New Zealand Energy Strategy to 2050

Powering Our Future

Towards a sustainable
low emissions energy system

October 2007

New Zealand Government

sustainability

Acknowledgement

The development of this New Zealand Energy Strategy has involved the help of dozens of organisations, associations, interest groups and individuals. Many have submitted documents and offered comment, either informally or formally, on the ideas and options raised in this strategy. These contributions have been invaluable to developing New Zealand's future energy path.

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Foreword

The *New Zealand Energy Strategy* is an important part of a package of initiatives the government is introducing to advance sustainability and economic transformation, and to help New Zealand respond to climate change.

The quest for sustainability is a defining issue of the 21st century. It has taken on a new urgency because of the scale of the environmental challenge the world faces. Traditional patterns of development and fast growing populations have put a huge strain on our planet. This government has put sustainability high on its agenda. In doing so, it has issued a call to action to make New Zealand a truly sustainable nation.

Becoming truly sustainable is not only the right thing to aspire to – it's also the smart thing to do. In a world that cares about sustainability, positioning New Zealand as sustainable is critical to our common future. It is fundamental to New Zealand's ability to achieve our economic transformation objectives to ensure our future prosperity and international competitiveness. Making New Zealand sustainable can also stimulate new kinds of business opportunities to transform our abundant natural resources into higher value products, while protecting the environment.

Government leadership on lowering New Zealand's environmental footprint is making significant headway. The government has released a proposal for an emissions trading scheme that will, in time, cover all sectors and all greenhouse gases. Tackling climate change will require each and every one of us to do what we can, with all sectors playing their part.

The *New Zealand Energy Strategy* sets the strategic direction for the energy sector to contribute to New Zealand's future prosperity and sustainability. Set within a framework of competitive markets and effective regulation, the strategy will ensure the right conditions for capital investment in coming years and provide leadership on energy security and climate change issues. The *New Zealand Energy Strategy* specifically responds to the challenges of providing enough energy to meet the needs of a growing economy, maintaining security of supply and reducing greenhouse gas emissions.

The *New Zealand Energy Strategy*, along with the *New Zealand Energy Efficiency and Conservation Strategy*, will take sustainability to new levels, by introducing initiatives that champion renewable energy across power generation and transport, energy efficiency at home and at work, and the development and deployment of sustainable energy technologies.

The government has set a target for 90 per cent of electricity to be generated from renewable sources by 2025. Increasing the proportion of renewable electricity is an affordable option for New Zealand, using current technology and our indigenous resources, and it is the best choice for a sustainable economy and environment.

Initiatives to increase the proportion of renewable energy used in transport, in the form of biofuels and electricity, will also help reduce New Zealand's reliance on imported fossil fuels. This will increase the resilience of our transport system and economy to sudden disruptions in oil supply, as well as longer-term concerns about global oil supplies and price uncertainty.

The *New Zealand Energy Strategy*, and the *New Zealand Energy Efficiency and Conservation Strategy* in particular, will also help us to become more energy efficient in our homes, working places and in transport. Improving the way we use energy makes good sense in terms of improved comfort, lower costs and reduced greenhouse gas emissions.

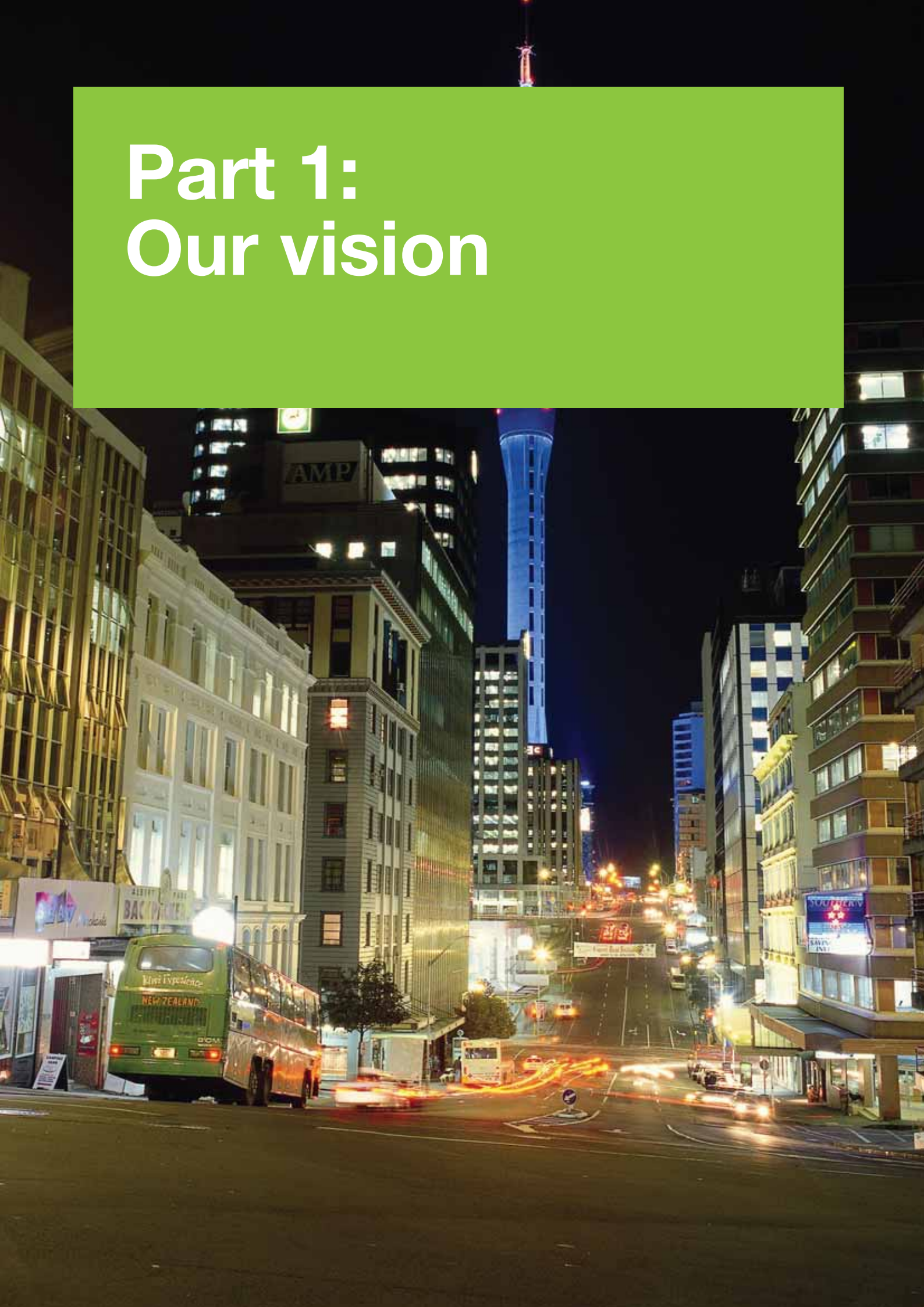
Moving to a secure and low emissions energy system will also require changes in the way energy services such as electricity, heat and motive power are produced and delivered. Many of the actions in the *New Zealand Energy Strategy* will ensure that New Zealand is well positioned to take up opportunities provided by emerging low carbon technologies when they are available, cost effective and applicable to New Zealand.

We are determined to become a truly sustainable nation, and even a carbon neutral nation. This strategy maps out an ambitious but achievable pathway for the reduction of energy-related greenhouse gas emissions.

Hon David Parker

Minister of Energy

Part 1:
Our vision



1. Introduction

New Zealand, like the rest of the world, faces two major energy challenges. The first is to respond to the risks of climate change by reducing the greenhouse gases caused by the production and use of energy. The second is to deliver clean, secure, affordable energy while treating the environment responsibly.

The *New Zealand Energy Strategy* (NZES) sets out the government's vision of a sustainable, low emissions energy system and describes the actions that will be taken to make this vision a reality.

The draft version of this document was released for public consultation in December 2006. Over 330 organisations and individuals made submissions, which reflects the high level of public interest in the importance of the choices we make about our future energy path.

The NZES is in two parts. Part 1 sets out the government's vision for a sustainable energy system and the key actions we can take now to move us towards making New Zealand the world's first truly sustainable nation.

Part 2 gives details of the initiatives the government will take, both now and in the future. The relevant issues and the actions to be taken in each area are discussed under the chapter headings:

- Resilient, low carbon transport
- Security of electricity supply
- Low emissions power and heat
- Using energy more efficiently
- Sustainable energy technologies and innovation
- Affordability and wellbeing.

1.1 Engagement with stakeholders

The feedback on the draft NZES was detailed, challenging and thought provoking.

Most submissions recognised that climate change was a major issue and that policies to mitigate its impact were of national importance. Some major energy users and other business interests believed the draft strategy was too weighted towards climate change, at the expense of security of supply and economic growth, and wanted to see a more detailed cost-benefit assessment of the proposals in the strategy.

Two common threads ran through comments on transport proposals – support for investment in public transport, and caution about rapidly increasing biofuels.

Energy companies and major electricity users believed security of electricity supply should be the strategy's prime objective. Some submitters thought substantial additional electricity generation could be achieved with renewables for little increase in price, while others thought this was too optimistic a view.

On low emissions power and heat, there was broad recognition of the need to introduce emissions pricing, preferably linked to international prices. The Resource Management Act (RMA) was seen by some as a barrier to new projects.

There was strong endorsement of the government's role in encouraging energy efficiency, but mixed views on the proposal to reduce the discount rate for evaluating energy efficiency actions from ten per cent to five per cent.

Some submitters called for more funding of research and development of sustainable technologies and innovations, while others cautioned against adopting new technologies prematurely.

Affordability and wellbeing received the least attention in the submissions.

Relevant material from the submissions has been incorporated into work programmes and taken into consideration. For a detailed summary of submissions, see the accompanying document *Summary Report on Submissions on the Draft New Zealand Energy Strategy to 2050*, available at www.med.govt.nz/nzes

1.2 Links with other policies

Energy policy is linked to government policies on economic development; sustainability; climate change; carbon neutrality; transport; resource management; and research, science and technology.

The government has signalled its aspiration for New Zealand to be carbon neutral over time.[1] Addressing climate change is central to the government's economic transformation agenda, which seeks to raise productivity and increase the value of our exports while improving our long-term environmental sustainability.

In 2003, the government introduced the *Sustainable Development Programme of Action* (SDPoA). It was the first step to taking a sustainable development approach to decision-making in four areas: water, energy, cities, and child and youth development. The main energy goal was to ensure energy services were delivered to all consumers in an efficient, fair, reliable and sustainable manner.

In 2004, the government released the report *Sustainable Energy*, which set out the long-term challenges of delivering secure, fair and efficiently priced and environmentally sustainable energy services. When stakeholders were consulted about the report, they urged the government to develop a clearer strategy for meeting its sustainable energy objectives.

The development of the NZES has been a whole-of-government process led by the Ministry of Economic Development.

The government's detailed policies and actions on energy efficiency and renewables are set out in the *New Zealand Energy Efficiency and Conservation Strategy* (NZEECS), led by the Energy Efficiency and Conservation Authority (EECA).

[1] See *New Zealand's Climate Change Solutions: An Overview* at www.climatechange.govt.nz

The transport energy and climate change objectives in the NZES will inform the update of the *New Zealand Transport Strategy* (NZTS).

In September 2007, the government released *Framework for a New Zealand Emissions Trading Scheme*. The government has decided in-principle that New Zealand will adopt an emissions trading scheme (ETS) to reduce emissions cost effectively, support global action on climate change, and set New Zealand on a path to sustainability. It is proposed that emissions trading will cover all greenhouse gases and sectors of the economy by 2013.

However, a price on emissions alone will not be enough. Further initiatives set out in the NZES and NZEECS will complement and support an ETS. These measures seek to achieve specific outcomes in the energy sector earlier than would occur under emissions pricing, or to address market failure or barriers to investment. These include:

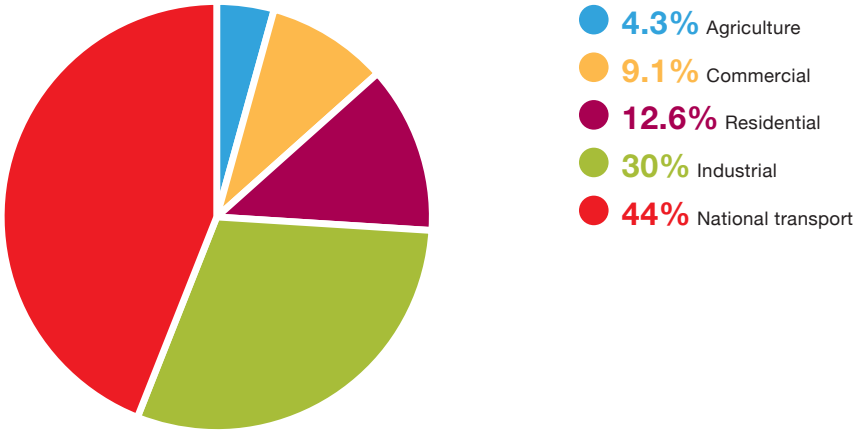
- improved policy guidance and regulation
- financial incentives, including subsidies for solar water heating and home insulation
- addressing regulatory barriers and market failures
- improved standards and codes, including energy efficiency standards for new homes and household appliances
- public education and information.

The first commitment period of the Kyoto Protocol expires in 2012. Discussions between governments are focusing on forging a global agreement to reduce emissions post-2012. Future agreements are likely be more complex and to factor in differences between countries and sectors. New Zealand will continue to take part in global forums, and our position will be informed by our own circumstances, our engagement with stakeholders, and our desire to see an enduring and fair global solution.

1.3 Our energy system

Our energy use is dominated by electricity and transport. We currently rely on primary energy from oil, water, natural gas, coal and geothermal energy. New Zealand's energy prices have historically been low by international standards, and there has been relatively little investment in energy efficiency for homes, shops, light industry and transport. The sectors in which we use energy are shown in Figure 1.1 below.

Figure 1.1: Total consumer energy by sector in 2006[2]



Source: Ministry of Economic Development

In the transport sector, New Zealand has:

- a high level of car ownership
- a high proportion of used imported vehicles and a trend towards importing older, larger vehicles
- public transport use that is low, but increasing
- a limited rail network because of our geography and small population.

New Zealand's total greenhouse gas emissions are only about 0.3 per cent of global emissions, but we have the 12th highest per capita emissions in the world. If we do not change our energy policies, energy-related greenhouse gas emissions are projected to rise 39 per cent by 2030 – including a 40 per cent increase in emissions from transport. The government believes this would not only be environmentally irresponsible, but would put New Zealand exports at a disadvantage, increase our exposure to the cost of imported fossil fuels and threaten our reputation as a clean, green tourist destination.

Detailed information on New Zealand's energy supply and demand is available in the following reports:

- *New Zealand Energy Data File,* available at www.med.govt.nz/energy/edf
- *Greenhouse Gas Emissions 1990 to 2006,* available at www.med.govt.nz/energy/ghg

[2] Agriculture covers agriculture, hunting and fishing. Industrial covers primary industry, food processing, textiles, wood, pulp, paper and printing, chemicals, non-metallic minerals, basic metals, mechanical/electrical equipment, and building and construction. Commercial excludes cogeneration.

2. Our challenges

2.1 Energy security

We rely on imported oil for around half of our energy needs[3] and must be prepared to respond to supply disruptions caused by international events beyond our control. The government has increased our oil reserves to act as a buffer and to meet our treaty obligations as a member of the International Energy Agency (IEA), as well as updating emergency response planning.

Gas has been a major energy source in New Zealand for 30 years. Proven reserves of gas declined sharply in 2001, when the Maui field was found to have considerably less economically recoverable gas left than previously thought. Renewed exploration efforts have found more gas and led to some increases in proven reserves.

New Zealand's geological basins are under-explored, and there is a significant chance of more oil being discovered in the future. In the meantime, using more gas would use up our reserves more quickly, which could cause gas and electricity prices to increase closer to the cost of imported liquefied natural gas (LNG). The government believes the current regime and incentives for gas exploration are generally appropriate and do not need to be enhanced further.

Although gas is not imported in significant quantities,[4] gas pipeline supplies can be interrupted by domestic events. Contingency arrangements to minimise the impact of a national outage are being reviewed to ensure they are appropriate to the changing nature of the gas market.

[3] Oil and petroleum products accounted for 50.6 per cent of total consumer energy demand in 2005, of which 93 per cent is imported on a net basis. *New Zealand Energy Data File*, Ministry of Economic Development, September 2006.

[4] Some liquefied petroleum gas (LPG) is imported to meet winter heating demand.

The pressure on global energy resources is expected to increase strongly. The IEA expects global demand for oil to grow by 41 per cent by 2030.[5] In its recently released *Medium Term Oil Report,* the IEA says world oil markets may come under increased pressure due to potential supply constraints within the next five years. In any event, these consumption patterns mean that, within a decade, the capacity to increase oil production will be concentrated to just a few predominantly OPEC countries. As the IEA observes, "the ability and willingness of major oil and gas producers to step up investment in order to meet rising global demand are particularly uncertain". In releasing the report, the IEA said that it was a wake-up call for increasing supply investment in producing countries and energy efficiency improvements by users.

New Zealand's import bill increases when oil prices rise, which is all the more reason to lessen our dependence on imported oil. The government will continue to monitor developments in oil markets closely.

2.1.1 Electricity security of supply

It is essential for New Zealand to maintain a secure electricity supply. The dominance of hydro electricity in our energy system has given New Zealand relatively cheap electricity, but our limited ability to store water puts us at risk of shortages in dry years. Historically, we have relied on fossil fuel-based generation to back up hydro when water is short.

For the foreseeable future, we will maintain a secure electricity supply through an increased use of new renewable sources of electricity generation with existing renewable and fossil fuel generation.

In 2003, the government established the Electricity Commission (EC) as its regulator and charged it with ensuring that the electricity system is able to cope with up to a 1-in-60 dry year. The EC is also responsible for setting wholesale electricity market rules and for approving transmission investment.

Some initiatives to improve the security of our electricity system would cost more, such as paying for additional levels of reserve energy generation to be available for dry years or peak demand. These costs would have to be weighed up against the benefits to consumers and the wider community. It is also important to improve competition in the market, which helps to ensure prices are kept as low as possible.

The government recently reviewed the operation of the electricity market and concluded that the current arrangements were fundamentally sound, although there is room for improvement. Initiatives to improve electricity security and competitive pricing are discussed in the action plan accompanying this strategy.

2.2 Climate change

Around the world, there is a growing sense of urgency about the need to address the serious challenges of climate change. For New Zealand, there are four main climate change challenges. We need to:

- control and reduce our own greenhouse gas emissions
- support international initiatives for multilateral action on greenhouse gas emissions, principally through maintaining momentum on the implementation of the Kyoto Protocol and ensuring this momentum is carried through into whatever agreements emerge for the period after 2012
- prepare for, and adapt to, the impacts of changes in our physical environment, by responding to the risks and taking advantage of the opportunities they present
- realise the objectives above at the lowest achievable long-term cost.

[5] *IEA World Energy Outlook 2006*, Paris.

The government has announced its intention to introduce an ETS to give businesses flexibility in deciding how to reduce their carbon footprint and to help set New Zealand on the path to a sustainable future. This is consistent with actions by other countries and jurisdictions that are also moving towards requiring emitters to carry the cost of their emissions.

Some sectors in New Zealand will find it comparatively harder to reduce emissions, which makes it even more important that we reduce greenhouse gas emissions in areas where we can, such as electricity production and use, and transport. Many climate change measures achieve other commonsense objectives. Using energy more efficiently reduces the amount we pay for electricity and petrol, while insulating our homes keeps us warmer and healthier.

The cost of putting a price on greenhouse gas emissions cannot be over-stated, as the predicted costs and risks of inaction would prove to be unacceptably high.

Box 2.1: What is climate change?

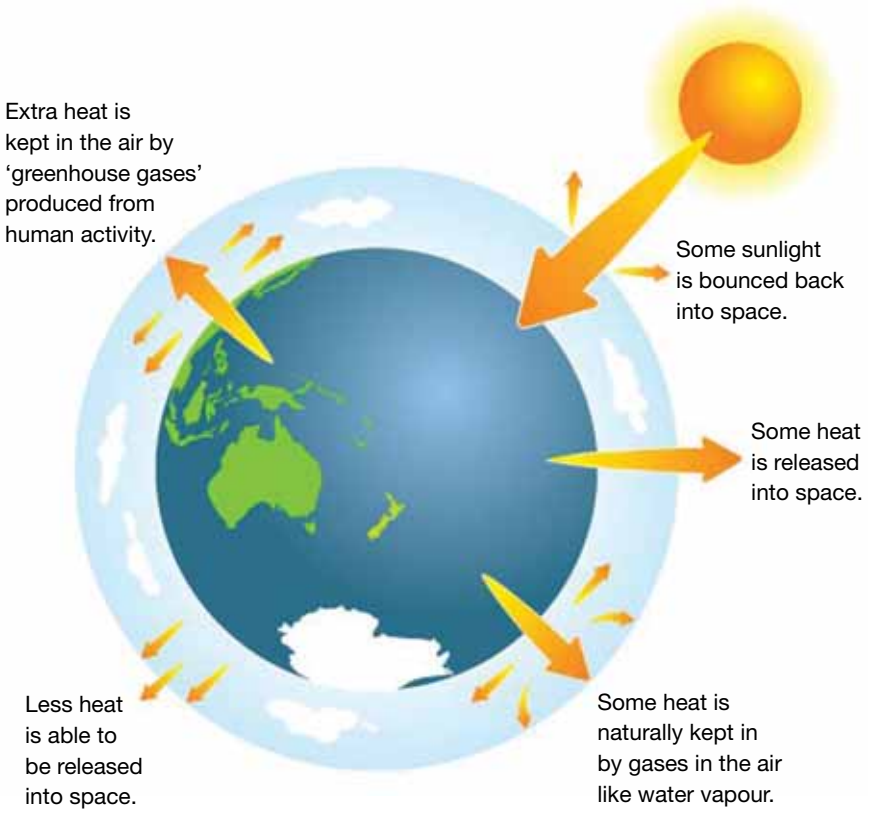
Human activities like driving cars, farming, burning coal and cutting down forests produce greenhouse gases – carbon dioxide, methane and nitrous oxide.

These gases gather in the atmosphere, wrapping around the earth and trapping the sun's heat.

The more greenhouse gases we emit, the thicker the gas blanket, and the faster the world's climate heats up. The result is more extreme weather events – floods, storms, cyclones, droughts and slips – and rising sea levels and coastal erosion.

International scientists now agree the global climate is changing. It's projected the world's average temperature could rise by 0.2ºC per decade over the next two decades.

Source: www.climatechange.govt.nz



3. Our energy vision for New Zealand

A reliable and resilient system delivering New Zealand sustainable, low emissions energy services, through:

- Providing clear direction on the future of New Zealand's energy system
- Utilising markets and focused regulation to securely deliver energy services at competitive prices
- Reducing greenhouse gas emissions, including through an emissions trading scheme
- Maximising the contribution of cost-effective energy efficiency and conservation of energy
- Maximising the contribution of cost-effective renewable energy resources while safeguarding our environment
- Promoting early adoption of environmentally sustainable energy technologies
- Supporting consumers through the transition.

4. From vision to action

This strategy and the NZEECS set out a package of actions to achieve our ambition of a reliable, resilient, sustainable and low emissions energy system.

The NZES focuses on seven areas, with proposed actions in each area. These are outlined in the following pages.

4.1 Progress made

Initiatives already underway that contribute to the government's vision include:

a. the establishment of the EC to promote energy security to a 1-in-60 dry year standard, and electricity efficiency and conservation

b. a 2004 amendment to the RMA to put greater emphasis on the benefits of renewable energy and energy efficiency

c. a 2005 amendment to the RMA to improve processes for decision-making on issues of national importance, including energy infrastructure

d. revising the Government Policy Statement (GPS) to the EC to ensure a more robust transmission grid

e. a ten-fold increase in central government funding for public transport over the last seven years[6]

f. the *2005 Minerals Programme for Petroleum*, which supports petroleum exploration in New Zealand

g. developing the *Energy Research Roadmap* in 2006 to support the science capabilities New Zealand will need for a sustainable energy future

h. retrofitting 22,000 poorly-insulated homes over the last seven years to improve their energy efficiency

i. the 2006 consultation[7] on ways to make homes and commercial buildings more energy efficient using insulation, solar water heating, more efficient lighting and other technologies.

[6] From 1990 to 2000, $45 million was spent on passenger transport infrastructure and services. In 2006/07, spending will total $451 million.

[7] The consultation can be found in *Energy Efficiency of Buildings: Consultation on Energy Efficiency Revisions to the New Zealand Building Code and Compliance Documents* at www.dbh.govt.nz/UserFiles/File/Building/Compliance/pdf/energy-efficiency.pdf

4.2 Strategic leadership

To provide clear direction on the future of New Zealand's energy system

A well-functioning energy system needs timely and efficient investment. The government can improve investor confidence and reduce non-market uncertainties by clearly signalling its strategic direction for the energy sector.

The government has based the NZES on the following principles:

1. Investment should occur in energy efficiency measures where this is cheaper than the long-term costs of building extra generation capacity, including environmental costs.
2. For the foreseeable future, it is preferable that all new electricity generation be renewable, except to the extent necessary to maintain security of supply.[8]

In support of this principle, and providing time for the full introduction of a price on greenhouse gas emissions, the government's view is that there should not be a need for any new baseload fossil fuel generation investment for the next ten years. The government expects all generators, including state-owned enterprises, to take its views into account when considering new generation investments, and the government will advise state-owned enterprises that it expects them to follow this guidance.

For transport, the government has taken an in-principle decision to set a target of halving domestic transport emissions per capita by 2040 relative to 2007 emissions. The key areas for action are reducing greenhouse gas emissions by using alternative renewable fuels, significantly increasing vehicle efficiency, using more efficient modes of transport, and travel demand management through smarter planning. The government is committed to building momentum in the uptake of electric vehicles and has taken an in-principle decision that New Zealand will be one of the first countries in the world to widely deploy electric cars. This will also make New Zealand more resilient to international oil price uncertainty and risks of supply disruptions. The introduction of biofuels will also increase the diversity of transport fuels.

4.2.1 Key actions

Initiatives that support the government's sustainable energy goals include:

a. setting clear policy intentions and priorities for investment in the energy sector, including for renewable generation, efficient transmission, sustainable transport, energy efficiency and new technologies

b. the in-principle decision to introduce an ETS

c. adoption of a target for renewable electricity generation of 90 per cent by 2025 (based on delivered electricity in an average hydrological year)

d. the in-principle decision to introduce a target to halve domestic transport emissions per capita by 2040

e. consideration of regulatory options under the Electricity Act 1992 to support the government's objectives for limiting new baseload fossil fuel generation over the next ten years

f. a National Policy Statement (NPS) is being developed under the RMA for renewable energy

g. a minimum *Biofuels Sales Obligation* has been announced to encourage the use of alternative transport fuels over the next five years.

[8] Low carbon fossil fuel-based generation using carbon capture and storage is being developed, but is not yet available or economic.

4.3 Markets, regulation and security of supply

To utilise markets and focused regulation to securely deliver energy services at competitive prices

Customers value reliable energy supplies, but some circumstances are too costly to insure against. A trade-off must be made between different price levels and different levels of security and reliability. Finding the right balance is an ongoing task involving government, producers and users of energy. The government believes a combination of competitive markets with backstop measures and effective regulation of networks is the best means of protecting the security of New Zealand's energy supplies.

Security has two key dimensions – reliability and resilience. Reliability means users are able to access the energy services they require, when they require them. Resilience is the ability of the system to cope with shocks and change. Diversifying energy sources, energy efficiency and demand-side management can help ensure both reliability and resilience.

4.3.1 Electricity

A competitive market operating within a stable regulatory environment and with reasonable certainty about fuel supplies will keep prices at a competitive level and encourage timely investment in generation and infrastructure. Strong grid and lines arrangements are particularly important for security and diversity of supply.

We regulate monopoly networks to encourage efficient investment and reliability. A system that can withstand events such as droughts and unexpected plant failures will also support resilience of supply.

The EC has responsibilities for managing security of supply. It monitors the evolution of competitive markets and key indicators of security of supply, and assesses whether additional reserve energy capacity is needed. To maintain security, it considers both supply and demand-side alternatives.

4.3.2 Transport

New Zealand minimises its vulnerability to oil supply disruptions through its membership of the IEA and holding oil reserves. The increasing use of biofuels and, in the future, electricity will also contribute to energy security in the transport sector.

Oil, and products derived from oil, will remain an important source of transport energy for New Zealand and the world for many years. New Zealand's proven oil reserves are small and do not meet our needs, although our prospective basins are largely under-explored. If more local oil is found, it would offset some of our oil imports, which cost $4.4 billion per annum.[9] It would also bring investment, jobs and export earnings into the economy. However, any oil discoveries should not stop us adopting the transport measures proposed in this strategy.

4.3.3 Energy diversity

Gas will continue to play an important role in meeting our energy supply requirements as we make the transition to a sustainable energy future, in which supply is increasingly met by renewables. This is particularly the case for the electricity sector: gas-fired generation plant will play a key role in maintaining security of supply. Gas produces fewer emissions than other fossil fuels, which makes it the fuel of choice for fossil fuel generation that may be needed in future for security of supply reasons.

The direct use of gas in industrial, commercial and residential applications provides increased diversity of supply and flexibility. In the future, using gas rather than coal in direct-use industrial and commercial applications may reduce greenhouse gas emissions while maintaining levels of flexibility and fuel diversity.

The government believes the current gas market settings, particularly the co-regulatory regime, will enable the market to make an efficient transition to the post-Maui era.

[9] Source: Statistics New Zealand, Table 6
www.stats.govt.nz/store/2007/03/overseas-merchandise-trade-feb07-hotp.htm?page=para014master

New Zealand also has large reserves of the low grade coal lignite. Lignite is an important long-term energy supply that could be used to generate electricity, produce substitute liquid fuels for transport, or make fertiliser and other chemicals. Current estimates indicate lignite is likely to be a more expensive fuel source for electricity production than renewables, especially once the expected future cost of greenhouse gas emissions is included. New Zealand is unlikely to make widespread use of its lignite reserves until carbon capture and storage (CCS)[10] technology is proven and economically viable.

Our high grade coal reserves are likely to be more valuable for smelting metals than for electricity production.

Nuclear design has substantially improved the safety standards of nuclear fission. Although modular plants may make smaller-scale nuclear power less expensive, it is still currently more expensive than other options. Serious concerns remain about the consequences of accidents, earthquakes or terrorist attacks, the disposal of radioactive waste and the use of nuclear materials in weapons. For these reasons and others, the government remains opposed to the development of nuclear power.

4.3.4 Key actions

Measures to ensure energy security include:

a. an ongoing commitment to competitive markets and focused regulation to deliver the objectives of the NZES

b. developing a NPS on electricity transmission under the RMA

c. increasing energy efficiency and facilitating demand-side response

d. bedding-in existing gas market arrangements

e. being prepared for possible disruptions to world oil supplies

f. relaxing restrictions on lines companies' ability to invest in generation

g. introducing distributed generation regulations to facilitate connection

h. clarifying the long-term role of gas (including LPG), oil and coal and other alternative energy sources in New Zealand's energy mix.

Whirinaki Power Station

A government power plant in Hawkes Bay helps to increase New Zealand's energy security, minimising the risk of future electricity shortages and reducing price volatility. The 155 MW plant at Whirinaki was completed in 2004 and provides reserve generation in unusually dry years, when hydro lake inflows are abnormally low. It also acts as a back-up in case of a major generation or transmission breakdown. The Crown leases the site from Contact Energy, which operates and maintains the plant.

Whirinaki power station.
Image courtesy of East Harbour Management Services.

[10] CCS in this context means capturing carbon emissions, including those from electricity generation, and storing them underground.

4.4 Pricing greenhouse gas emissions

To reduce our greenhouse gas emissions, including through an emissions trading scheme

Emissions trading is internationally recognised as an equitable, effective and efficient way to reduce greenhouse gas emissions.

Under an ETS, prices are established for units to emit greenhouse gases. These prices influence decisions by producers, consumers and investors, encouraging them to reduce emissions and look at more environmentally friendly alternatives. The introduction of an effective ETS will be a core building block for the transformation of the economy and will require everyone to consider the impact that gases emitted in the daily course of living may have on the world's future.

The proposed ETS takes the experiences of other trading systems into account. A successful sulphur dioxide ETS in the United States shows that trading schemes can reduce emissions by sending price signals to influence the decisions of individual businesses.

In covering all sectors of the economy and all greenhouse gases, New Zealand's ETS will be a world first. It will include agriculture, as pastoral agriculture produces half of our greenhouse gas emissions. New Zealand will be the first country to tackle agricultural emissions in this way, but we are proposing a gradual transition that focuses largely on influencing growth in emissions.

Given the increasing international efforts to curb emissions, a future cost to the economy is likely. It is in our interests to reduce that cost by taking steps now to reduce the emissions we produce in the future.

The long-term objective of New Zealand's ETS is that it supports and encourages global efforts to reduce greenhouse gas emissions by:

- reducing New Zealand's net emissions below business-as-usual levels
- complying with our international obligations, including our Kyoto Protocol obligations

while maintaining economic flexibility, equity and environmental integrity at least cost in the long term.

To reduce greenhouse gas emissions below 1990 levels, we will need not only greater efficiency and more use of renewable energy but also widespread uptake of zero and low carbon technologies such as electric cars and CCS. A commitment to support global efforts to reduce greenhouse gas emissions and the introduction of emissions trading will give the private sector an incentive to invest in clean technology, which is likely to be cheaper than current technologies with future emissions prices.

4.4.1 Key actions

Measures to reduce our greenhouse gas emissions include:

a. introducing emissions trading to price greenhouse gas emissions and provide an incentive to emitters to reduce emissions

b. considering regulatory options under the Electricity Act to support the government's objectives for limiting new baseload fossil fuel generation over the next ten years

c. using our energy more efficiently

d. encouraging the development and use of renewable energy resources

e. reducing greenhouse gas emissions in transport by encouraging the use of biofuels and electric vehicles, improving the fuel efficiency of New Zealand vehicles, and reducing kilometres travelled through smarter planning

f. encouraging use of public transport, rail, coastal shipping, cycling and walking

g. preparing New Zealand to be in a position to deploy zero and low emissions technologies when they become economic and viable.

QEII Park

Christchurch swimmers are benefiting from an initiative launched as part of the government's Projects to Reduce Emissions programme. Gas – 60 per cent of it methane – is being captured at Burwood Landfill and piped three kilometres to Queen Elizabeth II Park recreational complex, where it fires boilers at the public swimming pool. Christchurch City Council is involved in this climate change project, which is expected to prevent greenhouse gas emissions of more than 200,000 tonnes of carbon dioxide equivalent between 2008 and 2012.

QEII Park recreational complex.
Image courtesy of Christchurch City Council.

4.5 Using energy more efficiently

To maximise the contribution of cost-effective energy efficiency and conservation of energy

New Zealand uses energy less efficiently than other countries, which gives us scope for significant improvement.

Using energy more efficiently reduces greenhouse gas emissions and cuts energy costs, including the need to provide more costly electricity generation capacity. It also reduces network congestion, makes the system more secure, and makes it easier for New Zealand to increase the proportion of renewable sources of electricity and reduce emissions-intensive generation.

New Zealand will benefit if all participants in the energy system invest in energy efficiency measures that cost less – including the environmental costs – than extra generating capacity. In finalising the actions under the NZES, a five per cent real discount rate was applied to the economic cost-benefit analysis of government actions.

In the transport sector, technological advances offer exciting prospects both for alternative fuels and for using fuels more efficiently. Some modes of transport are also more energy efficient than others. As an example, coastal shipping services can be more efficient than land transport. Smarter urban planning will also reduce the need to travel and help to conserve energy.

4.5.1 Key actions

Energy efficiency measures are described in more detail in the NZEECS under the following themes:

a. *Energywise* homes
b. *Energywise* business
c. *Energywise* farms and rural communities
d. *Energywise* transport
e. Our renewable and efficient electricity system
f. Government leading the way.

YHA New Zealand

One YHA hostel is proof that profits and sound environmental management go together. Since 1997, the Wellington city hostel has been upgrading its energy efficiency by wrapping hot water cylinders, installing low-flow showerheads and installing an automated heating system. It also uses ECO GFX, a water-to-water heat exchanger that transfers the waste heat in shower waste pipes into the incoming cold water – halving shower costs. Manager Hamish Allerdyce says, "Good environmental management is a 'no-brainer'. It's just common sense and good business sense."

YHA, Wellington City.
Image courtesy of Youth Hostels Association of New Zealand.

4.6 Promoting renewable energy

To maximise the contribution of cost-effective renewable energy resources while safeguarding our environment

4.6.1 Electricity

New Zealand is in the fortunate position of being able to produce large amounts of zero or low emissions electricity from renewable sources such as geothermal, wind and hydro. Our renewable energy resources are plentiful and cheap by world standards. In the future, wave and tidal electricity generation are also expected to become economically viable.

It is in New Zealand's longer-term economic and environmental interests to meet increases in demand through an economic mix of renewable energy sources that will meet our security objectives. It is easier for New Zealand to commit to a low emissions electricity system than almost any other country. In this strategy, the government is introducing a target for 90 per cent of electricity being generated from renewable sources by 2025.[11]

This is a challenging target but, given our wealth of natural energy resources, is considered achievable without imposing significant additional 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, a very high rate of investment in new renewable generation, lower utilisation of existing fossil fuel plant and decommissioning of older fossil fuel plant is required.

Where fossil fuel generation is needed to maintain security of supply, priority should be given to using the lowest emissions fuel available.

Increasing the proportion of renewable electricity will help us cut emissions of carbon dioxide (CO_2). However, renewable electricity generation can have a larger visible effect on the local environment than fossil fuel electricity generation plants. As an example, some people believe wind farms have more impact on the environment than gas-fired thermal plants of equivalent output.

[11] Based on delivered electricity in an average hydrological year.

We need to balance the climate change benefits of increasing renewable electricity against the potential impact on the local environment. We will support this balancing act by giving consent authorities guidance on the various trade-offs involved. It is important that the public continues to have confidence that the system and processes are fair and robust.

There is likely to be enough geothermal, wind and hydro energy to meet New Zealand's electricity demand for the next 20 years or so, while still meeting appropriate environmental standards. If marine generation, deep (hot-rock) geothermal or solar photovoltaic generation become economically viable within that time, New Zealand would be able to use predominantly renewable electricity sources for even longer.

Hau Nui wind farm

In 1996, New Zealand's first wind farm began operating at Hau Nui, in the eastern Wairarapa hills. The farm was set up by Wairarapa Electricity, a community-owned power company. The wind farm's seven German-built wind turbines had a combined capacity of 3.5 MW of electricity. Wairarapa Electricity then commissioned turbine manufacturer Enercon to upgrade the turbines to a combined capacity of 3.85 MW. Hau Nui was later bought by Genesis Energy in 1999. Genesis Energy added a further eight turbines in 2004, bringing the total wind farm capacity to 8.65 MW. This is enough to service the annual energy requirements of around 4,200 homes in South Wairarapa.

Wind turbines at Hau Nui.
Image courtesy of Genesis Energy.

4.6.2 Transport

It is in New Zealand's wider interests to reduce our transport emissions and our dependence on imported oil. Achieving this is likely to require, among other actions, a combination of biofuels and the use of electricity for vehicles.

Biofuels are substitutes for petrol and diesel, and are made from crops or animal by-products. Biofuel crops release no more emissions when used than they absorb and store as they grow. As technology improves, we expect future biofuels to be made from sources such as trees and even weeds, algae and waste gases. Using biofuels from other sources will help to ease concerns about biofuels competing with food supplies and promoting unsustainable land use, especially in developing countries.

New Zealand's climate and agricultural history suggest we will be able to grow biofuels at internationally competitive prices. The government believes biofuels will be an important part of New Zealand's energy mix, especially for transport. There are advantages to the development of biofuels in New Zealand, and assessing the price and land use implications of using higher levels of biofuels in the future.

There may also be opportunities to work with Pacific countries to develop biofuels. For example, sugar, coconut oil, and palm oil grown in the Pacific could produce biofuels to be blended with fossil fuel-based diesel or petrol in New Zealand.

4.6.3 Direct use of biomass

New Zealand already makes good use of biomass for direct heating in homes and in industries such as wood processing. The environmental benefits of biomass include no net greenhouse gas emissions and, with modern clean-burning technology, fewer concerns about the impact on local air quality.

Schoolgen programme

Six primary and secondary schools in the greater Auckland area are using solar power to generate their own electricity. Under Genesis Energy's Schoolgen programme, the schools have had 2 kW photovoltaic systems installed on the roofs of school buildings at no cost. The system reduces the financial and environmental impact of the schools' energy use, while giving students an opportunity to learn about renewable energy, energy efficiency, electricity generation and climate change. Genesis Energy hopes to extend the programme to schools in other parts of New Zealand in future.

Tirimoana Primary School, Auckland.
Image courtesy of Genesis Energy.

4.6.4 Key actions

Measures to promote renewable energy include:

a. introducing a target for 90 per cent of electricity generated from renewable sources by 2025 (based on an average hydrological year)
b. using the RMA to provide greater leadership and guidance on consenting renewable electricity generation
c. introducing a *Biofuels Sales Obligation*
d. encouraging the development and use in future of electric vehicles fuelled by renewable electricity
e. removing barriers to distributed generation, including small-scale generation
f. encouraging the clean and efficient use of bioenergy
g. expanding our knowledge and understanding of New Zealand's energy resources.

4.7 Facilitating environmentally sustainable energy technologies

To promote early adoption of environmentally sustainable energy technologies

Energy generation, emissions capture and storage, and transport technology are all developing rapidly and will play an important part in moving New Zealand towards a sustainable low emissions energy system. Much of this technology will be developed overseas, but some will be developed here.

New Zealand should ensure it is able to start using new technologies as soon as they become proven and economically viable. We should, for example, monitor local and international developments closely and make advance preparations for using new technology, such as developing the consent framework for wave or tidal generators.

There is also a case for preparing the way for future technology, where this is not too expensive. For example, vehicles entering the fleet for the first time could be required to have the capability to run on biofuels, ready for the time when biofuels become widely available.

In the electricity sector, achieving a 90 per cent level of renewable energy by 2025 would return our emissions to 1990 levels. However, CCS is expected to be economic by that stage. To achieve our ambitions for a low emissions economy, new fossil fuel generation should be fitted with CCS once it is available, and we should progressively clean up existing electricity generation and other major industrial emission sources. We would need to be an active participant in international efforts to commercialise CCS, and have the regulatory and policy frameworks needed to enable us to use it.

The government will also continue to build New Zealand's research expertise. It will continue to encourage collaboration between existing research organisations and prepare for New Zealand's future research needs.

4.7.1 Key actions

Measures to facilitate environmentally sustainable energy technologies include:

a. supporting initiatives to build capacity and link participants from the research community, industry, and central and local government

b. establishing contestable funds to support the deployment of marine-based electricity generation and low carbon energy technologies

c. preparing New Zealand for the commercial uptake of new energy technologies in transport, electricity and industrial uses

d. improving international linkages to enable New Zealand to be a fast adopter and adapter of new technologies.

Varivac System

Electrical contractor Steve Corkill rose to the challenge when he heard farmers complaining their power bills had rocketed since building new milking sheds in the early 1990s. Steve's response was to develop the Varivac, a software-driven system that enabled farmers to control the level of vacuum being used in the dairy to ensure it was sufficient only for the number of cows being milked at the time. Taranaki-based Steve has turned his invention into a thriving business, while dairy farms around the country are reaping the environmental and financial benefits of this pioneering technology.

Steve Corkill of Corkill Systems Ltd with the Varivac.
Image courtesy of Corkill Systems Ltd.

4.8 Supporting consumers through the transition

To support consumers through the transition to a low emissions energy system

The investment required to meet New Zealand's future energy needs and reduce carbon emissions is likely to push energy prices up.

The government recognises this cost impact would be hardest on low income households and on firms competing with businesses in countries that have not put a price on emissions. The government is considering options to assist the most affected business and residential consumers as we make the transition to a low emissions energy system.

The likelihood of cost increases makes it essential that competition remains vigorous so the market can continue to deliver secure supplies and a range of competitively priced services to customers.

In the long run, reducing electricity emissions is likely to have less impact on prices in New Zealand than it will for some of our trading partners, such as Australia. This is because New Zealand's endowment of high quality renewable energy resources are a cost-effective way of meeting our growing energy demand. Increasing our renewable electricity may even give New Zealand an enduring competitive advantage by protecting us against fluctuations in imported fossil fuel prices.

4.8.1 Key actions

Measures to support consumers through the transition include:

a. considering additional measures to moderate the cost impact of higher electricity prices arising from the introduction of an ETS on low and modest income households
b. using energy efficiency initiatives such as retrofits and the installation of efficient lighting and appliances to help low income households
c. amending the Low Fixed Charge Regulations to allow for differences in average regional power usage due to temperature variations
d. keeping consumers informed about the energy services and options available
e. maximising the contribution of cost-effective renewable energy sources.

5. Our direction

Britomart railway station, Auckland.

To determine the strategic direction for New Zealand's energy system, we have weighed up a number of important considerations. Two major issues are energy security and greenhouse gas emissions. We have also considered the impact our choices will have on energy costs.

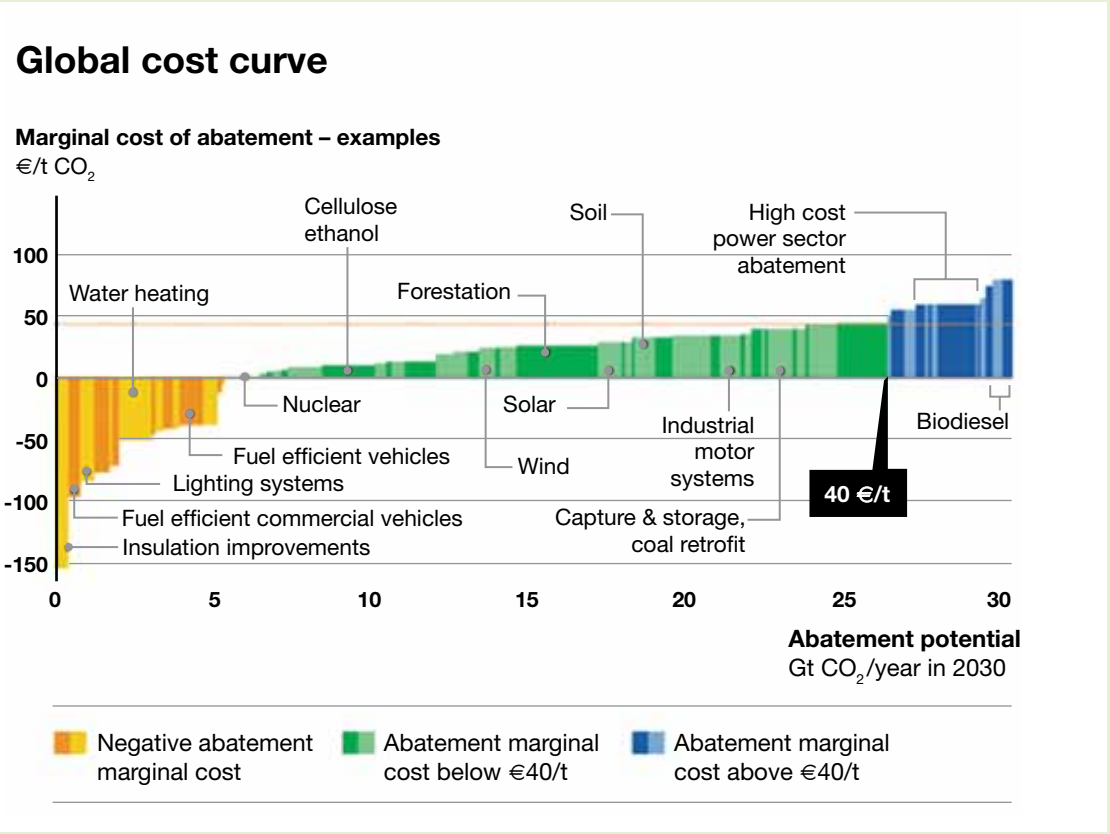
5.1 Pathway to a low emissions future

This chapter outlines modelling results from possible low carbon energy scenarios.[12] In these scenarios, emissions pricing, the adoption of emerging low carbon technologies, and complementary policy initiatives in the NZES and the NZEECS, drive sustained and substantial reductions in greenhouse gas emissions from the energy sector. The modelling involves estimates of the expected availability and costs of different electricity options, and assumptions about the availability of future technologies (see Box 5.1).

[12] For further information on the low carbon energy scenarios see *New Zealand Energy Strategy Low Carbon Energy Scenario* available from www.med.govt.nz/nzes

Box 5.1: Global abatement cost curve

In January 2007, the Swedish energy company Vattenfall published a comprehensive survey of all the measures that could be taken around the world to curb climate change and the costs associated with each. A global cost of abatement curve shows there is considerable cost-effective potential for reducing emissions in industrialised countries, particularly in energy efficiency measures with a 'negative cost', i.e. measures that finance themselves through reduced energy costs. These results reinforce the belief that bold reductions in emissions from the energy sector are feasible and, once a price on emissions is reflected, economic. The results are indicative only for New Zealand as local costs are often lower in New Zealand, and especially for renewable energy sources.



Source: Vattenfall AB.

In finalising the NZES, the government has considered the costs and benefits of the key actions, where possible, to ensure that they generate a net positive gain to New Zealand.[13] The government has also considered a series of principles that build on New Zealand's tradition of providing much of our energy from local renewable sources, and our goal of using resources wisely. In this way, the NZES also contributes to wider government objectives to transform the economy to best respond to the challenges and opportunities of the future, to protect our environment for future generations and to reinforce the values New Zealanders share.

5.1.1 Reducing energy sector emissions

The figures on the following pages demonstrate the potential for energy-related greenhouse gas emissions reductions and how emissions pricing and other initiatives in this strategy will move us towards carbon neutrality. For these reductions to occur, emissions pricing needs to drive low carbon investment and consumption choices (see Box 5.2 for discussion on the possible future international emissions price). In addition, the actions in the NZES and NZEECS encourage behaviour change, particularly in the transport sector, and position New Zealand to take up opportunities provided by emerging low carbon technologies when they are available, cost effective and applicable to New Zealand.

[13] For more information see *Benefit-Cost Analysis of the New Zealand Energy Strategy* available from www.med.govt.nz/nzes

Box 5.2: The future international price of emissions

Exactly what the international price of greenhouse gas emissions might be in the future is the subject of a large amount of speculation and conjecture. By its very nature, the future price of emissions is a great unknown, due to profound uncertainties about the international regulatory regime, technology developments and global economic growth and income distribution.

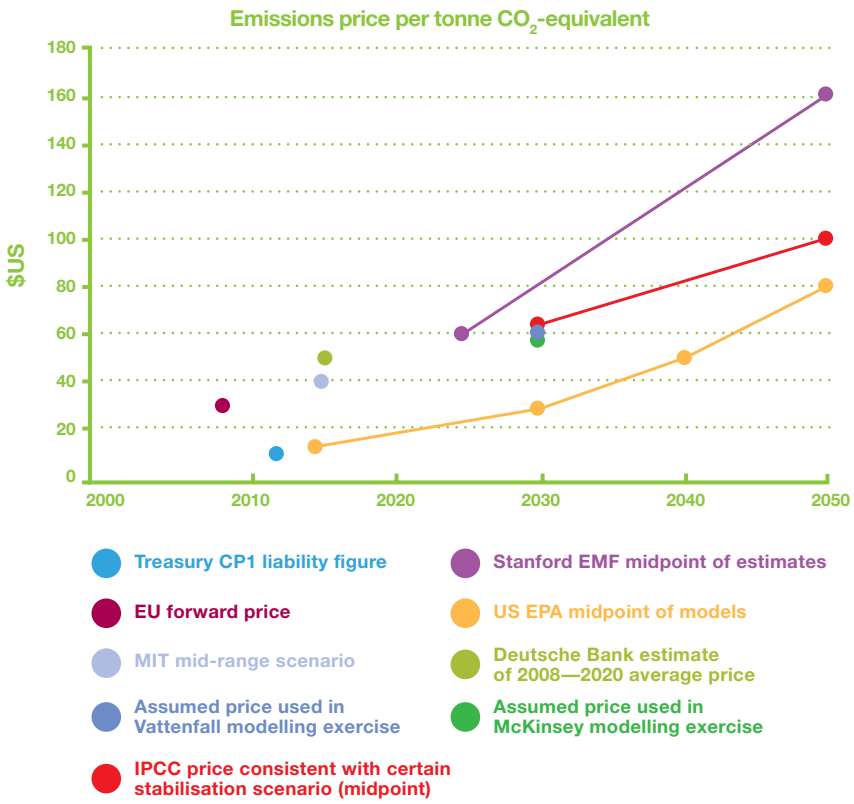
The current market price estimate used by the New Zealand Treasury in the government's 2007 financial statements is $US11.90 per tonne CO_2 equivalent.

A number of means of estimating longer-term emissions prices have been employed by various bodies. For example, Vattenfall and McKinsey have inferred future emissions prices on the basis of derived global carbon abatement cost curves. Estimates of $US30 per tonne for 2030 were produced.

The Intergovernmental Panel on Climate Change Working Group, in its draft fourth assessment report, estimates the emissions prices associated with various atmospheric greenhouse gas stabilisation scenarios. The stabilisation scenario consistent with a maximum global temperature increase of 2°C produced a price of $US100 in 2030.

Various modelling simulations and comparative analyses have also been undertaken by universities and think tanks, producing a wide range of estimates. Generally, these techniques have produced estimates with very large standard errors.

The diversity in estimates of future greenhouse gas emissions prices reflects the profound uncertainty of related factors. However, most commentators in this area broadly seem to expect the price of emissions to rise over time.



Source: Ministry for the Environment

Transport

Transport emissions currently represent around half of emissions from the energy sector, and are growing at an unsustainable rate. Bold action is required. The government is committed to building momentum in the adoption and uptake of sustainable transport measures and has taken an in-principle decision to halve domestic transport emissions per capita by 2040.[14]

A low carbon transport future scenario to 2050 has been established that reflects possible behavioural changes, travel demand management, improvements in vehicle efficiency and uptake of alternative low carbon fuels.[15] The challenge is to ensure we are well placed to commence the transition to this low carbon transport future.

There are many initiatives by both local and central government to manage private vehicle travel demand by improving urban design and promoting use of less carbon-intensive modes such as walking, cycling and public transport. We believe that, over time, significant demand reductions compared to business as usual can be achieved by building on current initiatives.

In the low carbon scenario, we have also assumed a significant reduction in the kilometres travelled by large vehicles through diverting freight from road transport to coastal shipping or rail, raising average loads of trucks and improving distribution practices.

The low carbon scenario assumes a 20 per cent improvement in the overall efficiency of the vehicle fleet by 2050, which is based on the technological improvements available from fleet turnover.

Diesel-fuelled cars are, on average, 30 per cent more efficient than their petrol equivalents. We expect half of all internal combustion cars purchased by 2050 to be fuelled by diesel, which will be well suited to use of biodiesel.

In this scenario, the greatest reductions in carbon emissions from transport are the result of increased use of biofuels, electricity and hydrogen. Each fuel source has significant technical challenges, so no one source is a comprehensive solution. For example, electric vehicles are unlikely to be as useful for the heavy fleet.

The Royal Society of New Zealand reports that “New Zealand has enough land to be more than self-sufficient in biofuels”. Improvements in production technologies will further improve the viability of second and third generation biofuels and allow a Biofuels Sales Obligation well beyond the current level.[16] The low carbon scenario estimates that, by 2020, 25 per cent of liquid fuels used in transport will be derived from renewable sources, and 85 per cent by 2050.

Major vehicle manufacturers[17] recently made a commitment to commercially develop electric cars, with reports suggesting that these may be available from as early as 2010. Our scenario assumes electric vehicle sales reach five per cent of market share in 2020, followed by a period of rapid growth that reaches a plateau of 60 per cent by 2040.

Hydrogen-powered vehicles have a similar performance to fossil-fuelled vehicles, and substantial international research is being carried out into addressing the major technological challenges involved in using hydrogen as a transport fuel. The scenario speculates that 25 per cent of New Zealand’s light vehicles could be hydrogen powered by 2050.

[14] Relative to 2007 emissions per capita.

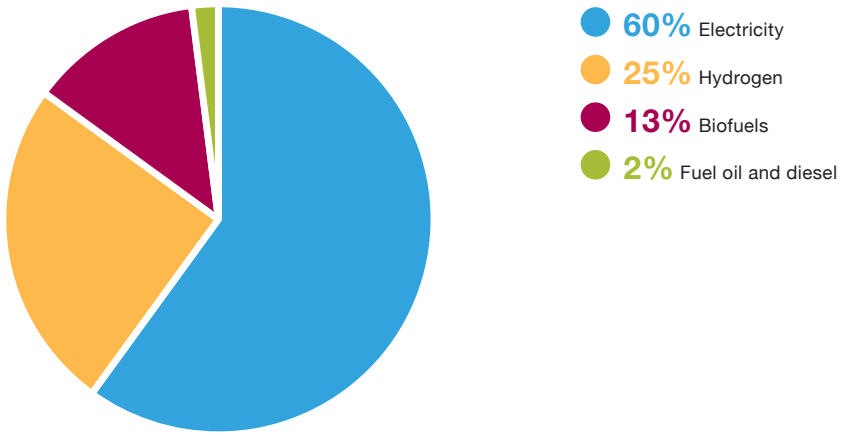
[15] *2020: Energy Opportunities, Report of the Energy Panel of the Royal Society of New Zealand* available from www.rsnz.org/advisory/energy/draft-energy-strategy.pdf

[16] It has become common to divide biofuels into ‘generations’, depending on the crop or the conversion technology involved. First generation biofuels: proven and on the market in commercial quantities now, typically sugar cane ethanol, starch-based or corn ethanol, biodiesel from pure plant oil or tallow, and are mostly from food related feed stocks or food wastes. Second generation biofuels: commercially unproven in development and typically derived from non-food related agricultural and forest biomass, algae and wastes, with many being derived from lignocellulosic materials from plants.

[17] www.chevrolet.com/electriccar/
www.jalopnik.com/cars/alternative-energy/mitsubishi-working-up-electric-car-for-us-market-206143.php
media.mitsubishi-motors.com/pressrelease/e/corporate/detail1626.html

The implications of the above changes on the composition of the light vehicle fleet are shown in Figure 5.1.

Figure 5.1: Light vehicle fleet composition in 2050 under a low carbon transport future

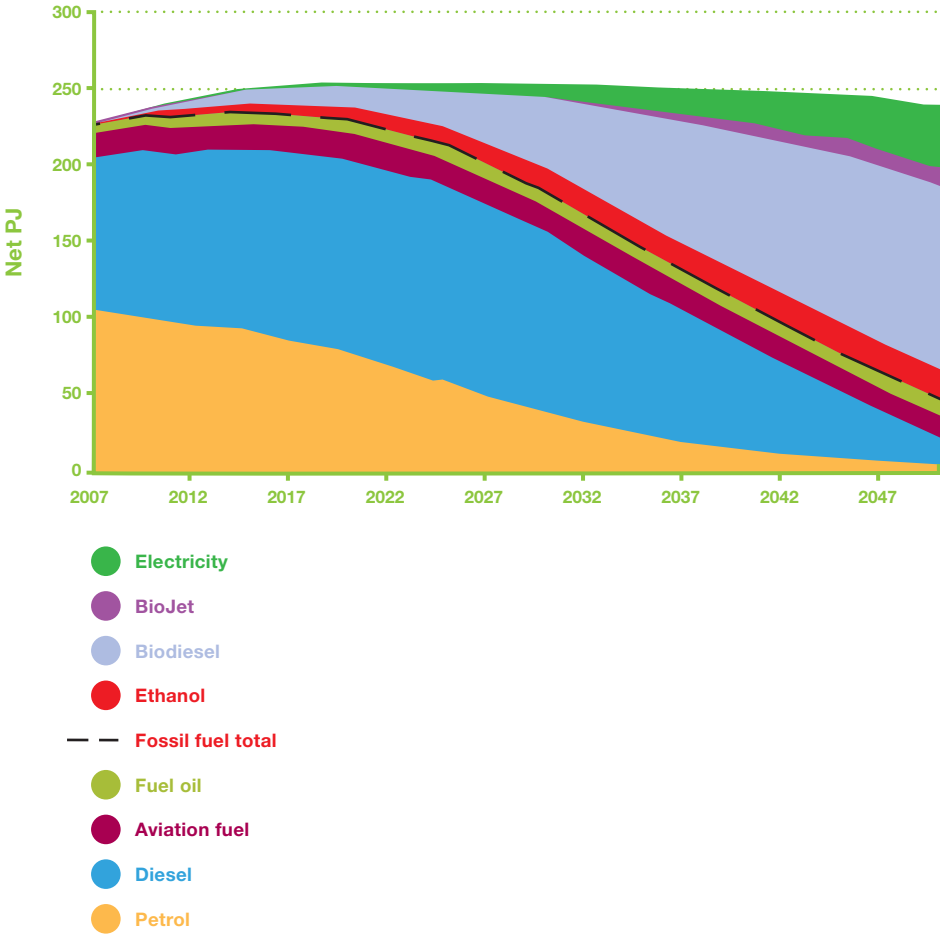


Source: Ministry of Economic Development

There is great uncertainty about the relative mix of alternative vehicle fuel sources and the extent of efficiency gains in the future, but it is clear that technological advances and increased recognition of the wider impact of transport choices could substantially reduce emissions from the vehicle fleet.

The implications for overall transport energy use are shown in Figure 5.2. Increased vehicle efficiency, changes in demand and uptake of electric vehicles substantially reduces the growth in demand for transport energy. This transition would also move us away from our current reliance on oil.

Figure 5.2: Transport fuel use in 2050 under a low carbon transport future



Source: Ministry of Economic Development

Notes for graph:

a. Transport fuel use for total domestic consumption, includes heavy vehicles, aviation, coastal shipping and off-road transport. International aviation and shipping is not included.

b. Energy shown reflects only "tank-to-wheel" energy demand.

c. Electric and hydrogen fuel cell vehicles have much greater efficiency than internal combustion vehicles. Fuel use by these new technologies displaces a much greater amount of fossil fuels.

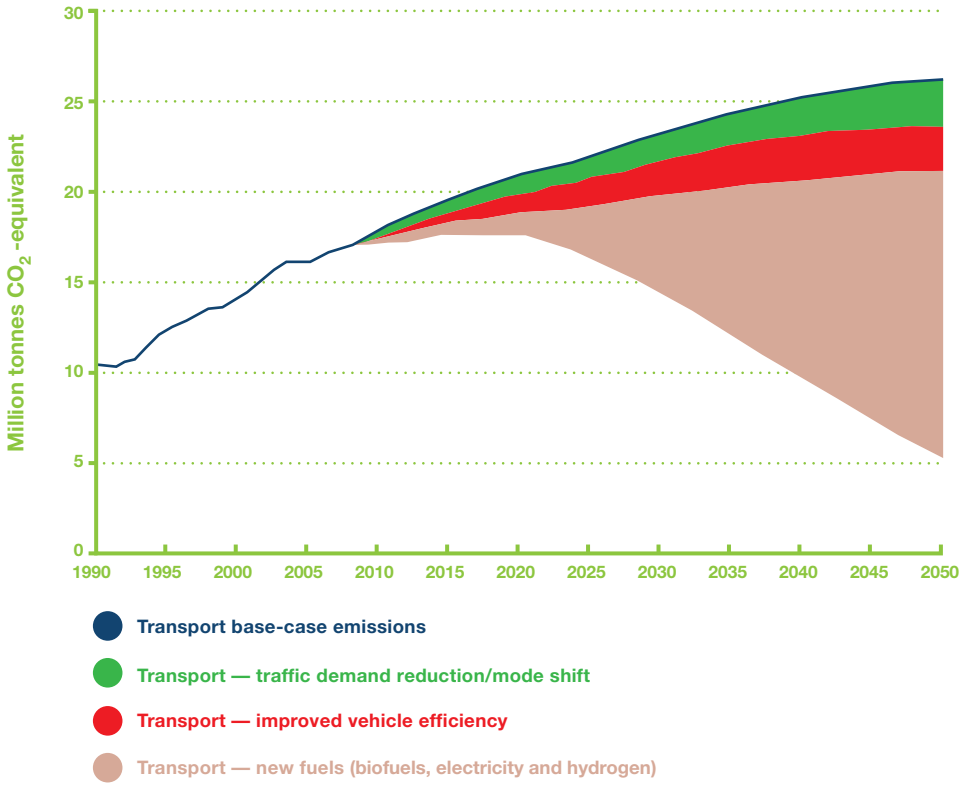
d. In this analysis Plug-in Hybrid Electric Vehicles (PHEV) require a "tank-to-wheel" energy demand only a third of an equivalent internal combustion vehicle (ICV). A hydrogen vehicle requires a "tank-to-wheel" energy demand half that of an ICV. These estimates are conservative – refer to http://www.energy.ca.gov/2007publications/CEC-600-2007-003/CEC-600-2007-003-D.pdf

e. Energy demand for hydrogen vehicles is shown as the electricity demand required for the hydrolysis production of hydrogen.

This scenario is compatible with growing demand for transport services assuming a continual improvement in the fuel economy of vehicles. This might be the case if, for example, there were a steady uptake of electric vehicles.

Figure 5.3 shows that a shift away from high carbon fuels to alternative forms of transport energy, such as biofuels or electric vehicles, would cause a substantial reduction in transport emissions.

Figure 5.3: Emissions reduction opportunities in the transport sector

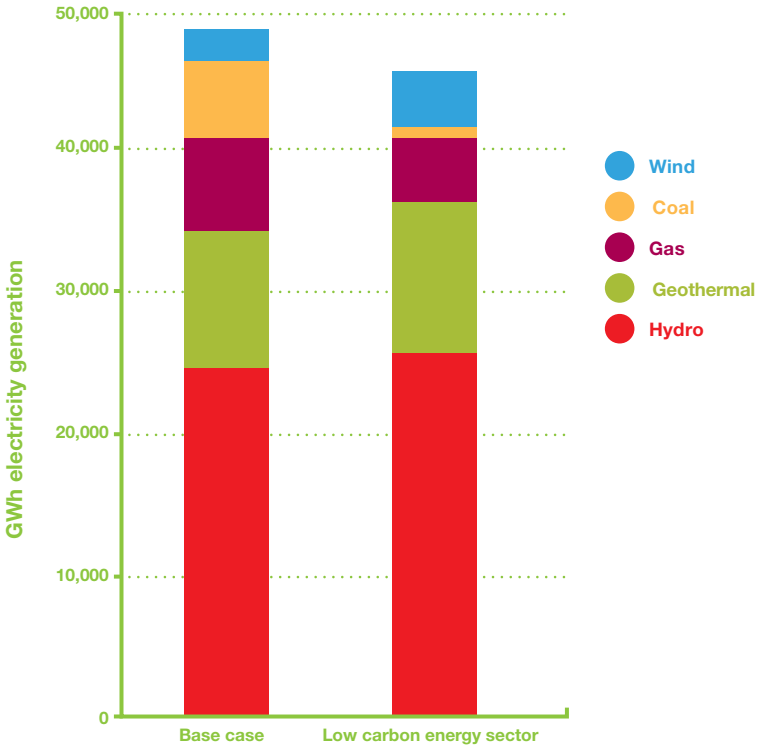


Source: Ministry of Economic Development

Electricity

This strategy sets a target to generate 90 per cent of our electricity from renewable sources by 2025. Figure 5.4 shows the expected impact of an emissions price of $25/tonne of CO_2-equivalent, rising beyond 2015 to $50/tonne of CO_2-equivalent emissions, as well as expanded energy efficiency measures on electricity generation.[18]

Figure 5.4: Electricity generation in 2025 under emissions pricing and efficiency measures



Source: Ministry of Economic Development

Improved energy efficiency suppresses growth in electricity demand and can defer the need for additional, potentially fossil fuel, electricity generation, and helps relieve pressure on resources.

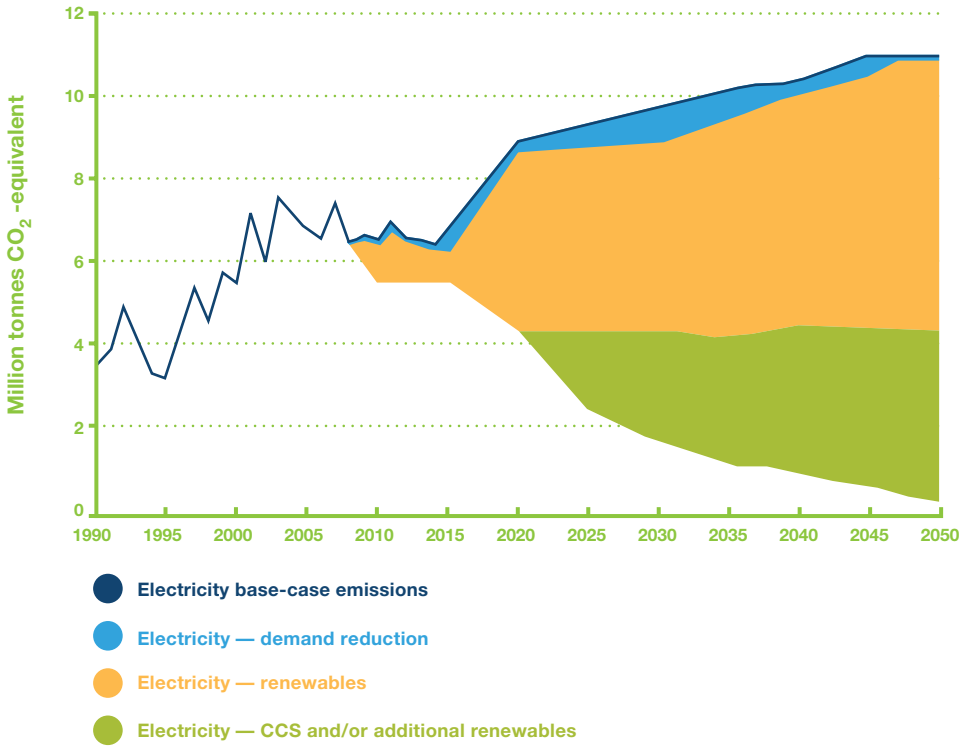
[18] For more information see *Synthesis of Analysis for the New Zealand Energy Strategy* available from www.med.govt.nz/nzes

Aggressively pursuing existing and new renewable-based electricity generation drives the majority of the emissions reductions in Figure 5.5. This strategy contains measures to ensure the resource consenting process does not unduly hinder investment in renewable generation, while ensuring local impacts are given sufficient consideration.

Figure 5.5 incorporates historical data up to 2006. Actual emissions in 2005 were high due to dry-year effects, with modelled emissions estimates for 2007 onwards based on average hydrology. The flat emissions profile in the medium term reflects the impact of new renewable generation projects already announced.

Based on the assumption that CCS will be available for use in fossil fuel electricity generation and heavy industry from 2020, electricity emissions head towards zero by 2050.

Figure 5.5: Emissions reduction opportunities in the electricity sector



Source: Ministry of Economic Development

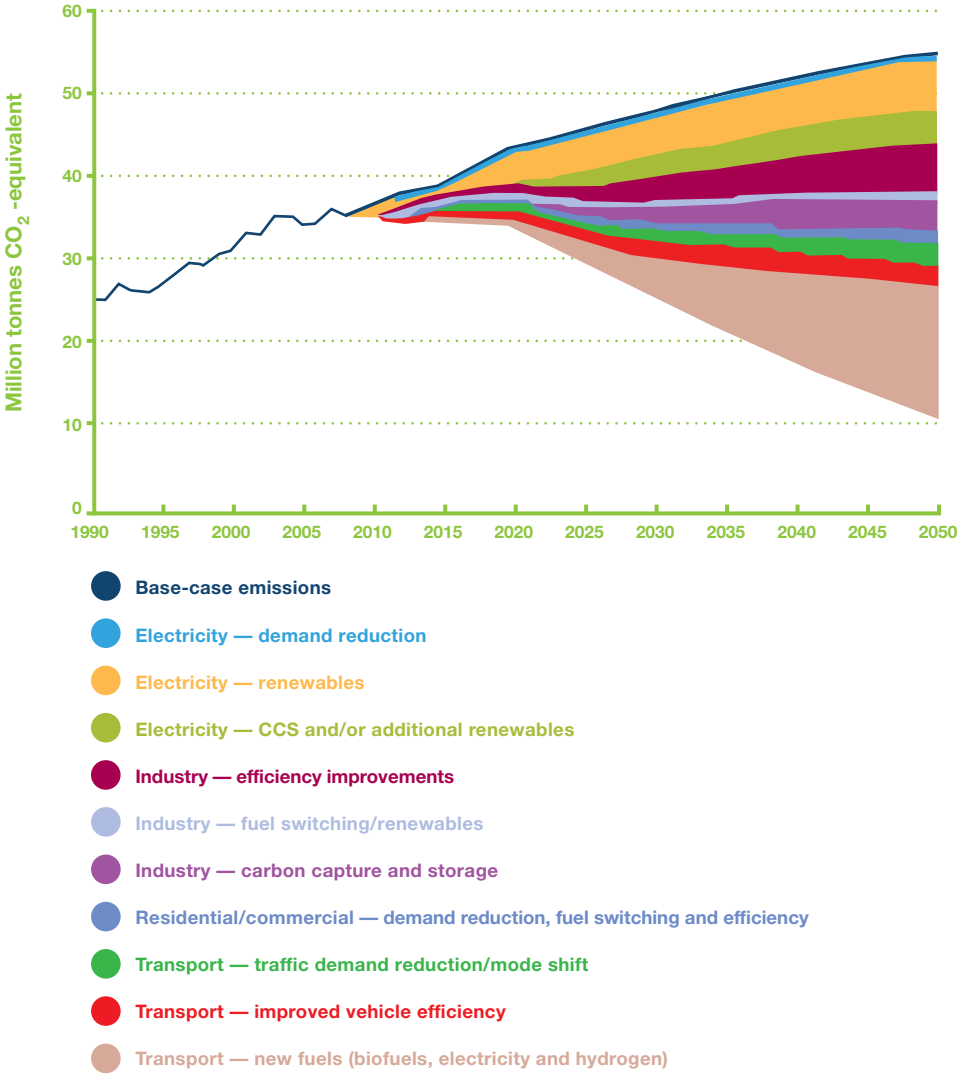
Industry

Industry is a large user of fossil fuels and a source of a substantial portion of New Zealand's total energy emissions. There is scope for large reductions in emissions from industrial processes by improving efficiency,[19] switching to lower carbon fuel sources (such as from coal to gas or bioenergy) and increasing cogeneration. Over time, emissions pricing will prompt investors to reduce the carbon intensity of industry.

[19] Notably through future process technological improvements and investment.

Figure 5.6 shows the potential emissions reduction opportunities for the energy sector as a whole. The actions in this strategy should enable us to take up these opportunities and aim to reduce energy sector gross emissions[20] to 1990 levels by 2030.[21]

Figure 5.6: Emissions reduction opportunities for the energy sector[22]



Source: Ministry of Economic Development

Under the CCS scenario shown in *New Zealand's Energy Outlook to 2030*, a similar picture emerges. CCS technology combined with additional renewable energy generation could significantly reduce emissions in the electricity and industrial sectors. Similarly, under this alternative scenario, electric vehicles substitute for conventional vehicles in the transport sector.

Different combinations of the above alternatives could achieve similar emissions reductions.

[20] Note that this is not the same as New Zealand's commitment under the Kyoto Protocol. Under the Kyoto Protocol, New Zealand is able to choose the most cost-effective mix of either reducing gross emissions, offsetting emissions through forest sinks or obtaining carbon credits through reducing emissions (or increasing forest sinks) in other countries.

[21] Figure 5.6 includes emissions from industrial processes, which are shown separately in the *New Zealand Energy Greenhouse Gas Emissions 1990 to 2006*, available from www.med.govt.nz/energy/ghg

[22] For more information see *New Zealand Energy Strategy Low Carbon Energy Scenario* available from www.med.govt.nz/nzes

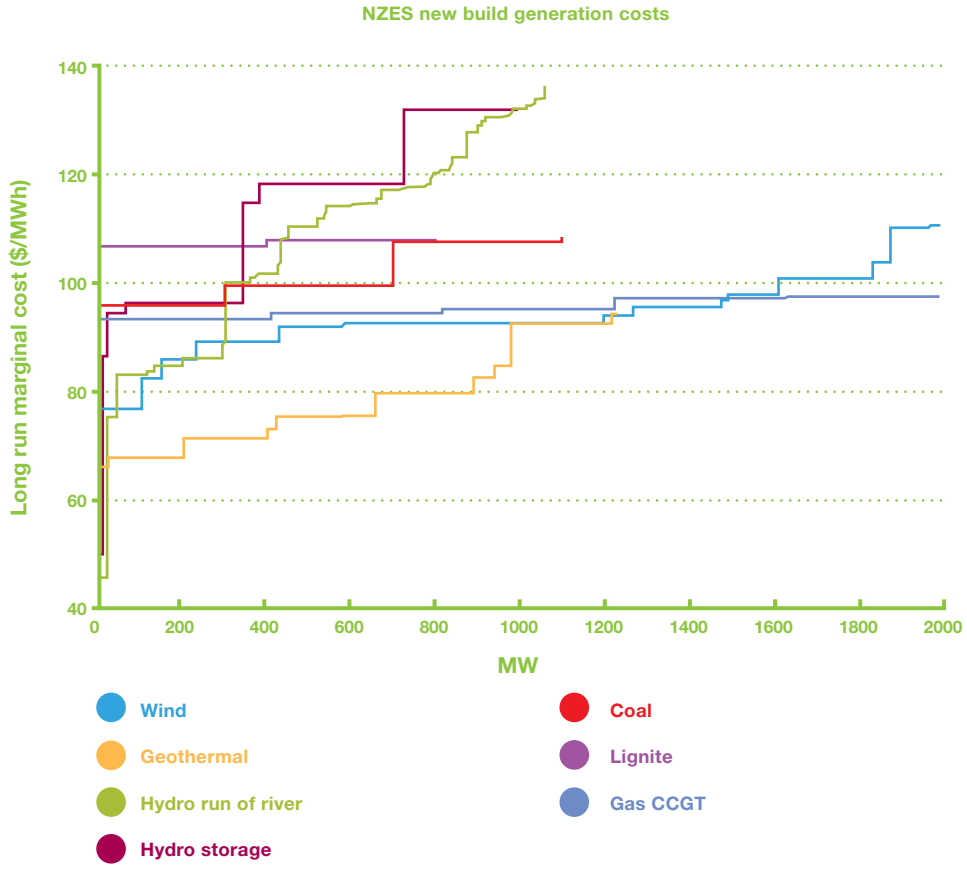
5.2 Effect of this strategy on prices

5.2.1 Electricity costs

Figure 5.7 shows the estimated costs of alternative sources of new electricity generation, including capital and fuel. The costs are based on information from the EC.[23]

The cost curve shows that, in the medium term, renewable sources of electricity generation are cost competitive with fossil fuel-based sources, particularly when the impact of an emissions price is incorporated.

Figure 5.7: Typical costs for new electricity generation (updated August 2007)[24]



Source: Ministry of Economic Development

The graph shows that new geothermal, wind and combined-cycle gas turbine (CCGT) generation are all available at around the same price, assuming medium-term gas prices of $9/gigajoule and an emissions price of $25/tonne of CO_2-equivalent emissions. If gas prices continue to move towards the higher cost of imported LNG, or if the cost of greenhouse gas emissions from fossil fuel-based generation rises in the longer term towards $50/tonne of CO_2-equivalent emissions, renewables are likely to be cheaper than gas-fired generation.

[23] Based on 2006 assumptions in the EC's *Statement of Opportunities*. www.electricitycommission.govt.nz/opder/transmis/500/

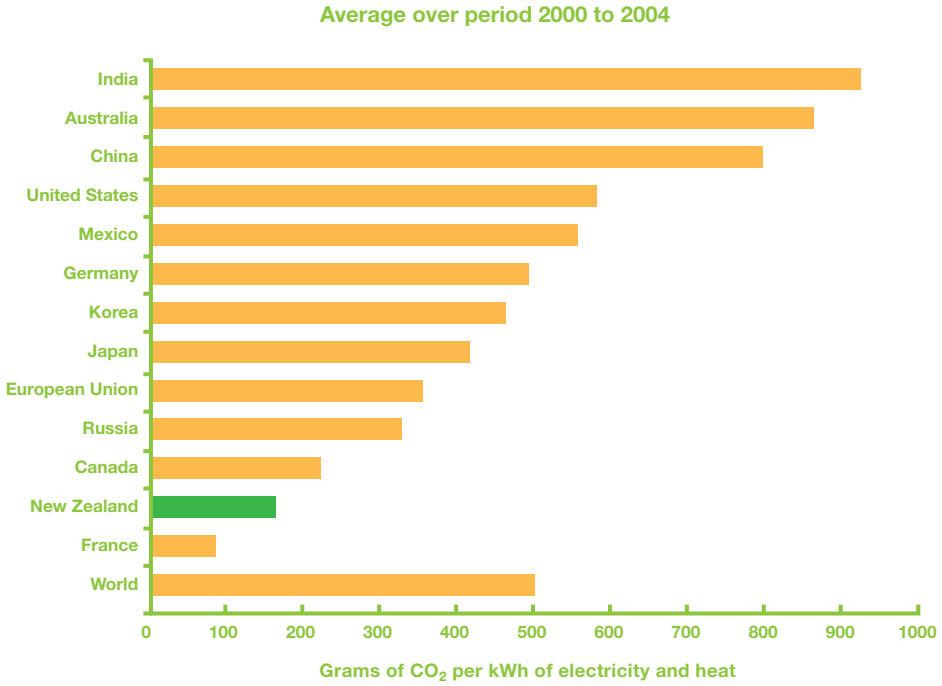
[24] Includes fuel transportation costs and location factors.

It is clear from recent modelling that using renewable electricity in place of new fossil fuel-based generation need not increase prices beyond the impacts of the emissions trading scheme, provided economic renewable projects gain consent and are built. However, the relative costs of renewable generation and fossil fuel-based generation will continue to change as fossil fuel prices and renewable generation capital costs change. In practice, there could be some trade-off between additional renewables and prices, especially if sufficient lower-cost renewables cannot obtain resource consent or if high levels of intermittent renewables, such as wind, impose additional costs on the system.[25]

The government believes pursuing renewable generation is not only environmentally preferable but is likely to keep electricity prices lower than if we rely on more fossil fuel-based generation that will need to bear the cost of its greenhouse gas emissions or the cost of CCS.

Over time, a high renewable generation mix means that New Zealand's electricity prices will be less affected by emissions pricing than in other countries that are more reliant on fossil fuel generation (see Figure 5.8 and Table 5.1).

Figure 5.8: Carbon intensity of electricity generation



Source: International Energy Agency

Table 5.1: Estimated cost impact on electricity prices of emissions pricing

Cost per tonne CO_2-equivalent emissions	$15	$25
Increase in retail price (c/kWh)	1c	2c
Percentage increase	5%	10%

[25] These costs can include the need for reserve capacity to be available to provide sufficient certainty (i.e. security) of meeting peak demand on an instantaneous and daily basis and providing back-up for dry years. Peaking plant is likely to be open-cycle gas or distillate.

5.2.2 Transport fuel costs

The price of transport fuels moves with the international oil price, which will continue to fluctuate. Oil has two likely renewable substitutes: biofuels and electricity.

Biofuels technology is making great advances. Costs are rapidly declining and are, in some cases, already competitive with oil (including ethanol from sugar in Brazil and possibly biodiesel from tallow in New Zealand). The cost of ethanol from corn (maize) is dropping in the United States, as production technology improves and uses less energy.

At present, biodiesel from tallow is expected to be similar in price to diesel.[26] The levels of biofuels currently being considered are not expected to materially increase prices at the pump.

The second renewable substitute for oil in transport is electricity, provided it is generated from renewable sources. Plug-in hybrid vehicles are expected to become commercially available within a decade. Electricity in New Zealand is cheaper than oil, and electric motors are more efficient than petrol or diesel motors. As a result, it is expected to cost much less to run electric cars than those powered by conventional fossil fuels.

Increased use of such low carbon transport fuels limits the overall impact of emissions pricing on petrol and diesel prices.

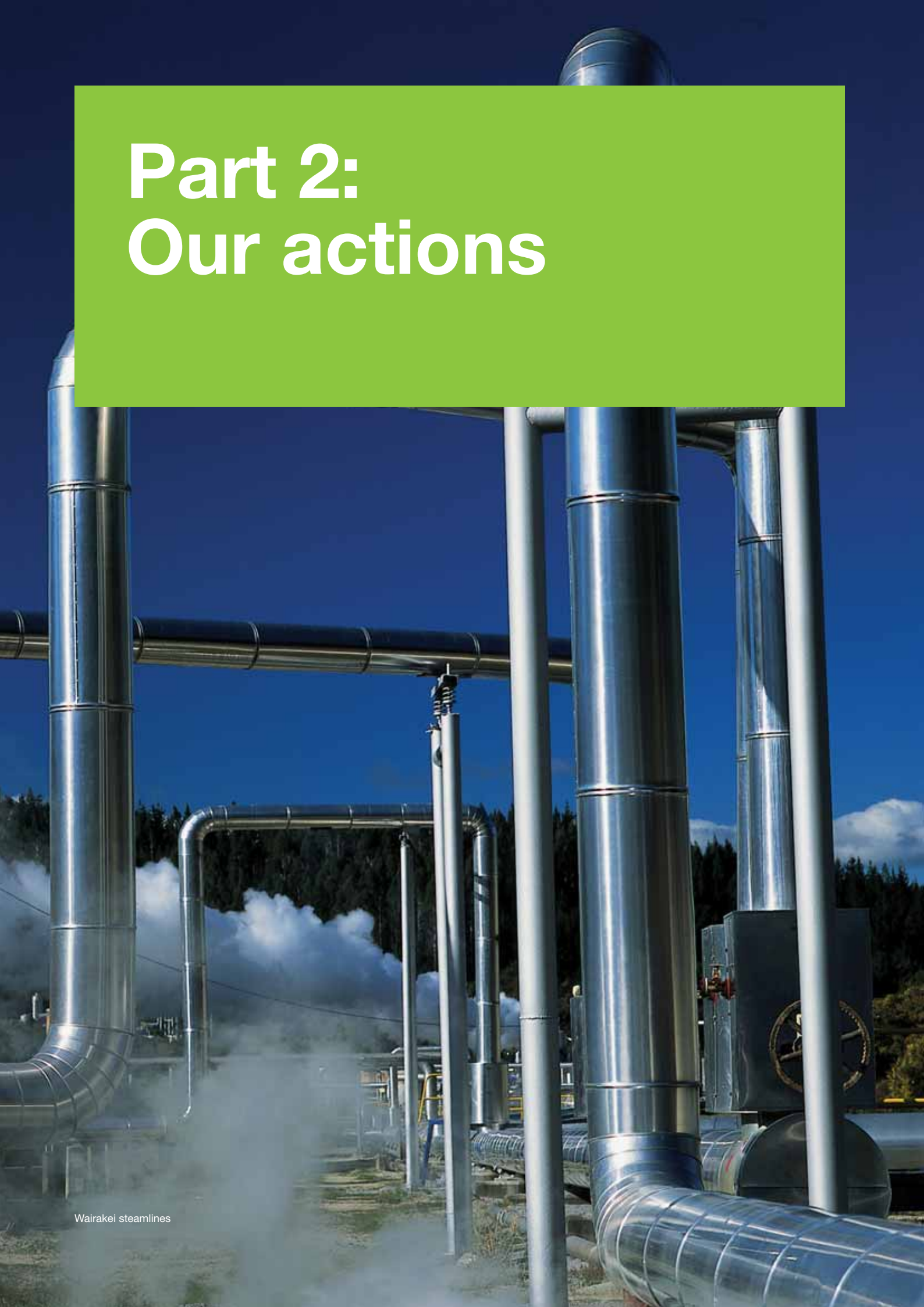
5.3 Conclusions

The government believes the principles and initiatives set out in this document will lead New Zealand to a sustainable, low emissions energy system for generations to come.

Making the right choices today will enable New Zealand to sustainably power its future.

[26] For more information visit www.transport.govt.nz/biofuels-440-index/

Part 2:
Our actions



Wairakei steamlines

6. Introduction

Part 2 provides further details on the initiatives in the *New Zealand Energy Strategy*. These are discussed under six broad chapter headings:

- **Resilient, low carbon transport**
- **Security of electricity supply**
- **Low emissions power and heat**
- **Using energy more efficiently**
- **Sustainable energy technologies and innovation**
- **Affordability and wellbeing.**

Each chapter identifies the key issues and policy intended to address these. The chapters also give details of work already in progress.

6.1 Delivery

Achieving the objectives of the NZES will require action by central government, local government, business and individuals. In this strategy, the government has laid out its policy intentions and the measures it will put in place to create the right conditions and incentives. Local government is expected to consider how to meet its responsibilities for energy policy (see Box 6.1). With a clear and stable framework in place, business will have the confidence to make cost-effective long-term planning and investment decisions.

Box 6.1: Partnership with local government

With regulatory and planning responsibilities across areas such as public transport, urban design, resource management and community awareness, local government has an important role in realising the ambition of the NZES.

The framework for engagement and partnership with local government is intended to promote constructive cooperation and communication between central and local government on further developing the initiatives in key areas in the NZES. The focus will be on areas where the achievement of national objectives depends on the decisions and actions taken at local level, particularly in those areas that have no working partnerships at present. The primary aim is to ensure local government input in designing NZES programmes that fall within the regulatory, planning and delivery functions of local government.

Most contact between central government and local government is expected to continue to be carried out on a bilateral or multilateral basis between agencies that deal on a day-to-day basis with the issues at stake. However, some central coordination across the multiple programmes included in the NZES will be useful. Central government agencies will continue the dialogue with local government in developing the framework.

6.2 Implementation

In each of the following chapters, a table summarises the principal measures in the NZES, the expected timing and the agencies responsible for carrying out the measures. Some measures do not require legislation or further policy development and will be implemented over the coming months. Some proposals will depend on the outcome of further public consultation, while others aim to ensure New Zealand is well placed to take advantage of future developments in technology such as electric vehicles and CCS.

6.3 Monitoring and assessment

The Ministry of Economic Development will prepare an annual report on progress on the NZES objectives and the implementation of the NZEECS for the Minister of Energy. The first interim progress report will cover October 2007 to June 2008.

7. Resilient, low carbon transport

Summary

- To reduce our greenhouse gas emissions overall, New Zealand must substantially cut emissions from transport.[27]
- Pricing greenhouse gas emissions is unlikely to be sufficient on its own to reduce the growth of greenhouse gas emissions from the transport sector. This chapter sets out the government's preferred measures to complement carbon pricing and achieve emissions reductions.
- The key areas of focus are using more efficient and lower-impact transport modes, using alternative renewable fuels, increasing the efficiency of the vehicle fleet and reducing vehicle kilometres travelled through smarter planning.
- The government has made in-principle decisions to set a target of halving domestic transport emissions per capita by 2040,[28] and for New Zealand to be one of the first countries to widely deploy electric vehicles.
- Increasing the diversity of transport fuels by introducing biofuels and, in time, electric cars will also make New Zealand more resilient to international oil price uncertainty and risks of supply disruptions.
- Provision for travel alternatives such as public transport, walking and cycling should be continually upgraded and improved to ease traffic congestion, provide an alternative to private vehicle travel and reduce greenhouse gas emissions.
- Making these changes will improve the transport choices available to New Zealanders, as well as improving the environmental sustainability of our communities and our economy.
- The energy and climate change objectives for transport in the NZES will inform transport policies, including the update to the NZTS.

[27] Greenhouse gas emissions from domestic transport (air, land and sea) make up about 18 per cent of New Zealand's total emissions.
[28] Relative to 2007 per capita emissions.

From vision to action	Lead agency	Timing
The government has made an in-principle decision to introduce a target of halving domestic transport emissions per capita by 2040 relative to 2007 emissions.	MOT	Ongoing
The government has made an in-principle decision that New Zealand be one of the first countries in the world to widely deploy electric vehicles.	MOT	Ongoing
The government will consider the NZES priorities for resilient, low carbon transport in developing the update to the NZTS.	MOT	2008
The government will continue to support local government on quality urban design, including investigating the role for greater national guidance.	MfE	Nov 2007
The government will continue to develop policies, including policies on funding, to encourage greater provision of public transport, walking and cycling.	MOT	2008
The government will encourage the deployment of low carbon bus fleets, including hybrid and electric buses, into the suburban passenger fleet.	MOT	Ongoing
The government is working with those involved in the shipping industry, including associated rail and road operators, to develop a *New Zealand Domestic Sea Freight Strategy*.	MOT	Now
The government will continue to work with the New Zealand-based aviation industry, and within international forums, to encourage the use of more fuel efficient practices and aircraft.	MOT	Ongoing
Through the NZEECS, the government will work with industry to develop average fuel economy standards for light vehicles entering the fleet.	MOT	End 2007
The government will establish an expert advisory group to look at future vehicle technologies, such as biofuel and electric vehicles, including barriers to early adoption.	MOT	End 2007
The government will introduce a *Biofuels Sales Obligation*.	MED	1 Apr 2008
The government will review the *Biofuels Sales Obligation* in 2010 to establish all aspects of the obligation after 2012, including obligation levels.	MED	Dec 2010
The government will continue to participate in international dialogue on the role and potential for alternative fuels.	MED	Ongoing
The government will work towards positioning New Zealand to be a world leader in the deployment of new vehicle technologies, including plug-in hybrids and electric vehicles.	MOT	Ongoing
The government will continue to support opportunities to develop and commercialise niche applications for hydrogen. It will also strengthen opportunities for international collaboration to ensure New Zealand can be a fast adopter if the use of hydrogen as an energy carrier becomes commercially viable.	MED/FRST	Ongoing
New Zealand will have access to at least 90 days' of oil stocks, in line with international obligations.	MED	Ongoing
The government will produce an updated *Oil Emergency Response Strategy*.	MED	Jun 2008

7.1 Our direction

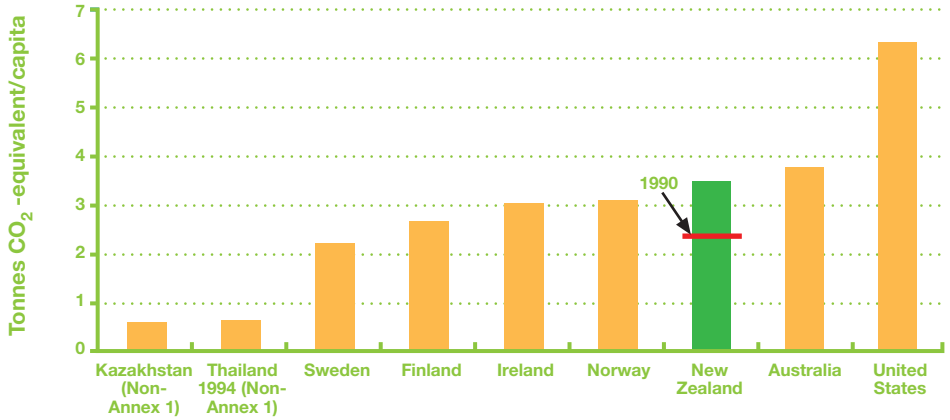
New Zealanders have a strong desire for mobility. We travel frequently, own more vehicles on average than people in many other countries and have historically had relatively low fuel costs. Our geographic isolation has made us reliant on ships and planes to connect us to the rest of the world, and our use of energy for freight transport has increased as the economy has grown.

If we make no changes to the way we travel and transport freight, transport energy use is expected to grow from today by approximately 40 per cent by 2030 – with three-quarters of that growth coming from road transport. Greenhouse gas emissions from transport would increase at a similar level. The risks of climate change make this path unsustainable.

Our key challenge is to reduce the greenhouse gas emissions from transport fuels while our transport systems continue to support a strong, competitive economy and our quality of life.

Greenhouse gas emissions from transport are an issue for all developed countries, both in terms of gross emissions and continued growth. There is some variation in the relative volumes of emissions (or equivalent fuel use) due to different circumstances. Figure 7.1 shows that New Zealand, on a per capita basis, has a more emissions-intensive transport system than some European countries. Australia and the United States have significantly higher levels, probably reflecting an even higher dependency on personal car use than New Zealand.

Figure 7.1: International comparison of domestic transport emissions



Source: Ministry of Transport

The government is committed to building momentum in the adoption and uptake of sustainable transport measures. It has taken in-principle decisions to set a target of halving domestic transport emissions per capita by 2040,[29] and for New Zealand to be one of the first countries to widely deploy electric vehicles. These decisions will be the subject of further engagement in 2007.

Focusing on reducing greenhouse gas emissions from the transport sector will also help to reduce New Zealand's dependency on oil. This will increase the resilience of our transport system and economy to sudden disruptions in oil supply, as well as longer-term concerns about global oil supplies and price uncertainty (see Box 7.1). Energy security for transport can also be improved through measures that address short-term disruptions (see section 7.8), increase diversity in the fuel mix (see section 7.7), encourage greater use of domestic fuel supplies and reduce demand for transport energy (see sections 7.4 and 7.5).

[29] Relative to 2007 per capita emissions.

Box 7.1: Peak oil

'Peak oil' is the term used to describe the point when worldwide production of conventional (cheap) crude oil peaks in volume. After it peaks, more expensive and non-conventional sources of oil will be needed to meet demand.

The peak oil debate is generally divided into two camps. The 'mainstream' view is that oil supplies should be sufficient to meet demand to 2030, provided that there is significant investment in the supply chain and increased efficiency in the use of oil. The 'peak oil' perspective is that current oil production levels are near or at their ultimate peak, and that there will be a considerable impact on oil prices and on the global economy. The key questions involved in this debate are:

1. How much oil is out there?
2. How much will the demand for oil grow?
3. Are the published statistics accurate?
4. What level of oil recovery is economically feasible?
5. How feasible is unconventional oil?

Estimates as to when peak oil may occur vary significantly depending on the answers to these questions. It is uncertain whether conventional oil production will peak in the next decade or a decade or two later, but demand for oil is certain to continue to grow.

The IEA's *World Energy Outlook 2006 Reference Scenario* projects that world oil demand will steadily grow over the next 25 years, from 84 million barrels per day in 2005 to 99 million barrels in 2015 and 116 million barrels in 2030. More than 70 per cent of this increase is expected to come from developing countries. Most of this increase will be absorbed by the transport sector.

However, while the demand for oil grows, the IEA notes that the world's proven reserves (including non-conventional oil) could sustain current production levels for 42 years. Rising prices will spur exploration and make previously uneconomic reservoirs of oil viable. Higher prices and other technologies will also prompt the extraction of liquid fossil fuels from sources such as gas, oil-rich shales and lignite. There are immense quantities of these non-conventional sources of oil, although extracting and using them will produce significant greenhouse gas emissions unless CCS is available. So, while there will, at some point, be peak 'cheap' oil from conventional sources, the world has plentiful sources of fossil-based oil.

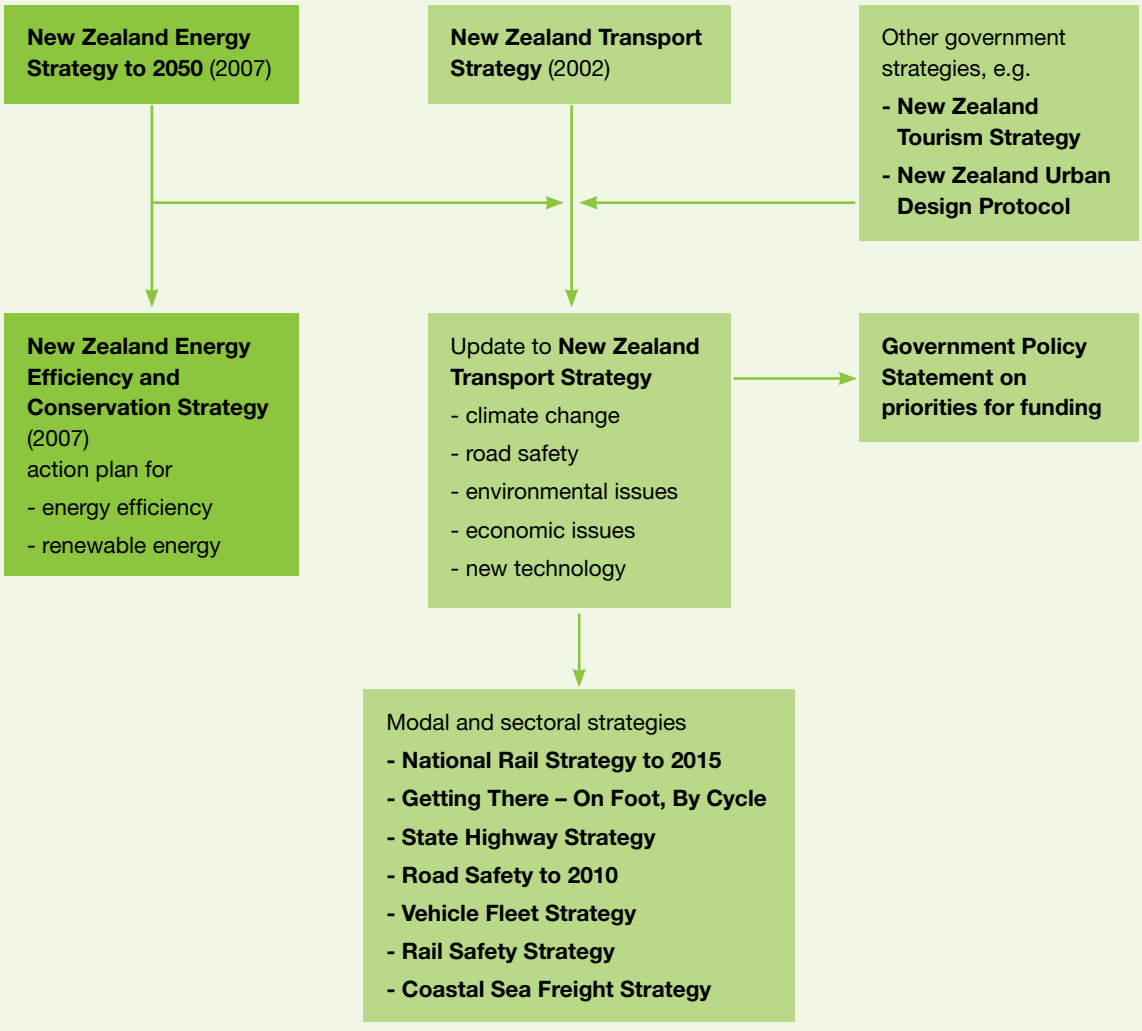
As oil prices rise, non-fossil-based sources of fuel become more viable. There are, however, concerns that biofuels will compete with food supplies and promote unsustainable land use, especially in developing countries. A possible solution lies in the so-called second generation biofuels produced from woody biomass and waste, which help reduce the world's dependence on oil-based fuels.

7.2 Linking with other strategies

The 2002 *New Zealand Transport Strategy* (NZTS) is the main transport strategy with links to the NZES (see Figure 7.2). Its five objectives are:

- assisting economic development
- assisting safety and personal security
- improving access and mobility
- protecting and promoting public health
- ensuring environmental sustainability.

Figure 7.2: The New Zealand Transport Strategy and links to other major government strategies



Source: Ministry of Transport

The NZES's objectives for transport focus on reducing transport greenhouse gas emissions and ensuring our transport systems support a strong, competitive economy and our quality of life. These are consistent with the NZTS's aim of assisting economic development and ensuring environmental sustainability. Further actions in the NZES support other transport strategy objectives, such as improving access and promoting health.

The update of the NZTS will be informed by the transport energy and climate change objectives set out in the NZES.

7.3 The progress we've made

The government has already set New Zealand on a course to meeting these transport objectives. Initiatives underway include:

- multi-modal transport planning and good urban design to encourage people to use public transport, cycle and walk
- enabling regions and local authorities to establish a regional fuel tax to help fund passenger transport activities and roads, subject to legislative processes
- increasing central government funding for public transport services from $141 million in 2006/07 to $165 million in 2007/08 – a rise of 17 per cent
- committing $301 million in 2006/07 to fund public transport, including more than $66 million to the Northern Busway in Auckland
- investing more than $1.4 billion over the next six years to upgrade the rail network (including expenditure already being used to improve Auckland's infrastructure)
- using the *Fuel$aver* website (www.fuelsaver.govt.nz) to encourage drivers to consider fuel economy when they buy their vehicles
- taking steps to ensure security of oil supply.

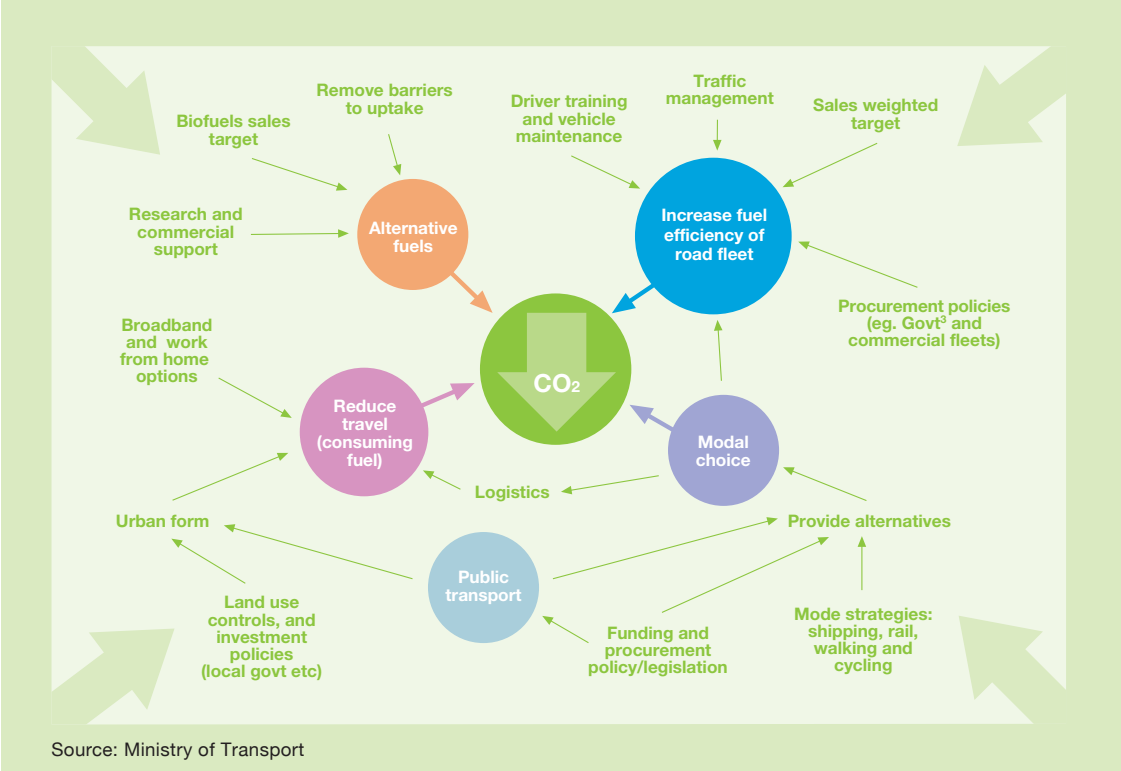
7.4 Our actions

An ETS alone is unlikely to be enough to reduce the growth of greenhouse gas emissions from the transport sector. This chapter sets out five action areas to complement emissions pricing and improve security:

- managing demand for travel
- shifting to more efficient and/or lower impact means of transport
- improving the fuel efficiency of the vehicle fleet
- developing and adopting future fuels
- ensuring the security of short-term oil supplies and a diverse supply of transport fuels.

Actions to reduce land transport greenhouse gas emissions are interrelated (see Figure 7.3 below). These are complementary to broad-based measures such as an ETS.

Figure 7.3: Measures to reduce land transport greenhouse gas emissions



Source: Ministry of Transport

7.4.1 Managing the demand for travel

There are two ways to manage the demand for travel. The first is to try to reduce travel that can be avoided, and the second is to use the mode of transport that is the most fuel efficient and has the least impact on the environment.

Actions to reduce travel focus on reducing the number and length of motorised trips. Short-term measures to reduce travel include teleconferencing instead of flying between cities, and encouraging drivers to combine trips.

The government's digital strategy and its support for broadband will reduce pressure on transport services by promoting teleconferencing and other forms of distance-based communication.

Longer-term actions include urban planning and design that minimise the transport impact from the siting of industry, services and transport systems. Local authorities have a critical role to play as they provide public transport services, oversee land use and developments, and develop regional multimodal land transport strategies.

The government will engage, work with and support transport Crown entities and local authorities on developing travel demand management strategies through the NZEECS.

The links between good urban form and transport are recognised in the *New Zealand Urban Design Protocol (2005).* Features that bring energy and transport benefits are planning for higher density urban form, mixed land use and greater connection between key urban sites, including more accessible public transport, and support for pedestrians and cyclists.

A number of major urban areas are already considering design approaches to link land-use planning decisions and transport infrastructure to reduce sprawl, improve access and reduce congestion. These measures also provide more cost-effective alternative means of transport and improve energy efficiency. At a local level, regional land transport strategies and regional and district plans are required to consider energy efficiency.

ACTION: The government will continue to support local government on quality urban design, including investigating the role for greater national guidance.

Auckland's Northern Busway

An interim express bus service has reduced the number of cars making the congested journey from Auckland's North Shore to its central business district each day. On average, the 1,620 customers who use Auckland Regional Transport Authority's Northern Express service drive five kilometres less each weekday than they did before the busway opened. Over 2006/07, the service is estimated to have reduced petrol and diesel use by 408,000 litres and cut greenhouse gas emissions by 1,000 tonnes of CO_2, as well as giving motorists a cheaper and faster way to get to work. The Northern Busway is scheduled to be fully completed in February 2008, further improving passenger transport connections to central Auckland.

Northern Express bus and station.
Photo courtesy of Auckland Regional Transport Authority.

7.5 More efficient transport modes

7.5.1 Land passenger travel

Between 1999 and 2006, estimated passenger use of public transport increased by 68 per cent in Christchurch, 43 per cent in Auckland and 23 per cent in Wellington, replacing an estimated 49 million car trips. The increase is partly because of rising fuel prices, but better public transport services have been another factor.

Recent IEA and OECD reports highlight under-investment in New Zealand's urban public transport over the past few decades. The recent increase in government funding will help address this under-investment. In 2004, the government repurchased the rail network and committed to spend $200 million upgrading the track, while Toll Rail is spending $100 million on new rolling stock. In 2005, the government agreed to contribute an additional $600 million between 2006/07 and 2009/10 to renew and upgrade the Auckland rail network. A further announcement about funding for urban rail improvements was made in the 2007 Budget. This resulted in a further $600 million of funding for Auckland and Wellington rail upgrades, including the electrification of the Auckland rail network.

The government is committed to encouraging convenient, environmentally friendly passenger transport systems. Much of New Zealand's urban and rural bus fleet is old and has a larger environmental footprint than modern buses. The government will encourage the use of low carbon bus fleets, including hybrid and electric buses.

ACTION: The government will continue to develop policies, including policies on funding, to encourage greater provision of public transport, walking and cycling.

ACTION: The government will encourage the deployment of low carbon bus fleets, including hybrid and electric buses, into the suburban passenger fleet.

Walking school buses

Walking school buses have proved a fun and safe way for children to walk to and from school. Each bus walks along a set route, with at least one adult 'driver' picking children up at designated stops and walking with them. Walking school buses have been introduced in schools around New Zealand and are a popular way to reduce traffic, encourage fitness and help children learn road safety.

Pupils at Gladstone Primary School, Mt Albert, walk from school. Image courtesy of Associated Press.

As New Zealand's largest population centre, Auckland requires special attention. In 2005, Auckland developed a new *Regional Land Transport Strategy* that recognised its level of public transport was only half that of comparable cities. The lack of public transport increases roading costs, transport delays, fuel costs and greenhouse gas emissions. The new strategy aims to double public transport patronage over the next decade. The main aim is to reduce traffic congestion, but the proposal would also reduce private car fuel consumption by an estimated 52 million litres of fuel (approximately two petajoules (PJ) of petrol and diesel) per year by 2016. The strategy's affordability is the subject of the *Auckland Transport Strategic Alignment Project*.

Walking and cycling are actively supported through the government strategy *Getting There – On Foot, By Cycle*. Policies that encourage use of lower impact modes of transport are also expected to increase the number of vulnerable road users, such as motorcycles, smaller cars, pedestrians and cyclists. Their safety needs to be considered. The government will continue to support lower emissions alternatives to road transport by working with local government to implement strategies through the NZEECS.

7.5.2 Land and marine freight movement

In 2005, the government released the *National Rail Strategy to 2015*, which focuses on increasing the amount of freight and numbers of commuters carried by rail. The rail strategy aims to make commercially viable freight services an attractive alternative to road transport.

The amount of freight that can be switched from road to rail is limited by time, route and other specific requirements. In the long term, land-use decisions such as where to site industry and services can increase the use of rail transport.

The government is also looking at ways of making road freight more efficient, such as by allowing concessions in the weight restrictions on heavy vehicles.

Coastal shipping services could be used more often if heavy freight activities took place near ports and if there were good links to rail networks. The government is looking at ways to promote maritime transport and is developing a *New Zealand Domestic Sea Freight Strategy*.

ACTION: The government will work with those involved in the shipping industry, including associated rail and road operators, to develop a *New Zealand Domestic Sea Freight Strategy*.

7.5.3 Aviation

International travel is covered by agreements between governments, and New Zealand supports the International Civil Aviation Authority's initiatives to reduce international aviation greenhouse gas emissions. The Airways Corporation is looking at minimising flight times, while other ways to improve fuel efficiency in domestic air travel include using modern, environmentally friendly aircraft technology and improving air traffic management.

ACTION: The government will continue to work with the New Zealand-based aviation industry, and within international forums, to encourage the use of more fuel-efficient practices and aircraft.

Air New Zealand's long-haul fleet

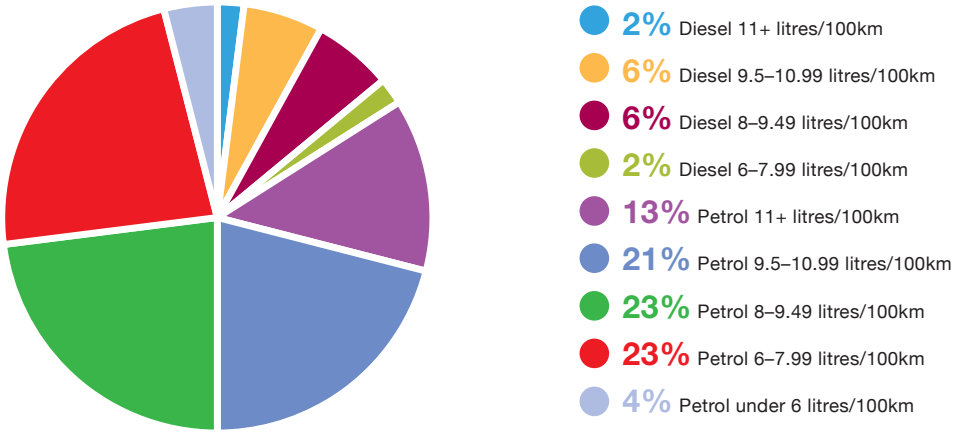
Air New Zealand believes it is on the way to having one of the most environmentally friendly long-haul fleets in the world. By 2012, the airline expects to have taken delivery of eight 787 Dreamliners and four 777-300ER (Extended Range) aircraft, all manufactured by Boeing. The Dreamliner is 20 per cent more fuel efficient than other long-haul aircraft, while the 777 is 16 per cent more fuel efficient than Air New Zealand's existing 747-400s. Since the early 1990s, the airline has been steadily reducing its CO_2 emissions by upgrading the fleet, using new technology, and improving its operating practices.

The 787-9 Dreamliner.
Image courtesy of Air New Zealand.

7.6 Increasing the efficiency of the vehicle fleet

Making New Zealand's vehicle fleet more fuel efficient can substantially reduce greenhouse gas emissions. Vehicle technology and the composition of the vehicle fleet (see Figure 7.4 below) can improve fuel efficiency, as can the choices made by drivers – for example, how many people are in the vehicle, and how it is maintained and driven.

Figure 7.4: Light motor vehicles entering the fleet in 2006 (new and used)



Source: Ministry of Transport

Vehicles that entered the fleet in 2006 had an average CO_2 emissions rating of 215–220 grams/km. The following changes would be required to improve the overall rating by 20–25 per cent, an average of 170 grams/km:

- the percentage of diesel-powered vehicles entering the fleet would need to increase from 17 per cent to 50 per cent
- the percentage of vehicles in the most efficient categories (diesel under 4.5 litres/km and petrol under six litres/100km) would have to increase from four per cent to 24 per cent
- the percentage of vehicles in the least efficient categories (diesel and petrol over 11 litres/100km) would have to decrease from 13 per cent to six per cent
- diesel and petrol vehicles with ratings of between six and eight litres/100km would have to become the most common vehicle.

New Zealand has traditionally had a slow vehicle replacement rate and a large stock of cheap, older used vehicles. Recent higher fuel prices have led to some consumer demand for smaller, more fuel-efficient vehicles.

To reduce transport emissions, the average carbon footprint of vehicles entering the fleet needs to decline. Given the length of time drivers keep their vehicles, there are significant climate change benefits to targeting vehicles entering the fleet for the first time.

As a result, the government is making it a priority to develop policies to improve the fuel economy of the New Zealand light vehicle fleet. It will do this by working with industry representatives to encourage drivers to buy fuel-efficient vehicles, ensure in-service vehicles meet environmental standards and promote the scrapping of inefficient vehicles.

Cars that provide substantial reductions in greenhouse gas emissions are already on the market. The Toyota Prius and Citroën C3, for example, have fuel economies of just over four litres/100 km (less than 120 grams CO_2/km). The current average fuel economy for light petrol vehicles entering the fleet is around 8.8 litres/100km. New Zealanders are also expected to follow the European trend towards using diesel vehicles, many of which are highly energy efficient.

ACTION: Through the NZEECS, the government will work with industry to develop average fuel economy standards for light vehicles entering the fleet by the end of 2007.[30]

The government has also reviewed the vehicle fleets of 21 government organisations and will use procurement policies to encourage changes to more efficient and low carbon vehicles.

The launch of the *Fuel$aver* website in 2006 made it easier for New Zealanders to find information on fuel efficiency, while the biennial *Energywise* Rally has successfully promoted the benefits of fuel efficiency, alternative fuels and fuel-saving driving techniques.

The government is also developing measures in the NZEECS to improve the fuel efficiency of vehicles, including developing fuel efficiency labelling for vehicles and providing leadership on fleet procurement and driver training programmes.

The government gathers significant revenue from the fuel excise duty, which is spent on New Zealand's land transport system. As a result of emerging vehicle technologies, increased fuel economy and alternative fuels, the government will need to explore other ways to raise revenue for the land transport system in order to ensure all users share the burden equitably. It is considering developing a distance-based charging regime for all vehicles to meet land transport costs.

7.7 Developing and adopting a diverse range of fuels

About 86 per cent of New Zealand's oil consumption is used in the transport sector. International oil supplies will dominate New Zealand's transport energy for some time to come, but our reliance can be reduced by increasing the proportion of alternatives in our fuel mix. In the short term, biofuels and electricity have the most potential for New Zealand.

Substituting carbon neutral biofuels and electricity for fossil fuels will reduce transport emissions and improve our energy security, particularly if local fuels replace imported oil.

The domestic supply of biofuels will be determined by the feedstock available, the economics of conversion technology and the relative price of oil. There is also likely to be some international trade in biofuels.

Switching to electricity as a fuel for our vehicles would make the most of New Zealand's abundant renewable electricity supplies, particularly if transport was not competing for supply at times of peak demand.

The government is establishing an expert group to consider the issues involved in renewable fuels and vehicles powered by electricity. These issues could include the infrastructure needed for biofuels distribution and for electric vehicles, vehicle capability with biofuels and vehicle fuel efficiency improvements.

ACTION: The government will establish an expert advisory group to look at future vehicle and energy technologies such as biofuels and electric vehicles, including barriers to adoption.

[30] There may be different mechanisms for new and used imports.

7.7.1 Biofuels

Biofuels can make use of existing distribution infrastructure, be used in existing vehicles and complement other efficient technologies, such as hybrids. In February 2007, the government announced a *Biofuels Sales Obligation* to ensure biofuels were introduced into the New Zealand fuels market.

The obligation will begin at a level of 0.53 per cent from 1 April 2008, increasing to 3.4 per cent of annual petrol and diesel sales by 2012. These are levels that fuel distribution systems and vehicles are capable of supporting. The obligation is measured in terms of energy content to accurately represent the amount of petrol and diesel actually replaced. It is likely that the early years of the obligation will be met predominantly by biodiesel, with uptake of ethanol later in the obligation period.

The potential for markedly increasing the uptake of biofuels, particularly bioethanol, is partly dependent on the composition and turnover of our vehicle fleet. On average, new technologies released in Japan are not widely available in New Zealand for seven years. Based on these trends, it would take approximately a decade before we begin importing used Japanese vehicles compatible with significantly higher biofuel blends.

The government will ensure transport and vehicle policies allow for an increasing proportion of biofuels. As part of the *New Zealand Vehicle Fleet Strategy*, policies will be developed to promote and encourage the purchase of vehicles that are capable of accepting a ten per cent blend of biofuels. Consequently, in time, the fleet composition is likely to allow the use of higher biofuel blends.

To significantly increase domestic biofuel production, second generation conversion technologies are likely to be needed. These technologies promise greater reductions in greenhouse gases and the use of non-food-related biofeedstocks, such as forestry and agricultural waste.

A gradual increase in the use of biofuels, as proposed in the *Biofuels Sales Obligation*, will give the government time to consider how to use scientific and commercial developments in the biofuels industry.

ACTION: The government will introduce a *Biofuels Sales Obligation* from 1 April 2008.

ACTION: The government will review the *Biofuels Sales Obligation* in 2010 to establish all aspects of the obligation after 2012, including obligation levels.

ACTION: The government will continue to participate in international dialogue on the role and potential for alternative fuels.

7.7.2 Electric powered vehicles

Substituting fossil fuels with renewable electricity will also be part of the solution to New Zealand's future transport challenges. The uptake of electric vehicles will gradually lessen our dependence on imported oil and significantly reduce daily running costs.

New Zealand's natural endowment of renewable electricity could enable us to become world leaders in producing sustainable transport energy. Technological developments are expected to significantly increase the performance and safety of electric vehicles in the near future.

The government has taken an in-principle decision that New Zealand be one of the first countries to deploy electric vehicles widely into the fleet.

To date, electricity use for transport has been confined to buses and trains. In the future, the advantages of transferring a proportion of the light vehicle fleet to electricity would depend on the relative economics, potential for uptake and the level of petrol and diesel that was displaced. Hybrid plug-ins and battery electric cars also have other benefits, such as reduced or no harmful exhaust emissions in urban areas. However, advances in battery capability will be needed before these vehicles can be mass produced to provide the same mobility benefits as an internal combustion engine.

The additional electricity required to charge electric vehicles is expected to fall within the capacity of the grid, if economic grid improvements go ahead. Uptake would have to be supplemented with a charging policy to manage peak demand.

New Zealand could begin introducing electric vehicles to the fleet without a large investment in infrastructure. Public charging facilities may be required as uptake levels increase and vehicles gain capacity to travel further. Battery disposal is seen as a consideration rather than an obstacle.[31]

The most exciting development for the New Zealand transport fleet for the next decade or so is likely to be plug-in electric hybrids, if they are affordable. Plug-in hybrids may significantly reduce emissions from the transport sector if they become widely used.

To adopt these technologies as early as possible, we need to remove potential barriers, such as how vehicles are classified, whether they conform to present safety regulations, how land transport charges for roading costs from the new technologies are collected, and how to develop appropriate time-of-use metering for electricity charging to prevent all motorists recharging their batteries at peak times.

ACTION: The government will work towards positioning New Zealand to be a world leader in the deployment of new vehicle technologies, including plug-in hybrids and electric vehicles.

EcoSaver IV hybrid bus

Bus building company DesignLine International Holdings has developed what it believes to be one of the most advanced hybrid buses in the world. Rather than having both an electric motor and a combustion engine to drive the wheels directly, the ECOSaver IV hybrid bus uses an LPG-fuelled turbine as an auxiliary power unit. The lightweight, clean-running, fuel-efficient unit is used solely to keep the vehicle's batteries charged, while the bus runs on power from the batteries. DesignLine, which has its main manufacturing facility in Ashburton, says the ECOSaver IV produces substantially fewer emissions than standard diesel buses or other hybrid models.

DesignLine hybrid bus.
Image courtesy of DesignLine International Holdings.

7.7.3 LPG

Liquefied petroleum gas (LPG) is a reasonably efficient and clean-burning fuel, and most of the LPG we use comes from New Zealand. Using more LPG increases fuel diversity and security, with some modest reductions in greenhouse gas emissions. Existing infrastructure can be used to distribute and sell LPG.

[31] For more information see *Electric Vehicles and New Zealand: Identifying potential barriers and future considerations* available from www.transport.govt.nz/electric-vehicles-2/

7.7.4 Hydrogen

Using hydrogen technology could improve New Zealand's energy security by further diversifying our fuel sources. It would also reduce greenhouse gas emissions from the transport sector if it were produced from renewable resources or from fossil fuels, providing the carbon dioxide released during the production process could be captured and stored.

However, storage, transportation and other technical issues are likely to prevent hydrogen having anything other than niche uses for the next 25 to 30 years. A further complication is that it would take significant time to address the safety, distribution and infrastructure issues around the development of hydrogen fuel-cell vehicles supplied by distributed hydrogen.

New Zealand is a member of the *International Partnership for the Hydrogen Economy* (IPHE), which coordinates research and development into hydrogen technology. New Zealand has also joined the IEA's *Hydrogen Implementation Agreement*, which encourages international cooperation.

ACTION: The government will continue to support opportunities to develop and commercialise niche applications of hydrogen. It will also strengthen opportunities for international collaboration to ensure New Zealand can be a fast adopter if use of hydrogen as an energy carrier becomes commercially viable.

7.8 Short-term oil security

New Zealand manages the risk of short-term supply disruptions through its membership of the IEA. We are required to hold 90 days of oil reserves (measured as net oil imports) as a buffer and to have the capability to reduce oil demand to enable the IEA to ease supply and demand pressures in the event of a major market disruption.

To manage the variability of commercial oil stocks and fluctuations in domestic production, New Zealand currently holds offshore oil ticketing contracts. These contracts ensure that New Zealand remains compliant with its IEA obligation to hold emergency oil reserves, and has access to those stocks in an emergency. We expect that reserve stock levels will average 94 days' of net oil imports in 2007. Expected increases in domestic oil production will mean that our requirement to hold offshore stocks will change over time.

The government recently released a revised draft *Oil Emergency Response Strategy* for consultation in September 2006.[32] The emergency response strategy will be used as necessary to respond to international and national supply disruptions. It will set out both the policy and operational approaches to managing an emergency disruption of oil supplies and will complement civil defence and emergency management planning.

ACTION: New Zealand will have access to at least 90 days' of oil stocks, in line with international obligations.

ACTION: The government will produce an updated *Oil Emergency Response Strategy* by June 2008.

7.9 Into the future

Emerging technologies will be important for reducing greenhouse gas emissions from the transport sector. New Zealand is largely dependent on international research and development, but technological improvements alone are unlikely to be sufficient. An integrated range of policies covering travel demand management, greater use of alternative modes, and better urban form and design will be needed.

[32] For more information, see the discussion paper *Options for government response to an oil supply disruption* available from www.med.govt.nz/templates/MultipageDocumentTOC____22559.aspx

8. Security of electricity supply

Summary

- Maintaining security of energy supply at competitive prices is essential for a modern economy.
- Security of electricity supply is delivered through a well-functioning market operating within a well-defined regulatory environment enabling efficient investment, competition and informed consumer choice, and the provision of appropriate back-stop measures.
- Energy efficiency, demand-side management and an increased diversity of electricity supply all contribute to higher levels of security.
- Increasing the use of renewable sources of energy will reduce our reliance on fossil fuels, including the possible need to import LNG or CNG in the future.
- New security-of-supply policies have reduced dry-year risks. Cost-effective options to further improve security of supply will be investigated.
- It will be important to establish a robust wholesale gas market as we move from a market dominated by the Maui gas field to sourcing gas from a number of fields.
- Increasing the proportion of renewable electricity from current levels to 90 per cent by 2025 should not compromise the security of the system and will reduce greenhouse gas emissions.
- Emissions pricing is not expected to affect security of supply.

From vision to action	Lead agency	Timing
The EC is reviewing its reserve energy policy, and the government will consider whether additional measures are required.	MED/EC	2007/08
The EC will continue its current work programme to advance wholesale market design issues. The Commerce Commission's investigation into the retail and wholesale electricity market is expected to be completed in 2008.	EC/CC	2007/08
The government will ensure that the GPS on the governance of the gas and electricity sectors are consistent with the directions of the NZES.	MED	End 2007
The government will introduce amendments to the Electricity Industry Reform Amendment (EIRA) to relax some conditions around investment by lines companies.	MED	End 2007
The EC is developing policies and processes to efficiently manage the frequency, voltage and reliability of the New Zealand generation and transmission system.	EC	Ongoing
The government is promulgating distributed generation regulations to process connection applications on a more fair and consistent basis.	MED/EC	End 2007
The government is developing a NPS and two National Environmental Standards on electricity transmission.	MfE	2008
The Gas Industry Company (GIC) is developing gas wholesale and transmission market arrangements to make it easier to establish more flexible and secure gas supply arrangements.	GIC/MED	2008/09
The GIC is reviewing the adequacy of the current arrangements in the case of a national gas outage.	GIC/MED	2008/09
The government is further considering the role of lines companies and retailers in energy efficiency initiatives.	MED	End 2007
The government is reviewing lines companies' supply obligations post-2013 and is consulting with stakeholders on options.	MED	2007

8.1 Our direction

Approximately half of the energy we use outside the transport sector comes from electricity. The other half comes from the direct use of coal, gas and renewables such as wood, biogas, geothermal and solar. For non-transport energy, security of supply generally refers to a secure supply of electricity and a reliable supply of input fuels for electricity generation.

Maintaining security of supply at competitive prices is essential for a modern economy. The reliability of a power system is measured by the frequency and duration of supply interruptions. The power system must have sufficient equipment and management systems to minimise the possibility of short-term supply interruptions as a result of equipment failure, the weather, operational error and other factors.

The long-term security of supply requires:

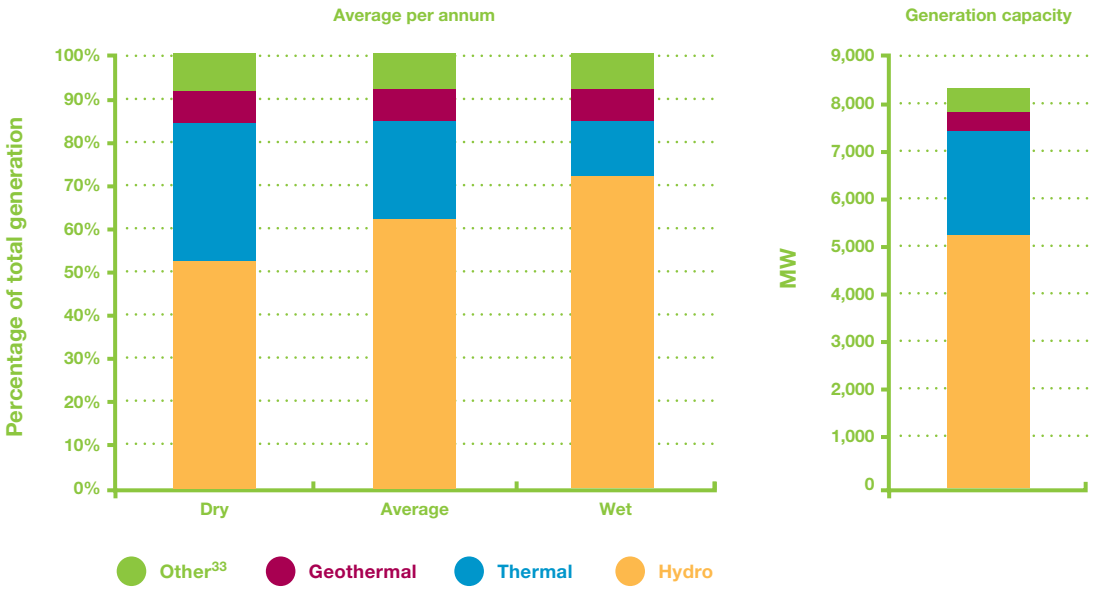
- building enough generation capacity to meet peak demands
- ensuring there is enough fuel (taking into account the uncertainty of hydro inflows and wind flows) to generate sufficient electricity at all times
- building and maintaining a transmission system to convey power from generation plants to consumers, particularly at peak times
- making the most of cost-effective energy efficiency opportunities.

8.2 Factors affecting security

New Zealand's electricity system has a number of characteristics that have implications for security of electricity supply:

1. The electricity system is dominated by an existing stock of hydro generation, which typically produces 60 per cent of total electricity supply annually. The amount of hydro electricity generated depends on the level of rainfall in the catchment areas feeding the hydro lakes (see Figure 8.1).
2. Main hydro stations are a long way from the main demand centres.
3. New Zealand cannot import or export electricity, which tends to make market outcomes more volatile.
4. Our market is small, so the preferred economic scale for new generation is large relative to the size of the system and the annual increase in demand.

Figure 8.1: New Zealand's electricity supply



Source: Concept Consulting Ltd

[33] Other includes cogeneration plant and all grid-connected wind.

New Zealand's supply security, in the context of hydro variability, has been managed by building thermal generation stations using fossil fuels such as coal, oil and natural gas. However, there has never been enough fossil fuel generation capacity to completely remove the risk of interruptions caused by hydro shortage. Instead, the power system has traditionally been managed to reduce the risk of a hydro shortage causing power interruptions. This has given us relatively cheap and low carbon electricity generation, but with the associated challenge of having to manage some dry-year risk. There is a trade-off between cost and higher levels of security.

8.2.1 Energy sources and generation options

New Zealand has substantial fossil and renewable primary energy supplies. Investment decisions and future electricity prices largely depend on our ability to access these resources and the costs of utilising them.

Large hydro developments and the Maui gas field have historically helped to keep New Zealand's electricity prices lower than international averages.[34] Using our local energy resources insulates our electricity prices from fluctuations in international fossil fuel markets.

The most recent assessment of known gas reserves indicates enough indigenous gas supply for existing uses, including gas-fired generation, to around 2016/18. However, gas supply from fields currently operating may be less flexible than before because, unlike Maui, newer fields are unable to vary production to enable large increases in gas extraction in dry years.

Several companies are exploring options for importing gas – compressed natural gas (CNG) or LNG – to cover the risk of insufficient local gas discoveries and to put a cap on local gas prices.

Wind generation cannot always guarantee firm capacity at times of peak demand. It is also less able than other types of generation technologies to provide services such as rapid reserve response, and frequency and voltage support.

New Zealand has abundant geothermal resources, which can provide valuable baseload generation and, in general, produce far fewer emissions than fossil fuel-based thermal generation. However, geothermal generation does not usually have the flexibility to manage sudden variations that can occur with wind generation output, so it will not diminish the continuing need for some fossil fuel generation capacity.

8.2.2 Supply security in a market context

New Zealand adopted liberalised market arrangements in the 1990s, breaking up the state-owned Electricity Corporation of New Zealand (ECNZ) to create a competitive market structure in power generation.

In the current market arrangements, investment decisions are made by individual firms in response to commercial drivers. This has the potential to create a perception that the electricity system is insecure.

In dry years, various market participants are affected by a shortage of fuels and higher spot market prices. Exposure to price risks tends to cause complaints and exaggerated predictions about the impact of short-term price rises. This can affect public confidence in current market arrangements.

In the near to medium term, planned generation is sufficient to ensure adequate generation capacity. The introduction of emissions pricing is not expected to reduce the amount of investment in generation, and is likely to increase investment in renewable generation.

Between November 2006 and August 2007, some electricity generators abandoned or deferred previously announced plans to invest in new fossil fuel generation plant and instead began working to develop renewable generation alternatives. This reflects their view of the relative future economics of renewable generation compared to fossil fuel alternatives, including emissions prices (see Figure 5.7 in Part 1).

[34] Compared to other OECD countries, New Zealand has the lowest industrial electricity prices for the September 2006 quarter. Source: *New Zealand Energy Data File,* Ministry of Economic Development, June 2007, pg 146. (Note: Industrial prices are a reasonable proxy for wholesale electricity prices.)

Table 8.1 presents generation projects that have either been given consent or are under consideration. Not all will be built or given consent.

Table 8.1: Planned generation projects[35]

Owners/ operators	Plant name	Planned year	Fuel type	Capacity (MW)	Status
Mighty River Power	Kawerau	2008	Geothermal	90	Consented
Top Energy	Ngawha II	2008	Geothermal	15	Consented
Contact Energy	Hawea Gates		Hydro	17	Consented
New Zealand Windfarms	Te Rere Hau Wind Farm	2006[a]	Wind	49	Consented
Ventus Energy (NZ)	Taumatatotara West Road	2008	Wind	20	Consented
Hawkes Bay Wind Farm Ltd	Te Pohue Wind Farm	2008	Wind	225	Consented
Meridian Energy	West Wind	2008	Wind	140–150	Consented
Meridian Energy	Manapouri Efficiency	2008	Hydro	16	Efficiency gain
Unison/Hydro Tasmania	Titiokura Wind Farm Stage 1 (Te Pohue)	2009	Wind	48	Consented
Taharoa C	Taharoa Wind Farm		Wind	100	Consented
Contact Energy	Otahuhu C		Gas	400	Consented
Genesis Energy	Awhitu		Wind	18	Consented, on hold
Trustpower	Wairau River		Hydro	70	Under appeal
Allco Wind Energy	Motorimu		Wind	110	Under appeal[b]
Contact Energy	Te Mihi	2008	Geothermal	18	Awaiting consent
Contact Energy	Poihipi Road (Steamfield)	2009	Geothermal	25	Awaiting consent
Trustpower	Arnold River/ Dobson		Hydro	46	Awaiting consent
Crest Energy	Kaipara Harbour		Tidal	200	Awaiting consent
Meridian Energy	Project Hayes		Wind	630	Awaiting consent
Trustpower	Mahinerangi		Wind	200	Awaiting consent

continued over

[35] The nameplate MW capacity is not directly comparable since load factors differ between generation types. For example, the load factor for wind is about 40 percent.

Owners/ operators	Plant name	Planned year	Fuel type	Capacity (MW)	Status
Pioneer Generation	Horseshoe Bend		Wind	1.8	In process
WEL Energy	Te Uku		Wind	84	In process
Contact Energy	Te Mihi Stage II		Geothermal	225	Notified
Unison	Te Waka		Wind	102	Notified[c]
Genesis Energy	Rodney		Gas	360	Consent applied for
Contact Energy	Tauhara	2011	Geothermal	200	Planning
Contact Energy	Wairakei upgrade/ replacement	2012	Geothermal	60	Planning
Allco Wind Energy	Waverly		Wind	135	Planning
Mainpower	Mt Cass		Wind	35–63	Planning

[a] Te Rere Hau Wind Farm is being commissioned in stages. The first five turbines (2.5 MW) were installed and operational from 2006, with a further 14 turbines (7 MW) due to be commissioned in late 2007.

[b] Original consent application was for 108 MW with 127 turbines. However, resource consent reduced the number of turbines to 75 with a total capacity of 64 MW. Allco Wind Energy has appealed the decision.

[c] New application. Original application was declined by the Environment Court.

Source: Ministry of Economic Development.

8.2.3 Supply security with a greater proportion of renewable generation

Emissions pricing will increase the competitiveness of renewable alternatives and encourage investment. In the past, New Zealand has had a higher percentage of renewable generation (predominantly hydro).[36]

A greater reliance on renewable generation has implications for the way security of supply is managed. Thermal plants such as Huntly will continue to play a critical role in New Zealand's electricity system, providing necessary security and versatility to both the provision of energy and the stability of delivery (voltage and frequency). Huntly, running on coal (or gas if it is available), is well positioned to provide dry-year energy security to the electricity market, particularly in autumn and spring. It could also provide market support during major generation plant or transmission maintenance outages.

Modelling shows that New Zealand could have up to 90 per cent renewables generation by 2025, based on current technology, without incurring substantial costs or reducing the security of supply (see section 9.3.2).[37] This would be a significant advance on the current proportion of 70 percent.

[36] Historically, the annual proportion of renewable generation (mostly hydro) was higher, generally at above 75 per cent in the 1970s and 1980s. This generation was backed by a much larger proportionate volume of infrequently used peaking gas and diesel plant, including Stratford (208 MW), Whirinaki (216 MW), Otahuhu A (223 MW) and Marsden A (228 MW), all of which were decommissioned in the late 1980s and 1990s.

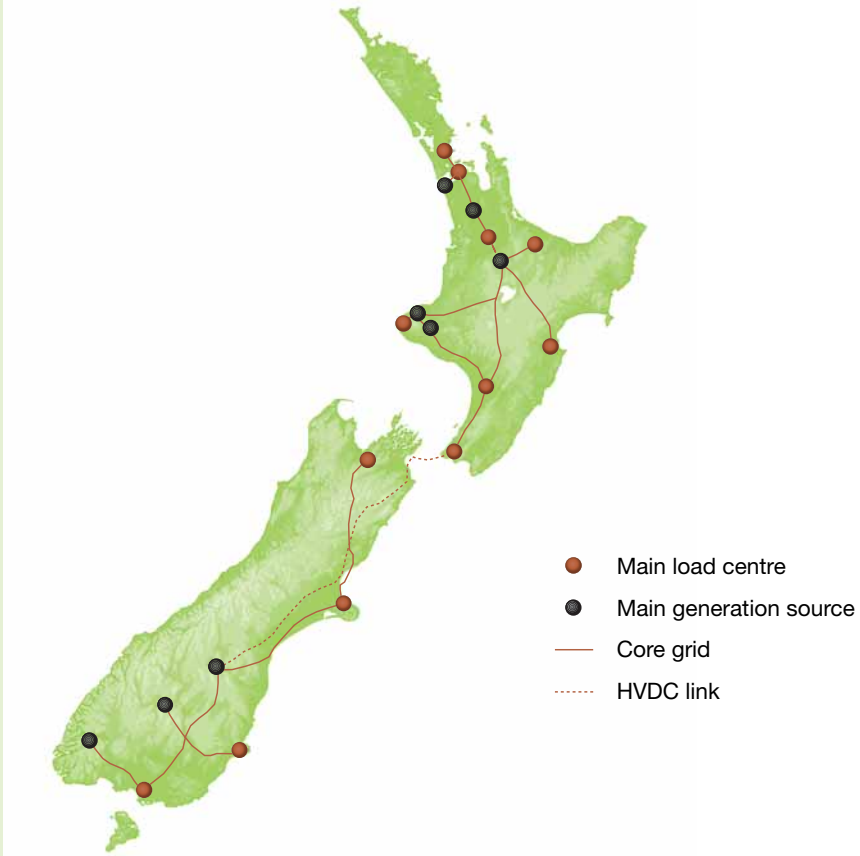
[37] This percentage refers to the proportion of total annual electricity generation (in GWh) from renewable sources in an average hydrological year.

8.2.4 Coordination of generation and transmission

In submissions on the draft NZES, there was widespread recognition that a strong and robust transmission grid was fundamental to implementing the strategy. Four issues emerged:

- major investment in the transmission grid is required to fulfil the NZES vision of a high renewables future
- differences in the lead-in time needed for transmission and renewable generation developments may make it harder to coordinate generation and transmission planning
- a high renewables mix will require a particular transmission grid formation, given intermittency – planning needs to start at an early stage
- much of the existing transmission infrastructure is old and urgently needs upgrading.

Figure 8.2: Location of electricity demand, supply and transmission grid



Source: Concept Consulting Ltd

It is important that decision-making processes around transmission planning and investment are coordinated, to allow the most efficient use of available and planned generation resources. Although the framework for grid planning is reasonably well established in the GPS on Electricity and Part F of the Electricity Governance Rules, the detailed planning processes, policies and guidelines are still being developed by the EC. The government expects the EC and Transpower to continue to develop guidelines that recognise the importance of transmission for investment in renewable generation.

8.2.5 Oversight of supply security

The Electricity Commission is responsible for ensuring that the power system is reliable. It does this by:

- setting and ensuring compliance with a wide range of technical requirements, such as maintaining acceptable voltages and power system frequency
- ensuring investment in the transmission grid is timely and adequate to meet anticipated needs, which are determined according to minimum standards and/or a cost-benefit test
- ensuring electricity demand can be met at all times without an emergency conservation campaign except in very dry years (worse than a 1-in-60 year drought[38])
- promoting and facilitating the efficient use of electricity.

The gas market is overseen by the GIC, which is responsible for developing and implementing improved gas market arrangements.

8.2.6 Managing dry-year security in the market context

The EC has a number of ways to ensure the New Zealand electricity system has dry-year security, including securing additional reserve energy (either through additional generation or demand reductions) if it believes there are not enough resources to deliver the required security standard. This regulatory back-stop gives a high level of confidence that the specified security standard will be met, but does not guarantee power will never be interrupted.

An important feature of the electricity market is that the wholesale spot prices at which electricity is bought and sold every half hour can increase dramatically when supply becomes tight. For example, in March 2006, spot prices averaged more than 20c/kWh, compared with the annual average spot price in the year to September 2006 of 6.4c/kWh. The high prices coincided with very low hydro storage levels following an unusually dry spring and summer.

Price movements play an important role in maintaining a secure power system. When prices rise above a certain point, some consumers use less power, making more electricity available to consumers who place a higher value on it. In this way, security of supply is inextricably linked to the price faced by participants in the market. High prices also give a signal to maximise available output and for investment in additional generation capacity.

In 2006, the government evaluated alternatives to the current market arrangements and concluded that, while alternative arrangements might provide higher levels of security, these would come at a cost. The government's preferred approach was to retain and improve the current arrangements – especially in respect of dry-year security and the operation of the market.

If the market moved to a more peak-constrained rather than more energy-constrained situation in future, the EC would be expected to revise the reserve energy policy.

8.2.7 Role of fossil fuel power stations

Fossil fuels will continue to play a critical role in meeting New Zealand's energy supply requirements as we make the transition to a sustainable energy future. Where fossil fuels are required, preference will be given to the lowest carbon-emitting indigenous energy supply, gas in preference to coal and distillate, and for security reasons, indigenous resources in preference to imports.

As demand is increasingly met by renewables, the role of fossil fuel generation could change as follows:[39]

- *Peaking plant*: Modelling projects a need from 2020 onwards for new peaking plant for security reasons to ensure that peak demand can be met as reliance on intermittent generation increases
- *Baseload thermal*: Modelling indicates lower load factors for fossil fuel baseload and mid-range plant as the volume of renewable generation increases.

[38] The current security standard is against a 1-in-60-year drought. This is subject to review under the EC's review of its reserve policy.

[39] For more information see *The implications of higher proportions of renewable energy by 2030* available from www.med.govt.nz/nzes

The load factor of peaking plant is low, indicating that this plant is likely to be required only infrequently, except in rare and unexpected circumstances. Consequently, expected emissions from this plant are low. However, construction and funding of such significant quantities of low utilisation plant are likely to require further consideration of market arrangements to ensure that the appropriate investment incentives are in place.

8.2.8 Role of demand-side response

Demand-side response is a way of describing electricity consumers' ability to respond to variations in market prices. To date, demand-side response has typically been limited to participating in the instantaneous reserves market, major electricity user response to high wholesale spot prices, use of ripple control technology to manage load at a regional level, and choices made as part of capital investment decisions.

Demand-side management capability generally requires capital investment. The cost of demand-side technologies continues to fall, and understanding of demand-side technologies is growing, as is the understanding of the structure of electricity prices to which demand can respond.

Demand-side response can play an important role in competitive markets. It can be an alternative to generation capacity to meet peaks, and avoid or delay the need for transmission and distribution investment. Within the New Zealand context, demand-side response is a cost-effective way to manage demand in dry years.

8.3 The progress we've made

8.3.1 Encouraging effective competition and investment

The government has taken steps to reduce uncertainty in the supply of gas. It led the renegotiation of the Maui gas field contract to give incentives to develop the field's remaining gas, and amended the royalty and taxation regime for petroleum exploration and production.

It also issued revised policy statements to the EC and the Commerce Commission to reflect the importance of security of electricity supply – particularly arrangements governing investment in transmission and distribution networks.

8.3.2 Investment in transmission and distribution networks

Transpower has recently increased its capital expenditure to upgrade and strengthen the grid. Investment in the grid has increased from $100 million per annum over the last decade to over $300 million in the year 2006/07, and is likely to increase to approximately $500 million per annum for the next five years.

A full review of the regulatory control provisions in the Commerce Act is under way, with recommendations expected by the end of 2007. In particular, the review is considering how to maintain the incentives for lines businesses and Transpower to invest in new and upgraded lines and to improve quality, including reducing line losses, while continuing to protect consumers from excessive prices.

8.3.3 Gas market initiatives

The New Zealand gas market is undergoing a period of significant transition, away from a market dominated by the Maui field to a market where gas will be sourced from a number of medium to small fields.

Initiatives in recent years have included forming the GIC. The *Minerals Programme for Petroleum*, which came into force in January 2005, contains initiatives to reduce royalties and fund seismic acquisition. The government has given further encouragement to upstream exploration and development by removing tax disincentives on oil rigs and seismic ships (the "183 day" rule).

The government believes these initiatives and the settings that they have created are generally appropriate.

8.4 Our actions

8.4.1 Improving market arrangements

The EC is reviewing its reserve energy policy, which is currently based on the probability of exceeding a dry-year inflow.

ACTION: The EC is reviewing its reserve energy policy and the government will consider whether additional measures are required.

Effective competition underpins a number of policy objectives for electricity and gas markets. As a general rule, wholesale market design issues and system operation are best reviewed by an appropriate specialist regulatory body – unless they are connected to other higher-level policy issues, in which case the government may need to look at the broad policy settings.

ACTION: The EC will continue its current work programme to advance wholesale market design issues. The Commerce Commission's investigation into the retail and wholesale electricity markets is expected to be completed in 2008.

The government will revise its policy statements on governance of the gas and electricity sectors to reflect the policy directions set out in this strategy. The revised policy statements will also be reissued formally to the Commerce Commission under the Commerce Act.

ACTION: MED will ensure that the government policy statements on the governance of the gas and electricity sectors are consistent with the directions of the NZES.

The government will reduce barriers to generation and related retailing by lines companies to increase supply-side competitiveness and renewable generation investment, while retaining controls against monopoly practice within local lines areas.

ACTION: The government will introduce amendments to the EIRA to relax some of the existing constraints on investment by lines companies by the end of 2007.[40]

8.4.2 Managing intermittent renewable generation

The market share of wind power and other intermittent renewables is likely to increase under emissions pricing and the introduction of the renewable electricity target. Wind generation is not a security-of-supply risk at current levels, but will need to be carefully managed as its share of total generation grows, to ensure security at peak times and to ensure the system has adequate reserve capacity in place. Options include improved wind forecasting, increased demand response and more geographically dispersed development of new wind farms. Other longer-term measures may include encouraging a greater diversity of renewables technologies. Existing fossil fuel generation will continue to be needed to provide back-up in the meantime.

The EC has completed the first phase of a study of the long-term implications of increased wind generation on the electricity system (including scenarios incorporating up to 2,000 MW of wind by 2016). Preliminary results for this study have indicated a range of operational issues to be managed, but they are not expected to substantially hinder the economic development of New Zealand's wind resource. The EC's forward work programme will include developing the market rules and processes to manage higher levels of wind generation.

ACTION: The EC is overseeing the development of policies and processes to efficiently manage the frequency, voltage and reliability of the New Zealand generation and transmission system.

[40] Further information is available in the Cabinet Paper *Investment in Generation by Lines Companies (Paper Three),* November 2006, available from www.med.govt.nz/templates/MultipageDocumenttoc_24878.aspx

Distributed generation, especially in combination with advanced[41] meters (see section 8.4.5), is expected to play an increasingly important role in improving the sustainability of our power supplies as the cost of smaller-scale and new renewable technologies continues to decline. Distributed generation can also improve security outcomes. The NZEECS will establish programmes to continue removing undue barriers to small-scale generation and to look at ways to encourage development.

ACTION: The government is promulgating distributed generation regulations to process connection applications on a more fair and consistent basis.

8.4.3 Facilitating transmission planning and upgrades

A NPS on electricity transmission under the RMA is proposed to provide national direction on the sustainable management of the electricity transmission network. The national significance of the electricity transmission network is expected to be recognised when considering resource management proposals. A Board of Inquiry is considering submissions and is expected to make recommendations by the end of 2007.

Grid capacity improvements must pass the EC's Grid Investment Test (an economic cost-benefit test) to ensure that they contribute a national net benefit.

ACTION: The government will develop a NPS and two National Environmental Standards on electricity transmission by 2008.

8.4.4 Improving gas market arrangements and availability

Reduced gas supply flexibility, as a consequence of the depletion of the Maui field, could have a harmful impact on the efficient use of gas in the downstream electricity market. The GIC is working on a range of measures to improve gas supply flexibility and will make recommendations on improved arrangements in 2007/08. Principally, new gas wholesale arrangements will be developed and will be supported by improved gas transmission and distribution measures. As a package, these measures will support gas trading and allow gas to be sourced from different fields and transported to customers.

Contingency arrangements are in place to minimise the impact of a national gas outage, including the industry's *National Gas Outage Contingency Plan* (NGOCP). The GIC is reviewing the NGOCP to ensure it is appropriate.

ACTION: The GIC is developing gas wholesale and transmission market arrangements to establish more flexible and secure gas supply arrangements.

ACTION: The GIC is reviewing the adequacy of the current arrangements in the case of a national gas outage.

8.4.5 Improving demand-side response

Demand-side participation within the New Zealand market is probably not meeting its potential. Price signals are muted for residential customers and business customers on fixed-price variable volume contracts, and levels of innovation and institutional arrangements to promote demand-side management need strengthening. The EC has an ongoing work programme to improve demand-side response.

Another example of innovative work is Transpower's two-year trial demand-side programme, known as the *Demand-Side Participation Project*. The programme may allow Transpower to defer some transmission investment by using contracts to reduce peak electricity demand.

Smart meters will enhance the existing load management capability. To be fully effective, smart metering requires 'smart' or innovative pricing. There have been concerns that current meter ownership arrangements are inconsistent with the deployment of smart metering technology. The EC will take account of these concerns when developing guidelines on smart metering under the NZEECS.

[41] Metering capable of two-way communication.

Smart meters

New 'smart' electricity meters being installed in more than 100,000 Christchurch homes in a pilot scheme by power company Meridian Energy will ensure bills are based on actual consumption rather than estimates. The smart meters, which have already been installed in 6,000 homes in Hawkes Bay, will enable customers to make better energy efficiency decisions by showing them how much power they use, when their peak times are, and eventually, how much power is consumed by different household appliances. The system will help Meridian Energy to manage peak demand periods and improve the efficiency of its network.

Initialising the system.
Image courtesy of Meridian Energy.

8.4.6 Enabling lines companies to undertake energy efficiency initiatives

Some lines companies have carried out energy efficiency initiatives, but others believe regulatory price controls create a disincentive to invest in measures that may lower energy volumes. A review is underway of the regulatory control provisions relating to incentives for lines companies and Transpower in the Commerce Act.

ACTION: The government is further considering the role of lines companies and retailers in delivering energy efficiency initiatives.

8.4.7 Reviewing supplier obligations

Section 62 of the Electricity Act 1992 provides that lines companies must maintain line services to connections established as at 1 April 1998. This section expires on 31 March 2013 and is to be repealed. The main consequence is that, following expiry, consumers connected to lines that are commercially non-viable face uncertainty about access to electricity at affordable prices.

This section of the Act is being reviewed in 2007 to reduce uncertainty before 2013. The aim of the review is to present a range of feasible options for consultation to ensure affected consumers continue to have access to electricity after 2013 and that it is delivered efficiently, fairly and reliably.

ACTION: The government is reviewing lines companies' supply obligations post-2013 and is consulting with stakeholders on options.

8.5 Into the future

Long-term security depends on competitive market mechanisms, a cost-effective demand-side response, greater use of renewables and a strong national grid.

The introduction of emissions pricing is not expected to affect security of supply.

The future introduction of advanced meter protocols and the uptake of these meters, together with compatible appliances, will enable retailers to offer more innovative tariff structures, rewarding customers for timely demand responses.

The increasing pace of international research into new technologies and practices should enable New Zealand to make more use of its abundant renewable energy sources. Advances in use of geothermal, wind and hydro resources are likely, with wind, in particular, expected to be able to take up a greater share of generation.

9. Low emissions power and heat

Summary

- Climate change is a serious global problem. A concerted global effort to reduce greenhouse gas emissions is in New Zealand's best interests.
- If current trends of electricity supply and demand continue, electricity-related greenhouse gas emissions will increase by approximately 50 per cent by 2030. This is neither economically nor environmentally sound.
- Some low emissions technologies are economically disadvantaged because the cost of fossil fuel-based generation does not currently include the cost of greenhouse gas emissions.
- Policy measures such as emissions trading will enhance investment certainty and not detract from economic development.
- New Zealand has a wealth of renewable energy resources, which supply around 70 per cent of our electricity. Our renewable electricity target is to increase the proportion of electricity generated from renewable sources to 90 per cent by 2025.
- Supplying 90 per cent of our electricity from renewable sources is technically feasible and economic with current technologies. However, higher proportions of renewable electricity would not be economic using current technology.
- If New Zealand achieves 90 per cent renewables electricity by 2025, then this – coupled with energy efficiency measures – will cut greenhouse gas emissions back to our 1990 emissions level.
- Developing a sustainable low emissions energy system will involve balancing local and global environmental impact, as well as energy prices.
- International research is strengthening efforts to develop technologies to reduce or capture the greenhouse gas emissions from fossil fuel electricity generation.
- To support these objectives, the government's focus is on providing the right economic framework, through an efficient market, effective infrastructure and supportive regulation including under the RMA to enable the ongoing development of renewable energy.
- The details of the government's programmes for encouraging the use of renewable energy are set out in the NZEECS.

From vision to action	Lead agency	Timing
The government has made an in-principle decision to introduce an emissions trading scheme.	Treasury/MFE	2007
The government has set a target for 90 per cent of electricity generated from renewable sources by 2025 (based on an average hydrological year).	MED	2007
The government is also considering regulatory options under the Electricity Act to support the government's objectives for limiting new baseload fossil fuel generation over the next ten years.	MED/ETG	2007
The government will continue the carbon capture and storage technical, regulatory and policy work programme to facilitate uptake and coordinate engagement in international partnership.	FRST/MED	Ongoing
The government is developing a NPS for renewable energy in 2008.	MFE/MED	2007/08
The EC and Transpower are developing planning processes and guidelines to better coordinate transmission and renewables investment.	MED/EC	2007/08

9.1 Our direction

About 70 per cent of New Zealand's electricity is generated from renewable sources, which is the third highest level in the developed world. This is good for the environment and also means that the expected future cost to our economy of electricity-related greenhouse gas emissions will be lower than for some of our trading partners, who rely much more on fossil fuels to generate electricity.

Nonetheless, if New Zealand continues on its current path, electricity demand is projected to grow at around 1.3 per cent per annum. At this rate of growth, approximately 3,900 MW of new capacity will be required to meet demand growth between 2005 and 2030. It is worth noting that this projected growth is significantly lower than recent historic levels of growth (around two percent per annum). Improved energy efficiency throughout the economy will lower the growth in demand, but a significant amount of new capacity is still expected to be needed.

In the absence of any price on emissions, projections suggest that approximately 2,325 MW of additional capacity needed would use fossil fuels. As a result, electricity-related greenhouse gas emissions would increase by approximately 50 per cent by 2030 if we do not change our course.[42]

The challenge set by this strategy is to reduce energy-related greenhouse gas emissions, while maintaining security of supply at competitive prices.

9.1.1 Reflecting the cost of emissions

The government consulted on a wide range of potential policy options to achieve New Zealand climate change objectives and address greenhouse gas emissions, including: direct regulation; information, promotion and voluntary initiatives; government funding of emissions reduction incentives; and narrow taxes and trading mechanisms. The feedback showed broad – although not universal – support for broad-based emissions trading. The government has decided in principle that New Zealand will adopt an ETS as its core price-based measure for mitigating climate change.

[42] Projections data are based on the base case from the renewable electricity target analysis available at www.med.govt.nz/nzes

9.1.2 Our renewable energy potential

New Zealand has significant renewable energy resources. Table 9.1 provides estimates of the potential electricity generation available from renewable sources by 2030, based on current technology and resource information. If electricity demand grows at projected rates, demand in 2030 will be approximately 12,400 GWh more than in 2006.[43] Geothermal resources, which provide baseload generation, are able to contribute some 900 MW (at least) of additional capacity. This is equivalent to more than seven years of demand growth by itself.

Table 9.1: New Zealand's renewable electricity potential

Primary energy source	2005 energy supplied (GWh/yr)[a]	Economic potentials (GWh/yr)[b]
Hydro	23,237	5,800
Geothermal	2,693	11,100
Wind	610	9,200
Total	26,540	26,100

Sources: [a] *New Zealand Energy Data File,* Ministry of Economic Development.
[b] Drawn from the latest Ministry of Economic Development generation industry analysis (unpublished).

Note: The 'economic potentials' included are identified prospective generation projects believed to be capable of development at costs less than 9c/kWh (electricity).

Substantial quantities of renewable capacity are likely to be less than or close to the cost of fossil fuel-based generation in the medium term, assuming an emissions price of $25/tonne of CO_2-equivalent (see Figure 5.7 in Part 1). New plant generation costs can shift, depending on changes in such factors as international demand for equipment, exchange rates, fuel prices, climate change policy and environmental constraints.

In considering the potential contribution of renewable generation to a sustainable energy future, the following factors need to be taken into account:

- the price and quantity of realisable renewable energy resources will vary depending on the outcome of consenting processes under the RMA
- economies of scale and the current market and regulatory environment tend to favour larger grid-connected renewable generation rather than distributed generation, with correspondingly more concentrated local environmental impacts[44]
- many renewable energy resources are remote from major load centres and will require a robust transmission grid
- renewables in the South Island will face higher transmission costs reflecting the distance from major load centres
- the intermittent nature of wind generation makes this form of generation less reliable – the economic cost of monitoring and managing this issue may put an upper limit on wind generation
- other renewable energy resources, such as marine energy, are not listed in Table 9.1. These resources may contribute towards New Zealand's electricity supply in the future, but are at a relatively early stage of development and are not currently economic.

[43] *Benefit-Cost Analysis of New Zealand Energy Strategy*, Ministry of Economic Development, September 2007.

[44] Notwithstanding economies of scale, renewable generation plants can be built in smaller increments than fossil fuel generation.

9.1.3 Distributed generation and small-scale generation

Distributed generation refers to a broad range of technologies that generate electricity close to the point where it is to be used, or supply electricity to other consumers through a local network at a distribution rather than a transmission voltage.[45] Distributed generation can contribute towards a sustainable energy future by:

- using renewable sources of energy or, in the case of cogeneration, using fossil fuels more efficiently than large-scale forms of electricity generation
- making our electricity supply more diverse and geographically dispersed
- making local networks more reliable and resilient, and potentially deferring future network investment by providing either voltage support or load during periods of peak demand (in the case of some distributed generation only)
- improving the energy efficiency of the electricity system by reducing transmission and distribution energy losses.

For remote communities, distributed generation may also be more cost effective than being connected to distribution networks (see section 8.4.6).

Distributed generation and small-scale generation face challenges that may limit growth in the short to medium term. Some technologies – particularly on the domestic scale – are technologically or commercially immature and cannot compete on cost with conventional forms of electricity supply. There are some market barriers to the use of distributed generation and small-scale generation.

Further investigation is required to determine the reliability and safety implications of widespread uptake of distributed generation and small-scale generation for local distribution networks.

'Smart' or advanced metering in conjunction with household-scale distributed generation is one step towards developing smart networks to manage power demand down to the residential level. Smart meters will enable more accurate time-based valuation of distributed generation exports, and will lower the cost of distributed generation metering for retailers (see section 8.4.5).

The government will seek to address barriers to the uptake of distributed and small-scale generation through the NZEECS.

Swift micro-turbine

Energy provider Vector is carrying out a trial of what is believed to be the world's first silent rooftop-mountable wind turbine. Swift micro-turbines, developed in Scotland, are being mounted at sites in Auckland and Wellington to explore the part micro-turbines may be able to play in the changing energy environment – particularly in the area of renewable distributed power generation. It has been estimated that Swift micro-turbines could provide 2,000–3,000 kWh of electricity a year in fairly modest wind conditions, which is between a quarter and a third of an average household's electricity needs.

Rooftop-mounted micro wind turbine.
Image courtesy of Vector Limited.

[45] Distributed generation includes smaller-scale generation (including wind, landfill gas, biomass and small hydro), cogeneration or combined heat and power plants, small stand-alone diesel generators, and domestic or small commercial photovoltaic solar generation.

9.1.4 Direct use of indigenous energy resources for heat

Direct use refers to consuming energy to produce heat in a variety of domestic, commercial and industrial applications. In 2005, 208 PJ or approximately 27 per cent of total energy consumption was associated with producing heat energy.[46] 42 PJ of heat energy in 2005 was provided by electricity, with the remainder being from direct use. Approximately 26 per cent of direct-use energy was from renewables, mostly geothermal and woody biomass. The majority of direct-use energy comprises fossil fuels, mainly coal (23 percent), oil (24 percent) and gas (26 percent).

In the residential sector, burning wood is an important and affordable renewable source of heat in many areas. Dry wood in modern wood burners or wood pellets in pellet burners can be used with low levels of particulate emissions. In areas where there are concerns about air quality, councils have a role to promote good practice for wood moisture levels and any necessary controls for burning appliances.

Good wood scheme

A firewood scheme run by Tasman District Council gives local wood suppliers a chance to play their part in reducing the air pollution caused by domestic wood fires. Suppliers who join the Good Wood Scheme are equipped with moisture meters to enable them to check the moisture content of the wood they sell. Dry wood is more efficient than green or damp wood, and wood for immediate burning should have a moisture content of less than 25 percent. The suppliers also give customers advice on ensuring their wood burners produce more heat and less smoke, resulting in cleaner, healthier air.

Tasman District Coucil's good wood suppliers.
Image courtesy of Dry Crest Communications Ltd.

The direct use of fossil fuels offers significant benefits to some sectors of the economy, such as the dairy processing, forestry and wood processing industries.

Switching to direct use of gas for space heating can reduce electricity demand, particularly at peak times. There may be fewer greenhouse gas emissions if gas is used directly to provide heat rather than generating electricity from gas- or coal-fired power stations. However, the comparative costs of gas appliances and their associated installation can be high. The growth of efficient forms of electric heating, such as heat pumps, may offset some of the potential gains from switching to gas.

The industrial sector has opportunities to substitute biomass and geothermal energy for some of its direct-use fossil fuel consumption, but much depends on location. Recent work by EECA suggests a price on carbon will improve the economics of switching from coal to woody biomass. Collecting and transporting biomass can be costly beyond a certain distance from the source, while only a few locations have suitable sources of geothermal energy. Some industrial sites may be able to cost-effectively use biomass by co-firing it with coal in existing heat plants.

[46] *New Zealand Energy Outlook to 2030*, Ministry of Economic Development, 2006.

Biofuel boiler

Meat marketing company PPCS will reduce its coal consumption and dispose of waste in a more environmentally friendly way with a $7.5 million bubbling fluidised bed boiler being built at its processing facility in Balclutha. The multi-functional boiler is likely to be run on a ratio of about 70 per cent sawdust and 30 per cent sludge from the company's wastewater treatment plant when it opens in mid-2008. The boiler will be able to burn around 80 per cent of the effluent solids produced at Finegand, and the resulting steam will be used on site.

Schematic of boiler.
Image courtesy of PPCS.

Renewable energy has the potential to supply low temperature heat for many residential and commercial applications. This includes solar hot water heating, efficient wood burners and possibly, in the future, ground source heat pumps.

9.2 The progress we've made

The government has already implemented a number of measures to reduce greenhouse gas emissions in the stationary energy sector.

9.2.1 Enabling renewables

- In 2004, the RMA was amended to ensure that the benefits from the development and use of renewable energy resources were considered in consenting processes.
- The RMA was amended again in 2005 to provide an improved consenting process to ensure high-quality and timely decision-making. The Resource Management Amendment Act gives more options for the development of NPS and National Environmental Standards that are relevant to major energy and other infrastructure projects.
- The 2005 amendments enabled the Minister for the Environment to make submissions on behalf of the Crown on nationally significant projects. Crown submissions have been made in support of two wind farms: Project Hayes in 2006 and the proposed Mahinerangi Wind Farm in 2007.
- In 2006, EECA established a regional renewable energy assessment programme to help regional and district councils identify renewable energy potential and use this information in their planning processes.
- Environment Waikato, in consultation with stakeholders and with the support of the government, has developed the Waikato Regional Plan to encourage the development of geothermal energy. Other regional and local councils have taken or are planning similar steps.
- The EC and Transpower released a report on the integration of wind power into the grid.
- EECA provides ongoing assistance to renewable energy associations, including the Sustainable Electricity Association of New Zealand, the New Zealand Wind Energy Association, the New Zealand Geothermal Association, the Bio-energy Association and the Aotearoa Wave and Tidal Energy Association.

9.2.2 Encouraging direct use

- The government supports bioenergy through the *Forestry Industry Development Agenda* (FIDA), which recently received additional funding. This programme focuses on increasing the use of wood waste and forest residues within the wood processing sector. Measures include raising awareness through a knowledge centre, demonstration projects and feasibility studies.
- EECA launched a new solar water heating programme in November 2006, focusing on expanding unit sales, improving quality and reducing prices.
- The Department of Building and Housing is developing guidelines on Building Code compliance for the installation of solar water heating and considering a water heating efficiency standard.

9.2.3 Facilitating distributed generation

- Regulations enacted in August 2007 help distributed generators connect to local lines. The regulations provide a standard application process and timeframes, regulated terms and conditions, pricing principles to ensure connection charges are fair and reasonable, and a process for resolving disputes.
- The EC has developed guidelines and model terms and conditions for agreements between electricity retailers and owners of small-scale distributed generation.

9.3 Our actions

9.3.1 Valuing low emissions energy

The government has decided in-principle that New Zealand will use an emissions trading scheme as its core price-based measure for reducing greenhouse gas emissions (see section 4.4 in Part 1).

Box 9.1: New Zealand emissions trading scheme (NZETS)[47]

In-principle decisions have been made on the following core design features:

- **Core obligation:** Points of obligation monitor and report emissions and surrender to the government one emission unit to cover each metric tonne of eligible emissions in a compliance period.
- **Coverage:** The NZETS will be introduced across the economy through a staged process such that, by the start of 2013, all major sectors of the New Zealand economy will be exposed at the margin to the international price of emissions for all operations, including liquid fuels from January 2009, and stationary energy from January 2010. The NZETS will include the six greenhouse gases specified in the Kyoto Protocol.
- **Unit of trade:** For the first commitment period, New Zealand Units (NZU) will be fully comparable to, and backed by, Kyoto units by the end of the period for determining compliance.
- **Cap:** A limited number of New Zealand emission units will be issued each year, and the scheme will operate within the global cap on emissions set by the Kyoto Protocol.
- **Linkages:** The NZETS will allow both sales to, and purchases from, certain international trading markets.
- **Compliance and enforcement:** Participants will face binding consequences for non-compliance with their obligations.

[47] A discussion document on the proposed emissions trading framework is available from www.climatechange.govt.nz

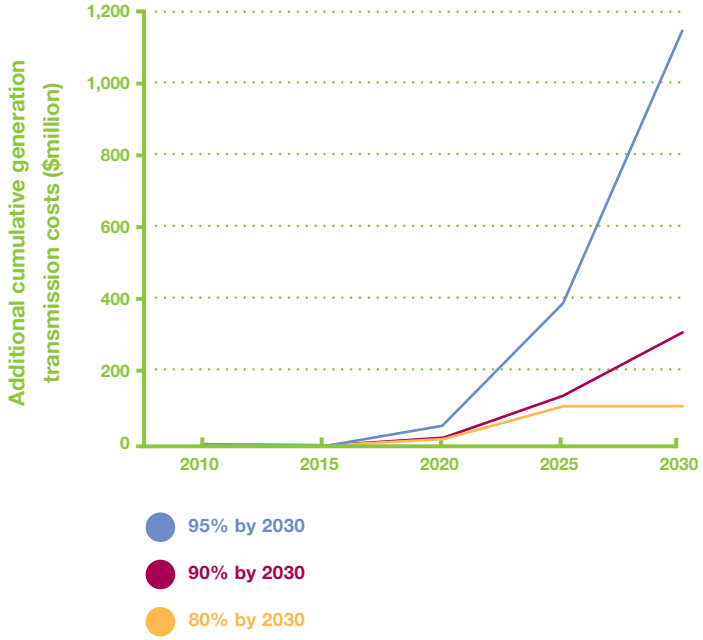
9.3.2 Maximising the contribution of renewables electricity

ACTION: The government has set a target for 90 per cent of electricity to be generated from renewable sources by 2025 (based on an average hydrological year).

The impact of a higher proportion of renewable electricity generation has been modelled by the government. This modelling looked at the proportion of renewable electricity generation achieved over the period from 2007 to 2025, with different emissions prices.[48]

Figure 9.1 below assumes a $25/tonne emissions price and shows the additional generation and transmissions costs from 2007 to 2030 to meet various renewable targets, while maintaining security of supply. Most of the additional costs are likely to be incurred after 2020, when existing fossil fuel plants are displaced and eventually retired.

Figure 9.1: Cumulative generation and transmission costs for renewable target levels



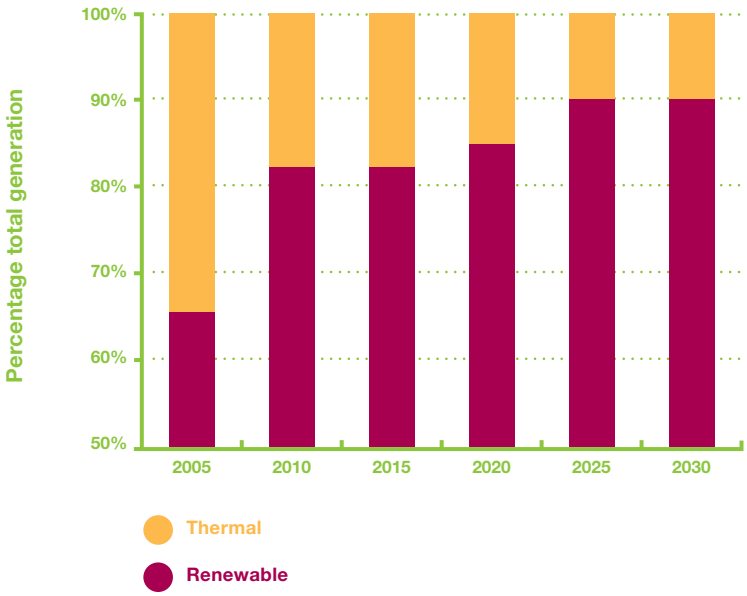
Source: Ministry of Economic Development

The additional costs of achieving proportions of renewable generation exceeding 90 per cent (around 95 per cent and above) are large. This is primarily because some renewable generation sources are intermittent, such as wind and hydro that are weather-dependent, so a higher level of renewable generation capacity is required to meet dry-year and peak-security constraints.

Modelling results show that 90 per cent of electricity could be generated from renewables in 2025, without imposing additional costs above those incurred under the 2030 target scenario. The chart below shows the expected generation mix for the scenario of achieving 90 per cent renewable electricity generation by 2025.

[48] The proportion of renewable generation refers to the percentage of total annual electricity generated (in GWh and from both grid-connected and distributed generation) from renewable sources in an average hydrological year.

Figure 9.2: Proportion of electricity generated from renewable sources



Source: Ministry of Economic Development

Achieving the target of generating 90 per cent of electricity by renewable sources by 2025 will require:

- market and regulatory structures to enable investment in a diverse range of renewable generation projects, including small-scale and distributed generation
- a robust transmission grid to support the development of renewable energy resources remote from major load centres
- prudent monitoring and management of security of supply, including minimising the potential detrimental impacts of intermittent forms of renewable generation on system security, as well as recognising the value of fossil fuel generation for supporting security and operational requirements
- investing in and encouraging demand-side management, energy efficiency (see chapter 10) and emerging technologies, such as marine and CCS (see chapter 11).

The government is confident sufficient quantities of renewable generation exist and can be developed without unacceptable or adverse environmental effects. The government also accepts that some economically viable projects should not proceed because of local environmental effects. Actions to give local decision-makers guidance on balancing local and national interests in the development of local renewable resources are discussed in section 9.3.5.

It is difficult to anticipate the impact of major technological developments such as CCS or other significant changes, such as higher international costs of carbon. The results presented here should not be regarded as an authoritative statement of the future but an indication of what is currently economic.

9.3.3 Leadership on the future role of fossil-fired generation

New gas-fired baseload generation will increase net electricity emissions over its economic life, except to the extent that it displaces existing older, less efficient generation. It will also increase demand for gas, which may make it more likely that New Zealand will need to import LNG in the future. Our electricity prices could then be linked to international oil and gas prices for the first time in our history.

Huntly, which runs on coal, will be needed for some time, especially in dry years. It is arguably less likely that Huntly will be able to lower emissions from using indigenous gas as a substitute for coal if gas demand for new gas-fired power stations increases.

The world is in a state of transition. The government believes that, during this transition, some areas of the energy sector would benefit from clear guidance to ensure we make the necessary changes to reduce our emissions of greenhouse gases.

As a result, the government has stated a clear preference that all new electricity generation be renewable, except to the extent necessary to maintain security of supply. In support of this principle, and providing time for the full introduction of a price on greenhouse gas emissions, the government's view is that there should not be a need for any new baseload fossil fuel generation investment for the next ten years. The government expects all generators, including state-owned enterprises, to take its views into account when considering new generation investments, and the government will advise state-owned enterprises that it expects them to follow this guidance.

Currently there are no powers to regulate or restrict new fossil fuel generation. The government will consider regulatory options to reinforce the government's objectives for limiting new fossil fuel generation. It is important that any new regulations are a flexible and effective means to restrict new fossil fuel generation except where necessary to ensure security of supply.

ACTION: The government is considering regulatory options under the Electricity Act to support the government's objectives for limiting new baseload fossil fuel generation over the next ten years.

9.3.4 Carbon capture and storage

The variable nature of renewable electricity generation gives fossil fuels an ongoing role, although their greenhouse gas emissions will need to be addressed.

Coal, mainly in the form of lignite, is New Zealand's most abundant fossil fuel. The government does not favour substantial increases in the use of coal or gas until technologies such as CCS become viable.

ACTION: The government will continue the CCS technical, regulatory and policy work programme to facilitate uptake and coordinate engagement in international partnership.

9.3.5 Environmental effects and the Resource Management Act

The RMA promotes the sustainable management of natural and physical resources. The management of electricity and heat generation under the RMA seeks to avoid, remedy and mitigate the associated environmental effects. Developing consent applications for electricity and heat generation requires investigative work that incurs a cost and can cause commercial uncertainty.

All forms of energy generation have some adverse environmental effects. Proposals with unacceptable adverse effects should not proceed, but our commitment to a renewable electricity target requires a substantial increase in renewable capacity overall.

In 2004, the RMA was amended to include section 7(j), which states that, in exercising the functions and powers under the Act, all persons shall have regard to the benefits to be derived from the use and development of renewable energy. Recent Environment Court decisions have provided further guidance on how decision-makers could consider these benefits in resource consents, policy and plans.

Many submitters have asked the government to provide national guidance on renewable energy projects. The government is responding by developing a proposed NPS on renewable energy to help decision-makers weigh up the national benefits of renewable energy. Councils have to incorporate a NPS in their regional policy statements and regional and district plans, and must consider it when deciding whether to grant consent applications.

The government intends to develop a NPS on renewable energy that could be in place in 2008. Key stakeholders will be consulted before drafting begins. The NPS could be developed for specific types of renewable generation, such as wind and geothermal, and reviewed later to include marine energy, hydro or biomass.

The government can also take the lead in ensuring that consenting processes are completed in time for sensible energy planning and construction. There is growing interest in the Minister for the Environment's call-in powers under the RMA. Calling in a project and referring it to a Board of Inquiry or directly to the Environment Court can reduce the time involved in granting consent to renewable energy projects, particularly projects that involve more than one local authority or are of national significance. In projects that are called in, appeals can only be made on points of law. A Board of Inquiry or the Environment Court would still hear applications locally and would have regard to the same district and regional council planning rules as would a local authority. The Board of Inquiry or Court must also have regard to the Minister's reasons for calling the matter in.

The Ministry for the Environment is setting up a pool of commissioners to draw from when commissioning Boards of Inquiry to hear called-in renewable energy proposals. It will also provide guidance on the use of the call-in power.

ACTION: The government is developing a NPS on renewable energy in 2008.

9.3.6 Coordination of transmission and renewable generation investment

Organisations considering investing in generation typically require transmission to be committed first to ensure they can deliver the power from their planned generation to market. Similarly, those funding transmission assets want a commitment from generators. This coordination problem is exacerbated by the substantial difference in lead times for transmission and some generation investments. Investment coordination can be particularly problematic for renewable generation because:

- generation is often remote from existing load centres and major transmission lines
- individual renewable generation plant is typically small relative to the size of the regional demand.

Without a clear policy to facilitate good coordination, there is a risk that some generator developers will be deterred from exploring renewable generation options in regions where there may be insufficient grid capacity.

ACTION: The EC and Transpower are developing planning processes and guidelines to coordinate transmission and renewables investment.

9.4 Into the future

New Zealand will have greater choice on ways to reduce greenhouse gas emissions in future. Fast-moving international investment in research into emission reductions is expected to increase the range of renewable or low carbon generation technologies.

A developing technology of significant potential for New Zealand is marine power – generating electricity from waves or tidal currents. Some countries are already using marine power devices commercially, with government support. New Zealand has a vast marine energy resource that would have the advantage of being less intermittent than wind.

The government is establishing a marine energy deployment fund to hasten the development of marine power. Further work planned under the NZEECS includes developing a marine energy atlas and helping regional councils with their coastal planning processes.

10. Using energy more efficiently

Summary

- The NZEECS is the dedicated and detailed action plan for whole-of-system energy efficiency.
- This chapter sets out an overview of energy efficiency initiatives to reduce growth in demand for stationary energy, which includes all forms and uses of energy services other than transport and mobility, which is covered in Chapter 7 of this action plan.
- Historically, New Zealand has not been particularly efficient in the way it uses energy.
- Energy efficiency measures can reduce energy costs and greenhouse gases, enhance security of supply and provide other benefits to people, communities and the economy.
- The EC's draft *Electricity Efficiency Potentials Study* and the cost-benefit analysis of the NZEECS provide a more robust guide to cost-effective energy efficiency improvements.
- The government believes everyone should make energy savings in areas where the savings are cheaper in the long run than the financial and environmental costs of supplying more energy.
- The NZES applies a discount rate of five per cent real per annum to economic cost-benefit assessment of government actions under the NZEECS rather than the ten per cent per annum rate. This will better reflect the long-term benefits of energy efficiency.
- Improving information on how and where energy is used is crucial in designing energy efficiency measures.
- The government has a role in ensuring pricing and other incentives encourage energy efficient choices, and in addressing any significant market barriers to energy efficiency.
- The government will continue to assess the costs and benefits of actions to improve energy efficiency to ensure they give value for money at a national level.

From vision to action	Lead agency	Timing
The government will clarify roles and accountability arrangements for energy efficiency policy development and programme delivery.	MED	2007
The NZEECS contains programmes to improve energy efficiency for both stationary and transport energy based around the following objectives: • *Energywise* homes • *Energywise* business • *Energywise* farms and rural communities • *Energywise* transport • Our renewable and efficient electricity system • Government leading the way.	EECA	2007/08

10.1 Our direction

New Zealanders need an energy system that is reliable, resilient, and fairly and efficiently priced in the future. Energy efficiency will be an important part of achieving this goal.

Energy efficiency measures can:

- reduce energy costs, including the need to build more costly electricity generation capacity
- reduce greenhouse gas emissions and other local effects from the production and use of energy
- enhance security of supply by increasing the margin between supply of energy and demand, particularly at peak times
- enable economic and environmental resources to be used more efficiently
- provide other benefits to people and to communities, such as creating warmer homes that lead to better health
- increase public awareness of energy issues and of the everyday energy efficiency measures that can contribute to our sustainable energy goals.

Much of what we consume, from paper to processed food, requires significant amounts of energy to produce. The cost and environmental impact of this lifestyle is increasing, and unchecked demand growth affects our energy security.

The price of energy is likely to continue to rise as more expensive supply options are developed. Energy is generally produced remotely, so we tend not to notice the impact of our energy use.

Energy efficiency can be defined as the ratio of productive output to energy use. Improving our use of energy is about cost-effectively reducing the amount of energy required to create a given quantity of a product or service (such as a litre of milk, or a warm room).

New Zealand is not particularly efficient in the way it uses energy, and there are many opportunities to make improvements. Saving energy makes common sense in areas where the savings are cheaper in the long term than the financial and environmental costs of generating more energy.

Cost-effective energy efficiency measures are often a better way of dealing with the demand for more energy than building new generation capacity because they can offer other benefits. For example, improved building insulation can make people healthier, reduce heating costs and energy-related greenhouse gas emissions, and ease energy supply constraints in winter.

10.2 The progress we've made

Existing measures to encourage New Zealanders to use energy more efficiently in the stationary energy sector have centred around products, homes, buildings and industry:

- *Energywise* home grants have helped retrofit insulation in over 30,000 pre-1977 houses occupied by low income families. The project has had major health benefits for the families involved, particularly for people with asthma or other respiratory illnesses.
- The government's solar water heating finance assistance programme encourages people to use solar water heating and strengthens the industry.
- The EC's electricity efficiency initiatives include a compact fluorescent lamps campaign and pilot projects for compressed air systems and motors in industry. These initiatives have already made savings of 208 GWh per annum at a cost of $4.58 million.
- The Department of Building and Housing is reviewing the Building Code to target significant energy efficiency improvements in houses and buildings. Public consultation on the review will include the possibility of using carbon dioxide emissions as a measure of the whole-of-life resource efficiency.
- EECA is cooperating in the joint New Zealand and Australia minimum energy performance standards and labelling programme covering appliances and various types of machinery. Endorsement labelling has also been introduced for highly efficient products.
- EECA's Emprove programme provides energy audit grants and support to the country's 300 largest industrial energy consumers to introduce energy efficiency initiatives. Savings reported by consumers in 2005/06 were 2.2 PJ.
- The EC has completed an economic assessment of barriers to using electricity-efficient technologies in commercial buildings.
- EECA supports the *Energy Intensive Business* programme, which provides cash grants for demonstration projects for energy efficiency measures in target industries.
- The government has shown leadership in implementing energy efficiency measures in buildings, transport and appliances through the 47-agency Govt[3] programme.

10.3 Our actions

Barriers that slow down the rate at which we can improve our energy efficiency include:

- the lack of reliable information on costs and benefits, including energy prices that do not fully reflect all costs
- energy price signals are often weak and do not sufficiently encourage some households and businesses to take cost-effective measures, especially at times of peak demand
- the absence of appropriate incentives (for example, for architects, builders and landlords)
- the low priority of energy efficiency for consumers, which is partly because of relatively low historic energy prices
- competition for time and attention to implement opportunities
- access to capital for energy efficiency investments.

These barriers are largest for smaller consumers, especially households, and smallest for major energy-intensive industries.

The government supports households and businesses voluntarily investing in energy efficiency improvements, but has a more active role to play when there are barriers that prevent cost-effective energy efficiency investments being made, for example, it will help fund the retrofitting of older houses occupied by low income families.

Rapid progress depends on government policies, market forces and public acceptance to:

- change behaviour around capital and technology investment decisions and consumer lifestyles and choices
- deploy technologies particularly suited to New Zealand conditions
- ensure energy efficiency is considered in the upgrade, design and management of processes, buildings and infrastructure.

Interventions will be guided by the principles and framework set out in this strategy and in the NZEECS and will be subject to detailed analysis of their costs and benefits.

10.3.1 The *New Zealand Energy Efficiency and Conservation Strategy*

The government's policies, objectives, targets and means for energy efficiency, energy conservation and the use of renewable energy are set out in the NZEECS, a statutory document that is a subset of this strategy.

The NZEECS sets out actions to promote more efficient use of energy. It focuses on implementation by sector, identifying the main measures, policy instruments and who is responsible for them.

In the stationary energy efficiency area, the NZES has two main priorities that guide the actions of the NZEECS.

The first priority is maintaining security of energy supply. For electricity, this is essential for both dry-year energy and peak demand. Energy efficiency can improve energy security by reducing demand and reducing peak load.

The second priority is to facilitate investment in energy efficiency measures that are cheaper in the long run than the costs of building extra generation and network capacity, including environmental impacts such as the cost of greenhouse gas emissions.

10.3.2 Filling information gaps

Gaining information on energy use is crucial in designing energy efficiency measures. More information is becoming available on homes, but significant gaps exist in the commercial and industrial sectors. To establish whether large-scale investment in energy efficiency to reduce demand is cheaper than new supply, it is important to have reliable information on the net benefits of saving energy. This includes the cost of programmes for consumers,[49] the value of the energy saved and any co-benefits.

Analysis carried out by the EC and EECA has significantly improved the information needed to design energy efficiency programmes, and will continue to be refined and updated. A significant project is under way to improve our understanding of energy use in commercial buildings.

10.3.3 Government discount rates

Energy efficiency initiatives are assessed using cost-benefit analysis. As the costs and benefits accrue over many years, a discount rate places a lower value on those costs and benefits occurring in the future. Currently, government cost-benefit analysis typically uses discount rates of ten per cent real, which undervalues long-term savings. The discount rate used for all government policy-making in the United Kingdom has recently been revised to 3.5 per cent real per annum. Using the same approach as the United Kingdom, this strategy has adopted a discount rate of five per cent real per annum for cost-benefit analyses of energy efficiency and other measures under the NZES.[50]

[49] For more information, see *Benefit-Cost Analysis of the New Zealand Energy Strategy,* Ministry of Economic Development, 2007, available at www.med.govt.nz/nzes

[50] Higher discount rates will be included in the assessment of initiatives as part of sensitivity analysis.

10.3.4 Opportunities for greater energy efficiency

The EC's draft Electricity Efficiency Potentials study identifies the cost-effective electricity efficiency potential of the New Zealand economy, and the EC's role in realising this potential. The information produced by the potentials study will underpin the EC's future electricity efficiency activities.

The EC's potentials study is yet to be finalised, and the results presented in this strategy are subject to review. The draft report shows economic potential for electricity savings of up to 13 per cent of base electricity use by 2016, and that savings[51] of five per cent of base electricity use are achievable and cost effective through electricity efficiency programmes that the EC could implement. Achievable potential takes into account market barriers and reflects consumer discount rates.

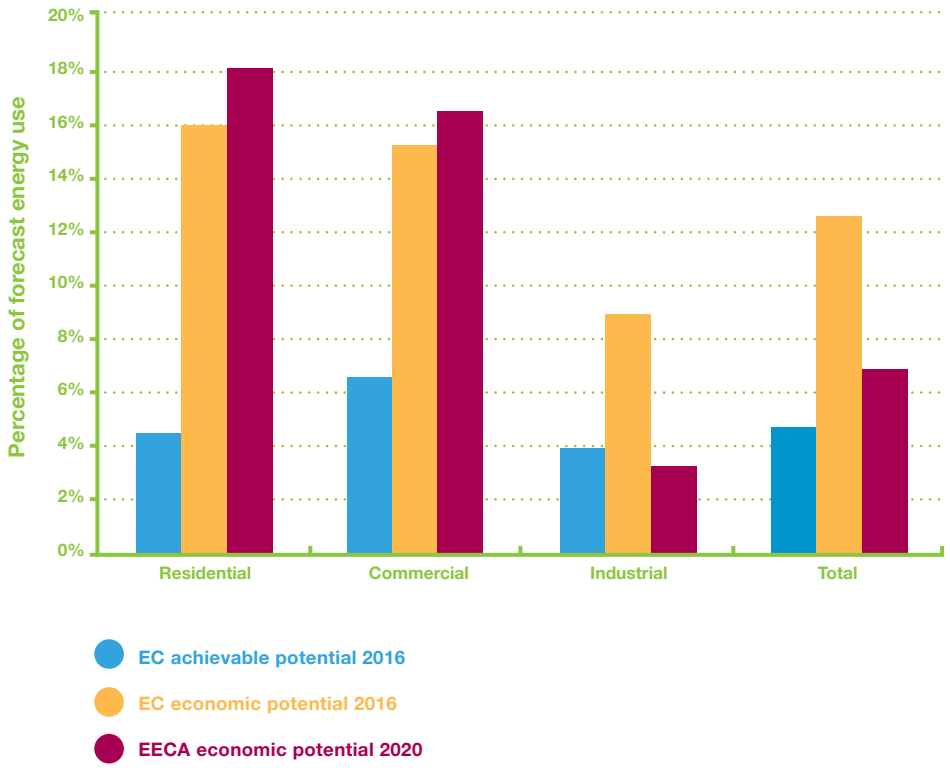
The EC work also suggests that long-term savings could be much higher, with increased uptake and developments in technologies.

EECA has also produced analysis of potential energy efficiency gains, which reflects a wider range of benefits.[52] The value of co-benefits, such as reduced greenhouse gas emissions and outcomes for householders such as health benefits from warmer houses and cleaner air, are important inputs into assessment of the net benefits of government interventions. Studies have shown, for example, that household retrofit programmes can deliver a two-for-one benefit by improving the health of vulnerable families.

EECA's analysis shows economic potential for energy savings in residential and commercial sectors of around 18 per cent of projected baseline demand (see Figure 10.1).

The actions set out in the NZEECS are supported by the cost-benefit analysis by the EC and EECA.

Figure 10.1: Potential for energy efficiency improvements



Source: Ministry of Economic Development

[51] Economic potential is based on efficiency measures that are cost effective from a total resource cost perspective that includes the value of avoided electricity production and the costs of individual programmes.

[52] *Sustainable Energy Value Project*, Covec, 2007.

10.3.5 Promoting energy efficiency

Government leadership and action from firms and individuals will be needed to substantially improve energy efficiency. People will be more able to make cost-effective choices if they are given the right information when they buy a product. Incentives to encourage people to minimise costs over the lifecycle of their assets, rather than just the initial costs, will also improve energy efficiency.

Government leadership

The government will continue encouraging the wider public service to take energy efficiency and conservation measures and to use renewable sources of energy. The core public service is already taking steps to enable it to be carbon neutral from 2012. Govt[3] is a programme for core central agencies, departments and ministries, focusing on four key areas:

- recycling/waste minimisation
- buildings
- transport
- office consumables and equipment.

There are also two major cross-cutting themes – sustainable procurement (also known as sustainable purchasing) and energy efficiency.[53]

Pricing mechanisms

Accurate prices are necessary to signal the actual costs of energy supply. The proposed ETS will incorporate the cost of greenhouse gas emissions in energy prices, but the energy efficiency initiatives set out in the NZES and the NZEECS can help reduce the impact on power bills.

At present, smaller electricity consumers and householders do not have the smart metering technology and tariffs to enable time-of-use electricity pricing. The EC is working on setting out guidelines for the introduction of smart meters. The government will also continue to provide estimates of future prices to help firms and individuals make decisions on investing in energy-using plant and equipment.

Information and labelling

Existing appliance labelling and the proposed *Home Energy Rating Scheme* emphasise energy efficiency. These initiatives help people to make better energy choices and provide a basis for the possible introduction of minimum performance standards and incentives.

For new buildings and other long-lived assets where energy use is locked in for decades, it is important that high-quality information and analysis supports design decisions. The ongoing review of the Building Code and the use of best practice standards will improve design decisions at low transaction costs.

Equipment suppliers and the energy industry can help consumers make even better choices in future, provided they have clear drivers to do so. The government also helps consumers make cost-effective investments by providing independent information and maintaining programmes that demonstrate the value of new technologies and energy efficient assets.

Government support for information and monitoring initiatives are especially justified where initiatives also offer significant health and social benefits, such as with the *Energywise Home Grants Programme*.

[53] For more information on Govt[3] go to http://www.mfe.govt.nz/issues/sustainable-industry/govt3/about.php

Incentives

The government provides direct financial incentives for investment in energy efficiency measures that offer substantial net public benefits and would not occur without government support. The electricity industry levy, for example, can support investment to achieve electricity savings that are cheaper than the cost of new supply. The government is particularly active in improving residential energy efficiency by providing grants and interest-free loans for insulation, clean heating and solar hot water.

For businesses, grant and subsidy programmes to upgrade industrial motors and compressed air will be expanded. In the rural sector, the FIDA for bioenergy and distributed generation will be extended.

Standards

Where there are weak incentives for the market to deliver solutions with net public benefits, the government has a role in setting minimum standards. There are already minimum energy performance standards at point of sale for some appliances and for building construction.

The government will extend the current *Minimum Energy Performance Scheme* (MEPS) through the NZEECS to include several new product classes and update stringency levels for existing product classes.

Institutional issues

Government agencies that support improved energy efficiency in the stationary demand sector include EECA, the EC, the Ministry for the Environment, the Department of Building and Housing, and Housing New Zealand Corporation. EECA and the EC have a common objective – to promote the use of electricity in an efficient and environmentally sustainable manner.

EECA's main roles are to deliver energy efficiency programmes, provide advice to the Minister on energy efficiency in general, and give advice on how energy could be used more efficiently. The EC's main roles are to act as regulator of the electricity industry and to ensure that electricity is produced, delivered and used in an efficient, fair, reliable and environmentally sustainable manner.

The two agencies have developed a memorandum of understanding setting out the way they will manage the areas that overlap.

Private firms are to be applauded for investing in measures to help consumers become more energy efficient. However, there is scope for even more effort, particularly from energy companies and retailers, through leveraging off existing commercial relationships and through government partnering with third parties. The government has allocated a substantial amount of additional funding to deliver a wider range of residential energy efficiency through third parties.

Local government will continue to play a valuable role in delivering programmes and policies, including administering the Building Code and the RMA, and making decisions on urban form and transport planning.

ACTION: The government will clarify roles and accountability arrangements for energy efficiency policy development and programme delivery.

10.4 Into the future

Measures to improve energy efficiency are described in detail in the NZEECS.

Energy-saving prisons

New Zealand's prisons are modelling energy-saving ideas. A Christchurch prison recycles the leftover heat from its laundry dryers, while an Auckland prison has installed sensors that switch off lights when rooms are empty. Several prisons use solar heating systems instead of gas to provide hot water. Energy-saving initiatives have been adopted in 18 major sites and in 94 Probation Service and Offender Services offices, while energy efficiency is being incorporated into the design and construction of four new prisons.

Energy Manager Cees Ebskamp examines solar panels at Rimutaka Prison.
Image courtesy of the Department of Corrections.

11. Sustainable energy technologies and innovation

Summary

- Affordable, energy efficient, low emissions technologies will be critical to improving New Zealand's security of supply and reducing greenhouse gas emissions. Sustainable energy is likely to be sourced from more diverse and distributed sources, including energy efficiency.
- In the short term, increasing the contribution of renewable energy and improving energy efficiency can significantly slow the increase in New Zealand's energy-related greenhouse gas emissions.
- Ongoing technological developments such as electric cars and CCS, behaviour change and infrastructure investment are fundamental to progressively decarbonising the energy system over the long term.
- No single technology will achieve New Zealand's energy objectives by itself. Using a range of technologies will maximise the benefits to New Zealand and minimise the risks from technologies that make less progress than expected.
- New Zealand needs to be well connected with international research efforts while carrying out its own research into potential solutions for its own unique mix of energy resources, energy infrastructure, cost structures and social values.
- Policy certainty, transparency, effective regulation and other incentives are important to support high levels of innovation and implementation.

From vision to action	Lead agency	Timing
The government will continue to support initiatives to build capacity and link participants from the research community, industry, and central and local government to bring forward a low carbon and sustainable energy future.	MED and others	Ongoing
The government has introduced business tax credits for research and development expenditure.	IRD	2007 onwards
The government will continue to facilitate participation in international technology and collaborative research efforts in areas relevant to New Zealand.	MED	Ongoing
The government is establishing a contestable fund of $8 million over four years to bring forward deployment of marine generation devices in New Zealand.	EECA	Oct 2007
The government is establishing a contestable fund of $12 million over three years to support new low carbon energy technologies.	FRST	Jul 2008

11.1 Our direction

Technological innovation can boost productivity, improve our quality of life, create new industries and solve environmental problems. The government has a role to play in encouraging innovation and supporting private sector initiatives.

Moving to a secure zero or low carbon energy system will require major changes in the production, delivery and use of energy services such as electricity, heat and motive power. There are already many innovations to save energy, reduce emissions and delay the need for costly energy infrastructure investments, including hybrid cars, efficient diesel vehicles, efficient wood burners, efficient lights, smart meters and 'green' buildings. Energy efficient technologies and practices available to businesses include motors, boilers and sophisticated energy management and control systems.

Some of these developments are already economic over their lifetime: in other words, the savings in energy costs more than cover the cost of purchase and installation. A key challenge is to encourage more energy consumers to adopt them. The NZEECS focuses on improving energy efficiency and increasing the use of renewable energy.

Over the coming decades, sustainable energy technologies from overseas and New Zealand will increase the number of options, and provide opportunities to commercialise climate-friendly technologies and practices.

In the short term, better material and waste recovery technologies, advanced materials, cleaner coal technologies and energy substitution technologies will help keep existing energy supplies affordable and available.

New technologies also increase the diversity and availability of low carbon stationary and transport energy. New renewables such as marine energy, offshore wind, deep geothermal, and fossil fuel power generation with CCS will help decarbonise global electricity supplies in the medium term. The use of biofuels and the evolution of vehicles – from petrol to diesel to hybrids to electric – have significant potential to substantially reduce transport-related emissions.

Over the longer term, there is likely to be an increasing number of cost-effective alternatives to the way energy services are provided. Ideally, we will reduce our need to use fuel by, for example, using passive solar design to heat buildings and by using advanced communications technology as a substitute for travelling to meetings. Innovative energy supply technologies may include improved battery technology, fuel cells and hydrogen.

Two key messages can be taken from global energy research and development.[54]

The first is that there are already low carbon technologies and practices that can make a difference over the next 10–50 years. International research focuses on nuclear energy, CCS, energy efficiency, renewable electricity generation from new sources, vehicle technologies, biofuels, clean fossil fuels and hydrogen.

[54] *Energy Technology Perspectives: Scenarios and Strategies to 2050*, International Energy Agency, Paris, 2006.

The second message is that no single technology will make a sufficient difference on its own. Pursuing a range of technologies will increase the opportunities and reduce the risks and, potentially, the costs if one or more fails to make the expected progress.

New Zealand needs to keep up to date with international research into emerging technologies and practices, particularly in relation to vehicles, CCS and renewables. Our researchers must be able to engage with international work programmes, and we must prepare to adopt new technologies by doing the necessary policy, regulatory and legal groundwork.

However, New Zealand-based research is needed to harness our indigenous energy supply options and to identify appropriate energy demand technologies and practices, energy efficient buildings, urban design and sustainable transport systems.

The NZES, the NZEECS, climate change policies and the *New Zealand Transport Strategy* provide the high-level objectives around enhancing security of supply and mitigating the global and local environmental effects of energy production and use. A flexible approach is needed to meet these objectives, given that a wide range of potential technologies and practices is likely to emerge in future.

The NZES maps out an ambitious pathway for greenhouse gas emissions reductions. This is based on assumptions around the availability of technologies, capital turnover, behaviour change, an effective physical infrastructure and public willingness to drive the necessary changes. There are two significant milestones for accelerating clean energy and emissions reductions.

By 2025:

- the economic, environmental and social value of energy efficiency in homes, businesses, travel and trade will be widely accepted and incorporated into the daily lives of New Zealanders
- transport, particularly the light vehicle fleet, will meet a significant proportion of its demand from low carbon fuels, such as biofuels and renewable sources of electricity
- low cost renewable technologies (including wind, geothermal and possibly some marine) will help to achieve the renewable electricity target
- electricity and heat for industry will be produced from low carbon sources and near-zero process emissions, and CCS technologies will be used.

By 2050 and beyond:

- the switch to a low carbon New Zealand energy system will be largely complete. Demand will have significantly reduced, and the overall energy mix will include a large proportion of renewable electricity and biofuels, CCS and the use of alternative energy storage systems such as high performance batteries and hydrogen.

In step with other countries, New Zealand is adopting a broad framework to encourage sustainable energy technology development and innovation. This includes:

- creating a market and economic incentives to increase the use of new technologies, including introducing carbon pricing to provide an incentive to adopt innovations and to use low carbon technologies
- ensuring regulatory and legislative frameworks are in place to support long-term investment, including removing barriers and maintaining regulatory arrangements to set up the infrastructure to accommodate new technology
- ensuring we have the necessary technical skills and capabilities to adopt and adapt technologies when they become available and economic
- introducing incentives and support, such as well targeted funding from public and private sources
- improving monitoring of technology, behavioural and commercial developments, as well as improving links to relevant international research and development
- assessing the opportunities for rapidly adopting key technologies and practices, and managing any associated challenges.

11.2 The progress we've made

11.2.1 *Energy Research Roadmap*

In 2006, the Ministry of Research, Science and Technology prepared an *Energy Research Roadmap* with stakeholders to identify the research capabilities New Zealand needed to develop sustainable technologies and practices. The roadmap identified four broad roles for energy research in New Zealand[55]:

1. New Zealand lead – for research that must be carried out in New Zealand to reflect our unique energy resources or energy uses.
2. Fast adapter – to enable New Zealand to quickly adapt technologies and practices developed overseas.
3. Emerging opportunities – to ensure we can identify and evaluate new energy opportunities identified overseas for possible future use in New Zealand.
4. Niche/commercial opportunity – to recognise energy innovations that may provide commercial opportunities for New Zealand, regardless of whether they are used here.

11.2.2 Public energy research and development

New Zealand's total public investment in energy research through Vote Research, Science and Technology is close to $18 million per annum.[56] This is invested through the Foundation for Research, Science and Technology and is targeted at specific energy objectives. Additional research in universities is funded through Vote Education. This funding is not targeted to meet specific outcomes.

In 2007, the Foundation for Research, Science and Technology made three short-term linked investments to improve our understanding of future energy opportunities:

- the *New Zealand Energyscape*, led by the National Institute of Water and Atmospheric Research Limited (NIWA) ($1.3 million), assesses the range of indigenous energy resources and their potential contribution
- *Bioenergy Options*, led by Scion ($1.1 million), assesses the range of indigenous bioenergy options in a similar way to Energyscape
- *Hydrogen Economy*, led by CRL Energy ($0.5 million), identifies the role hydrogen could play in New Zealand's energy system.

A further investment in CCS opportunities has been part funded by industry representatives.

11.2.3 International partnerships and collaborative research

The benefits of international research efforts to New Zealand include: cost efficiency; less duplication of research; the ability to pool scientific and technical results; access to expertise and experience; the ability to forge links between researchers, industry and policy-makers; accelerated development and deployment of technologies; harmonised technical standards; and the opportunity to strengthen and demonstrate New Zealand capacities and skills.

New Zealand's most significant international links are:

- IEA implementing agreements. These technology collaborative contracts enable international experts to work collectively and share results. New Zealand is officially a member of seven IEA implementing agreements, which cover greenhouse gases, bioenergy, geothermal, solar heating and cooling, wind energy systems, hydrogen, and energy conservation in buildings and community systems.
- *International Partnership for the Hydrogen Economy* (IPHE). Led by the United States, the IPHE has major international backing and covers the entire spectrum of hydrogen technologies.

[55] At this stage, the roadmap does not identify or prioritise the more detailed research programmes.

[56] The bulk of this was invested in the Research for Industry output class, and to a lesser extent, the Environmental Research output class, both from Vote Research, Science and Technology administered by the Foundation for Research, Science and Technology. The remainder ($0.4 million) was provided in the form of business-related Vote Research, Science and Technology investments under Technology New Zealand.

- *Renewable Energy and Energy Efficiency Partnership* (REEEP). This is an international energy organisation focusing on facilitating energy efficiency and renewable energy projects in developing countries.
- *APEC Energy Standards and Information Systems Project* (APEC ESIS). This is a collaborative New Zealand-led project managed by a steering committee made up of energy experts and officials from Australia, Japan, New Zealand, Thailand and the United States. The primary objectives of APEC ESIS are: to provide up-to-date information about appliance and equipment energy standards and regulations; to provide links to experts and information related to standards and regulations being used by APEC and other economies; and to provide 'communities of practice' where experts and officials can discuss efforts to harmonise the testing and labelling of appliances and equipment, and to develop minimum energy standards for them.
- International development of MEPS and product energy efficiency labelling systems. Mandatory energy efficiency standards list the technical requirements that certain products must meet, while technical standards and specifications underpin voluntary and mandatory labelling regimes. Almost all our standards are, or soon will be, joint standards with Australia.

11.3 Our actions

New Zealand's international collaboration, research funding and the capabilities roadmap are all important steps towards developing sustainable technologies and practices. However, further measures are needed to help us create a low carbon energy future.

11.3.1 Enabling zero and low carbon technologies

An emissions trading scheme will help to create a market for emissions reductions and give an economic incentive for innovation.

Other important developments include some of the actions included in this strategy to encourage innovation (such as the expert group for new vehicle technologies) as well as setting a conducive policy framework and removing barriers to long-term investment in low carbon technologies.

11.3.2 Energy innovation priorities

Establishing research excellence in key areas will help New Zealand stay connected to international research efforts.

The Ministry of Research, Science and Technology is looking at transformational areas of research, science and technology (TRST) in which new investments can make substantial differences to economic, environmental or social outcomes for New Zealand. A TRST proposal for making renewable energy work for New Zealand is under development, with a focus on the piloting, demonstration and proving stages of new renewable energy technologies.

11.3.3 Increasing capabilities and improving coordination

The transition to a sustainable energy future will take place over many years. New Zealand will need to build on the strengths of the energy research community and foster stronger links with representatives from energy companies, regulators, and central and local government.

National Energy Research Institute

A new research organisation has been set up to coordinate energy research and to examine ways to curb carbon emissions. The National Energy Research Institute (NERI), a network of universities and other research institutions, was established in July 2007 with the help of a $1.5 million grant from the Tertiary Education Commission. NERI's activities will include improving energy education, developing a database of energy researchers, setting up a digital database on energy topics and running master classes and conferences. NERI will also encourage a stronger emphasis on collaboration between research organisations, and support cross-disciplinary research between the energy industry, consumers, iwi and the government.

Dr Janet Stephenson and Professor Gerry Carrington.
Image courtesy of National Energy Research Institute.

ACTION: The government will continue to support initiatives to build research capacity and link participants from the research community, industry, and central and local government to bring forward a low carbon and sustainable energy future.

Box 11.1: Private-public partnerships on technologies

Carbon capture and storage is an emerging technology that has the potential to greatly reduce carbon dioxide emissions from burning fossil fuels such as coal and natural gas.

The transportation and injection elements of CCS are not new, but it has not yet been demonstrated that carbon dioxide can be stored geologically over the long term. CCS is not expected to be adopted in commercial plants on a wide scale for at least ten to 15 years.

If CCS is adopted here, New Zealand is likely to be a technology-taker, given the level of investigation and investment into the technology and process overseas. However, scientific research within New Zealand will be essential, particularly in relation to potential reservoir sites in the New Zealand geological landscape.

In response, a government and industry research steering group has been convened. It is made up of representatives from the Foundation for Research, Science and Technology, the Crown Minerals section of the Ministry of Economic Development, the Coal Association, Solid Energy, the Petroleum Exploration and Production Association of New Zealand, Genesis Energy and L&M Mining Group. Its aim is to increase New Zealand's technical capability and knowledge in CCS and to participate in knowledge-sharing with Australia's CO_2 Cooperative Research Centre initiative – CO_2 CRC.

Further work will be convened across government to consider the regulatory, legal and policy considerations involved in introducing CCS technology to New Zealand.

11.3.4 Strengthening international linkages

Technology agreements and partnerships are expected to become a prominent feature of international cooperative efforts on climate change mitigation and adaptation.

We will work with interested parties to determine whether joining additional IEA implementing agreements would offer tangible benefits for researchers, the private sector and New Zealanders generally. The Ocean Energy Systems Implementing Agreement is probably well aligned with government policy.

Other relevant international partnerships and agreements that New Zealand might find it useful to join are:

- *IEA Demand-side Management Programme*
- *IEA Implementing Agreement on Electricity Networks, Research and Development*
- *Carbon Sequestration Leadership Forum*.

ACTION: The government will continue to facilitate participation in international technology and behaviour change collaborative efforts that are relevant to the areas of innovation that are important to New Zealand.

11.3.5 Accelerating innovation

In 2007, the government announced a 15 per cent tax credit for companies carrying out research and development, to encourage more investment in technology development by New Zealand firms, bringing New Zealand into line with Australia and other OECD countries. A research and development tax incentive was considered a more efficient mechanism than a grant system.

ACTION: The government has introduced business tax credits for research and development expenditure.

If we are to reduce greenhouse gas emissions, low carbon energy technologies (LCETs) will be a major part of our future energy supply. New Zealand private and public entities have limited means to fund pilots or demonstrations of new LCETs. The funding gap between research and commercial development (the 'valley of death') is difficult to overcome and places emerging low carbon technology at risk.

Co-funding arrangements give the private sector – particularly smaller firms – a strong incentive to invest in sustainable energy innovations. Under the NZES, the government has agreed to establish two funds to assist private sector innovation.

The first is a fund to provide capital grants to developers who wish to install or deploy pre-commercial wave and tidal stream energy devices. New Zealand has a vast marine energy resource, and wave and tidal energy is less intermittent than wind.

ACTION: The government is establishing a contestable grant fund of $8 million over four years to bring forward the deployment of marine generation devices in New Zealand.[58]

Proposals for other LCETs, including second generation biofuels – bioethanol from cellulose and biodiesel from algae – are not progressing or are at risk of going overseas. A second fund will be available to assist other LCETs such as biofuels, biomass, hydrogen, deep geothermal, wind, hydro, CCS and other new technologies to the point of commercial investment in New Zealand. The initial focus will be on liquid biofuels to assist government decisions on biofuel sales obligation levels post-2012.

ACTION: The government is establishing a contestable fund of $12 million over three years from July 2008 to support new LCET opportunities.[58]

11.4 Into the future

A viable energy innovation system is essential to bring innovations to the point of commercial use in New Zealand. This system includes:

- basic or underpinning energy research
- applied energy research
- the piloting, scale-up, demonstration and proving of energy technologies
- the commercial development or implementation of new technologies.

The government and the energy industry both have a role in this process. Public funding is needed to support research and development up to the stage where a new technology is ready to be demonstrated. Investment by the energy industry is required for commercial development and implementation. The government and industry will need to work together to ensure their investments are well coordinated.

Government incentives for innovation are included in energy policy, legislation and regulation. They may also involve targeted incentives for particular energy technologies, industry support and public education or uptake incentives.

Developing an innovative low carbon sustainable energy system will require much greater engagement between the energy research community, the energy industry and New Zealand energy users at all levels.

[57] For more details on the fund eligibility criteria and application procedures, please see EECA's website at www.eeca.govt.nz

[58] More information on the eligibility criteria and application procedures to the fund will be available in due course from the Foundation of Research, Science and Technology's website at www.frst.govt.nz

12. Affordability and wellbeing

Summary

- Every household in New Zealand should be able to heat and light their home.
- Competitive markets are vital to ensure energy prices are fair and efficient. Ensuring that the market remains competitive will remain a key part of our work to protect all customers, including vulnerable customers.
- The introduction of emissions pricing will have a cost impact for consumers. The government is considering ways to help business and residential consumers make the transition to a low emissions energy system.
- Actions in the NZES and the NZEECS will help improve the affordability of energy services. These initiatives target the underlying causes of high spending and include household energy efficiency initiatives, steps to improve the fuel efficiency of the vehicle fleet, and efforts to support a range of transport options in communities.
- The Electricity (Low Fixed Charge Tariff Option for Domestic Consumers) Regulations 2004 (the LFC Regulations) have made it a little easier for households using low levels of power to pay for their electricity services.
- The EC has issued new guidelines to reduce the likelihood of consumers having their electricity disconnected.

From vision to action	Lead agency	Timing
The government will amend the Electricity (Low Fixed Charge Tariff Option for Domestic Consumers) Regulations 2004 (the LFC Regulations) to take into account regional climate variations that impact on heating costs.	MED	2008
The government will continue to support the provision of high-quality information to provide householders with information about how to improve energy efficiency, such as Powerswitch (Ministry of Consumer Affairs) and Smarter Homes (Department of Building and Housing).	MCA/DBH/ EECA	Ongoing
The government is considering additional measures to reduce the cost impact of higher electricity prices arising from the introduction of an ETS on low and modest income households.	Treasury/MfE	2007/08

12.1 Our direction

Cheap and abundant energy – particularly gas and electricity – has been one of the foundations of the New Zealand economy's competitive advantage. As a result, investment in energy efficiency measures in homes, businesses and industry has been relatively low. However, electricity prices have risen in recent years, largely in response to growing demand and the depletion of cheap Maui gas. In the transport sector, oil prices have increased sharply as a consequence of overseas price increases.

The government does not set prices for energy. Prices are determined in competitive markets within a regulatory framework. Ensuring that the market remains competitive will remain a key part of our work to protect all customers, including the most vulnerable.

Prices provide important signals for producers to ensure necessary investment in new supply. Consumers react to prices when making choices about which goods and services to purchase, and whether to economise.

Using energy more efficiently can save households money and contribute to better health and wellbeing. However, some energy efficiency actions come with up-front costs, even if these are soon repaid through savings in energy costs.

The introduction of emissions pricing under an ETS will raise the price of electricity, gas and transport fossil fuels, but the government will consider options to manage these cost impacts on business and residential consumers during the transition to a low emission energy system.

12.2 Our actions

Reliable access to energy resources is essential to a vibrant economy. The government has a programme of fostering greater energy efficiency and maintaining security of supply at fair and efficient prices.

Low income households are more vulnerable to energy price increases in homes and for transport. Energy costs may take up a relatively high proportion of their income, leaving less money for other essentials.

12.2.1 Household energy use

Households generate greenhouse gas emissions through using electrical appliances, burning fuel to cook or heat homes, and using transport such as driving a car or riding on the train. Everyone can make a difference to household greenhouse gas emissions by being more energy efficient.

Bluff Healthy Homes Project

Bluff is on its way to becoming the best-insulated town in New Zealand. With money and support from the Energy Efficiency and Conservation Authority (EECA), NZ Aluminium Smelters and others, 600 of the town's 800 homes are having insulation installed or upgraded, hot water cylinders wrapped, and doors draught proofed. Te Rau Aroha marae is at the heart of the Bluff Healthy Homes Project, which is part of an ongoing EECA initiative. To date, nearly 30,000 homes have been made warmer, more energy efficient and healthier through EECA's Energywise home grants.

Ceiling insulation.
Image courtesy of EECA.

Homeowners and households will not be directly involved in the ETS. But households will feel some of the effects as the main sectors pass costs on to them. We expect that the main impact of emissions trading for households will be a rise in fuel and electricity prices.

For example, we currently expect fuel to rise by around four cents/litre, and electricity to rise by around five percent.

However, consumers will benefit from a number of related policies, such as the planned fuel economy information labelling programme for vehicles, additional investment in public transport, the solar water heating programme, *Fuel$aver* (information about the fuel consumption of different vehicle models) and the *Choke the Smoke* campaign (encouraging people to go on a 'low carbon diet').

In 2008 the government will be rolling out under the NZEECS *Energywise* homes package a new household assistance programme to help people make their home warmer, healthier and more energy efficient.

ACTION: The government is considering additional measures to reduce the cost impact of higher electricity prices arising from the introduction of an ETS on low and modest income households.

Electricity

New Zealand houses tend to be damp and to have lower indoor temperatures than the World Health Organisation recommends.[59] This is particularly true for low income households in colder parts of the South Island.

Several central and local government initiatives are under way to make it easier for low income households to pay for electricity services.

The EC has issued new guidelines to reduce the likelihood of vulnerable consumers from having their electricity disconnected. The guidelines encourage better communication between retailers, consumers and social agencies. Retailers should provide alternative payment options, such as prepayment meters or smoothed billing, to help vulnerable consumers manage their bills. They could also give low income consumers advice on the information available on such issues as energy efficiency practices and technologies to help them meet their electricity costs.

[59] See, for example, the *Household Energy End-Use Project* (HEEP), a multi-year study of energy end-use in the residential sector, led by the Building Research Association of New Zealand (BRANZ) with funding from the Foundation for Research, Science and Technology.

The NZEECS will also target the underlying causes of high spending on electricity, such as inadequate house insulation. The government's *Energywise* homes package significantly increases funding for energy efficiency measures in homes.

The LFC Regulations assist households using less than 8,000 GWh of electricity per year. The current LFC regime will be amended to take into account regional differences in energy use, and will benefit households in colder parts of the country. Under the amended LFC Regulations, households from Christchurch south will be eligible for the LFC tariff up to a threshold of 9,000 GWh per year. This amendment will be introduced by the end of 2007.

ACTION: The government will amend the Electricity (Low Fixed Charge Tariff Option for Domestic Consumers) Regulations 2004 (the LFC Regulations) to take into account regional climate variations that have an impact on heating costs.

Gas

The GIC works to minimise barriers to competition to keep gas prices down for the long-term benefit of gas consumers.

The GIC has worked on developing an effective switching arrangement for gas consumers, which is expected to improve competition in the gas retail market and to reduce associated costs for retailers and consumers. In addition, the GIC hosts annual consumer conferences to keep in touch with consumer concerns and to update consumers on retail-related gas issues.

12.2.2 Transport accessibility

High transport costs make it harder for people on low incomes to stay involved in community, economic and social activities. Rising prices can have a disproportionate impact on particular groups of people, such as those living in rural areas or in outer suburbs of large cities with few services close by.

Assuming a cost of emissions of $15/tonne of carbon dioxide, petrol prices would increase by approximately four cents/litre in 2009. This is well below the changes in petrol and diesel prices, which are respectively up 47.7 and 35.1 cents/litre between 2002 and 2007.[60]

Chapter 7 sets out measures to increase the fuel efficiency of vehicles and improve the availability of public transport services in major urban areas. Both measures will help to reduce the impact of emissions pricing on transport costs.

Improved accessibility isn't necessarily about cars. Transport infrastructure can make it safer and more enjoyable for children to walk or cycle to school, while better urban design and transport planning for new developments can improve public transport links and provide more services that are accessible by foot or by bicycle.

Central government funding for public transport services has increased ninefold over the past seven years. The government will continue to support the development of more sustainable urban form and transport infrastructure changes through the NZEECS and the NZTS.

[60] These are calculated based on 2002 average nominal price versus 2007 average nominal price for nine months (up to September) sourced from www.med.govt.nz/oil/prices/weekly/

12.2.3 Making informed energy choices

A core focus of the NZEECS is to improve the quality of information consumers are given about their energy options.

As part of the *Energywise* homes package, EECA will manage an energy efficiency information campaign. The campaign will include a website to help householders find the best ways to improve the energy efficiency of their homes.

The Ministry of Consumer Affairs and the Consumers' Institute promote the Powerswitch (www.consumer.org.nz/powerswitch) website, which enables consumers to find the best electricity supplier for them.

The Department of Building and Housing has launched the Smarter Homes website (www.smarterhomes.org.nz).

ACTION: The government will continue to provide households with information about how to improve energy efficiency.

Smarter homes website

A Smarter Homes website has been launched to give New Zealanders advice on building, buying renting and renovating homes to make them healthier, more energy efficient and cheaper to run. **www.smarterhomes.org.nz** provides clear and authoritative advice to enable people to make well-informed choices on building materials, construction methods, appliances, heating systems, landscaping and many other issues.
It includes examples, case studies and tools to help people make decisions about their specific projects. Smarter Homes, a collaborative project between the public and private sectors, was commissioned by the Ministry for the Environment and is administered by the Department of Building and Housing.

Smarter Homes website.
Image downloaded from www.smarterhomes.org.nz.

Glossary

APEC ESIS	APEC Energy Standards and Information Systems project.
Biodiesel	Diesel fuel derived from plant or animal sources.
Bioethanol	A form of alcohol derived from plant or animal sources. May be blended in low concentrations with petrol and used in conventional petrol vehicles, or used in higher concentrations in specially modified petrol vehicles.
Biofuels	Any (generally liquid) fuel derived from plant or animal sources, including biodiesel.
Biomass	Any (generally solid) organic matter that is available on a renewable or recurring basis, including dedicated energy crops and trees, agricultural food and feed crop residues, wood and wood wastes, animal wastes and other waste materials.
Business as usual	'Business as usual' is used in *New Zealand's Energy Outlook to 2030* as a neither optimistic nor pessimistic view of New Zealand's energy future. Business as usual can be forecast with the least number of controversial assumptions about how the world will change in the future, with the additional advantage that it can be used to gauge the impact of actual and/or possible policy actions.
BSO	*Biofuels Sales Obligation*
Carbon dioxide	Carbon dioxide, or CO_2, is a naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as of land-use changes and other industrial processes. It is the most important man-made greenhouse gas.
Carbon neutrality	Zero net emissions. Practical emissions reductions are to be made with remaining emissions offset through carbon sinks or other emissions reduction projects.
Carbon sequestration	Any process for removing carbon dioxide from the atmosphere. May be natural (such as forests) or artificial (see CCS above).
CC	Commerce Commission.
CCS or carbon capture and storage	A technology under which carbon dioxide is extracted from the flue gases of power plants or industrial facilities and injected back into geological structures, such as depleted oil and gas reservoirs, unminable coal beds, or deep saline aquifers.
Climate change	Increasing industrialisation and human activity (such as industry, agriculture and transportation) are increasing the amount of greenhouse gases in our atmosphere and causing Earth not only to heat up, but to heat up at an unprecedented rate. This effect is known as global warming. Since this warming will also affect our weather patterns and climatic conditions, we refer to it as climate change.
CO_2-e or CO_2-equivalent	Measures the combined climate changing potential of emissions of multiple greenhouse gases. Emissions of each gas are converted to an amount of CO_2 that would cause the same climate change impact and summed.
CCGT or combined-cycle gas turbine	A gas turbine whose exhaust is used to heat a boiler, allowing generators to be driven by both a gas turbine and a steam turbine.
CNG	Compressed natural gas.
Consumer energy	The amount of energy used by consumers, excluding energy used or lost in the process of transforming primary energy into other forms – such as electricity – and transporting it.
Cost curve	A graphical representation relationship between the cost and quantity of a good or service.
Cost effective	Utilising a specified amount of money in a way that delivers the largest benefits from all available alternative uses (minimises opportunity cost).
DBH	Department of Building and Housing.
Distributed generation	Any electricity generation facility that produces electricity for use at the point of location, or supplies electricity to other consumers through a local lines distribution network.

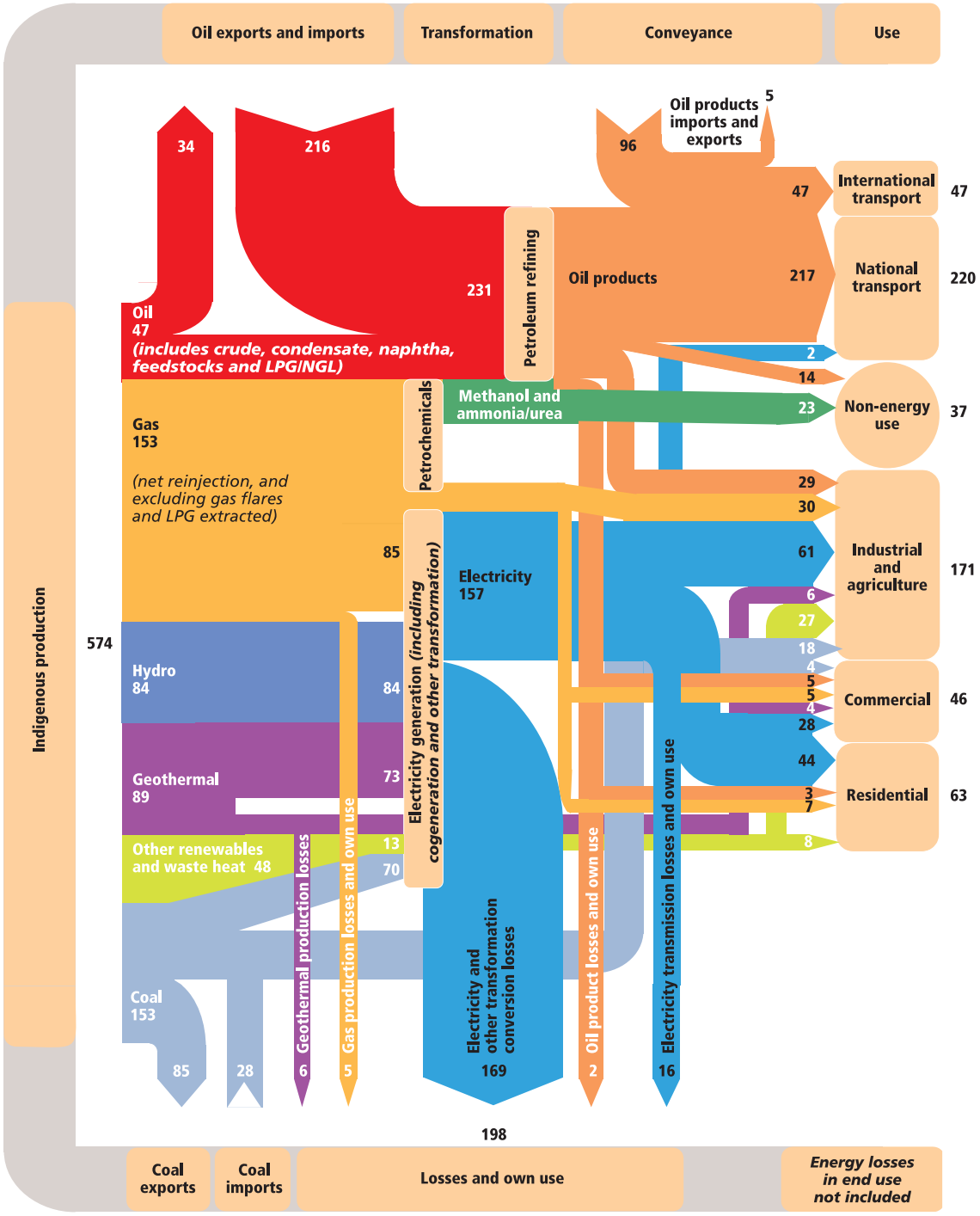
EC or Electricity Commission	A Crown entity established under the Electricity Act to oversee New Zealand's electricity industry and markets.
Economic potential	For the purposes of the NZEECS, economic potential is the fraction of overall technical potential that can theoretically be realised in the market based on cost-benefit analysis and assuming full uptake rates.
EECA or Energy Efficiency and Conservation Authority	EECA's role is to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy sources in accordance with the Energy Efficiency and Conservation Act 2000.
EIRA	Electricity Industry Reform Amendment Act, currently being introduced by government.
Electricity system	The electricity system comprises electricity generation, transmission, distribution and consumption.
Energy efficiency	Any measure of the ratio of useful energy services to energy input. For the purposes of the NZEECS, energy efficiency is defined by the Energy Efficiency and Conservation Act 2000 as a change to energy use that results in an increase in net benefits per unit of energy used.
Energy productivity	Gross domestic product per unit of energy – the inverse of economic energy intensity. It can be specified at an economy-wide level or at a sector level.
Energy security	Energy security has two key dimensions, reliability and resilience. Reliability means users are able to access the energy services they require, when they require them. Resilience is the ability of the system to cope with shocks and change.
Energy system	An energy system includes all forms of energy (such as electricity, transport fuel and direct uses) and all aspects of the process that takes energy from producers or generators and transports that energy to the final consumers.
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.
ETG	Emissions Trading Group.
ETS or Emissions Trading Scheme	An emissions trading scheme creates a responsibility for a defined group of emitters to hold tradeable units or allowances to match some or all of their greenhouse gas emissions over a defined period. Entities subject to the scheme are able to either reduce their own emissions or trade units or allowances to meet their obligations.
Externality	Occurs when an action impacts on parties (either negatively or positively) not directly involved in the activity and these impacts are not reflected in the cost or price of the goods or services being produced**.**
Fossil fuels	Coal, natural gas, LPG, crude oil and fuels derived from crude oil, including petrol and diesel. They are fossil fuels because they have been formed over long periods of time from ancient organic matter.
FRST	Foundation for Research, Science and Technology.
GIC	Gas Industry Company.
GPS or Government Policy Statement	The GPS on Electricity Governance sets out the objectives and outcomes that the government wants the Electricity Commission to give effect to. It is made under section 172ZK of the Electricity Act.
Greenhouse gas pricing	Placing a value on greenhouse gas emissions (e.g. through a carbon tax or emissions trading system), which internalises the environmental cost of the emissions and creates an incentive for actions to reduces such emissions.
Greenhouse gases	Atmospheric gases that retain more energy from outgoing infra-red radiation than from incoming solar radiation. Man-made greenhouse gases include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO). Nearly half of New Zealand's total emissions are produced by agriculture, predominantly methane from farm animals and nitrous oxide from soils and fertilisers. However, the principal growth in New Zealand's emissions comes from increased carbon dioxide (CO_2), primarily from the energy sector. Most of this increase has come from transport and electricity generation.
ICV	Internal combustion vehicle.
IEA or International Energy Agency	The IEA is an autonomous body within the OECD based in Paris. It was established in 1974 following the first oil crisis (in 1973) and in response to the enhanced power of OPEC (Organisation of Petroleum Exporting Countries).

Incentive	An inducement for a firm or an individual to behave in a way that is consistent with their own best interests.
IPHE	International Partnership for the Hydrogen Economy.
Intermittent	Renewable electricity generation that is dependant on resource availability that may vary over time. For example, wind and wave generation is intermittent.
IRD	Inland Revenue Department.
Kyoto Protocol	A 1997 international agreement under the *United Nations Framework Convention on Climate Change* to address climate change, which sets greenhouse gas emission targets for developed countries.
LCET	Low carbon energy technology.
LFC regulations	Low fixed charge tariff option for domestic consumers.
Lignite	A low grade brown or soft coal that burns less efficiently, producing particulates and more greenhouse gas emissions than high-quality coals.
LNG or liquefied natural gas	Natural gas that has been converted to a liquid by chilling it to extremely low temperatures. Natural gas is frequently moved by ship in the form of LNG.
Low carbon	To minimise carbon dioxide emissions from a human activity.
LPG or liquefied petroleum gas	Consists of propane (60 percent) and butane (about 40 percent). LPG is a gas at room temperature, but is a liquid under pressure.
Marine energy	Energy generated from forces in the marine environment such as tidal and wave energy.
Market barriers to energy efficiency	Features of the market for energy services that are thought to prevent uptake of existing opportunities to use energy more efficiently.
Maui contract gas	Gas from the Maui field that is produced under a 'take or pay' contract with the Crown at a fixed price that tends to be lower than the market price for natural gas.
MCA	Ministry of Consumer Affairs.
MED	Ministry of Economic Development, which has led development of the NZES.
MEPS	Minimum Energy Performance Scheme.
MfE	Ministry for the Environment.
MoRST	Ministry of Research, Science and Technology.
MOT	Ministry of Transport.
National Environmental Standard	Central government regulation under the RMA of activities that affect the environment, which overrides the rules that are contained in the district and regional plans of local government.
National grid	The national grid delivers electricity throughout the country, using a network of transmission lines, substations and a control system that matches generation to demand. See www.transpower.co.nz
NERI	National Energy Research Institute.
NGOCP	Nationial Gas Outage Contingency Plan.
NIWA	National Institute for Water and Atmospheric Research.
NPS or National Policy Statement	A document issued by the Minister for the Environment under the RMA, which affects the way natural and physical resources are managed in relation to a matter of national significance. Local authorities must change their district and regional plans to give effect to these national objectives and policies.
NZEECS or New Zealand Energy Efficiency and Conservation Strategy	The NZEECS is developed by EECA in conjunction with the Ministry for the Environment and sets the agenda for government programmes to promote greater energy efficiency, energy conservation and the use of renewable energy across the economy in accordance with the Energy Efficiency and Conservation Act.
NZES	New Zealand Energy Strategy.
NZTS	New Zealand Transport Strategy.
OPEC	Organisation of Petroleum Exporting Countries.

OCGT or open-cycle gas turbine	An open-cycle gas turbine extracts energy from a flow of hot gas produced by combustion of gas in a stream of compressed air. The exhaust gas (mostly normal air) is not used again, but transferred to the environment for cooling.
Peak oil	The term used to describe the point when worldwide production of conventional crude oil peaks in volume, which is expected to result in an increase in oil prices from a decline in the availability of cheap and easily accessible oil sources.
Petajoule	Energy can be measured in joules. The joule is the international unit of energy. A petajoule = 10^{15} (one quadrillion) joules. It is the unit most often used to measure energy production and use on a national scale. One petajoule is roughly equivalent to: • all the electricity used in Nelson in a year • a coastal tanker load of 25,000,000 litres of oil • over 10 days' output from the Huntly power station at full capacity.
Photovoltaic	A solar energy technology that uses semiconductor materials to convert sunlight directly into electricity.
PHEV or plug-in hybrid electic vehicle	A vehicle powered by a combination of petrol and electricity.
Policy measures	Actions developed to address a perceived problem or further a government objective. Can include regulatory, fiscal or information-based tools.
Primary energy	Energy as it is first obtained from natural sources. Does not include electricity or refined petroleum products.
Projects to Reduce Emissions	A government programme providing Kyoto Protocol carbon credits to projects that will reduce New Zealand's greenhouse gas emissions during the Kyoto Protocol's first commitment period (2008–2012).
Realisable potential	Realisable potential is 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.
Renewable energy	A form of energy that can be produced indefinitely without depletion, including solar, wind, hydro, biomass, tidal, wave and ocean current sources. Geothermal energy is considered renewable, although geothermal fields can be depleted if fluids are extracted at a higher rate than they are replenished.
REEEP	Renewable Energy and Energy Efficiency Partnership.
RMA	The Resource Management Act 1991, which regulates the use of New Zealand's regional natural resources.
Smart meters	A smart meter can track how much electricity a consumer uses and when it is used. Smart meters can send/receive data, i.e. sending usage data to an electricity company.
Stationary energy	All energy production and consumption including electricity and direct uses of energy for heating and industrial processes but excluding transport.
Technology taker	An entity that receives technology developed elsewhere and adapts that technology for its own needs rather than independently developing a unique technology for itself.
TRST	Transformational areas of research, science and technology.
Watt	Energy can be measured in watts. A watt is the unit of power, which is the amount of work done or energy transferred in a unit of time. A megawatt (MW) is one million watts. It is the standard unit for electricity generation capacity. One megawatt of capacity is enough to supply the peak electricity needs of about 500 households. New Zealand's largest power station at Huntly has a capacity of 1,000 MW.
Watt hour	A gigawatt-hour (GWh) is one billion watts of power over an hour. It is the standard unit for measuring electricity production on a national scale. The 1,000 megawatt (1 gigawatt) Huntly power station running at full capacity for one hour would produce a gigawatt-hour of electricity. Total annual electricity production in New Zealand is about 40,000 GWh.
Wholesale electricity market	A computerised trading system enabling electricity purchasers, including retailers and large power users, to buy electricity from generators. It includes a half-hourly spot market, longer-term contract markets, and security and reserves markets.

New Zealand's energy flows for the 2006 calendar year

Diagram scaled approximately to nearest 10 PJ. Other uses of less than 2.5 PJ per annum and stock changes are excluded. 'Other renewables' includes solar water heating and electricity generation from wind, biogas and wood.



Energy generation from tidal currents.

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