunlight to produce hot water, heat for buildings, or electric power. Solar thermal applications range from simple residential hot water systems to multimegawatt electricity generating stations. In Galena, discussions with the City Manager determined that this technology would more appropriately be installed by individual home or business owners. Its impact on the utility was determined to be limited. A more detailed discussion is presented in Appendix 2 and at the following web sites.

http://solstice.crest.org/renewables/re-kiosk/solar/solar-thermal/index.shtml

http://www.eren.doe.gov/erec/factsheets/solrwatr.pdf

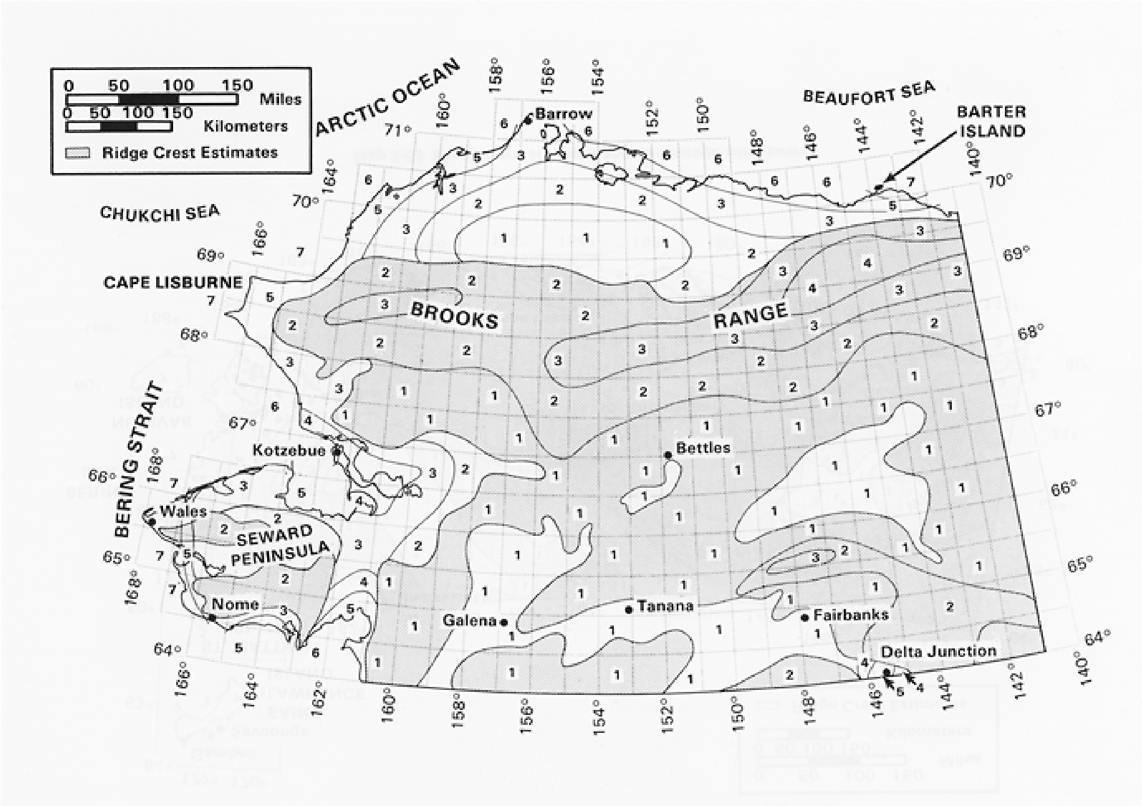
http://www.thermomax.com/

2.4.3 Biomass

Biomass can be wood from trees as well as plant residue, animal waste, and the paper portion of municipal solid waste (MSW). The dispersed nature of this resource makes the energy and time involved in harvesting an important issue. With a typical MSW generation of 4 lb/capita/day and an energy content of about 4 K Btu/lb, such wastes from a village of 700 people may have a heating value of 11 M Btu/day. If this could be converted to electricity with 20% efficiency, the power output may be about 34 kW – too small for a stand-alone unit. However, MSW could be burned in the AFBC of the coal power plant.

2.4.4 Wind

Wind generation is making in-roads into electricity production worldwide. However, at best wind turbines make up to 15 to 20% of the utility load. They are being employed successfully in Alaska in Kotzebue, Wales, and St. Paul. To be effective, a certain level of sustained wind resource is necessary. **Figure 2.9.** shows the wind regimes in Alaska. Average wind speed must be greater than about 16 miles/hr on average for wind generation to be effective (Class 5, 6, or 7). Galena is in a Wind Class 1 region with average speed much too low to be feasible. Therefore, wind generation was not assessed in detail for this investigation.



http://rredc.nrel.gov

Figure 2.9. Alaska, North, Wind Map. Map of wind regimes in northern Alaska. More information can be obtained on the web at www.bergey.com/Maps/Wind_classes.htm. Maps courtesy of U.S. DOE and NREL.

2.4.5 Fuel Cells

In fuel cells, hydrogen and oxygen are combined to produce water and release energy in the form of electricity. This reaction occurs in a thin layer on the surface of a membrane in the presence of a catalyst. Fuel cells convert the chemical energy of reactants (a fuel and an oxidant) into low voltage D.C. electricity via electrochemical reactions while generating almost no pollutants. Unlike conventional batteries, the fuel cell does not consume materials that are an integral part of its structure but rather acts as a converter. It will continue to operate as long as fuel and oxidant are supplied and reaction products are removed. Fuel cells require a minimum of maintenance, because they have very few moving parts. The most mature technology is the phosphoric acid fuel cell (PAFC), which utilizes hydrogen for the fuel and produces water. This product is valuable, especially in Alaskan villages in the winter, where potable water can cost over 10 cents/gallon. Since the water is produced at temperatures approaching 200˚F, it can be used for space heating. Current capital costs for a 200-kW device are around $4500/kW, with efficiency for electrical production around 40%. A 1-MW PAFC plant consisting of 5-200 kW cells was installed an Anchorage, Alaska airport post office complex. The project lasted for 5½ years and at the end, the cells were degraded to the point they needed to be replaced.

Other types of cells being actively developed include direct methanol (DMFC), molten carbonate (MCFC), and solid oxide (SOFC). The DMFC has the advantage of being fueled with a liquid fuel (methanol) which is more readily obtained than hydrogen. A disadvantage is crossover of some methanol from the anode to cathode side. The latter two offer the potential for internal reforming of conventional liquid and gaseous fossil fuel into hydrogen. Their higher operating temperatures also are more compatible with cogeneration. Disadvantages include the need for more expensive materials at these higher temperatures.

Since most fuel cell stacks under active development today require hydrogen as the fuel, reformers at the front end to convert fossil fuels to hydrogen are being developed. So far, cleaner fuels such as natural gas and methanol are easier candidates than "dirtier" fuels such as diesel and gasoline. Sulfur and CO in small concentrations can poison catalysts used in the stack membranes. It must be noted that when fossil fuels are used to produce hydrogen, CO_2 is released.

A second strategy is to use excess electrical generation capacity to generate hydrogen from water (electrolysis) and store the hydrogen for later use. This excess electrical power could come either from a renewable source, such as wind generation, or from excess capacity of existing diesel electric generators, using fuel cells in a load-leveling application.

The proton exchange membrane (PEM) fuel cell operates at around 60^{o}C and has solid polymer membranes sandwiched between carbon cathodes and anodes. With a little less than one volt per cell, it takes about 18 cells in series to generate 12 volts. (Johnson et al., 2000). Multinational corporations such as Daimler Chrysler are spending billions of dollars developing this technology for transportation applications. Several corporations are also interested in this technology for stationary power.

Currently, this promising technology is not commercially available and thus was not considered for Galena deployment.

2.5.6 Coal Bed Methane

Gas has been produced commercially from coal beds in the lower 48 states. Development of resources in other parts of Alaska is in the preliminary stage. Insufficient information is available about how to develop CBM in arctic conditions to consider it for Galena. If considered for development, extensive work to delineate local reserves is required before development could occur.

3. ENERGY CONSERVATION

Important technologies and techniques, that impact the amount of electricity required of the utility, are available for energy conservation but implementation of them is end-user driven and best conducted by the users. Therefore, a discussion of conservation is included here for reference.

Energy conservation refers to a variety of strategies employed to reduce the demand for energy. This can include adding extra insulation on building exteriors, setting building thermostats closer to ambient temperatures, or carpooling. Conservation is different from increasing energy efficiency, which refers to increasing the useful output for a given energy input. This could involve replacing incandescent light bulbs with compact fluorescent ones, driving more fuel-efficient motor vehicles, and purchasing more efficient appliances. All of these practices are end-user initiatives. Even though end-use conservation is not the primary utility activity, utilities may help educate and encourage consumers. Utilities throughout the United States are engaged in energy conservation programs. For example, GVEA's Energy Conservation Program is outlined in Section 7.1 of the Administrative Manual. Some highlights of this program include

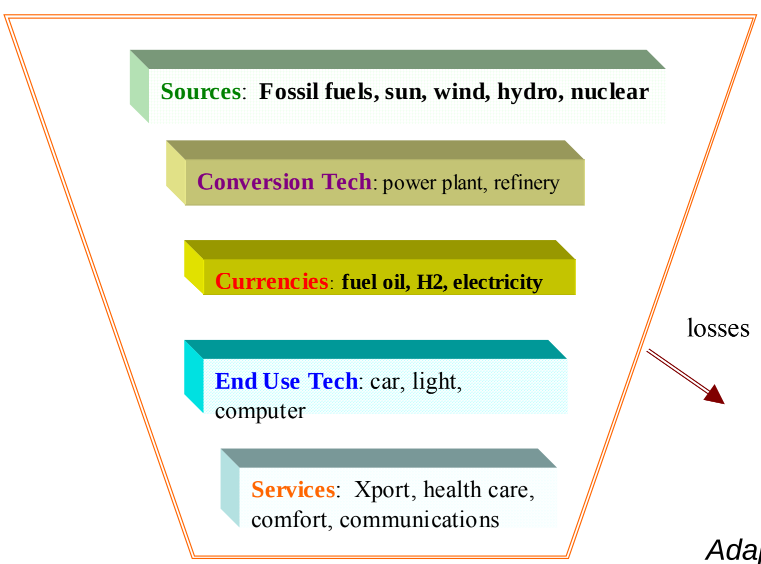
(a) developing and maintaining an effective load-management program,
(b) providing conservation information to the membership,
(c) monitoring energy use in all aspects of operations including facility operation, facility construction, and use of vehicles, and
(d) maintaining an active employee training program.

A detailed discussion of the options and benefits of conservation is given in the Appendix B.

4. USES OF EXTRA POWER

One unifying way to picture the flow of energy is by considering the below energy trapezoid as presented by Scott (2002) and others in **Figure 4.1.**

This study is focused on the top three items, sources and technologies and their ability to supply heat and electricity or other energy forms. The energy currencies of today are fossil fuels and electricity, but many believe hydrogen may be an important fuel in the future. What we want to provide are end services with several listed in the bottom part of the energy trapezoid.



Adapted from Scott(2001)

Figure 4.1. Energy Trapezoid

Some of the power plant enhancements being considered may provide electric power and heat at rates in excess of today's loads. Hence, one needs to consider growth in these loads such as that associated with population increases, new commercial enterprises, development of a regional grid, or tourism. In the future, if hydrogen becomes a vibrant energy currency, Galena could serve as a production center through water electrolysis powered by a coal or nuclear-fueled central power plant.

4.1 District Heating – Sales to Air Station

District heating currently serves the needs of the school, town offices, swimming pool, fire hall, and the power and water plants. Currently, the air station area gets space heat via oil-fired boilers that consume around 471,000 gals/yr of diesel fuel. This heat is delivered to individual buildings by utilidors. Part or all of this fuel could be displaced by district heating. If the power plant [nuclear, coal, or diesel] supplying this co-generated heat were located, say, 2 miles from the thermal load, a substantial capital expense would be required to construct the heat transmission line ($200/ft). But, the losses in a well-insulated line would be substantially less than the heat delivered.

4.2 Residential Electric Heating

If electric rates to the homeowner can be sufficiently reduced, there is a strong possibility that many of the approximately 220 residences (and commercial/office buildings) would convert to electric baseboard heat as their primary method of heating. There are several reasons this may be attractive. If the cost is lower than the use of fuel oil, economics becomes a strong driver. Additionally, a clean heating source reduces contaminants in the air of the building thereby increasing the indoor air quality. Indoor air pollution is of particular concern during the long winter months when most people stay indoors much of the time. Convenience is also a strong incentive. Baseboard heat is even and automatic, reducing the need to bring fuel inside (as wood-fired stoves require) or fill/haul fuel tanks.

If it is assumed the 220 residences were converted to electric baseboard heat, the following summarizes the costs and requirements. Each home requires about 15 kWs of heating capacity (50,000 Btu). Baseboard heaters cost $50/kW and about $25/kW for shipping and installation. Thus, each home would require an investment of $1,125 to install the heating systems. Each home may also require up to $1,000 investment to upgrade the service and wiring to handle the increase in load. This investment might be financed through the utility as an incentive for residents to convert. For this reason, the overall costs are included as part of the capital cost in assessing the economics of the 4S nuclear system. An estimated $250,000 would be required to upgrade the utility distribution system and purchase a replacement transformer. The following calculation yields $717,500 as the total cost for conversion.

$$\frac{15\ kW}{residence} \times \frac{\$75}{1\ kW} = \frac{\$1125}{residence} \times 220\ residences = \$247{,}500$$

$$\$247{,}500 + \frac{\$1000}{electric\ service\ upgrade} \times 220\ residences = \$467{,}500$$

$$\$467{,}500 + \frac{\$250{,}000}{distribution\ transformer\ \&\ feeders} = \$717{,}500$$

Note that this cost estimate does not include the cost of electricity and is independent of the source. Supplying power for electric baseboard heaters from existing DEGs would result in operating costs much greater than for current forms of heating (oil furnaces and wood stoves). This option is discussed in more detail in the economics section.

4.3 Hydrogen Production

Many are projecting that hydrogen will be the fuel of the future. While there are some good reasons for this, significant issues that must be addressed. Hydrogen is the lightest element and thus has a very low density. It easily diffuses through many materials including some metals. One gallon of liquefied hydrogen weighs just 0.58 lbs (gasoline weighs over 6 lb/gal). It has a high energy content, but its low density means it has a low energy density (Btu/unit volume). Liquid hydrogen's energy density is about 22% of that for #2 diesel fuel. Thus, storage and containment are significant issues relative to hydrocarbon fuels.

Hydrogen is not a primary fuel as are conventional fuels such as natural gas, coal, and petroleum, but rather it is an energy carrier. Hydrogen does not occur in a free state in nature (because of its reactivity with oxygen to form water). Thus, hydrogen used as a transportation fuel must be made employing significant amounts of primary energy. Most hydrogen used is currently made from reforming of natural gas. It can be made by electrolysis of water – requiring large amounts of electricity. However it is made, more energy is used in its production than it contains. If produced from electricity from a 40% efficient coal-fired power plant, with a 75% efficient electrolyzer, the energy content of the hydrogen product would contain at most 30% of the energy of the coal used to produce it. Hydrogen is attractive as an alternative for transportation fuel because it burns very cleanly and has no by-products except water and perhaps some traces of nitrogen oxides. It produces no carbon dioxide. There is currently very little infrastructure for the production, storage, and distribution of hydrogen on a large scale anywhere in the world.

In Galena's setting, hydrogen would most efficiently be used locally in the community, because storage tanks are expensive. If it had to be shipped outside the City, tank storage would be required to store the production during the winter (about seven months) when the barges cannot use the river, adding significant capital cost. Shipping of the product might be envisioned using semi trailer mounted tanks that could be barged to Nenana and pulled to Fairbanks or Anchorage for sale to the military, railroad, or other users. Shipping in this manner would add more than $0.90/gal to the cost, making it prohibitively expensive.[1] Therefore, it was concluded that any hydrogen enterprise should be sized to be used entirely in Galena.

For purposes of this study, it was assumed the venture would be a private enterprise and the economics were calculated as such. A modular plant was conceptualized and after several iterations, a plant based on the concept outlined by Air Products was used as a basis. It would use 1 MW as the input to the electrolyzer with a total power requirement of 1.5 MW. The output could be as large as 404,000 gallons per

[1] based upon barge shipping rate quotes, Inland Barge Service, Nenana, Alaska, May 2004

year of liquid hydrogen, matching well with the projected local demand. No provision was made to collect or market the coproduced oxygen. The economics were run assuming that the Air Station equipment was converted from diesel (50,000 gal/yr) and the school district buses and city vehicles were converted from gasoline (25,000 and 15,000 gal/yr, respectively).

Table 4.1. Equivalent liquid hydrogen needed to displace local petroleum based fuels

	Current Fuel Use	Equivalent Liq. Hydrogen
Air Station Vehicles	50,000 gal/yr diesel	229,000 gal/yr
School buses	25,000 gal/yr gasoline	94,000 gal/yr
City Vehicles	15,000 gal/yr gasoline	56,000 gal/yr
	TOTAL	379,000 gal/yr

Therefore, the local market could use about 94% of the production capacity.

Table 4.2. Results of hydrogen economic analysis

Capital	Power Cost	Production Cost	Target Price
$6.2 million	-0-	$46/M Btu	$15-30/M Btu Diesel equivalent
-0-	$0.015/kWh	$17/M Btu	

Based on these assumptions, on a Btu comparative basis, hydrogen cannot compete with diesel and gasoline. However, if as a demonstration the capital equipment could be procured via a grant, with a low electrical power cost, the fuel can be produced at a rate comparable to diesel. Details are presented in the Economics Section.

Excess electricity could also be used to produce hydrogen via electrolysis of water. With a 70% efficient electrolyzer, each MW of electric power could produce hydrogen at an energy flux rate of 700 kW. An energy content of 141.8 MJ/kg = 39.4 kWh/kg results in an H_2 production rate of 17.8 kg/hr. Under 1 atmosphere pressure and 0^oC, 2 kg of H_2 occupies 22.4 m^3. If pressurized to 300 atmospheres [about 4500 psi], one day's production of H_2 would occupy about 16 m^3. If stored for periods of weeks, the storage costs [amortization of the capital costs of the container] become significant. The energy required for compression is a few percent of the energy contained in the hydrogen.

4.4 Transmission to Other villages

A regional grid could link five neighboring communities with transmission lines supplied by a central power plant in Galena. These five communities have a combined generation capacity of about 3 MW with the farthest (Kaltag) being 83 river miles away.

Table 4.3. Cost of installing a transmission line to serve near-by villages

	Distance				Cost ($million)		
Village/ Population	**From Galena**	**From Previous Village**	**Portion Along Roads**		**Road Portion @$80K/mi**	**Overland Portion @$200K/mi**	**Total for Segment**
Down Stream							
Koyukuk/ 169	32**	32	5		0.4	5.4	5.8
Nulato/ 336	50**	18	4		0.32	2.8	3.1
Kaltag/ 230	83**	33	5		0.4	5.6	6
				TOTAL	1.1	13.8	14.8
Up Stream							
Ruby/ 169	42*		9		0.72	6.6	7.3
				TOTAL	1.8	20.4	22.2

* Used a direct route on north shore of Yukon River
** Used abandoned telegraph right-of-way to estimate

From Galena, Ruby is the closest village upstream on the Yukon. It is roughly 52 river miles away. If a transmission line was run along the north shore of the river cutting across some of the oxbows, the distance is estimated to be about 42 miles. Going downstream, a line could be run to pick up Koyukok (32 miles), Nulato (an additional 18 miles), and Kaltag (an additional 33 miles). **Table 4.3.** summarizes the cost for the lines. That portion of each leg, which can be constructed along a road is estimated to cost $80,000/mile and overland the cost is $200,000/mile, based on Galena and AVEC experience. Using these assumptions, a transmission line from Galena downstream to Koyukok, Nulato, and Kaltag covers about 85 miles along the river and would cost an estimated $15 million. A line upstream to Ruby (population 169, generation capacity of 0.6 MW) would cost about $7.3 million. Thus, for a total of about $22.2 million, about 800 people with a load of 1.8 MW could be served. Details of the economic assessment of the Transmission Options are presented in the Economics Section.

4.4 Greenhouses and Aquaculture

With the copious amounts of low-grade heat produced in conjunction with power production, several opportunities for commercial enterprises exist, such as raising produce in greenhouses and fish farming. These ventures could supply Galena and surrounding villages with fresh and relatively low-cost produce. Fish raised in tanks could provide for local consumption or be marketed as fresh, frozen, and processed products. Besides providing fresh produce, new businesses such as this would provide employment opportunities.

4.4.1 Greenhouses

Galena has plenty of sunlight in the springtime and could readily grow various crops such as tomatoes, potatoes, squash, cabbage, carrots, etc. if the proper environment could be maintained. This includes the right temperature and an adequate supply of clean air. To illustrate, suppose one needed to keep a 100 x 20 x 10 ft greenhouse 80^{o}F above ambient in which the shell had an R value of 2 ft^2 hr ^{o} F/Btu, representing a day in March. **Figure 4.1** below illustrates how much heat would need to be supplied as a function of air changes per hour assuming a 50% efficient heat recovery ventilation system. This heat rate represents a small fraction of the rejected heat from a multimegawatt power plant.

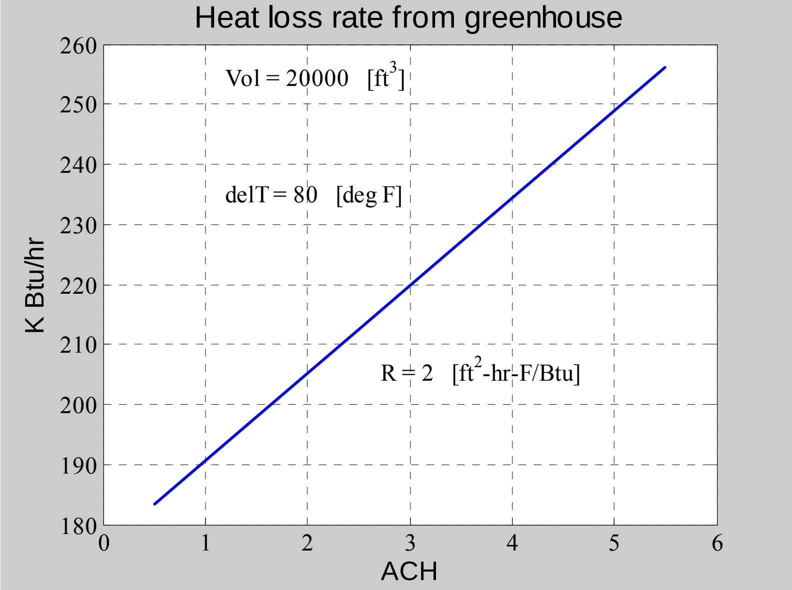


Figure 4.2. Heat load for a greenhouse

4.4.2 Aquaculture

Raising fish in tanks (farming) is often controversial, because of the concern of farmed fish escaping into local streams. However, if allowed and permitted by state and local processes, it is another avenue open for local entrepreneurs to use the heat produced by power plants of various types. Fish could be used locally or processed into frozen or value-added products for sale outside.

An example is trout production. Requirements include;

- Water temperatures of 8^{o}C to 18^{o}C are recommended
- Dissolved oxygen in excess of 5 mg/L
- 10-20 kg fish/cubic meter (22-44 lbs/264 gallons)
- Flow rates of recharge water = 510 L of water/sec/ton of fish (153 gallon/sec/ton)

Other species have less stringent water requirements. An economic comparison and assessment for various species would have to be conducted as part of the business planning process. (Gooley, 1997)

5. ENVIRONMENTAL ISSUES AND PERMITTING

5.1 Primary Environmental and Permitting Issues

All major aspects of power generation and distribution will carry with them some adverse environmental effects. There will be effects relating to the construction and operation of power plants, regardless of the means by which the power is generated. There will also be potential environmental effects from operating each type of power plant. Transportation of fuels and/or power plant components will also involve environmental impacts, especially if new power lines and/or roads are necessary. Each of the three primary energy options addressed in this report (diesel, coal, and nuclear) will also result in the emission of water and air pollutants and the generation of wastes of various types. In the case of coal, disturbance from mining must also be considered. Each of these potential threats to the environment are regulated by one or more agencies of the state or federal government.

The purpose of this portion of the Galena Energy Assessment is to (1) briefly summarize the key environmental issues associated with the primary energy options; (2) provide a short summary of the state and federal regulations that address these environmental issues; and (3) rank the primary energy options in terms of the effort and costs that will be associated with the various options. This section is ***not*** intended to provide a comprehensive assessment of environmental issues and permitting for energy development but is intended to provide a high-level summary of the key environmental issues relating to the potential diesel, coal, or nuclear power generation at Galena. Such a comprehensive assessment will be part of the overall permitting process, regardless of which option (or options) the City of Galena selects to pursue.

For the sake of convenience, environmental impacts associated with energy production and delivery can be placed into four general categories:

(1) significant **disturbances** of land and surface water, and groundwater;
(2) emission of **air pollutants**;
(3) emission of **water pollutants**; and
(4) management of various types of regulated **wastes**.

5.1.1 Disturbance

These issues are covered by a wide variety of permitting and licensing requirements from an equally wide variety of state and federal agencies. A partial list of issues and the agencies responsible for regulating those issues is provided in **Table 5.1.**

Table 5.1. Partial list of permitting requirements related to disturbance of lands and waters.

Permit requirement	Primary regulatory agency
NEPA Environmental Impact Statement	U.S. Environmental Protection Agency
Storm water Discharge Permit	U.S. Environmental Protection Agency

Threatened and Endangered Species and Critical Habitat Assessments	Alaska Department of Fish and Game
Wetlands Assessment	U.S. Army Corps of Engineers
Building Permits	Alaska Department of Public Safety
Wastewater and sewage permits	Alaska Department of Environmental Conservation

5.1.2 Air Pollution

Control of air emissions in the United States is regulated under the Clean Air Act as amended in 1990. At the national level, new air pollution point sources are regulated by the U.S. Environmental Protection Agency (EPA). However, as with most environmental regulations at the national level, the Clean Air Act provides states with the option to take over regulatory authority for air pollution sources within their boundaries. In Alaska, the Department of Environmental Conservation – Division of Air Quality is the primary regulatory agency with respect to air emissions. The State of Alaska therefore maintains primacy over air quality issues in the state through Title 44, Chapter 46, and Title 46, Chapter 3 and Chapter 14.

5.1.3 Water Pollution

Control of water pollution in the United States is also maintained by the EPA under authority of the Clean Water Act. In contrast to the situation with air emissions, however, the State of Alaska has not opted to take over regulatory authority from EPA. For this reason, any water pollution permitting must be through the EPA rather than through a state agency. Much of the general information on water pollution issues is taken directly from the EPA internet web sites.
http://cfpub2.epa.gov/npdes/regs.cfm?program

Although there are differences in water permitting needs for the three primary energy options discussed in this report, the primary permitting issue for each will be storm water permitting under the National Pollutant Discharge Elimination System (NPDES). Administered by the EPA, the NPDES regulates point sources that discharge pollutants into waters of the United States. An NPDES permit is required for any construction activity that disturbs one acre or more of land, including construction of the power plant, roads, power lines, tank farms, mines, ore processing facilities, etc. On March 10, 2003, new regulations came into effect that extended coverage to construction sites that disturb one to five acres in size, including smaller sites that are part of a larger common plan of development or sale. Sites disturbing five acres or more were regulated previously.

Where the EPA is the permitting authority, the Construction General Permit (CGP) outlines a set of provisions construction operators must follow to comply with the requirements of the NPDES storm water regulations. The CGP covers any site one acre and above, including smaller sites that are part of a larger common plan of development or sale, and replaces and updates previous EPA permits. To be eligible for coverage under the Construction General Permit (CGP), you must assess the potential effects of storm water discharges and storm water discharge related activities on federally listed endangered and threatened species and any designated **critical habitat** that exists **on or near** the site. In making this determination, one will need to consider areas beyond the immediate footprint of the construction activity and beyond the property line, including those that could be affected directly or indirectly by storm water discharges.

5.1.4 Waste Management

Each of the three primary energy options will generate waste of various types. In Alaska, solid wastes (nonhazardous) are regulated by the Alaska Department of Environmental Conservation. Solid wastes will be a substantial issue with the coal option because coal mine overburden is classified as a solid waste. Each option will also generate some volume of wastes classified as hazardous. The primary authority for regulating hazardous wastes is the Resource Conservation and Recovery Act (RCRA), administered by the EPA. Regulatory authority for hazardous wastes in Alaska, however, is shared between EPA and the Alaska Department of Environmental Conservation.

Radioactive waste is unique in that it is regulated by the U.S. Nuclear Regulatory Commission (through a memorandum of understanding with the EPA) under authority of the Atomic Energy Act.

5.2 Enhanced Diesel

5.2.1 Background and Assumptions

It is assumed that a new diesel plant and related infrastructure will be located near the existing power plant, reducing the need for the construction of additional roads, power lines, and tank farms, thereby simplifying the environmental permitting process. It is also assumed that fuel will be transported to Galena in the same manner as at present, primarily by barge during the summer shipping season on the Yukon River. Although the permitting process for this option is probably the least restrictive, numerous permits will have to be obtained for the diesel option to be implemented.

5.2.1.1 Disturbance.

In comparison to the coal and nuclear power plant options, and based on the assumptions listed above, construction and operation of an enhanced diesel power plant will likely result in less disturbance of land and waters than the other primary options. However, a number of state and federal permits could be required, especially if additional roads and/or power lines are necessary.

5.2.1.2 Air Pollution.

The Alaska DEC Division of Air Quality has a general air quality operating permit for diesel electric generating facilities. This permit can be accessed through the DEC website (http://www.state.ak.us/dec/air/ap/docs/gp1.pdf). The general permit covers emissions of primary pollutants such as oxides of nitrogen and sulfur, respirable particulates (PM-10), volatile organic compounds, and carbon monoxide, all of which may be released from the power plant stack. There are also provisions for visible emissions (smoke) from the power plant, and for emissions from stored fuel.

5.2.1.3 Water Pollution.

A storm water permit through the EPA NPDES program will be required for any construction activity, including the new power plant, tank farm, roads, or power lines. Requirements for spill prevention and response may also be imposed.

5.3 Coal

5.3.1 Background and Assumptions

For coal to be a viable option as an energy source for the City of Galena, it has been assumed that a surface coal mine would be developed above old Louden, and a coal-fired steam plant would then be built in or very near the City. All aspects of coal production and use must therefore be considered – from permitting the mine itself to the disposal of wastes generated by the power plant. All of the infrastructure required to extract the coal, transport the coal, and produce the power must therefore be considered. It is also assumed that coal generated would be used locally and not be shipped to market elsewhere.

Power generation using locally derived coal can be viewed as a five-step process: (1) mining; (2) preparation (primarily crushing); (3) transport; (4) power generation; and (5) waste management. Each of these basic steps in coal power generation has inherent environmental issues associated with it, and each is regulated by one or more state or federal agencies.

5.3.1.1 Coal Mining.

Much of the information in this section on coal mining environmental issues and permitting is taken directly from internet web sites of the Alaska Department of Natural Resources (DNR). Background information on Alaska's Coal Regulatory Program is taken largely (and often directly) from an Alaska Division of Mining, Land, and Water web site (http://www.dnr.state.ak.us/mlw/mining/coal). Permitting requirements for surface coal mining are provided on a related DNR web site (http://www.dnr.state.ak.us/mlw/mining/coal/coalreg.pdf).

Although coal mines have operated in Alaska since 1855, only two mines are currently operating in Alaska: the Gold Run Pass Mine and the Poker Flats Mine. Both mines are owned and operated by Usibelli Coal Mine, Inc., and both are located within six miles of each other east of Healy. Usibelli has been mining coal in the Healy area since 1948. Production therefore began before the current federal and state regulatory programs were put into effect, so not all of the standards that would be applied to a new mine are actually in effect at the two Usibelli mines. Also, coal mining is regulated in a manner that is entirely different from that of other types of mines. Points of comparison for environmental compliance for any new mine near Galena or elsewhere in Alaska are therefore generally lacking.

At the federal level, coal mining is regulated primarily by the Surface Mining Control and Reclamation Act (SMCRA) of 1977. This Act substantially increased the environmental oversight applied to coal mining nationwide. As with many federal environmental regulations, SMRCA also provided individual states with the opportunity to assume primacy over the federal program by developing a state regulatory program for coal in a manner which complies with federal SMCRA standards. Alaska opted to develop its own program consistent with SMRCA, enacting the Alaska Surface Coal Mining Control and Reclamation Act (ACMCRA) in 1983.

ACMCRA is administered by the Alaska Division of Mining, Land and Water Management (DMLW), a division of the Department of Natural Resources. The Act comprehensively regulates almost all aspects of coal mining activity from exploration through final reclamation. Some of the more important parts of the program include the following (http://www.dnr.state.ak.us/mlw/mining/coal/):

- Exploration permit: Permitting is required before any coal exploration activity occurs on any land ownership (federal, state, municipal, or private lands).
- Review Process: Any new mine proposal must undergo extensive review before any permit is approved. The review includes at least two separate public notice periods and is highly prescribed by regulation.
- Performance Standards: 65 separate performance standards are set for various coal mining activities, everything from the placement of signs to statistical requirements for measuring revegetation success.
- Inspection: DMLW personnel must inspect each operating coal mine an average of once each month.
- Penalties: Criminal and civil penalties are enforced for violations of ACMCRA.

5.3.1.2 Disturbance from Mining

It is impossible to mine coal without disturbing large areas of the land surface. This is especially the case with surface mines, although land disturbance from subsurface, tunnel mines may also be substantial. Disturbance of the environment due to mining is generally covered by reclamation requirements, and one of the primary goals of ACMCRA (and SMCRA) is to ensure that reclamation is performed in an effective and timely manner. Toward that end, the State of Alaska’s coal mining regulations contain a variety of reclamation requirements. To ensure that reclamation is accomplished adequately, the operator must submit a reclamation bond before mining begins. This bond must be sufficiently large to allow the state to reclaim the site if the operator fails to do so. The Usibelli Coal Mine, Inc. has pledged a collateral bond of approximately $3 million for the reclamation at its two mines. Once the area is reclaimed, the state can incrementally release the bond. Alaska's coal program regulations require that final bond release not occur until at least 10 years after the mine site is graded and initial vegetation established. The 10-year period is intended to provide time to determine whether revegetation is successful. The Usibelli Coal Mine, Inc., has a full-time reclamation engineer on staff, as well as seasonal reclamation work crews. Each year, the company seeds and fertilizes land being reclaimed. In 1997, they planted several thousand birch, willow, alder, and spruce seedlings on the two mines. Reclamation requirements may be found on the Alaska DNR internet web site (http://www.dnr.state.ak.us/mlw/mining/coal/coalreg.pdf).

DMLW recently approved a new mine permit for the Two Bull Ridge Mine. Some of the important reclamation provisions of the permit were the following:

- Topsoil: An extensive pre-mining soil inventory was conducted, and all soils removed were required to be saved except those that are unsuitable for reclamation use and those on steep slopes. All of these salvaged soils will ultimately be placed back onto reclaimed areas. As the active mining area moves through the 832-acre area of the mine, grading will be completed and topsoil will be replaced within approximately 800 feet of the actively mined area.
- Post-Mining Land Use: The mining area will ultimately be reclaimed for wildlife habitat, which was the predominant pre-mining land use.
- Revegetation: Usibelli's Revegetation Plan has two parts. First, the area will be seeded with native grasses to quickly establish a ground cover that will control erosion. Second, although they expect natural regeneration to provide the larger woody plants, this natural regeneration process will be accelerated by planting 100 plants per acre using naturally occurring woody plants such as willow, alder, or spruce.

5.3.1.3 Air Pollution for Coal Mining

For coal mining, the primary air pollution issues include the generation of fugitive dust and the potential release of methane. These emissions will be controlled under a permit by the Alaska Division of Air Quality.

5.3.1.4 Water Pollution for Coal Mining

Aside from standard storm water discharge issues, coal mining is a water pollution concern primarily because of acid mine drainage. Requirements of the EPA will restrict or eliminate the potential for acid mine drainage. The greatest water pollution regulatory burden for coal mining will be the NPDES permitting, which has been cited as "the greatest obstacle to timely development of mines in Alaska" (Report of the 2004 Alaska Minerals Commission).

5.3.1.5 Waste Management for Coal Mining

A solid waste disposal permit will be required from the Alaska Department of Environmental Conservation. The most recent solid waste disposal permit approved in Alaska was a renewal of a solid waste disposal permit for the Usibelli mine. This permit (http://info.dec.state.ak.us/decpermit/eh/sw/0031-ba002.pdf) is for the continued operation of "an inert waste monofill for construction and demolition debris, shop wastes, and coal ash, located at the Usibelli Coal Mine "… in accordance with AS 46, 18 AAC 15, and 18 AAC 60." The permit was issued in April 2000, and extends for a five-year period, after which it must be renewed again. The Usibelli permit allows for the disposal of these specific nonhazardous waste types "within the boundaries of the Poker Flats and Two Bull Ridge mining areas at Usibelli Coal Mine."

5.3.2 Coal Preparation – Air Pollution

In April 2003, the Alaska Department of Environmental Conservation, under the authority of AS 46.14 and 18 AAC 50, issued Air Quality Operating Permit No. 317TVP01 to the Usibelli Coal Mine, Inc., for the operation of the Usibelli Coal Preparation Plant. This permit is in force until the expiration date of May 13, 2008. The Usibelli permit included provisions limiting emissions of regulated air contaminants including particulate matter (PM-10), Sulfur Oxides (SOx), Nitrogen Oxides (NOx), Carbon Monoxide, and Volatile Organic Compounds (VOCs), and requires the permittee to submit assessable emission estimates no later than March 31 of each year. The submittal is required to include all of the assumptions and calculations used to estimate the assessable emissions in sufficient detail so they can be verified. A list is provided below of sources at the Usibelli mine site that have specific permit stipulations for monitoring, record keeping, or reporting conditions. From **Table 5.2** (below) each source has stipulations associated in the permit. Many of these involve record keeping.

Table 5.2 Usibelli Coal Preparation Plant Source Inventory

ID	Source Name	Source Description	Rating/size	Install Date
1	CRU1-Primary Crusher	Stamler Feeder Breaker-12465	1,400 Tph	1986
2	CRU2-Secondary Crusher	McNally 34 x 38	1,000 Tph	1982
3	CRU3-Secondary Crusher	Gundlach	500 Tph	1997
4	SCR1 Screener	Rippleflow Screener	500 Tph	1997
5	SCR2 Screener	Rippleflow Screener	500 Tph	1997
6	TRA1	Transfer point #1	500 Tph	1997
7	TRA2	West Tipple Transfer	400 Tph	1997
8	FIN1	Fine coal Loadout	1,400 Tph	1982
9	DUM-1	Truck Dump	1,400 Tph	1990
10	TRN1	Train loadout	2,500 Tph	1992
11	TRK1	West Tipple Truck Loadout	200 Tph	1996
12	STK1	Coal Stockpile Loadout	20,000 tpy – loadout	1992
13	Boiler 1	Kewanee Coal fired	7.22 M Btu/hr	1982
14	Boiler 2	Ferrar & Trefts 578 Coal fired	7.69 M Btu/hr	1977
15	Boiler 3	Hastins 55A Diesel fuel	1.0 M Btu/hr	1996
16	Boiler 4	Kewanee 4430 Waste Oil	5.0 M Btu/hr	1996
17	Tank 1	Diesel Fuel	24,000 gal	1993
18	Tank 2	Diesel Fuel	24,000 gal	1993

5.3.3 Coal – Transportation

A new coal mine, even if "local," will require that some new roads be built. For Galena, the type and distance of these roads will depend on a number of factors, including (1) how close the mine and coal processing facilities are located from the power plant; and (2) whether coal will be produced to be shipped for use elsewhere. Construction of new roads in Alaska require a number of permits, the most substantive of which are summarized below:

5.3.3.1 Federal

U.S. Army Corps of Engineers: Disturbance of any lands containing wetlands requires a permit (or waiver) from the Army Corps of Engineers before any dredged or fill material is placed in wetlands. The Corps is responsible for determining whether an area is wetland for permit purposes and issues permits for dredging, filling, or placing structures in tidal waters, streams, lakes, and wetlands. For additional information, or for a wetlands determination, contact the U.S. Army Corps of Engineers, Regulatory Branch, PO Box 898, Anchorage, AK 99506-0898 (1-800-478-2712).

U.S. Environmental Protection Agency: As described in previous sections, the EPA manages NPDES storm water permits required for all construction projects that disturb over 5 acres of land. Contact information: U.S. Environmental Protection Agency, Region 10, Office of Water, 1200 Sixth Avenue, Seattle WA 98101 or 1-800-424-4372 x6650. Permits available at http://www.epa.gov.r10earth/stormwater.htm

5.3.3.2 State of Alaska

Department of Fish and Game: The Alaska Department of Fish and Game is responsible for issuing permits for any activities or projects which impact waters that support salmon and high value resident fish species as well as for activities within Critical Habitat Areas, State Game Refuges and State Game Sanctuaries. Contact the Alaska Department of Fish & Game, Habitat & Restoration Division, 333 Raspberry, Anchorage, AK 99518. (907) 267-2285.

Department of Public Safety: A State building permit is required for all commercial buildings for any location in the State. The State Fire Marshal issues permits after appropriate plans and specifications are submitted and approved. Information and application are available at: State Fire Marshal, 5700 East (907) 269-5604.Tudor Road, Anchorage, AK 99507

Department of Environmental Conservation: The Alaska Department of Environmental Conservation (ADEC) provides and enforces standards for water quality and waste disposal, as described in earlier sections. For information specific to domestic water wells and septic systems, contact the state or local ADEC office.

5.3.3.3 Local

There may also be additional permits required relating to construction, zoning, easements, covenants, waste disposal, flood plain development, critical habitat, etc.

5.3.4 Coal Power Generation

Construction of a coal-fired power plant in Galena will require a number of construction, air pollution, water pollution, and waste management permits. Air permits will deal with emissions for sulfur and nitrogen oxides, particulates, and carbon monoxide, and may also restrict visible emissions. For water, an NPDES permit will be required for the power plant, and thermal loading to waters may also be restricted. Waste management will include disposal of ash and other materials.

5.4 Toshiba 4S Nuclear Plant

The U.S. Nuclear Regulatory Commission (NRC) regulates the construction and operation of all new commercial nuclear power facilities that produce electricity in the United States. The NRC is responsible for issuing standard design certifications, early site permits, construction permits, operating licenses, and combined licenses for commercial nuclear power facilities. NRC regulates reactor siting, construction, operation, and decommissioning through a combination of regulatory requirements, licensing, and oversight, including inspection. Recently, the NRC has been making minor revisions in its policies to help make new licensing reviews more effective and efficient and to reduce unnecessary regulatory burden on future applicants. NRC's Regulations are found in Chapter I of Title 10, "Energy," of the Code of Federal Regulations (CFR). These are summarized in Appendix 3.

5.4.1 Disturbance

As with the other energy options discussed, construction of the Toshiba 4S reactor in Galena would require a storm water permit under EPA’s NPDES program. Depending on the area of land disturbed (including security fences, etc.), additional disturbance-related regulations may be invoked, including those listed in Table 4-1 for Coal Mining.

5.4.2 Air Pollution

The Toshiba 4S power plant is an entirely closed system. As such, no atmospheric emissions are anticipated under normal operating conditions. Any air permitting issues associated with the 4S plant will likely be routine nonradioactive emissions permits through the Alaska Division of Air Quality.

5.4.3 Water Pollution

As with air pollution, the closed system design of the 4S plant will likely limit water pollution permitting to the construction storm water permits described above under “disturbance.”

5.4.4 Waste Management

Operation of the 4S reactor will generate small volumes of solid waste (trash) and potentially some small volumes of hazardous (nonradioactive) wastes. Both classifications will be permitted as described for the other energy options listed above. Under the assumptions provided by Toshiba, the 4S plant will not generate any radioactive waste except the reactor core itself, which will be returned to Japan following the decommissioning of the plant.

5.5 Conclusions – Environmental Issues and Permitting

Given the assumptions stated throughout this report, and strictly from an environmental permitting standpoint for the City of Galena, evaluation of the permitting requirements for each of the three primary energy options yields a clear loser (coal) and an apparent winner (nuclear). Two key assumptions that play heavily into this result. The first is that coal will be generated locally. This represents a distinct disadvantage from a permitting standpoint in that permitting for the mine site must be considered for this option, but not the others. The second assumption is that all of the information provided to us by Toshiba proves to be accurate and is accepted by the NRC. Specifically, (1) if the 4S reactor truly generates no air or water emissions; (2) the reactor is returned to Japan at the end of its useful lifetime (thereby eliminating nuclear waste issues), and (3) Toshiba bears all (or most) of the licensing costs, then the permitting “cost” to Galena is reduced to the point that the nuclear power option becomes the clear preference. Before a final decision is made, it is imperative that these assumptions be verified.

6. ECONOMIC ANALYSIS

6.1 Overview of Methodology

The economic analysis model calculates the total cost of providing electric power to the Galena utility distribution system (the “busbar cost”). The analysis runs for 30 years, from 2010 to 2039. In all cases, the existing electric and district heat loads are served as firm loads. In some cases, additional heating loads are also served, and the delivered energy is valued at the avoided cost of displaced fuel. Electric space heating of residences is treated as a firm load, which must be met by the utility with diesel backup, while the air station heating load is treated as a nonfirm or “economy energy” load.

The model computes and considers the relevant electric and heat loads one day at a time to determine how much energy can be delivered that day by the primary generation source (diesel, coal, or nuclear) and how much must be delivered from diesel as a peaking and/or backup resource. Nonfirm energy sales are counted as a credit against total energy production cost to determine the net cost of serving the firm load. The model calculates the net present value of all annual costs to determine the total system life-cycle cost of power generation to the City of Galena Electric Department. It also computes the approximate average electric rate necessary to cover each year’s annual cost of providing electric service. The average electric rate also includes estimated distribution and administration costs.

To deal with uncertainty, we employ low and high values for some critical parameters. These are discussed below. We also employ sensitivity analysis to determine the effect of changing some specific assumptions.

6.1.1 Example of Model Structure

The following highly simplified example illustrates the basic steps in the analysis. More details on the model structure are presented in Appendix D. The full model is available from the authors as an Excel spreadsheet.

Suppose the total firm load to be served on January 1, 2010, is one megawatt (1 MW) of electricity (measured at the busbar) and the primary generation resource is diesel.

The busbar energy requirement for that day is

1 MW x 24 hours = 24 megawatt-hours (MWh),

The amount of diesel required is

24,000 kWh / (14 kWh/gallon) = 1,714 gallons/day.

where 14 kWh/gallon is the assumed efficiency of the diesel generators.

The cost of this fuel is

1,714 gallons times $2.50 / gallon = $3,685/day

Additional variable operating costs (such as lube and overhauls) are

24,000 kWh x $.02/kWh = $480/day

The total variable cost of generation for this one day is

480 + 3,685 = $4,165/day

The total variable cost for other days differs because more or less electricity is produced. The model adds all of these daily variable costs together; the total variable cost for one year might therefore be about $1.2 million.

The annual fixed cost is

$300,000 (for labor) + $200,000 (for generation equipment) = $500,000

Therefore the total annual cost of generation for the year 2010 is $1.7 million. If the total cost of the distribution system and utility administration is $500,000 per year, then the total cost of electric service for the year is $2.2 million.

Total electric sales are projected to be

9,440 MWh x 0.9 = 8,496 MWh,

where the factor 0.9 accounts for 10% losses between the point of generation and the customers' meters.

To cover the total cost of generation, the average rate must be

$2,200,000 / 8,496,000 kWh = $.26/ kWh

Of this, 18 cents per kWh is for generation and the remaining 8 cents per kWh is for distribution and administration. In this simple example, the entire load is a firm load. In subsequent years, the load grows and costs increase. The required electric rate may go up or down over time. The life-cycle cost of electric service is the discounted present value of all annual costs.

This simplified example does not consider the economics of serving additional heat loads. Sales of additional heat or electricity beyond the current utility requirements would be counted as a credit against the total cost of the energy system. The details of how this analysis plays out are considered below, in the results section.

6.1.2. Economic Model Limitations

The economic analysis is based on the comparison of scenarios for change occurring 30 years into the future. While scenario analysis is a useful tool for examining long-range feasibility, it does have several limitations.

1. the validity of the analysis depends on the validity of the scenarios and the assumptions that are used to generate them.
2. the analytical model does not contain internal "feedbacks" such as an explicit link between higher electricity prices and reduced electricity consumption.
3. we have not attached probabilities to any of the assumptions or scenarios. Therefore the model cannot produce estimates of a single "most likely" or "best" estimate for any of the results.
4. finally, no attempt has been made to explicitly evaluate the degree to which any of the options may increase or decrease economic and financial risk.

In summary, our scenario-based analysis requires the reader of the report to make their own judgments about which scenarios and assumptions are more likely to occur. Although this can be viewed as a limitation of our method, it can also be viewed as a strength, since there is a clear link between assumptions and conclusions for each scenario examined.

6.2 Assumptions

6.2.1 Overview of Assumptions and their Use

The analysis period runs for 30 years, starting in 2010. This is the first year in which the nuclear or coal systems could plausibly be put in place. All dollar values are “real” dollars with today’s (year 2004) purchasing power. The discount rate for computing the net present value of future dollar amounts is assumed to be 4% over and above inflation. This is consistent with interest rates for public-sector borrowers such as the City of Galena.

Numerous assumptions drive the analysis. Some are more important than others, and some are more uncertain than others. Some assumptions are both very important and fundamentally uncertain. We have designated these as *critical assumptions*. The five critical assumptions for this analysis are

1) the initial price of diesel in 2010,

2) the future increase in the price of diesel,

3) the price of coal,

4) the efficiency of the coal plant, and

5) the number of security staff needed at the nuclear plant.

Each critical assumption has a low value and a high value, which are presented below and summarized in **Table 6.1**. Combinations of low and high values for the five critical assumptions jointly determine the basic range of results. We have made no attempt to choose a "most likely" value or an "average value" for any of the critical assumptions.

Table 6.1. Summary of critical assumptions

	units	low value	high value
Diesel fuel price in 2010	$/gallon	1.50	2.15
Diesel fuel price increase	% per year	0.0%	2.0%
(over and above general inflation)			
Coal price (delivered to Galena)	$/ton	100	125
Coal plant average efficiency		30%	40%
Nuclear plant security staff	positions	4	34

For all other assumptions, we have adopted single values for the basic analysis. These are presented and discussed in the following sections. Sensitivity cases explore some variation in these other assumptions, which are discussed in the results section, below.

6.2.2 Current Loads and System Costs

Galena electric energy requirements have been growing at about 2% per year, reaching about 9.5 MWh in 2003. Generation efficiency has also increased and is now close to 14 kWh per gallon. The current cost of providing electric service is about 26 cents per kWh, as shown in **Figure 6.1**. As this figure shows, about one-third of the total cost is for distribution and administration. To be competitive with diesel, an alternative generation system must deliver electricity to the distribution system for about 18 cents per kWh.

Table 6.2. Galena electric utility statistics.

	units	FY00	FY01	FY02	FY03	Average annual growth
Electricity generated	MWh/yr	9,026	9,141	9,408	9,578	2.0%
Electricity sold	MWh/yr	8,038	8,531	8,342	8,103	0.3%
Diesel fuel used	gallons	667,815	662,908	686,104	692,932	1.2%
Peak load	MW				1.6	
kWh generated per gallon		13.5	13.8	13.7	13.8	0.8%
Electric losses		10.9%	6.7%	11.3%	15.4%	
District heating load	B Btu/yr				8.0	

source: City of Galena

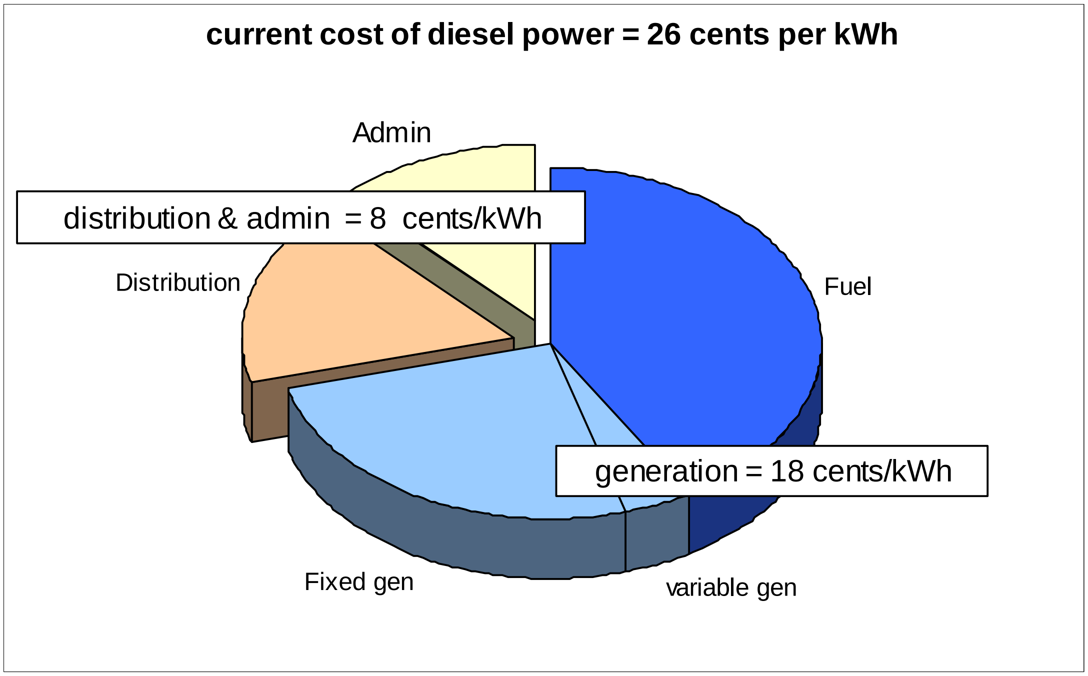


Figure 6.1. Current cost of electric service with diesel fuel at $1.32/gal for 2003, the year of this data.

6.2.3 Assumptions about Future Loads

Table 6.3 and **Figure 6.2** summarize our projections of future energy requirements. We assume that current utility electricity requirements will continue to grow at 2% per year. The existing district heating load remains constant and is treated as a firm load. Both the coal and nuclear systems must serve this load.

Table 6.3. Future energy requirements.

source of load	type	units	2010	2039
Utility electricity	firm	MWh	11,002	19,539
Existing city heating loop	firm	MWh	2,344	2,344
Residential space heating	firm	MWh	7,413	13,164
Air station heat	non-firm	MWh-equiv	8,464	8,464
Greenhouse	firm	MWh	570	570
Total energy requirements at power plant		MWh	**29,794**	**44,081**

note: MWh-equiv denotes the amount of electricity that could be generated by passing the heat load in question through a turbine/generator.

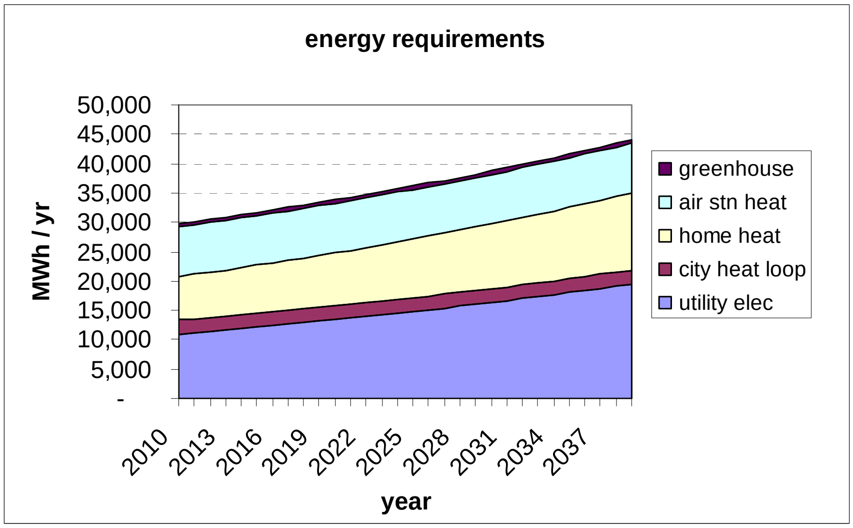


Figure 6.2. Projected future energy requirements.

Table 6.4. shows additional assumptions about the residential space heating load and the air station district heat load. We have estimated the home space heating load to be about 7.4 MWh in 2010, based on 220 houses each using the equivalent of 1,000 gallons of stove oil per year. This home space heating load is also treated as a firm load. However, our analysis revealed that it does not make economic sense to try to serve any of this load with electricity generated from diesel or coal. Therefore, home electric space heating is only provided by the nuclear system. It is valued at the avoided cost of stove oil, which we assume costs 75 cents more per gallon than utility diesel. Partially offsetting these savings are the costs of upgrading the distribution system and installing electric baseboard heating in all existing homes.

The air station heat load is assumed to remain constant at 52 billion Btu per year (B Btu/yr). To analyze this load in the context of the electric system, we have expressed this load in terms of how much electricity could be produced with the heat energy.[2] The air station heat load is nonfirm. The nonfirm heat sales are treated as economy energy sales of steam or hot water metered at the power plant. In the model, these sales are not backed up with diesel power when the coal or nuclear systems are down. The coal or nuclear power plant is assumed to be sited near the current power plant, resulting in a 2-mile distance to the air station. The capital cost of installing this heat distribution pipe is deducted from the fuel savings measured at the air station when calculating the benefits of providing this heat.

[2] We assume a 50% conversion efficiency in the turbine/generator system. A 52 billion Btu/yr thermal load can also be expressed as 15,235 MWh of heat energy. This heat energy could be converted at 50% to 7,618 MWh of electric energy. Adjusting this figure for 10% heat losses in the heat delivery pipe, we arrive at a figure of 8,464 MWh-equivalent. It takes the same fuel resources to provide 52 billion Btu to the distant end of a heating pipe as it does to produce 8,464 MWh of electricity at the busbar.

Table 6.4. Assumptions about heating loads.

Residential Space Heat		
number of houses, year 2010		220
annual growth in number of houses		2.0%
stove oil consumption per house	gallons/yr	1,000
residential furnace efficiency		75%
residential fuel price premium (delivery c	$/gallon	0.75
Utility line upgrades capital cost	$	800,000
customer premises upgrade cost	$/house	3,000
electric dist'n loss from busbar to house		10.0%
District Heat		
Current district heat load	B Btu/yr	8.0
Cost of bulk distribution pipe	$/foot	200
Air station boiler efficiency		80%
Distance from power plant to air station	miles	2.0
district heat loss in pipes		10.0%
Heat load factor (based on HDD data)		0.51
Heat sales tariff as % of net avoided cost		75%

6.2.3 Assumptions about the Diesel System

Table 6.5 summarizes our assumptions about the diesel system. The main technical assumption is that starting in 2010 new units will be rotated into the system such that the overall generation efficiency is 15 kWh per gallon. We assume that this figure then remains constant throughout the analysis. This is a simplification of what would actually be a gradual improvement in efficiency over time.

The main economic assumption underlying the cost of diesel generation is the price of fuel. The low projection for diesel fuel prices is constant (in real dollars) at $1.50 per gallon. Historically, utility diesel prices have actually been constant or declining for significant periods during the past 30 years when measured in real dollars. The high assumption is that diesel fuel prices start at $2.15 per gallon (in today's dollars) in year 2010, then increase at 2% per year over and above inflation. Since the cost of crude oil represents only about 30% of the cost of delivered diesel fuel, this assumption of 2% diesel price growth corresponds to a 7% annual growth in real crude oil prices. Crude oil prices could rise to over $300 per barrel (in today's dollars) by 2039 and still be consistent with this scenario. Of course, numerous other factors -- such as carbon taxes or increasing costs of tank farm storage -- could also contribute to increased prices.

Table 6.5. Assumptions about the diesel system.

	units	selected value (yr 1)	low value	high value
Diesel capital cost (replace engines)	$/kW	400		
Diesel Fuel				
Utility fuel initial price	$/gallon	1.50	1.50	2.15
Annual real escalation	% per yr	0.0%	0.0%	2.0%
Utility initial fuel efficiency	kWh/gal	14		
kWh measured at busbar				
Efficiency of New Units	kWh/gal	15		
Nonfuel diesel O&M				
Diesel generation labor	$/year	305,157		
Variable O&M (includes overhauls)	$/kWh	0.017		

If the diesel system is run as the primary generation source, we assume that capital replacements would be required such that every seven years new capacity equal to the current peak load for that year is added to the system to replace old units and to expand overall capacity consistent with load growth. Engine overhaul costs are subsumed into the assumed variable O&M cost of 1.7 cents per kWh. The capital cost of possible incremental fuel storage is not considered. The maintenance cost of fuel storage is included in the variable O&M cost.

Note that for all systems considered, a diesel generation capability is retained to serve as backup for times when the primary production facility is down for maintenance or emergencies.

6.2.4 Assumptions about the Coal System

Table 6.6 summarizes our assumptions about the coal system. It is important to recognize at the outset that all of these assumptions are very uncertain. Very few AFBC units have been built at the scale contemplated here (between 1 and 5 MW). The Galena coal resource has not been delineated. Detailed designs that would match the thermal and electrical output of the coal plant to these loads have not been developed. To address this uncertainty, we have designated the coal plant electric generation efficiency and the delivered price of coal as critical assumptions with low and high values.

Table 6.6. Assumptions about the coal system.

	units	selected value (yr 1)	low value	high value
Coal plant capital cost	$/kW	3,000	3,000	not used
Coal plant availability		91%		
Coal plant efficiency (electric output/coal input)		40%	30%	40%
Coal or nuclear "heat to electric" efficiency		50%		
Coal fuel				
Energy content	M Btu/ton	20		
Delivered price of coal	$/ton	100	100	125
Ash disposal cost	$/ton	20		
Nonfuel coal O&M				
Coal labor	people	6		
cost per operator	$/yr	53,200		
variable O&M and consummables	$/kWh	0.01		

The size of the coal plant is not predetermined. For each set of critical assumptions, we used the model to determine the optimal size for the coal plant. We also determined whether or not it was economic to serve the air station heat load with coal-fired district heat.

6.2.5 Assumptions about the Nuclear System

Table 6.7 presents our assumptions about the nuclear system. In all basic cases, the assumed capital cost to the City of Galena and to ratepayers is zero. For the purposes of sensitivity analysis, the assumed capital cost for the 10-MW plant is $25 million, based on Toshiba's data showing a capital cost of $2,500 per kW.

Annual supplies and expenses are in addition to labor. Toshiba estimates about $1 million for this line item for their 50-MW plant. Since the reactor is sealed, these expenses probably relate almost exclusively to the steam piping and turbine/generator systems. Although the components would be smaller, it does not seem plausible that consumables costs for a 10-MW plant could drop to one-fifth of those for 50 MW. Some of these costs probably do not change at all. Lacking specific data on this point, we have assumed that annual supplies and expenses are one-half the amount estimated by Toshiba for the 50-MW design.

Decommissioning costs are not considered in the analysis, under the assumption that they would be borne by Toshiba or some other party.

Table 6.7. Assumptions about the nuclear system.

	units	selected value (yr 1)	low value	high value
Nuclear capacity	MW	10.0		
Nuclear capital cost	$	0		
Nuclear security staff	people	34	4	34
Nuclear operator staff	people	8		
Nuclear availability		95%		
Nuclear annual supplies and expenses	$/yr	500,000		

6.3 Economic Analyses Results

6.3.1 Basic Results

The basic results presented in this section come from varying only the five critical assumptions. Additional sensitivity cases are discussed in the following section.

6.3.1.1 Diesel

The total life-cycle cost of power generation with diesel ranges from $38 million to $59 million. This range results solely from variation in the future price of diesel fuel. **Figure 6.3** shows that electric rates (in inflation-adjusted dollars) could go down if fuel prices stay flat, or they could rise significantly under the high fuel price assumption. The projected electric rates are determined by adding estimated distribution and administration costs to the cost of power generation. Total distribution costs are assumed to increase with the number of households (2% per year) while total administration costs are assumed to remain constant. Electric rates go down slightly under the assumption of low and flat diesel prices because the constant total cost of administration gets spread over more and more kilowatt-hours.

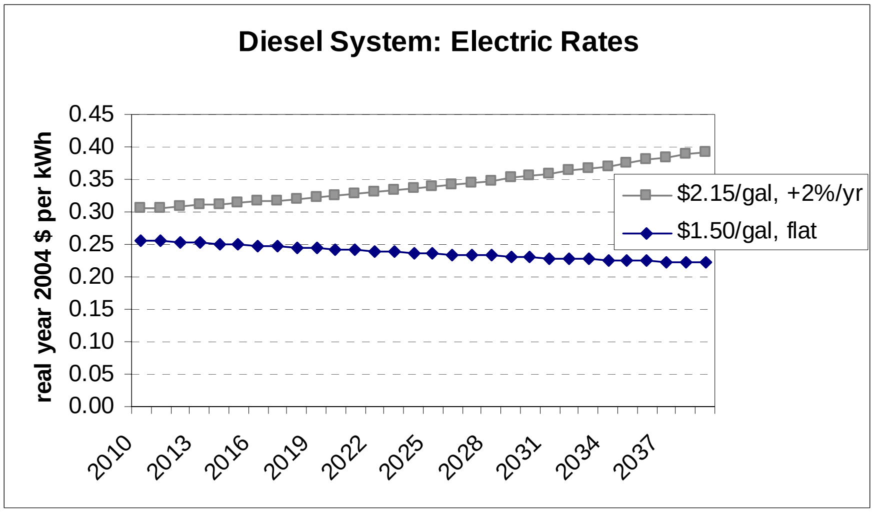


Figure 6.3. Projected future electric rates with diesel system.

6.3.1.2 Coal

The total life-cycle cost of power generation with coal ranges from $23 million to $35 million. The low cost of $23 million results from a combination of high diesel fuel prices, low coal prices ($100/ton), and high (40%) coal plant efficiency. Under these conditions, it is economic to serve the air station heat load with district heat. Almost $20 million worth of fuel oil costs can be avoided, which more than justifies a $2 million capital expenditure to build a distribution pipe from the power plant to the air station. The optimal size of the coal plant under these assumptions is 4.0 MW, which is sufficient to meet all peak loads in 2010, as shown in **Figure 6.4.**

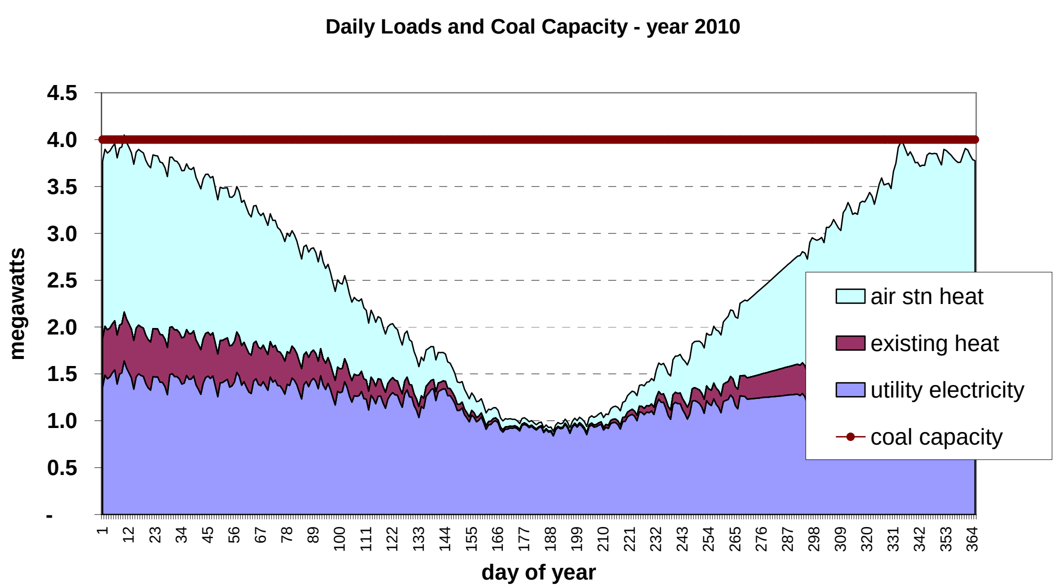


Figure 6.4. Coal plant capacity vs. daily loads for high diesel prices.

The net cost of power generation from a coal system is highest when diesel prices are high, coal prices are high ($125/ton), and coal plant efficiency is low (30%). Under these conditions, it is still economic to serve the air station heating load and the optimal size of the coal plant drops only slightly, to 3.8 MW. However, the higher cost of coal drives up the overall cost of power. **Figure 6.6** shows projected electric rates corresponding to the two scenarios just discussed.

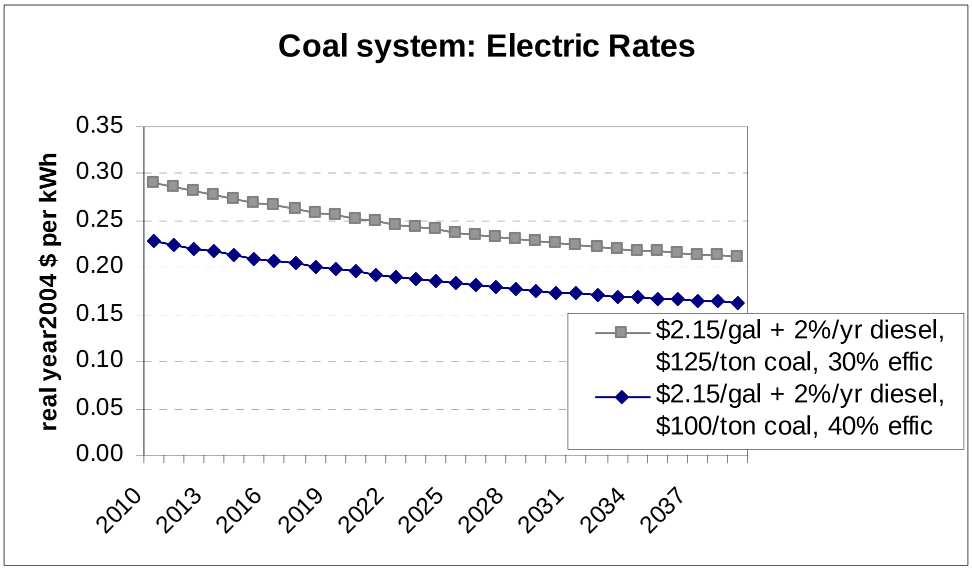


Figure 6.5. Projected future electric rates with coal system

Although the absolute cost of the coal system varies by only $12 million, it is important to note that the net benefits from coal relative to diesel vary by much more. When diesel prices are high and coal prices are low, the coal system costs $36 million less than diesel. When diesel prices are low and coal prices are high, the coal system costs only $3 million less than diesel. However, in all cases, the coal system costs less than diesel under the assumptions used here.

6.3.1.3 Nuclear

Inspection of the projected daily load curves shows sufficient nuclear capacity to meet all the potential electric and heating loads at all times during all years. (Some diesel power is still required during times of unavailability.) This is demonstrated in **Figure 6.7**, which compares daily loads to nuclear system capacity for the year 2039, when loads are highest. This figure also shows the large amount of heat energy that can be provided in a way that displaces expensive diesel fuel and generates revenue for the utility. Revenue from heat sales can be applied against the total cost of all utility service to drive down consumer electric rates.

The total life-cycle cost of providing power with the assumed nuclear system ranges from *minus* $7 million to [plus] $35 million. The low figure occurs when diesel prices are high and the required security staff is low (4 people). The total cost of electric generation at the busbar is negative because the avoided cost value of heat sales to the air station and to residential customers is more than enough to pay for the total cost of serving *all* loads. Therefore the remaining cost to be allocated to the provision of nonheat electricity is negative.

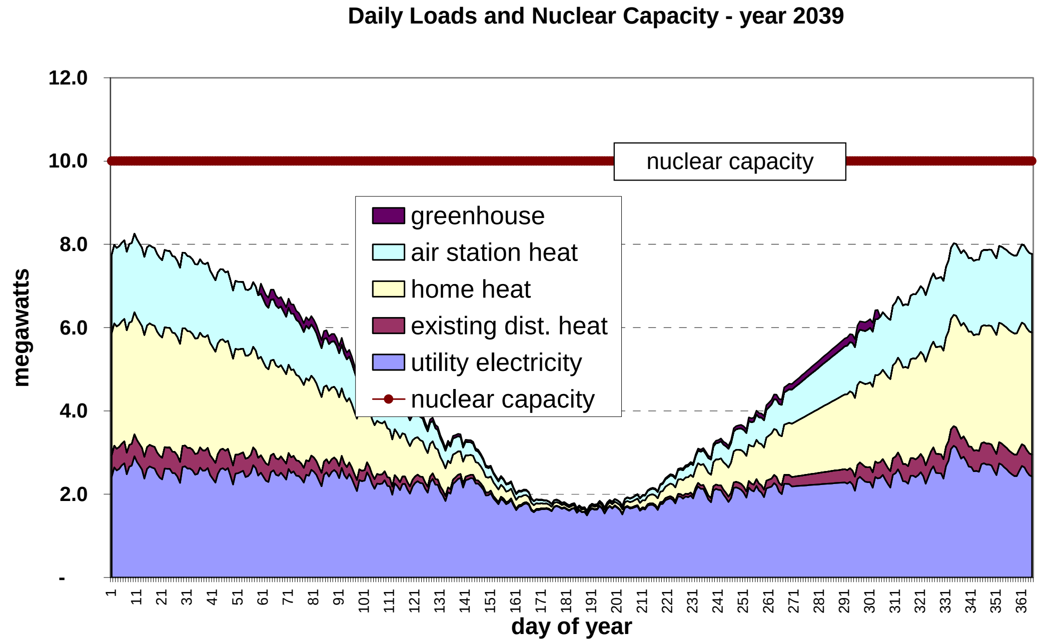


Figure 6.6. Daily loads vs. nuclear capacity, year 2039.

This result does not mean that electric rates can be negative. There are two reasons for this. First, even if the total cost of electricity generation was minus $7 million, there is also a total life-cycle cost of about $14 million for distribution and administration. This would yield a net life-cycle revenue requirement of $7 million that would have to be covered by rates. Second, actual sales of electric space heat and air station district heat are unlikely to take place at a price equal to the buyer's avoided cost. The actual price will surely "split the savings" between the utility and the heat customers. In calculating projected electric rates, we have assumed that air station heat will be sold, on average, for about 75% of its avoided cost value. For both of these reasons, the projected average electric rate when nuclear costs are lowest declines over time from 10 cents per kWh to 6 cents per kWh.

The life-cycle cost of power generation from nuclear is highest, at $34 million, when diesel prices are low and when the required number of security staff is high (34 people). This cost is still $3 million below the comparable cost of diesel power. Under these conditions, the avoided cost value of electric heat and district heat is much lower and the absolute cost of running the nuclear plant is much higher due to labor costs. The projected average electric rates decline over time from 21 cents per kWh to 13 cents per kWh. In this case, it would be necessary to offer a special rate for electric heat, since with low diesel prices the avoided cost of oil heating would equate to only about 7.5 cents per kWh. Even with special rates for electric heat, it is important to remember that customers would pay less for their core (nonheat) electricity than they would with diesel.

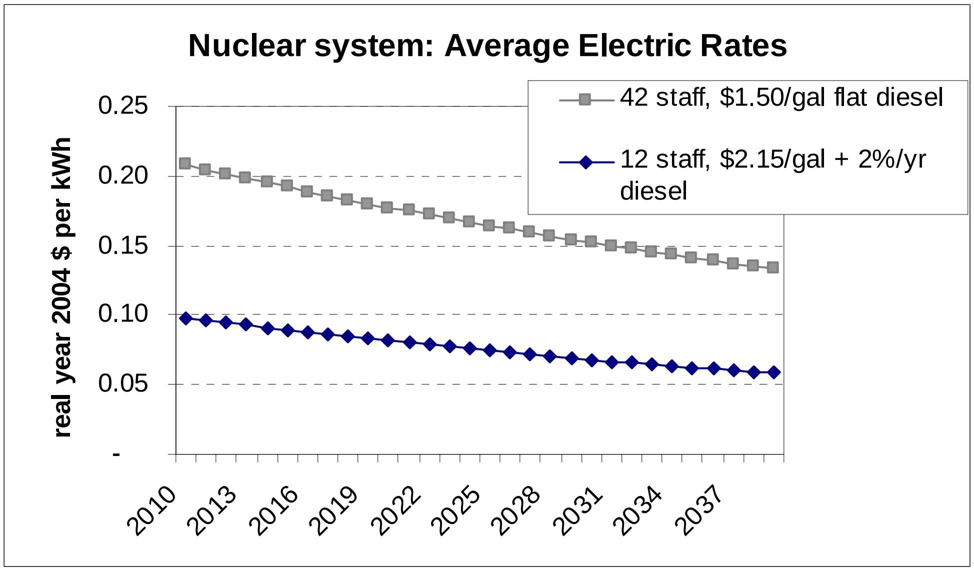


Figure 6.7. Projected future electric rates with nuclear system.

6.3.1.4 Summary of Basic Results.

Table 6.8 summarizes the results described above. The ranges shown for costs and rates come from varying only the five critical assumptions.

Table 6.8. Summary of basic results.

	Diesel	Nuclear	Coal
Loads served:			
utility electricity	X	X	X
existing district heat	X	X	X
residential electric space heat		X	
greenhouse		X	
air station district heat		X	[sometimes]
Life-cycle total cost ($million)			
low value	38	(7)	23
high value	59	35	36
Net benefits compared to diesel ($million)			
low value		3	3
high value		67	36
Average electric rate in 2010 ($/kWh)			
low value	0.26	0.10	0.23
high value	0.30	0.21	0.29
Average electric rate in 2030 ($/kWh)			
low value	0.23	0.07	0.17
high value	0.36	0.15	0.23

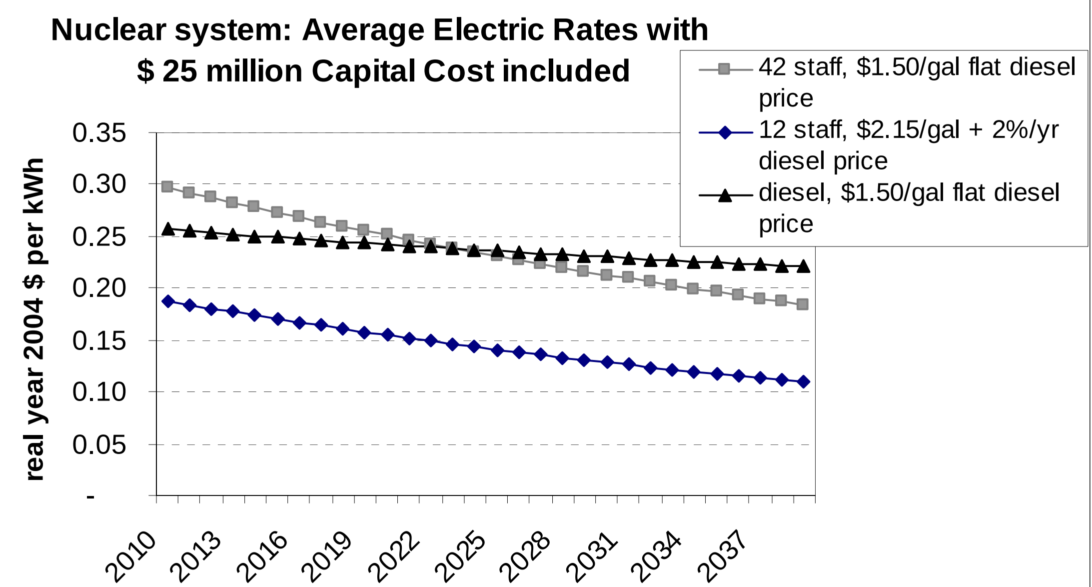
6.3.2 Special Sensitivity Cases

In this section, we report the results of several sensitivity cases. These cases address two questions that are a natural outgrowth of the basic analysis. The first question is, how does the analysis change if nuclear capital costs are included? The second question is, how does the analysis change if the nuclear or coal plants were sited 7 miles from the air station rather than 2 miles away.

6.3.2.1 Cases with Nuclear Capital Costs Included

Toshiba estimates that the capital cost of its 4S system is $2,500 per kW, or $25 million for the 10 MW plant.[3] Using this figure, the life-cycle costs of the nuclear system would increase in all cases by exactly $25 million. They would range from $18 million to $60 million. The impact on average rates is to increase them all by about 9 cents per kWh.

If diesel prices stay low and flat, as in our low critical assumption, then diesel power generation is less expensive than nuclear by $22 million (life-cycle cost). **Figure 6.8.** shows that with low diesel prices, average electric rates would be comparable between nuclear and diesel. However, as discussed above, lower rates would be needed for electric heat and rates for nonheat electricity would be higher than this average. Ratepayers would clearly be better off with diesel if diesel prices stay flat and nuclear capital is included in rates and a large security staff is required.



note: diesel figures are the same as presented with diesel system analysis. They are included for comparison.

Figure 6.8. Projected future electric rates with nuclear capital costs included in rates.

[3] Toshiba presented this estimate with slides describing the 50-MW plant. We have used the cost per kW figure and applied it to the smaller size. Due to economies of scale, this approach may understate the cost of the smaller, 10-MW plant. However, we are unaware of a direct cost estimate for the 10-MW size.

If diesel prices are high, rising at 2% per year from a base of $2.15 per gallon, and if the nuclear plant requires only a small security staff, then the life-cycle cost of power generation from nuclear would be $41 million lower than the cost of diesel and electric rates would be dramatically lower.

These sensitivity cases demonstrate that if a $25 million capital cost is included in the analysis, the nuclear system is not always a clear winner. There are many combinations of slowly rising diesel prices and high staffing requirements that would make nuclear more expensive than diesel or coal. If the analysis were being done for another community, the rankings would also depend strongly on the size and nature of the electric and heating loads in that place.

6.3.2.2 The Effect of Power Plant Location

The basic analysis assumes that the nuclear or coal plant would be sited near the current Galena power plant, resulting in the need for a 2-mile pipe to transport district heat to the air station. If this distance were increased to 7 miles, the capital cost of a heat distribution pipe costing $200 per foot would increase by $5.3 million.[4] Under our methodology, this increased capital cost of the pipe would increase the life-cycle cost of power generation by exactly the same amount - $5.3 million – in all cases where the air station heat load is served.

This increase would not affect the economic attractiveness of the nuclear or coal systems if diesel prices take on the high trajectory, although average rates would increase by about 1 cent per kWh. In particular, with high diesel prices it would still make economic sense for the coal plant to serve the air station. If diesel prices are low and flat, however, and if the nuclear staff is large, then the increased capital cost of heat pipe makes the nuclear system slightly more expensive than diesel. Adding 5 miles of extra distance to the heat pipe is economically equivalent to adding about 6 security staff to the required nuclear labor force.

These sensitivity cases demonstrate that distance from the coal or nuclear power plant matters, but only in a moderate way. Adding distance becomes critical to the economic conclusion only if diesel prices are low and flat. If diesel prices are high and rising, even a 7-mile heat transmission line still makes good economic sense at a $200/foot construction cost.

6.3.3 Transmission

Since the nuclear plant is capable of producing large amounts of electricity in excess of current Galena electric loads, it is natural to consider the economics of building a transmission line to send the excess electricity to neighboring communities. We considered two possible transmission lines. Line A would run from Galena to Koyukuk, Nulato, and Kaltag. The total distance is 83 miles, and the transmitted electricity could displace about 172,000 gallons of diesel per year. We assume that the line could be built for $80,000 per roadside mile plus $200,000 per overland mile. The total cost would be $14.9 million and the net present value of the avoided fuel costs would be $8.1 million under our high diesel price assumption. Thus, this line would have a net economic cost of $6.8 million.

[4] We recognize that there would also be additional costs in the form of higher heat losses, but for simplicity these are not treated explicitly, since this case is only illustrative. Adding a specific allowance for higher heat losses would be analytically equivalent to postulating an even longer distance with the same losses.

The second line we considered was from Galena to Ruby. The distance is 42 miles and the transmitted power could displace 59,000 gallons of diesel per year. The total cost of $7.3 million would far exceed the avoided fuel costs of $2.8 million. **Table 6.9** summarizes the transmission analysis.

Table 6.9. Economic costs and benefits of transmission lines.

from	to	segment avoidable diesel gal/yr	segment road miles	segment overland miles	segment cost
Line A:					
Galena	Koyukuk	23,279	5	27	5,800,000
Koyukuk	Nulato	89,448	4	14	3,120,000
Nulato	Kaltag	58,929	5	28	6,000,000
Total line A		171,656	14	69	14,920,000
Present value of avoided costs (assumes high diesel price)					8,147,440
Net economic benefit of line (with free power at Galena)					**(6,772,560)**
Line B:					
Galena	Ruby	59,180	9	33	7,320,000
Total line B		59,180	9	33	7,320,000
Present value of avoided costs (assumes high diesel price)					2,808,906
Net economic benefit of line (with free power at Galena)					**(4,511,094)**

6.3.4 Economics of hydrogen production

Another potential use for the power generated by the nuclear plant in excess of existing needs is the production of hydrogen. We considered hydrogen production from the point of view of a potential private business enterprise. The enterprise would obtain power from the Galena electric utility and bear the responsibility for all aspects of the hydrogen production process. **Table 6.10** summarizes our analysis of this option.

The potential hydrogen enterprise is assumed to have a higher required rate of return – 7% above inflation. The analysis begins by assuming that electricity is a free input to the production process. There appears to be sufficient local demand for vehicle fuel to fully utilize one hydrogen production module (about 1 MW of electricity input). However, the production cost of hydrogen to meet this demand is extremely capital intensive. Using current costs of commercially available equipment, we estimate that it would cost at least $6.2 million to construct one production module producing 404,000 gallons of liquid hydrogen per year with an energy content of about 12 billion Btu(Keenan, 2004). When modest operating costs are added, the total annual cost of energy is about $46 per million Btu, which far exceeds the target cost of diesel or gasoline for vehicle and equipment use. This target cost is about $17 per million Btu under the high diesel price assumption, rising over time to about $30 per million Btu. This conclusion is based on almost full utilization of the capital equipment to serve local demands. In other words, there is no “excess capacity,” and it would not make sense to produce additional hydrogen and ship it by barge to a community like Fairbanks that has lower fuel costs.

Table 6.10. Hydrogen enterprise analysis.

Variable		Unit cost, or # of units, or units	present value cost	Year 1 2010	30 2039
Real discount rate for enterprise venture		7.0%			
Capital Cost:					
H2 generator (900 kWe input, 150Nm3/hr output))			1,500,000		
H2 liquefier (150 Nm3 and 175 kWe input)			2,000,000		
Storage tanks unit cost, per 50,000		500,000			
Number of storage tanks		1			
Storage tanks capital cost			500,000		
Shipping tnks unit cost 17k gal ea		450,000			
Number of shipping tanks		1			
Shipping tanks capital cost			450,000		
Nitrogen liquefier			700,000		
Filling station equipment, contingency			1,000,000		
Total Capital per Gasifier			6,150,000		
Electricity	0.000	$/kWh		-	-
O&M on gasifier & liquefier		$/yr	$153,682		85,000
Labor on gasifier, liquefier, and storage		$/yr	$620,452	50,000	50,000
Total liquid H2 production		gal/yr		404,000	404,000
Energy content of liquid H2 Btu/gal		30,000			
Total Energy in liquid H2 form		billion Btu		12.12	12.12
Local demands and export availability		gallons	Btu/gal	billion Btu	
City vehicle demand		15,000	114,100	1.7	3.0
Schools vehicle demand		25,000	114,100	2.9	5.1
Military vehicle demand		50,000	138,000	6.9	6.9
Total local demand		billion Btu		11.5	15.0
Total local demand		gal H2		382,133	500,165
Supply to local market		gal H2		382,133	404,000
Available for Export		gal H2		21,867	-
Amortized production cost					
Amortized capital including return				495,606	495,606
Amortized (smoothed) O&M				12,385	12,385
Labor				50,000	50,000
Electricity				-	-
Total amortized cost				**557,991**	**557,991**
Amortized cost per gallon H2 of local demand				1.46	1.38
Amortized cost per million Btu				**48.67**	**46.04**
Target cost per million Btu				12.00	12.00

Nearly the entire cost of hydrogen production is the cost of capital equipment. If this capital could be secured with a grant or other external funding source, the operating cost of producing hydrogen would likely be low. A sensitivity case shows that with zero capital cost, a hydrogen enterprise could afford to pay about 1.5 cents per kWh for electricity and still produce hydrogen at a cost per million Btu comparable to diesel or gasoline.

7. CONCLUSIONS

7.1 Economics Conclusions

Under the assumptions presented above, the nuclear system is the clear economic winner when compared to diesel, even when diesel prices are low and nuclear security staff requirements are high. This result is due to the ability of the 10-MW nuclear plant to serve the entire residential heat load (about 8,000 MWh/yr and 2.3 MW peak) and the entire air station heat load (52 B Btu/yr). We have used a daily dispatch model to verify that nuclear capacity is always adequate to meet daily energy requirements for both of these large loads. When the nuclear plant is unavailable, the air base can back up its own heat load and the Galena diesel system can almost surely back up the Galena residential heat load.

The nuclear system also beats coal on economic grounds in every basic case except one. If diesel prices are low *and* coal prices are low *and* coal efficiency is high *and* the total required nuclear staff is 42 people (8 operators plus 34 security), then the coal system has a life-cycle cost that is $7 million below that of nuclear.

Coal is attractive relative to diesel in all of the basic cases. It must be stressed that the critical assumptions about coal prices and coal plant capital costs, fuel costs, and efficiency are perhaps the most uncertain, and they all matter. Having said that, when diesel prices are high and rising, the coal system is very likely to produce less expensive power for Galena customers than diesel.

Sensitivity cases show that if a $25 million capital cost is included in the analysis, the nuclear system is not always a clear winner. When capital charges are included, many combinations of slowly rising diesel prices and high nuclear staffing requirements would make nuclear more expensive than diesel or coal. The amount of potential electricity demand would also be a critical factor in system economics if the nuclear system were to be considered for a community other than Galena. Siting the nuclear or coal plants farther from the air station heat load has a similar but smaller direct effect on system costs. For Galena, this variation in distance is only important if diesel prices remain low.

Table 5.11 supports these conclusions with a comprehensive summary of all cases considered in this analysis. The first six cases are the basic results that come from varying only the critical assumptions. The second six cases report the same results, but include an additional $25 million capital cost for the nuclear system. The final four cases document the effect of siting the nuclear or coal plants 7 miles from the air station.

Table 7.1. Summary of basic cases and sensitivity cases.

case code	diesel price $/gal	coal price $/ton	coal average efficiency	coal capacity MW	nuclear capital charges	nuclear staff	total present value cost $ million diesel	nuclear	coal
basic cases (varying the critical assumptions)									
lhllh	1.50	125	30%	1.3	0.0	42	37.8	34.6	35.2
llhlh	1.50	100	40%	2.1	0.0	42	37.8	34.6	27.5
llhll	1.50	100	40%	2.1	0.0	12	37.8	7.0	27.5
hhllh	2.15	125	30%	3.8	0.0	42	59.3	20.2	35.5
hlhlh	2.15	100	40%	4.0	0.0	42	59.3	20.2	23.1
hlhll	2.15	100	40%	4.0	0.0	12	59.3	(7.4)	23.1
sensitivity cases - nuclear capital included									
lhlhh	1.50	125	30%	1.3	25.0	42	37.8	59.6	35.2
llhhh	1.50	100	40%	2.1	25.0	42	37.8	59.6	27.5
llhhl	1.50	100	40%	2.1	25.0	12	37.8	32.0	27.5
hhlhh	2.15	125	30%	3.8	25.0	42	59.3	45.2	35.5
hlhhh	2.15	100	40%	4.0	25.0	42	59.3	45.2	23.1
hlhhl	2.15	100	40%	4.0	25.0	12	59.3	17.6	23.1
sensitivity - nuclear and coal sited 7 miles rather than 2 miles from air station									
llhlh	1.50	100	40%	2.1	0.0	42	37.8	39.9	27.5
llhll	1.50	100	40%	2.1	0.0	12	37.8	12.3	27.5
hlhlh	2.15	100	40%	4.0	0.0	42	59.3	25.4	28.4
hlhll	2.15	100	40%	4.0	0.0	12	59.3	(2.1)	28.4

NOTE: shaded cells highlight changes in assumptions and results relative to the previous case

Even though installation of the 4S nuclear plant presents a potential long-term solution to Galena's critical energy issues, one must caution that, as with any non-commercialized technology, there is no guarantee. In our view, the most critical issue associated with the adoption of this technology is the difficulty of utilizing liquid sodium as a heat transfer medium. With any nuclear power plant, long-term disposal of radioactive waste is also an issue. If this technology is successfully deployed in Galena, its economic viability in other Alaska villages and elsewhere depends on the actual life-cycle costs yet to be quantified, as well as the actual energy demands in these places.

Benefits associated with adoption of one or more of the technologies discussed in this report go beyond their ability to meet Galena's thermal and electric energy loads. We see the potential for Galena to serve as a training center for rural Alaskans interested in utilizing similar technologies in their villages. We also see the potential for use of additional cogeneration leading to economic development such as the development of horticulture and aquaculture. The enhancement of local employment by these activities is another benefit. With today's uncertain energy situation, many communities are diversifying their energy options. This includes adding renewably based technologies to lessen dependence on fossil fuels. Adding a few tens of kW of PV arrays, for example, could help Galena insulate itself against fluctuations in the price and supply of diesel fuel.

7.2 Environmental and Permitting Conclusions

Given the assumptions stated throughout this report, and strictly from an environmental permitting standpoint for the City of Galena, evaluation of the permitting requirements for each of the three primary energy options yields a clear loser (coal) and an apparent winner (nuclear). Two key assumptions play heavily into this result. The first is that coal will be generated locally. This represents a distinct disadvantage from a permitting standpoint in that permitting for the mine site must be considered for this option, but not the others. The second assumption is that all of the information provided to us by Toshiba proves to be accurate and is accepted by the NRC. Specifically, (1) if the 4S reactor truly generates no air or water emissions; (2) the reactor is returned to Japan at the end of its useful lifetime (thereby eliminating nuclear waste issues), and (3) Toshiba bears all (or most) of the licensing costs, then the permitting "cost" to Galena is reduced to the point that the nuclear power option becomes the clear preference. Before a final decision is made, it is imperative that these assumptions be verified.

8. RECOMMENDATIONS

On the basis of environmental permitting, the nuclear plant appears to be a clear winner. The coal mine and power plant option appears to be the most difficult for which to obtain permits. This conclusion is stated with the caveat that this will be determined by the process of gaining a design certification and a license from the NRC.

The economic analysis reveals that the 4S option will provide the lowest cost power if the assumptions hold. In the Galena case, the assumption is that capital cost will be borne by an outside party and that reasonable staffing levels will result from the licensing process. The coal option may be economic in some scenarios compared to enhanced diesel systems, so the coal option should not be entirely discounted.

Therefore, the recommendations are:

- Proceed with refining the 4S evaluation process in conjunction with the NRC
    - It may be advantageous for Galena to enlist an independent organization to estimate the time required for licensing and permitting
    - Toshiba and Galena should consider partnering with a U.S. organization or National Laboratory to assist in the process

- Retain the current diesel systems (with scheduled upgrades) until a decision is made regarding the installation of a replacement by about 2010.

- Retain the option of a coal mine and power plant until it is determined if the 4S system can be permitted and licensed. If the 4S cannot be realized, then the coal option appears feasible (with a favorable coal resource assessment result).

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APPENDICES

APPENDIX A. Presentation by Yoshiaki Sakashita, Toshiba, at the 2004 Alaska Rural Energy Conference, April 27-29, 2004, Talkeetna, Alaska

4S Current Status

4S: Super Safe, Small & Simple

2004 Alaska Rural Energy Conference
Talkeetna, Alaska
April 27-29, 2004

TOSHIBA Corporation
Industrial and Power Systems & Services Company

Contents

1. 4S Overview

    Features, Plant outline, Target cost, Expected schedule, R&Ds

2. 4S applications

    Fresh water

    Hydrogen & oxygen

TOSHIBA

What is 4S ?

4S Major Features

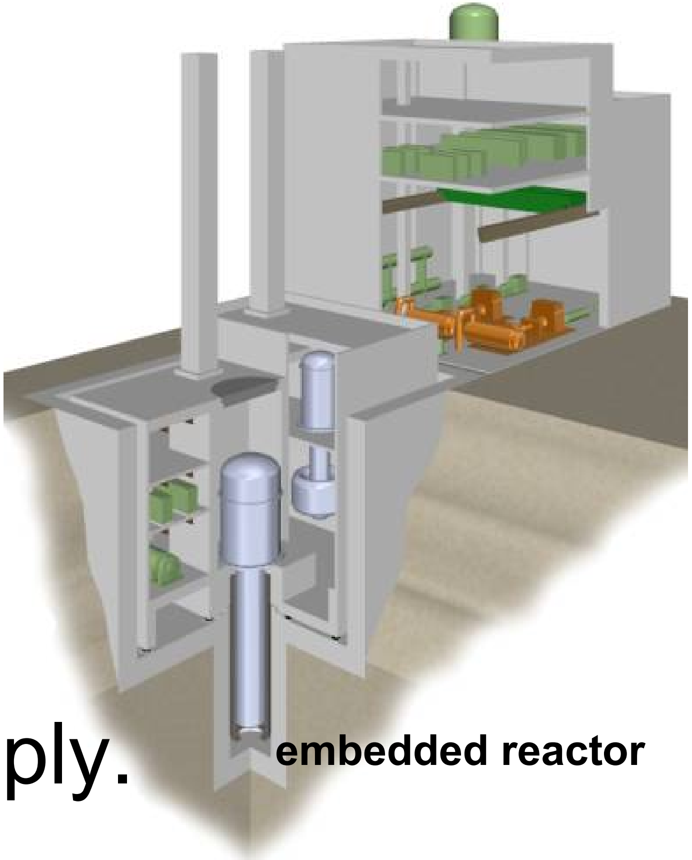
(1) No refueling,

(2) Passive safety,

(3) Transportability,

(4) Reasonable cost for distributed power supply.

4S power station



TOSHIBA

What is no refueling ?

No refueling means

(1) Reducing a load of fuel transportation,

(2) Lower maintenance requirements,

(3) Non proliferation,

(4) Design simplification, ex., no refueling device,

(5) Zero emission during plant lifetime.

4S Core

Fuel material: U-Zr (metallic)

Coolant material: sodium

Core lifetime: 30 years

Core height: 2.5 m (50MWe)

2.0m (10MWe)

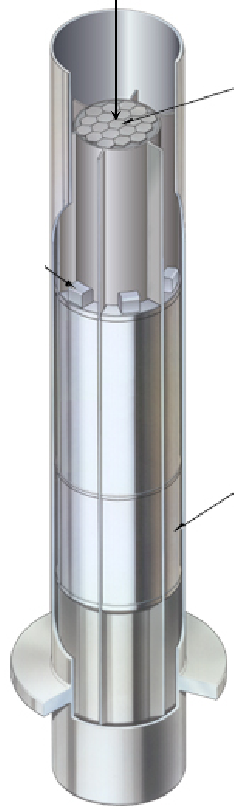
Core diameter: 1.2m (50MWe)

0.9m (10MWe)

Reactivity temperature coefficient: negative

Center SA: Ultimate shutdown rod (neutron absorber as back up)

Fuel subassemblies (18 SAs)



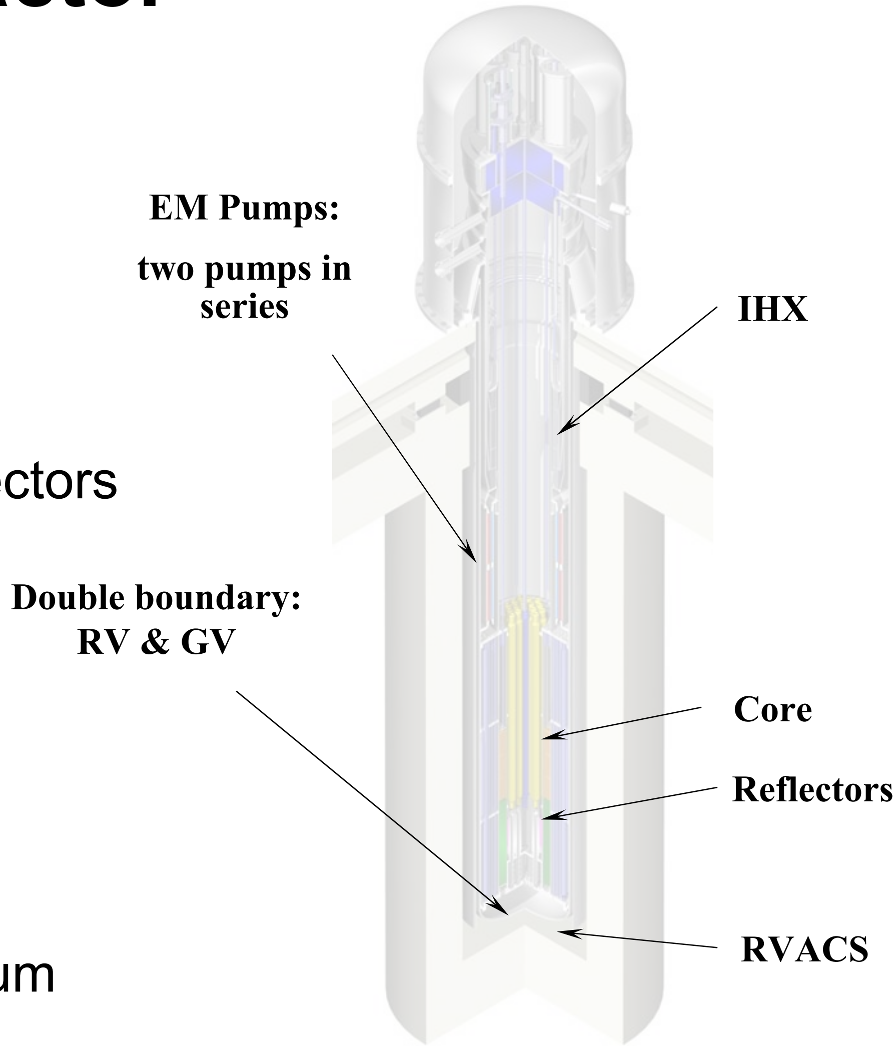
Reflectors are moving upward and surrounding the core slowly(*) in order to compensate the reactivity loss during 30 years burn-up. If an accident occurred, reflector would fall down to make core subcritical.

(*) average velocity: 1mm/week approximately

TOSHIBA

4S Reactor

- Output: 10MWe (30MWt),
  50MWe (135MWt)
- Coolant: sodium
- Coolant temp: 510 / 355 deg.C
- Reactivity control: movable reflectors
- RV type: integral type
- EM Pumps: annular type
- Core position: bottom in the RV
- RVACS: natural air circulation
  (Reactor Vessel Auxiliary Cooling System)
- GV: second boundary for sodium
  (Guard Vessel)



TOSHIBA

4S Primary Cooling System

Primary Coolant

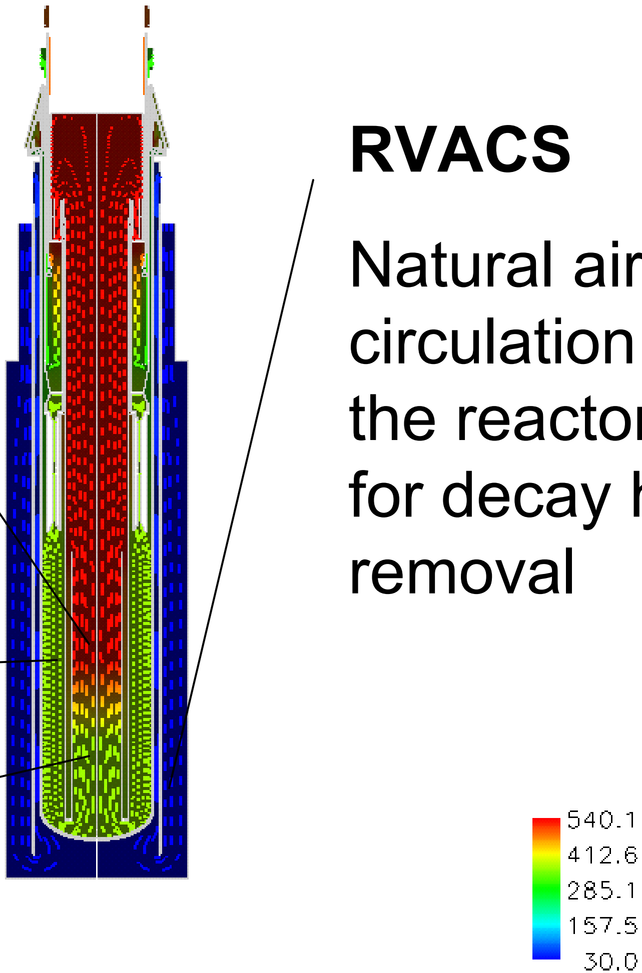
Sodium coolant flows inside the reactor vessel by static (EM) pumps.

Outer region:

downward flow

Inner region:

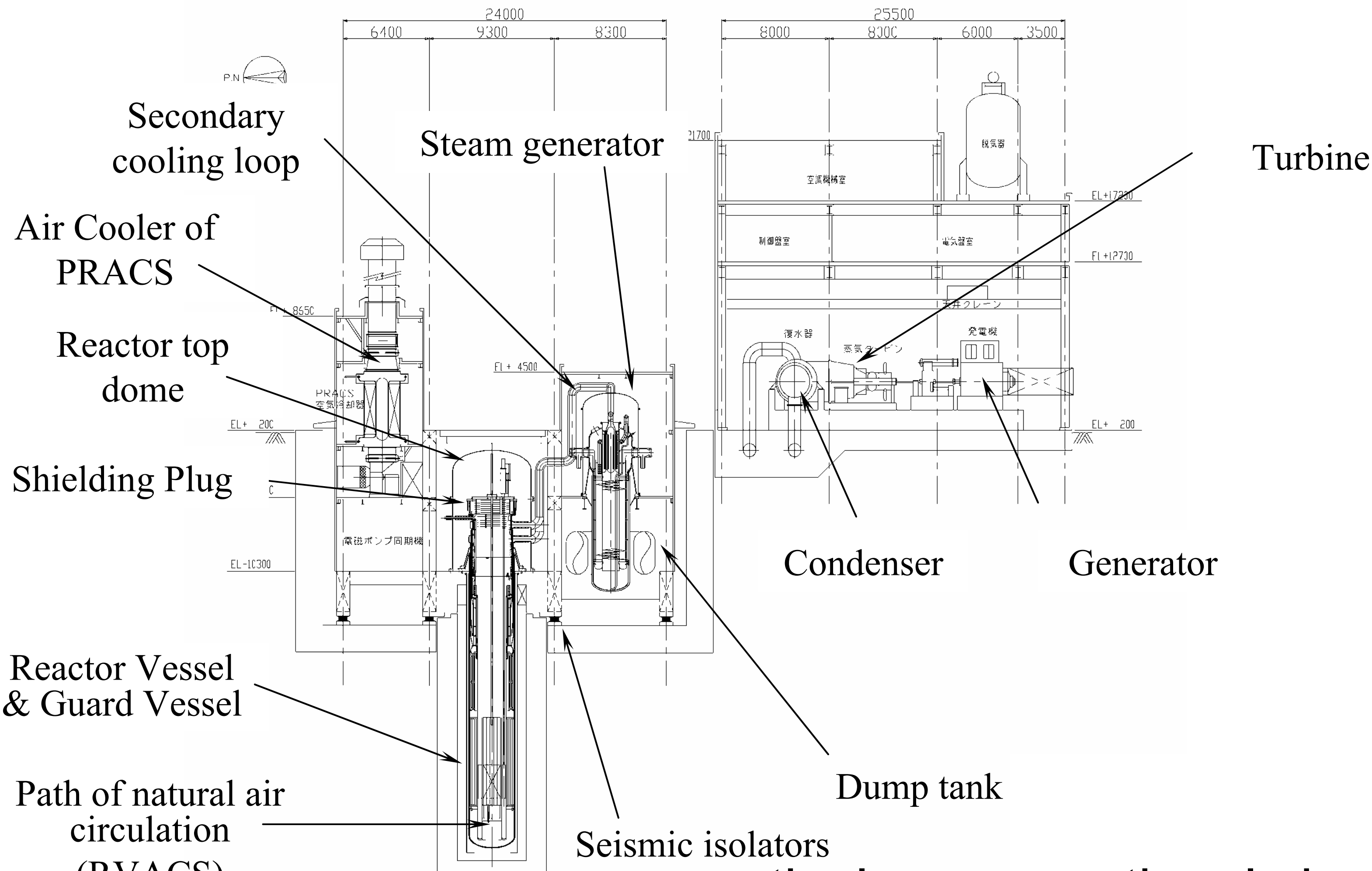
upward flow



RVACS

Natural air circulation around the reactor vessel for decay heat removal

4S Plant Arrangement (50MWe)



vertical cross-sectional view

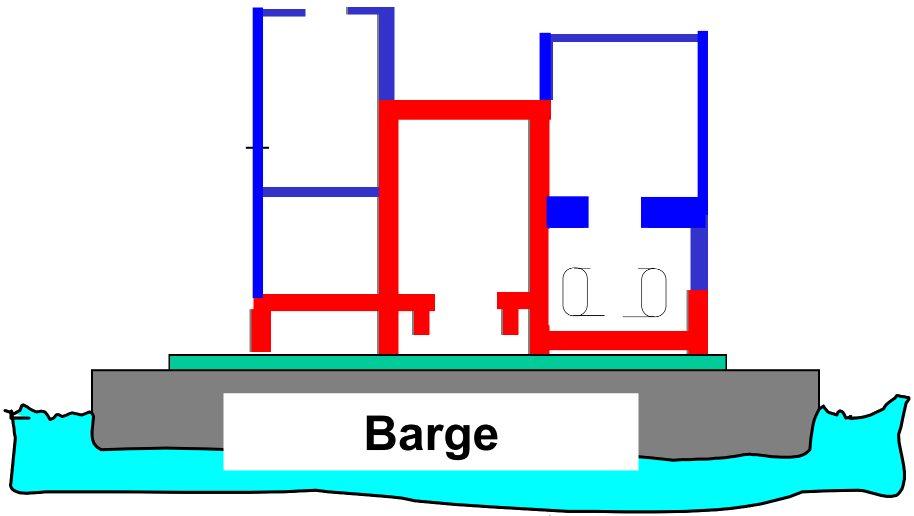
TOSHIBA

Transportation

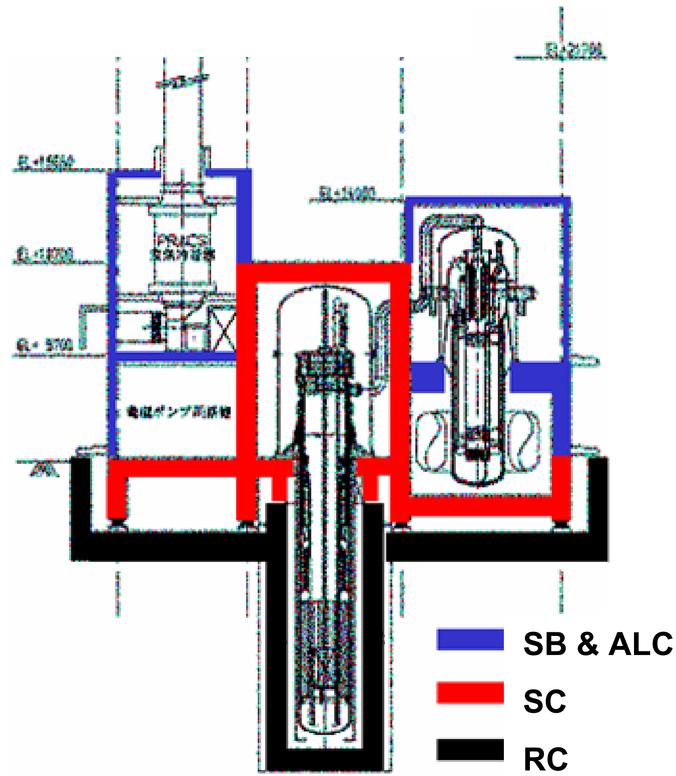
Design for shop fabrication, lightweight, and mass production

Steel beam and autoclaved lightweight concrete

Steel plate reinforced concrete

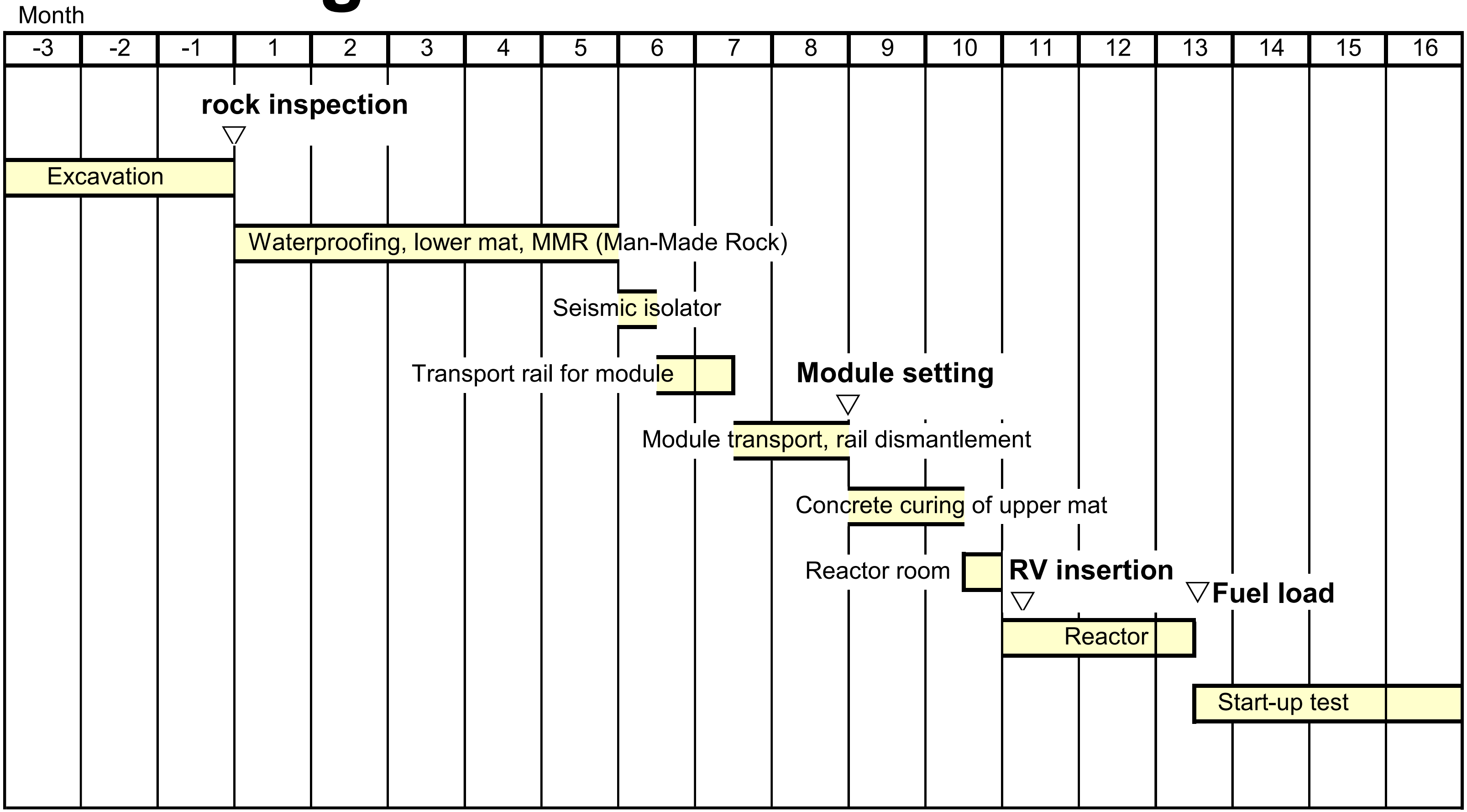


Marine transport



TOSHIBA

Target of Construction Period

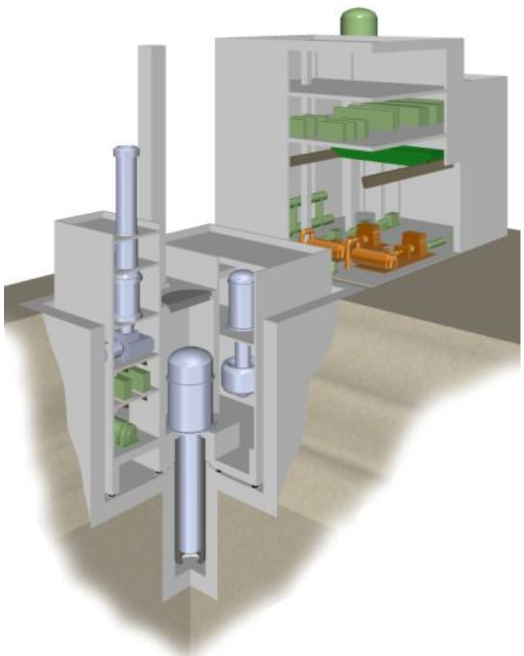


Construction periods for laying underground in frozen-soil site should be optimized.

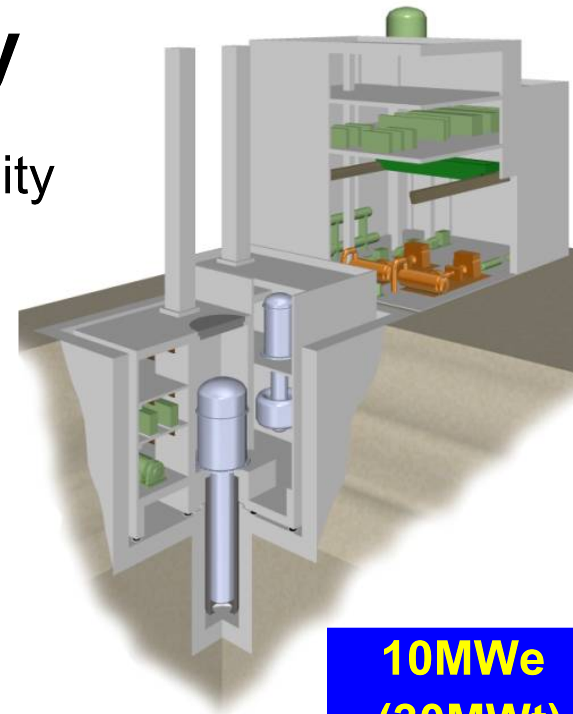
Safeguard & Security

For safeguards & security

(1) To minimize unauthorized accessibility to the reactor including fuels by earth-sheltered reactor building.



50MWe (135MWt)



10MWe (30MWt)

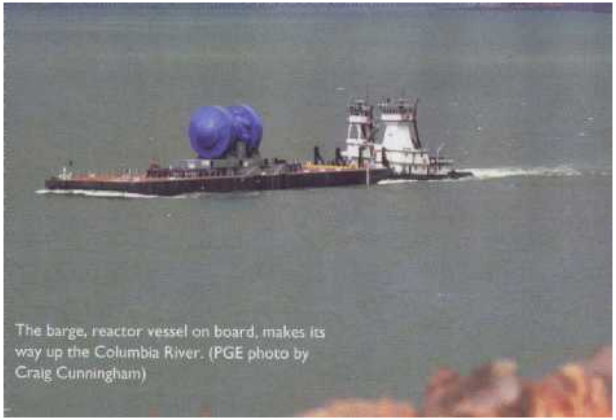
(2) To provide redundancy by two stacks of RVACS.

After 30 years

About the decommissioning after 30-year operation

(1) Fuel

Long-term geologic repository in Yucca Mountain site.



(2) Reactor

Transport and disposition in accordance with US experience, e.g.,Hanford site (Trojan reactor, etc.)

(3) Sodium, buildings & substructure

Reutilized for next 4S installation.

Reference of the photos; http://www.nucleartourist.com/systems/rv_trip.htm

TOSHIBA

4S Preliminary Cost Estimation

50MWe (135MWt) :

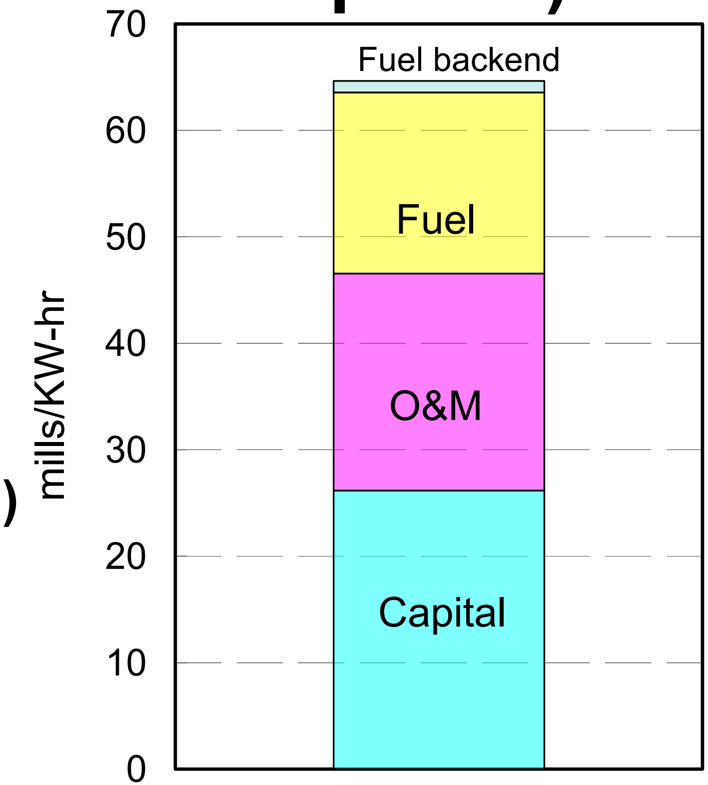
Commercial plant (mass production phase)

- Plant Construction:

$ 2,500/KWe

- Busbar Cost:

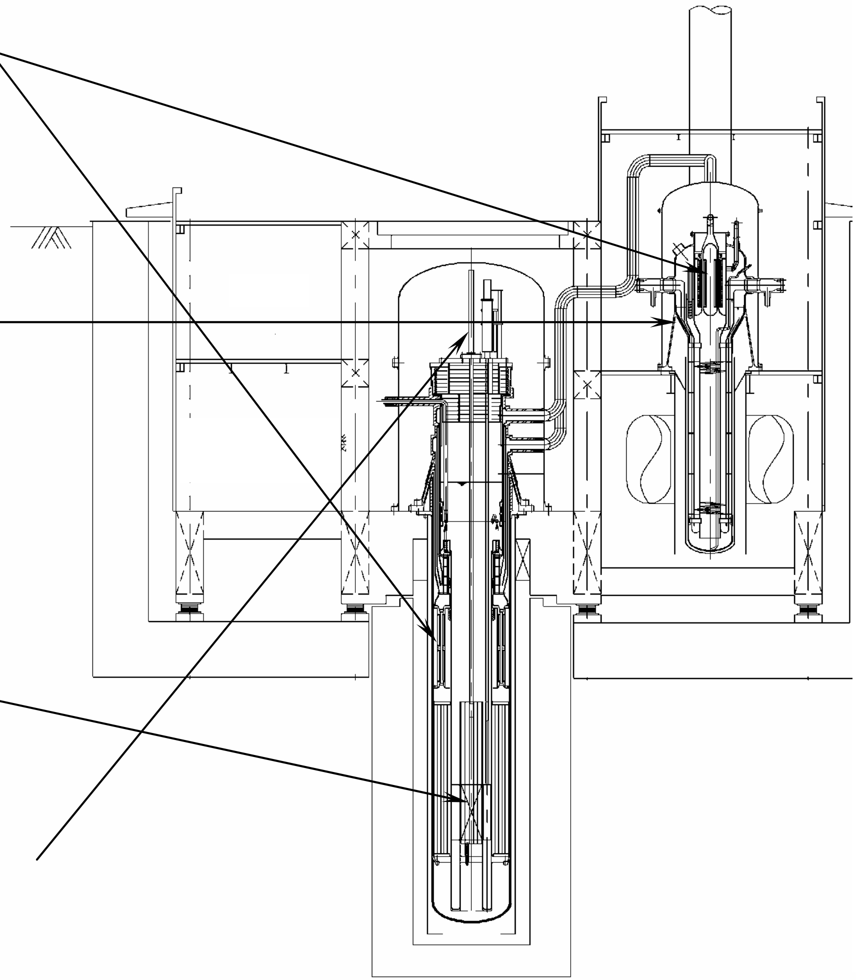
65 mills/KW-hr(*1)



(*1) 8% house load factor is assumed.

R&D status for 4S

- **EM Pumps**
  (Electromagnetic pumps)
- **SG**
  (Steam generator)
- **Core**
- **Reflector Driver**



EM Pumps

Capacity for 4S:

50m^3/min (50MWe)

Sodium Test Facility:

ETEC, U.S.

40 m^3/min*1

160 m^3/min*2

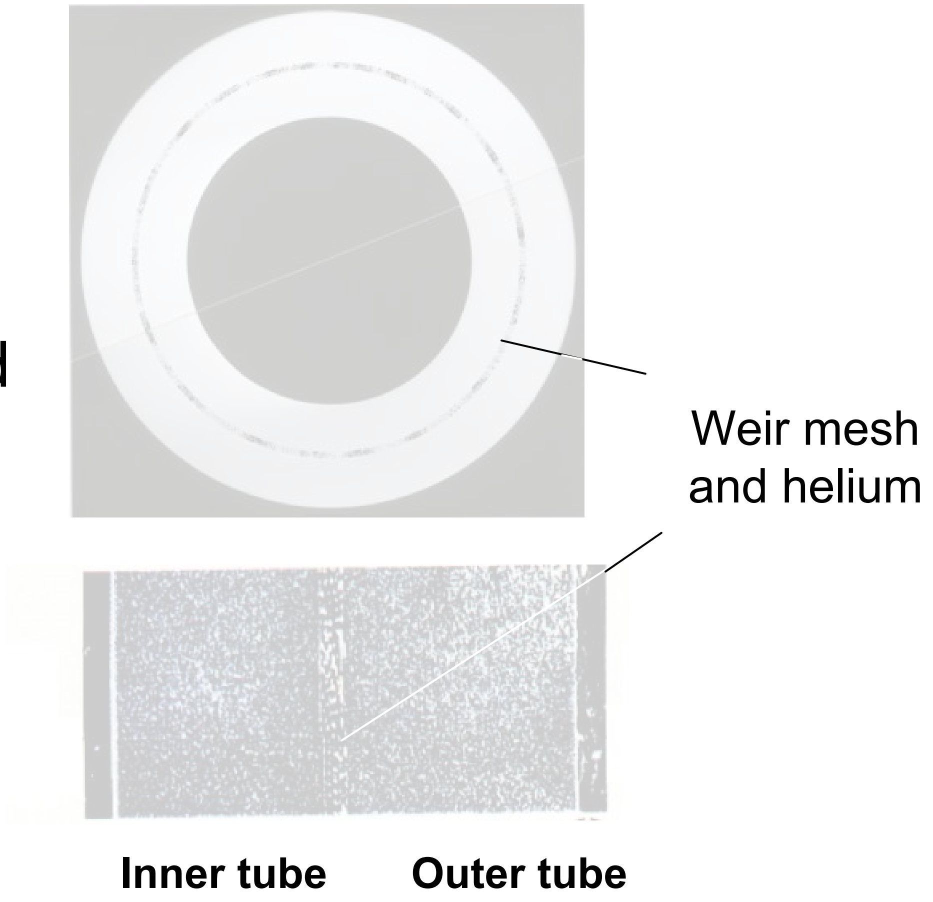
*2) These R&Ds have been performed as a part of joint R&D projects under sponsorship of the nine Japanese electric power companies, Electric Power Development Co., Ltd., the Japan Atomic Power Company (JAPC) and the U.S. Department of Energy (DOE).

*3) These R&Ds have been performed as a part of joint R&D projects under sponsorship of the nine Japanese electric power companies, Electric Power Development Co., Ltd., and JAPC.

SG

Double wall tube

with leakage detection system for both inner and outer tubes to prevent a reaction between secondary sodium and water



*2) These R&Ds have been performed as a part of joint R&D projects under sponsorship of the nine Japanese electric power companies, Electric Power Development Co., Ltd., the Japan Atomic Power Company (JAPC) and the U.S. Department of Energy (DOE).

Core: Critical experiment for 4S

NCA: finished (TOSHIBA)

Toshiba and CEPCO*2

FCA: 2004 (JAERI)*1

JAERI, Toshiba, CRIEPI, Osaka Univ.

*1) These R&Ds have been performed as a part of " Innovative Nuclear Energy System Technology (INEST) Development Projects" under sponsorship of MEXT (JAPAN).

CRIEPI: Central Research Institute of Electric Power Industry, JAERI: Japan Atomic Energy Research Institute.

*2) CEPCO: Chubu Electric Power Co.,Inc.

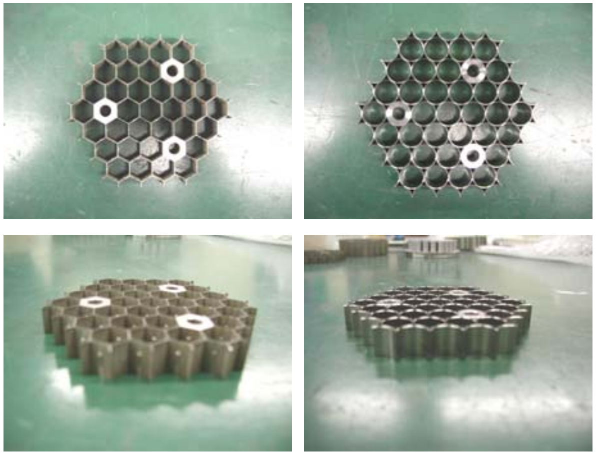
Fuel subassembly

Hydraulic Experiments for high fuel-volume fraction subassembly*1

CRIEPI and Toshiba

Basic tests: finished,

Full-scale mockup: 2003-04



*1) These R&Ds have been performed as a part of " Innovative Nuclear Energy System Technology (INEST) Development Projects" under sponsorship of MEXT (JAPAN).

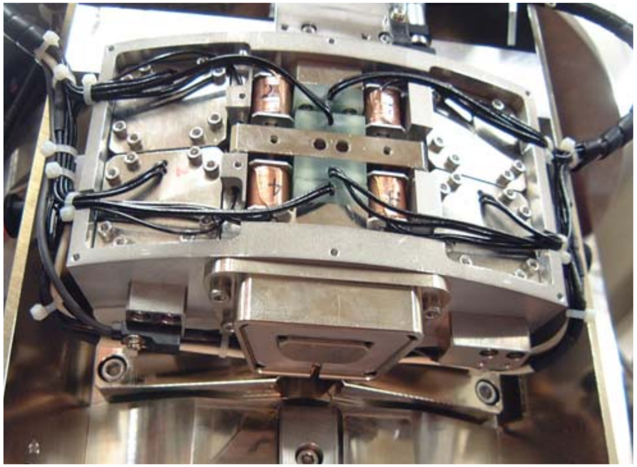
Reflectors (EMI: Electromagnetic Impulsive force drive)

Fundamental test: finished

Toshiba and CEPCO*2

1/3 model test: 2004-05*1

Photo: EMI pre-test module*1 ; finished



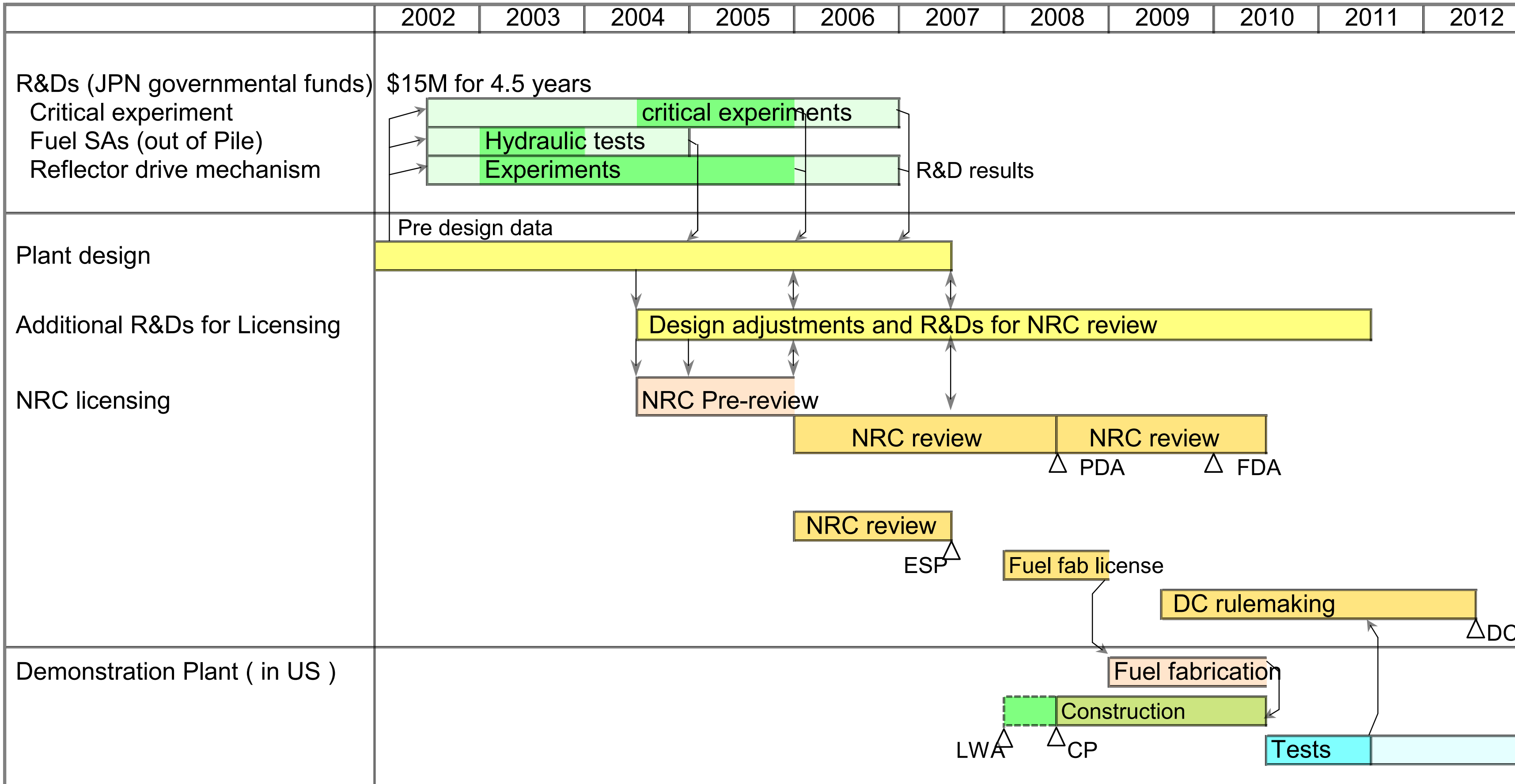
Toshiba, Univ. of Tokyo, and CRIEPI

*1) These R&Ds have been performed as a part of " Innovative Nuclear Energy System Technology (INEST) Development Projects" under sponsorship of MEXT (JAPAN).

*2) CEPCO: Chubu Electric Power Co.,Inc.

TOSHIBA

Expected 4S developing schedule



2. 4S applications

4S applications (1)

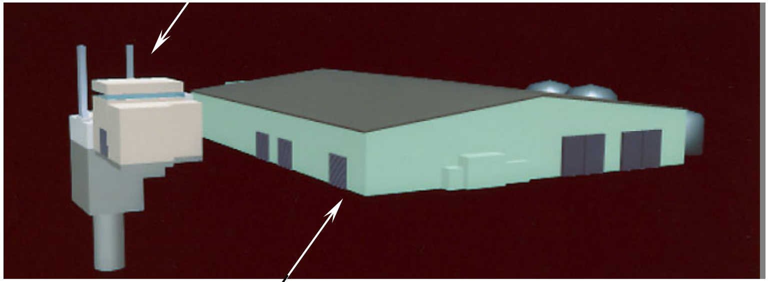
Sea water desalination

Single 4S Plant

- Two stage reverse osmosis system
- Water production:

  34,000 m^3/day (10MWe)

  170,000 m^3/day (50MWe)



4S applications (2)

Hydrogen production

Single 4S Plant

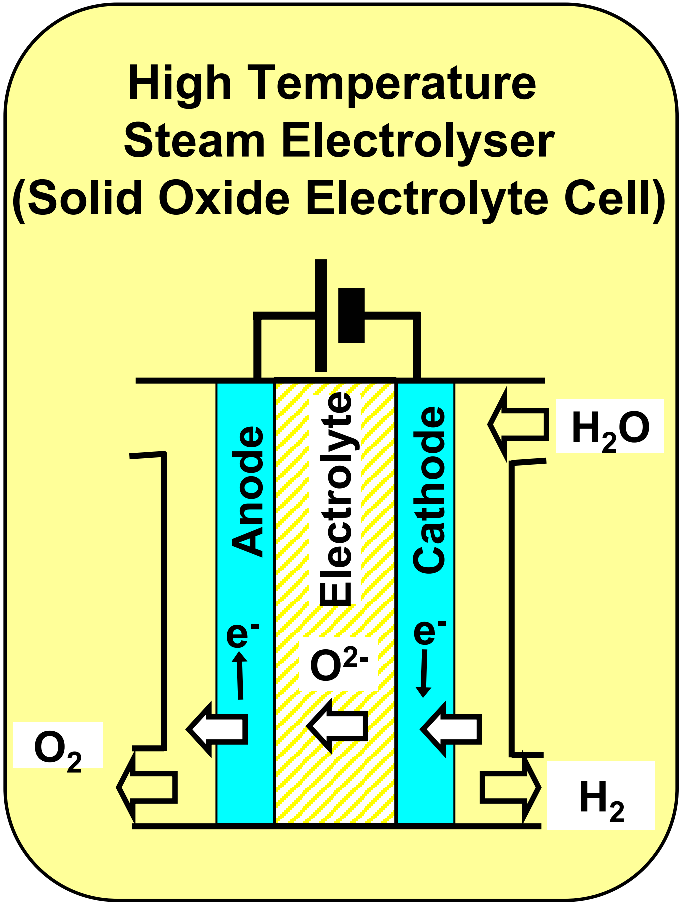
- High temperature steam electrolyser,

  No CO_2 emission.

- Hydrogen production:

  3,000 Nm^3/h (10MWe)

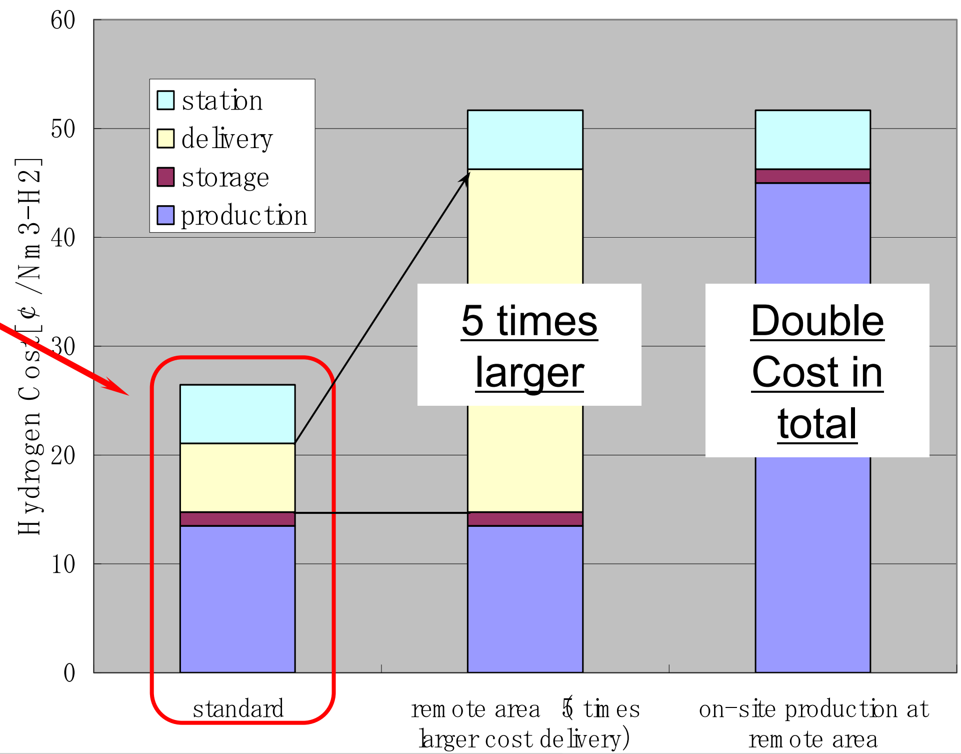
  15,000 Nm^3/h (50MWe)



Discussion: Acceptable cost of hydrogen in rural area.

*Point1: Transportation cost would increase along the distance from production site to user area.

*Point 2: Production cost in rural area tends to increase because of scaling-effect (requested production capacity is not so large).



*Assumption:

If transportation cost for rural area would increase to 5 times larger than the standard case, double cost in total might be acceptable for rural area?

Summary

4S is a sodium cooled, metallic fuelled small fast reactor with long core lifetime.

4S has a proper features for distributed energy station in rural areas, such as

- No refueling,
- Passive safety,
- Lower maintenance requirements,
- Transportability on construction,
- Reasonable cost.

APPENDIX B. Detailed Discussion of Hydropower, Solar, and Conservation

Presented below are detailed discussions of the Hydropower, Solar, and Conservation topics. These technologies are available to be applied in Galena, but their nature or capacity is not suited to make large impacts on operation of the electric utility. They can be used in conjunction with the utility (as add-on modules) or by end-users (utility customers) to reduce their energy use.

Hydro - In-river Turbines

Galena is on the north bank of the Yukon River, one of the largest in the country. A tremendous amount of water passes the site each day – winter and summer and seems to be a logical place to install in-river turbines for electric power generation. However, compared to the load requirements of the City, this may not be a valid conclusion. A variety of turbines are being developed. The one apparently most suited to the Galena site is under development by UEK Corporation. It is proposed to be installed in rivers, anchored to the bottom, and operated year around – even under ice. A project to demonstrate it at village Eagle on the upper Yukon River has been approved but is awaiting U.S. DOE funding. This turbine design has dual 3-meter diameter blades. To estimate the power output of a similar unit at Galena, a look at the power density is in order.

The power density in a flowing fluid is

$$Pmax = 0.5\rho V^3$$

For water flowing at V = 2 m/sec (characteristic of the Yukon at Galena) and density ρ = 1000 kg/m^3 corresponding to 4 kW/m^3. For reasons related to mass conservation and efficiency, one may only be able to capture 40% of this or less with a conventional turbine. For a water turbine with two 3-meter turbines or an area of 14.1 m^2, this results in power generation of 22.5 kW – much less than that required by the City's load. Ten units would have to be installed to make even a marginal contribution and the cost would be too great for the benefit. UEK estimates $ 1,000/kW capacity for a 10-MW plant yet to be built.

(http://www.delawareonline.com/newsjournal/local/2003/09/06tidalpowerplant.html)

On the other hand, an operational 300kW tidal turbine in Norway, costs $23,000/kW capacity. (http://www.eere.energy.gov/RE/ocean.html)

Operational issues include turbine blade erosion [and maybe even destruction] caused by solid objects in the river, impacts on aquatic life, and hazards to navigation. For rivers that are ice-covered at least part of the year, one must also deal with potential damage to submersed structures associated with breakup.

On the plus side, the Yukon River flows year round so the hydro resource is a continuous one.

Water turbines

Several firms worldwide have developed in-stream water turbines with applications to typically capture the power from tidal currents. UEK Corporation has estimated the capital cost for 56 machines generating 10.8 MW in a 7-knot current to be $10M. It is a buoyant turbine/generator suspended like a kite in a tidal stream (Tricon Consultants, 2002). At the present time, the standard UEK machine consists of twin turbines, each 3 m in diameter. This produces 90 kW in 5-knot currents and weighs approximately 3 tons without the anchorage harness and shore equipment. UEK plans to have a 6.7 m twin turbine system available in the future and has plans for a 1-MW system.

Blue Energy Canada is developing Darrieus [vertical axis] turbines and Marine Current Turbines Ltd [MCT] incorporates two axial flow rotors, each 15 to 20 m in diameter mounted on a vertical tower set in the seabed. Each turbine could develop up to 1 MW.

Limited cost data are available for the MCT units and for smaller UEK units. The lack of detailed cost data from other tidal current companies makes it impossible to compare the proposed technologies on the basis of cost efficiency. For two 15.9-m diameter variable-pitch rotors with a combined power output of 1 MW at a rated velocity of 2.3 m/s, estimated units costs of electricity at two different sites on the Canadian west coast were $0.11 [800 MW cap] and $ 0.26/kWh. [43 MW]

For these studies, the energy output was estimated assuming a rotor efficiency of 45% (based on wind power experience), gearbox and generator efficiencies of 94% and 92%, respectively, and a reliability of 95%. A discount rate of 8% was assumed with the scheme being decommissioned after 25 years of production.

A 300-kW unit [$7M] in Norway operating in a 1.8 m/sec current has D = 20 m blades. It can rotate to keep the turbine facing the current and is 12% efficient. This tidal power plant in Kvalsundet was made by Hammerfest Strø.
http://www.eere.energy.gov/RE/ocean.html

Solar

Solar-electric

Vendors of PV components in Fairbanks include ABS Alaskan [907-452-2002] and Arctic Technical Services [907-452-8368]. Major US manufacturers include BP Solar [http://www.bpsolar.com] , and Kyocera Solar Inc. [http://www.kyocerasolar.com].

In one specific example, the BP 3160B photovoltaic module has 72 cells in series and produces 160 watts [4.5 A at 35 V] of nominal maximum power [at 1 sun]. It has a footprint of 159 x 70 cm [1.11 m^2] . It weighs 35 lbs and has a 25-yr power output warrantee. The temperature cycling range is – 40 to 185°F, and the allowable wind and snow loadings are 50 and 113 psi, respectively. The temperature coefficient [Tcoef] for power is – 0.5%/°C with a nominal panel T = 47°C at Ta = 20°C, es = 0.8 kW/m^2, and V_w = 1 m/sec. The negative Tcoef is good news for Alaska. For example, if the panel T = 5°C instead of a nominal 25° C, the output power will be 10% higher.

As an example, **Figure 2.8,** indicates average daily insolation in Fairbanks [approximating that for Galena] from March – July of about 5 kWh/m^2 or about 5.5 kWh incident on the BP 3160B daily for a tilt angle of 64^o. This panel produces 160 W for each 1000 W/m^2 incident or 160 Wh for each kWh/m^2 incident. Hence, its nominal daily output at 25^{o}C is 5[160] = 800 Wh. This can be increased by ambient temperatures colder than 25^{o}C and decreased by system losses. If the solar generated electricity is worth about $0.28/kWh, then over the aforementioned 5-month period, the approximately 150[0.8] = 120 kWh would be worth about $33. If one assumes an installed cost of $10/$W_p$, then the initial capital outlay would be $1,600. For the nine months [March through November], the insolation for a collector at latitude tilt of about 1131 kWh/m^2. This corresponds to a daily average of about 4.2 kWh/m^2. So, the PV module would output 1131[0.16] = 180 kWh worth approximately $51, making a very long payback period.

Solar Thermal

Solar thermal technologies use the heat in sunlight to produce hot water, heat for buildings, or electric power. Solar thermal applications range from simple residential hot water systems to multimegawatt electricity generating stations.

Throughout history, humans have used the heat from sunlight directly to cook food and heat water and homes. Today, solar collectors can gather solar thermal energy in almost any climate to provide a reliable, low-cost source of energy for many applications including hot water for homes, residential heating, and hot water for industries such as laundry and food processing. In recent years, utilities have begun to use solar thermal energy to generate electricity by boiling water and using the steam to drive a turbine which generates electrical power.

Millions of solar thermal systems are in place around the world today with many used for hot water heating. The three types of collectors are flat-plate, evacuated-tube, and concentrating. The most common, the flat-plate type, consists of an insulated, weatherproofed box containing a dark absorber plate at the bottom with the side closest to the sun covered with a transmitting material such as glass. The fluid being heated flows through tubes placed on the black surface and can be warmed by tens of degrees C as it passes through the collector. If the fluid is pure water, it must be drained if the temperature is predicted to fall below freezing. The water can be forced through the collector by a pump or can flow because of thermal siphon effects. The latter relies on the fact that warm water is less dense than cold and hence tends to rise. The active system shown in **Figure B.1** below relies on a double-walled heat exchanger to prevent the antifreeze solution on the hot side from contaminating the domestic water on the cold size. Not shown are sensors and controls to protect the system from excessive temperatures or pressures. This control loop would, for example, only turn the pump on to circulate water through the collector when the water temperature about to leave the collector exceeded a preset amount such as 90^{o}F. It could cause a pressure relief valve to release fluid if the pressure exceeded a set point.

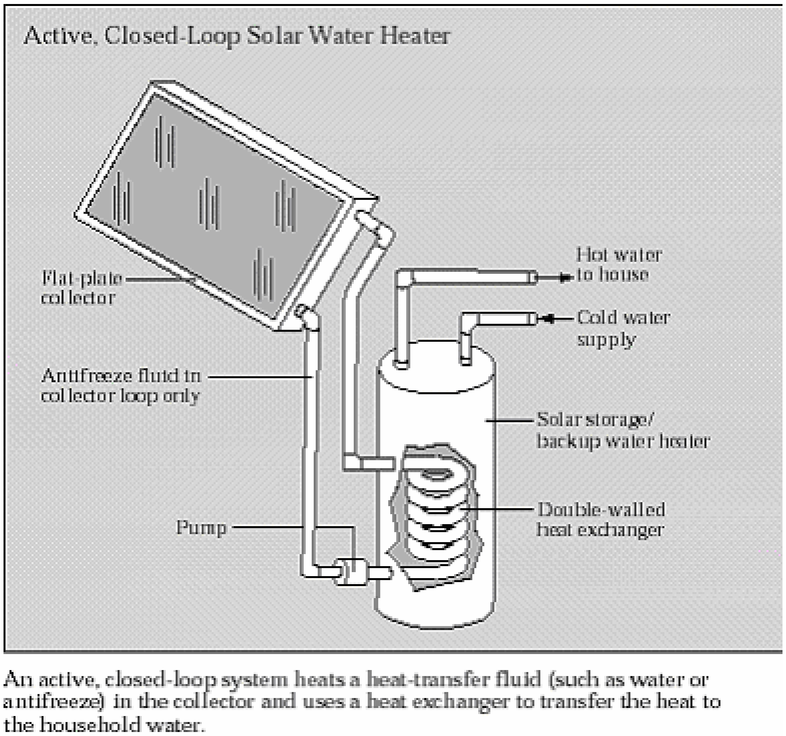


Figure B.1 An active solar closed-loop water heating system. Courtesy of U.S. DOE

http://www.eren.doe.gov/erec/factsheets/solrwatr.pdf

In addition to collectors, the complete system needs an insulated storage tank, and sensors and controls to prevent overheating. Cold water flows from the bottom of the insulated storage tank to the bottom of the collector, and then returns to the storage tank when warmed**.** Active systems use electric pumps, valves, and controllers to circulate water or other heat-transfer fluids through the collectors and range in price from about $2,000 to $4,000 installed for residences. Storage tank sizes can range from 50 gals for 1 to 3 people up to 120 gals for 4 to 6 people. For sizing collector area, allow about 40 ft^2 for 2 people with another 8 ft^2 for each additional person in the Sun Belt. These numbers should be around 60% larger for the northern United States.

http://solstice.crest.org/renewables/re-kiosk/solar/solar-thermal/index.shtml

http://www.eren.doe.gov/erec/factsheets/solrwatr.pdf

One example of a technology applicable for northern climates, Thermomax Evacuated Heat Pipe Solar Collectors, consists of copper heat pipes inside vacuum sealed tubes.

As the sun shines on the black surface of fins mounted on the heat pipes, the alcohol within the heat pipes is heated and the hot vapor created rises to the tops of the pipes. Water, or glycol, flows through a manifold at the top of the tube bank and picks up the heat from the tubes. The heated liquid circulates through another heat exchanger and gives off its heat to water stored in a solar storage tank.

A 20-tube array is 60” by 80” by 6 “ and gives a maximum of ~ 25K Btu/day ~ 8 kWh/day

The A ~ 3 m^2 [not all of this area filled with tubes] and, with a peak insolation ~ 5.6 kWh/m^2/day, we expect ~ 16.5 kWh in. Hence, the system efficiency ep ~ 50 %.

http://www.thermomax.com/

Energy Conservation

Energy conservation refers to a variety of strategies employed to reduce the demand for energy. This can include adding extra insulation on building exteriors, setting building thermostats closer to ambient temperatures, or carpooling. Conservation is different from increasing energy efficiency, which refers to increasing the useful output for a given energy input. This could involve replacing incandescent light bulbs with compact fluorescent ones, driving more fuel-efficient motor vehicles, and buying more efficient appliances.

Projections made in early 1970s indicated the United States would be using energy at the rate of 160 Q by 2000 (Ristinen and Kraushaar, 1999). In actuality, our use today is less than 100 Q. Here, Q = 10^{15} Btu where a Btu is the energy required to heat 1 lb of water by one degree Fahrenheit. A typical home in Alaska today might require 100 million Btu annually for space heating. Reasons that our energy use today is less than predicted include a rising cost of energy, the adoption of many federally and state sponsored energy conservation programs, and the use of more efficient technologies.

In Alaska, there is a large potential for fuel oil savings in villages by using heat captured from the jacket water of diesel-electric generators for space heating.

Ideas for lowering energy use in homes include lowering the water heater thermostat temperature to 120^{o}F, insulating the water tank and hot water piping, replacing incandescent light bulbs with compact fluorescent ones, installing better weather stripping, increasing the thickness of insulation, and installing air to air heat exchangers. The latter preheat outside air by capturing heat from the inside air before it exits to the outdoors. Their use can save hundreds of dollars annually in fuel bills in a residence in Alaska. As much as 30 percent of a home's heating and cooling energy is lost through leaky ductwork. In the United States, that totals $5 billion in wasted energy each year. A good site for energy conservation issues in homes including heat loss from ducts is
http://www.southface.org/home/sfpubs/miscpubs.html

A 15-watt compact fluorescent light bulb costing about $5 and lasting 10,000 hours provides the same illumination as a 60-watt incandescent bulb costing about $0.50 and lasting 1000 hours. Hence, over 10,000 hours of use, the total capital outlay for each is the same, $5.00. But, the compact fluorescent will use [60-15][10] = 450 kWh less electrical energy and save $45 in energy bills at $0.10/kWh. Replacing the higher use light bulbs in a home with compact fluorescent light bulbs can easily save hundreds of dollars in energy bills over a several year period.

As an example of a federal program encouraging energy conservation, the U.S. Department of Energy (DOE) has established a Center Of Excellence For Sustainable Development. This center assists communities across the United States in establishing programs on community conservation, industrial efficiency, building efficiency, community renewable energy, and demand-side management (DSM).

The Energy Efficiency And Renewable Energy Network of the U.S. Department of Energy has a web site dedicated to helping homeowners save energy. The site covers topics such as weatherization, water heating, lighting, and appliances. It has a special section on the use of windows in cold climates, encouraging the use of double pane windows with low emissivity coatings. With appliances representing about 20% of a household's energy consumption, buying energy efficient refrigerators can save up to $1000 over a 15-year lifetime compared with a model designed 15 years ago. In fact, the cumulative energy saved by adopting energy efficient refrigerators starting around 1974 represents $17 billion annually in the United States. This energy savings represents the value of all electricity produced by nuclear power plants.

The American Council for an Energy Efficient Economy (Prindle, 2003) found a typical U.S. household could save $500 annually by adopting more efficient appliances and lights.

According to MAFAc (2002), aggregate household electrical energy use could improve from roughly 6.7kWh/ft^2/yr to around 4.5kWh/ft^2/yr if rural households adopted a number of the end-use energy efficiency measures including switching from electrical hot water heaters to efficient oil-fired water heaters. Heating energy use could improve from roughly 1.14 to around 1.0 gal/ft^2/yr if rural households switched to high efficiency direct vent heaters for space and water heating.

The benefits of new high efficiency lighting and electric water heater replacement programs appear to far outweigh the cost, including the potential for "free riders," short-term declines in utility energy demand and efficiency and market uncertainty.

Rural Alaska schools consume roughly 49,200,000 kWh/yr electric energy and 5 M gal/yr of fuel oil. According to MAFAb (2002), these could each be reduced by 50% by end-use efficiency improvements. Some of this is being realized every year as schools periodically replace existing inefficient lighting, appliances, fixtures, and HVAC equipment with new, more efficient ones.

APPENDIX C. Summary of Nuclear Regulations

Chapter I of Title 10, "Energy," of the Code of Federal Regulations (CFR) guide licensing of nuclear power plants. .

Among the most important for permitting are the following Parts:

Chapter 1 Title 10, "Energy," of the Code of Federal Regulations (CFR)

10 CFR Part 2. Governs all proceedings, other than export and import licensing proceedings, under the Atomic Energy Act of 1954, as amended, and the Energy

Reorganization Act of 1974, for --

(a) Granting, suspending, revoking, amending, or taking other action with respect to any license, construction permit, or application to transfer a license;

(b) Issuing orders and demands for information to persons subject to the Commission's jurisdiction, including licensees and persons not licensed by the Commission;

(c) Imposing civil penalties under section 234 of the Act; and

(d) Public rulemaking.

10 CFR Part 50. Domestic Licensing of Production and Utilization Facilities: Provide for the licensing of production and utilization facilities pursuant to the Atomic Energy Act of 1954, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242). This part also gives notice to all persons who knowingly provide to any licensee, applicant, contractor, or subcontractor, components, equipment, materials, or other goods or services, that relate to a licensee's or applicant's activities subject to this part, that they may be individually subject to NRC enforcement action for violation of § 50.5.

10 CFR Part 51. Environmental Protection Regulations for Domestic Licensing and Related Functions: Contains environmental protection regulations applicable to NRC's domestic licensing and related regulatory functions. Subject to these limitations, the regulations in this part implement Section 102(2) of the National Environmental Policy Act of 1969, as amended.

10 CFR Part 52. Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants: This part governs the issuance of early site permits, standard design certifications, and combined licenses for nuclear power facilities licensed under Section 103 or 104b of the Atomic Energy Act of 1954, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242). This part also gives notice to all persons who knowingly provide to any holder of or applicant for an early site permit, standard design certification, or combined license, or to a contractor, subcontractor, or consultant of any of them, components, equipment, materials, or other goods or services, that relate to the activities of a holder of or applicant for an early site permit, standard design certification, or combined license, subject to this part, that they may be individually subject to NRC enforcement action for violation of § 52.9.

As used in this part,

(a) Combined license (COL) means a combined construction permit and operating license with conditions for a nuclear power facility issued pursuant to subpart C of this part. A COL authorizes construction and conditional operation of a nuclear power facility. An application for a COL may, but need not, reference a standard design certification issued under Subpart B of 10 CFR Part 52 or an ESP issued under Subpart A of 10 CFR Part 52, or both.

(b) Early site permit means an NRC approval for a site or sites for one or more nuclear power facilities. The NRC can issue an ESP for approval of one or more sites for one or more nuclear power facilities separate from the filing of an application for a construction permit or combined license in accordance with 10 CFR Part 52. An ESP is a partial construction permit and is, therefore, subject to all procedural requirements in 10 CFR Part 2 that are applicable to construction permits. Applications for ESPs will be reviewed according to the applicable standards set out in 10 CFR Parts 50 and 100 as they apply to applications for construction permits for nuclear power plants. Early site permits are good for 10 to 20 years and can be renewed for an additional 10 to 20 years. ESPs address site safety issues, environmental protection issues, and plans for coping with emergencies, independent of the review of a specific nuclear plant design.

(c) Standard design means a design which is sufficiently detailed and complete to support certification in accordance with subpart B of this part, and which is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review.

(d) Standard design certification, design certification, or certification means a Commission approval, issued pursuant to subpart B of this part, of a standard design for a nuclear power facility. A design so approved may be referred to as a certified standard design.

10 CFR Part 100. Reactor Site Criteria: The siting requirements contained in this part apply to applications for site approval for the purpose of constructing and operating stationary power and testing reactors pursuant to the provisions of part 50 or part 52 of this chapter.

Reactor Decommissioning

NRC continues to regulate nuclear reactors after they are permanently shut down and begin decommissioning. Decommissioning is defined in NRC regulations as "to remove a facility or site safely from service and reduce residual radioactivity to a level that permits (1) release of the property for unrestricted use and termination of the license; or (2) release of the property under restricted conditions and termination of the license." The NRC maintains a series of internet web sites to provide information on reactor decommissioning (see http://www.nrc.gov/reactors/ decommissioning/regs-guides-comm.html)

During the operating life of a reactor, plant components can become radioactive, either through contamination or as a result of activation caused by the fission reaction. Therefore, special care is needed in the decontamination and dismantlement of the facility. Contaminated materials are shipped to a low-level radioactive waste disposal site for burial. The NRC has adopted extensive regulations for dealing with the technical and financial issues associated with decommissioning.

During the reactor decommissioning process, NRC conducts inspections, processes license amendments (including approval of the License Termination Plan), and monitors the status of activities. This monitoring ensures that safety requirements are being met throughout the process.

All decommissioning associated with the 4S reactor is assumed will be the responsibility of Toshiba, which will remove the entire reactor module at the end of the 30-year operating life. Toshiba will therefore be responsible for all wastes, spent fuel, etc. associated with the 4S plant. The NRC license will stipulate details as to how and when this removal will occur. NRC may also require some form of financial guarantee that the decommissioning occur according to the license granted. Because the entire reactor module will be removed, and will remain sealed while in the United States, it is assumed that many of the standard NRC decommissioning requirements will not be applicable to the 4S reactor. However, once the power plant is removed, the demolition of the buildings and infrastructure are assumed to be the responsibility of Galena. This may include a requirement to monitor the remaining buildings and infrastructure for radioactivity prior to release for unrestricted use.

NRC regulations that are most applicable to reactor decommissioning include:

- 10 CFR Part 20, Standards for Protection Against Radiation
- 10 CFR Part 30, Rules of General Applicability to Domestic Licensing of Byproduct Material
- 10 CFR Part 40, Domestic Licensing of Source Material
- 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities
- 10 CFR Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions
- 10 CFR Part 70, Domestic Licensing of Special Nuclear Material
- 10 CFR Part 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste
- 10 CFR Part 73, Physical Protection of Plants and Materials

Regulatory guides are issued in 10 divisions and are intended to aide licensees in implementing regulations. The guides most applicable to reactor decommissioning are in:

Division 1, Power Reactors (http://www.nrc.gov/reading-rm/doc-collections/reg-guides/power-reactors/active/)

Division 4, Environmental and Siting (http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/active/). The list of environmental and siting Reg Guides is provided below.

Division 8, Occupational Health (http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/active/)

Monitoring and Emergency Preparedness: NRC permits will likely involve some routine monitoring as well as some emergency preparedness activities. How involved each of these activities will be is not known at this time.

NRC Regulatory Guides - Environmental and Siting (Division 4)

This page lists the title, date issued, revisions, and some ADAMS accession numbers for each regulatory guide in Division 4, Environmental and Siting.

Table C.1. NRC Regulatory Guides - Environmental Siting (Division 4)

Guide Number	Title	Rev.	Publish Date
4.1	Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants (Rev. 1, ML003739496)	--	01/1973
		1	04/1975
4.2	Preparation of Environmental Reports for Nuclear Power Stations (Rev. 2, ML003739519)	--	03/1973
		1	01/1975
		2	07/1976
4.2S1	Supplement 1 to Regulatory Guide 4.2, Preparation of Supplemental Environmental Reports for Applications To Renew Nuclear Power Plant Operating Licenses (ML003710495) (Proposed Supplement 1, DG-4002, published 8/91; second Proposed Supplement 1, DG-4005, published 7/98)		09/2000
4.3	(Withdrawn--See 41 FR 53870, 12/199/1976)	--	--
4.4	Reporting Procedure for Mathematical Models Selected To Predict Heated Effluent Dispersion in Natural Water Bodies (ML003739535)	--	05/1974
4.5	Measurements of Radionuclides in the Environment--Sampling and Analysis of Plutonium in Soil (ML003739541)	--	05/1974
4.6	Measurements of Radionuclides in the Environment-- Strontium-89 and Strontium-90 Analyses (ML003739544)	--	05/1974
4.7	General Site Suitability Criteria for Nuclear Power Stations (Revision 2, ML003739894) (DG-	--	09/1974
		1	11/1975

	4003, Proposed Revision 2, published 11/1992) (DG-4004, Second Proposed Revision 2, published 2/1995)	2	04/1998
4.8	Environmental Technical Specifications for Nuclear Power Plants (for Comment) (ML003739900)	--	12/1975
4.9	Preparation of Environmental Reports for Commercial Uranium Enrichment Facilities (Rev. 1, ML003739926)	-- 1	12/1974 10/1975
4.10	(Withdrawn--See 42 FR 59436, 11/17/1977)	--	--
4.11	Terrestrial Environmental Studies for Nuclear Power Stations (Rev. 1, ML003739935)	-- 1	07/1976 08/1977
4.12	(Not published)	--	--
4.13			
1	Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications (Rev. 1, ML003739935)	-- 07/1977	11/1976
4.14 (1.1M)	Radiological Effluent and Environmental Monitoring at Uranium Mills (Rev. 1, ML003739941)	-- 1	06/1977 04/1980
4.15	Quality Assurance for Radiological Monitoring Programs (Normal Operations) -- Effluent Streams and the Environment (Rev. 1, ML003739945)	-- 1	12/1977 02/1979
4.16	Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants (Rev. 1, ML003739950) (Draft CE 401-4, Proposed Revision 1, published 9/1984) (Errata published 8/1986)	-- 1	03/1978 12/1985
4.17	Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories (Rev. 1, ML003739963) (Draft GS 027-4 published 4/1981) (Draft WM 404-4, Proposed Revision 1, published 2/1985)	-- 1	07/1982 03/1987
4.18	Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste (ML003739515) (Draft WM 013-4 published 4/1982)	--	06/1983

4.19	Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste (ML003739520) (Draft WM 408-4 published 3/1987)	--	08/1988
4.20	Constraint on Releases of Airborne Radioactive Materials to the Environment for Licensees other than Power Reactors (ML003739525) (Draft DG-8016 published 12/1995)	--	12/1996

A number of other useful guidance documents are available, including:

- Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactors (NUREG-1628)
- Standard Review Plan for Evaluating Nuclear Power Reactor License Termination (NUREG-1700)
- Residual Radioactive Contamination From Decommissioning Parameter Analysis (NUREG/CR-5512)
- Standard Review Plan on Power Reactor Licensee Financial Qualifications and Decommissioning Funding Assurance (NUREG-1577)
- Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants (NUREG-1738)
- Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG-1575)
- NMSS Decommissioning Standard Review Plan (NUREG-1727)
- Report on Waste Burial Charges: Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities (NUREG-1307)
- Decommissioning of Nuclear Power Reactors (Regulatory Guide 1.184)
- Standard Format and Content for Post-Shutdown Decommissioning Activities Report (Regulatory Guide 1.185)
- Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown (Regulatory Guide 1.191)
- Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586)

APPENDIX D. Economic Analysis Model

This appendix provides sample output from the economic analysis model. The sample output illustrates some of the calculations and provides a sense of how the assumptions are translated into results. Some sections of the model, such as the daily dispatch algorithms, are too voluminous to present here. Others, such as the analysis of transmission lines, have already been presented in the text. Interested readers may obtain the full Microsoft Excel spreadsheet model from the authors.

The sample output is organized as follows:

- Parameters and Assumptions
- Diesel system cost
- Coal system cost
- Nuclear system costs

Table D.1. Parameters and Assumptions for Economic Analyses

Parameters and Assumptions

	units	selected value (yr 1)	low value	high value
Overall Parameters				
Start Year		2010		
Real discount rate	%	4.0%		
Loads and Common Parameters				
Utility Electric Load				
Initial load at busbar	MWh/yr	11,002		
Annual load growth	% per yr	2.0%		
Peak Load	MW	1.8		

	units	value
Residential Space Heat		
number of houses, year 2010		220
annual growth in number of houses		2.0%
stove oil consumption per house	gallons/yr	1,000
residential furnace efficiency		75%
residential fuel price premium (delivery c	$/gallon	0.75
Utility line upgrades capital cost	$	800,000
customer premises upgrade cost	$/house	3,000
electric dist'n loss from busbar to house		10.0%
District Heat		
Current district heat load	B Btu/yr	8.0
Cost of bulk distribution pipe	$/foot	200
Air station boiler efficiency		80%
Distance from power plant to air station	miles	2.0
district heat loss in pipes		10.0%
Heat load factor (based on HDD data)		0.51
Heat sales tariff as % of net avoided cost		75%

Table D.1. Parameters and Assumptions for Economic Analyses - continued

Diesel

	units	selected value (yr 1)	low value	high value
Diesel capital cost (replace engines)	$/kW	400		
Diesel Fuel				
Utility fuel initial price	$/gallon	2.15	1.50	2.15
Annual real escalation	% per yr	2.0%	0.0%	2.0%
Utility initial fuel efficiency	kWh/gal	14		
kWh measured at busbar				
Efficiency of New Units	kWh/gal	15		
Nonfuel diesel O&M				
Diesel generation labor	$/year	305,157		
Variable O&M (includes overhauls)	$/kWh	0.017		

Coal

	units	selected value (yr 1)	low value	high value
Coal plant capital cost	$/kW	3,000		
Coal plant availability		95%		
Coal plant efficiency (electric output/coal input)		40%	30%	40%
Coal or nuclear "heat to electric" efficiency		50%		
Coal fuel				
Energy content	M Btu/ton	20		
Delivered price of coal	$/ton	100	100	125
Ash disposal cost	$/ton	20		
Nonfuel coal O&M				
Coal labor	people	6		
cost per operator	$/yr	53,200		
variable O&M and consummables	$/kWh	0.01		

Nuclear

	units	selected value (yr 1)	low value	high value
Nuclear capacity	MW	10.0		
Nuclear capital cost	$	0		
Nuclear security staff	people	34	4	34
Nuclear operator staff	people	8		
Nuclear availability		95%		
Nuclear annual supplies and expenses	$/yr	500,000		

Table D.2. Diesel-Only Power Supply Economic Analysis

			Units	Present Value	Year 1 2010	30 2039
Diesel-Only Power Supply Economic Analysis						
		Variable	Units	Present Value	2010	2039
Busbar Energy Requirements			MWh		11,002	19,539
Peak Demand			MW		1.8	3.2
Diesel Fuel Use by Unit						
	kWh/gal					
1	15.0	New	gal		733,497	1,302,576
2	15.0	New	gal			
3	14.0		gal			
4	14.0		gal			
5	14.0		gal			
6	14.0		gal			
Total Diesel Fuel Used			gal		733,497	1,302,576
Diesel Fuel Price			$/gal		2.15	3.82
Total Diesel Fuel Cost			$	$45,745,507	1,577,018	4,973,321
Labor				$5,276,785	305,157	305,157
Other Diesel System Variable Costs						
	Major Overhauls ** included in O&M					
	O&M (includes overhauls)		$	$4,129,163	187,042	332,157
	Total nonfuel variable cost		$	$4,129,163	187,042	332,157
Diesel Avoidable Capacity Cost			$	$4,147,366	711,886	
	amortized				239,843	239,843
Total Cost of Busbar Diesel Electricity			$	**$59,298,821**	**2,309,059**	**5,850,478**
Rate Impacts					2010	2039
	Total sales		MWh		9,902	17,585
	avoidable busbar cost		$/kWh		0.23	0.33
	distribution, general, and admin		$/kWh		0.07	0.06
	Average cost of electric service		**$/kWh**		**0.30**	**0.39**

Table D.3. Coal Power Supply Economic Analysis

Coal Power Supply Economic Analysis					
				Year	
				1	30
Variable	Units	in-clude?	Present Value	2010	2039
Busbar Energy Requirements					
Utility electricity	MWh	1		11,002	19,539
Existing city heating loop	MWh	1		2,344	2,344
Residential heating	MWh	0		-	-
Air station heating	MWh-equiv	1		8,464	8,464
Greenhouse	MWh	0		-	-
Total Energy Requirements at power plant	MWh			21,811	30,347
Total Energy Output Capacity (electric equ	MW			4.0	4.0
Availability	%			95%	95%
Energy from Coal and from diesel					
firm energy from coal	MWh			12,679	20,788
firm energy from diesel	MWh			667	1,094
non-firm energy for Air Station	MWh-equivalent			8,040	5,816
Total Energy generated by coal	MWh-equivalent			20,719	26,605
Coal Fuel					
Coal requirements	tons			8,839	11,350
Cost per ton	$/ton			100	100
Total coal fuel cost	$		17,035,458	883,920	1,135,027
Coal Capital			12,000,000	693,961	693,961
Coal labor			5,519,617	319,200	319,200
Diesel peaking and backup variable cost (from below)			2,614,234	96,746	267,259
Other coal system variable costs					
consummables and variable O&M			3,993,075	207,189	266,048
Ash disposal @ $20/ton			3,407,092	176,784	227,005
Total nonfuel variable cost			7,400,167	383,973	493,053
Total busbar cost of coal system			40,576,400	2,170,610	2,642,453
less: net value of heat sent to air station			(17,483,703)	(839,746)	(1,113,613)
equals: net busbar cost of coal system			**23,092,697**	**3,010,357**	**3,756,066**

Table D.3. Coal Power Supply Economic Analysis – continued

Avoided cost from heat used by Air Station				
Air station end-use heat demand	B Btu		52.0	52.0
Coal heat energy delivered to station	B Btu		49.4	35.7
avoided diesel fuel	gallons		447,388	323,659
avoided diesel price	$/gallon		2.15	3.82
avoided diesel cost	$	19,595,703	961,884	1,235,750
less: capital cost of pipe upgrade		(2,112,000)	(122,137)	(122,137)
equals: Net value (fuel savings only) of heat		17,483,703	839,746	1,113,613
Net value per M Btu delivered at plant	$/M Btu		15.30	28.05
Rate Impacts			2010	2039
Total cost of coal system			2,170,610	2,642,453
prospective tariff for heat (metered at plant)	$/M Btu		11.48	21.04
amount of heat sold (metered at plant)	B Btu		54.9	39.7
sales revenue from base heat sales	$	13,112,777	629,810	835,210
net cost of generation			1,540,801	1,807,243
distribution, general, and admin			710,728	1,054,748
Utility revenue requirement from rates			2,251,529	2,861,991
utility non-heat electricity sales	MWh		9,902	17,585
Electric heat sales to homes	MWh		0	0
Average cost of electric service	**$/kWh**		**0.23**	**0.16**
avoidable busbar cost	$/kWh		0.16	0.10
distribution, general, and admin	$/kWh		0.07	0.06

Table D.4. Nuclear Power Supply Economic Analysis

Variable	Units	Present Value	Year 1 2010	30 2039
Nuclear Power Supply Economic Analysis				
Busbar energy requirements	MWh		11,002	19,539
Peak demand	MW		1.8	3.2
Power output	MW		10.0	10.0
Availability	%		95%	95%
Available energy output	MWh		83,220	83,220
Firm energy requirements	MWh		21,330	35,617
Firm energy supplied	MWh		20,263	33,836
to utility electricity	MWh		10,452	18,562
to district heat	MWh		2,227	2,227
to home space heating	MWh		7,042	12,506
to greenhouse	MWh		542	542
Surplus energy available for H2 production	MWh		62,957	49,384
Diesel energy to cover unavailability	MWh		1,066	1,781
Nuclear capital paid by utility		0	0	0
Nuclear decommissioning	[not considered in this model]			
Labor				
plant operators	persons		8	8
cost per operator	$/yr		82,460	82,460
Operator Labor			659,680	659,680
security staff	persons		34	34
cost per security staff	$/yr		53,200	53,200
Security Labor			1,808,800	1,808,800
Total nuclear labor		42,685,038	2,468,480	2,468,480
Nuclear annual O&M		8,646,017	500,000	500,000
Diesel backup variable cost (from below)		4,984,179	181,911	515,947
Total busbar cost of nuclear energy production		56,315,234	3,150,391	3,484,427
less: Avoided cost from using residential electric heat (below)		(15,903,166)	(553,568)	(1,700,247)
less: Avoided cost of heat for air base, at power plant		(20,243,434)	(890,513)	(1,676,172)
equals: Net busbar cost of electric service		20,168,634	1,706,310	108,008
Surplus energy for hydrogen production	MWh		62,957	49,384

Table D.4. Nuclear Power Supply Economic Analysis – continued

Savings from sales of heat to air base						
	Air station end-use heat demand		B Btu		52.0	52.0
	less: unserved energy at peak times		B Btu		0.0	0.0
	equals: heat energy delivered to base		B Btu		52.0	52.0
	avoided diesel fuel		gallons		471,000	471,000
	avoided diesel price		$/gallon		2.15	3.82
	avoided diesel cost		$	22,355,434	1,012,650	1,798,309
less:	capital cost of pipe upgrade		$	(2,112,000)	(122,137)	(122,137)
	Net value (fuel savings only) of heat at power plant			20,243,434	890,513	1,676,172
	Net value per M Btu of heat at power plant				15.41	29.01
Rate Impacts						
	Total cost of nuclear system			56,315,234	3,150,391	3,484,427
	prospective tariff for heat (metered at plant)		$/M Btu		11.56	21.76
	amount of heat sold (metered at plant)		B Btu		57.8	57.8
	sales revenue from air station heat sales		$	15,182,576	667,885	1,257,129
	net cost of generation			41,132,659	2,482,507	2,227,298
	distribution, general, and admin			14,299,453	710,395	1,037,214
	Utility revenue requirement from rates			55,432,111	3,192,901	3,264,511
	non-heat electricity sales		MWh		9,895	17,193
	Electric heat sales to homes		MWh		6,338	11,255
	Average cost of electric service		**$/kWh**		**0.20**	**0.11**
	Check savings to homes:					
		per household cost of diesel			2,900	4,568
		per household cost of electric heat			5,667	3,306
Required Diesel generation			MWh		1,066	1,781
Diesel Fuel Use by Unit						
	kWh/gal					
1	14.0	Unit 1	gal		76,177	127,204
2	14.0	Unit 2	gal			
3	14.0	Unit 3	gal			
4	14.0	Unit 4	gal			
5	14.0	Unit 5	gal			
6	14.0	Unit 6	gal			
Total Diesel Fuel Used			gal		76,177	127,204
Diesel Fuel Price			$/gal		2.15	3.82
Total Diesel Fuel Cost			$	$4,595,785	163,781	485,672
Other Diesel System Variable Costs						
	Major Overhauls					
	Other Energy-related O&M		$	$388,394	18,130	30,274
	Total Nonfuel Variable Cost		$	$388,394	18,130	30,274
Diesel Avoidable Capacity Cost			$	$0		
Total Identifiable Cost of [backup] Diesel			$	**4,984,179**	**181,911**	**515,947**