New Zealand’s Energy Outlook 2009

Reference Scenario

Welcome

Welcome to the new look *Energy Outlook*. While the purpose of this publication remains the same as previous editions, how the information is released has changed. The changes have been designed to provide more detailed information than has previously been available, while delivering the key messages in a clear and simple manner.

Previous editions of the *Energy Outlook* have been published approximately every 3 years setting out a 25-year projection of New Zealand’s energy supply, demand, prices and energy sector greenhouse gas emissions. These projections are principally aimed at informing New Zealand’s energy policy debate.

The new *Energy Outlook* consists of a series of short articles released on an annual cycle. The first set of articles maps out a projection for a *Reference Scenario* and examines the sensitivity of this projection to a range of key macroeconomic parameters including oil price, emissions price and economic growth (GDP). This will be followed by a set of articles outlining scenarios *Seeking Solutions* to the challenges presented in the *Reference Scenario*.

These articles are supported by detailed data tables available on the MED website.

This article focuses on the *Reference Scenario*, which is essentially a measuring stick for comparing all other sensitivities and scenarios. The *Reference Scenario* is not our expectation of what is going to happen. Rather, it starts from an assumption of business as usual continuing in terms of broad **trends in key economic drivers, policy settings, technology and fuel choices.** As such, it uses central forecasts of population, gross domestic product (GDP) and New Zealand dollar exchange rates and assumes continuation of enacted government policies such as the emissions trading scheme. Detailed assumptions are discussed at the end of this article.

ABOVE: The previous *Energy Outlook* publication was released on a 3–4 year basis. Our new approach releases more comprehensive information each year.

Key messages from the *Reference Scenario*

- Wholesale electricity prices are projected to increase by ~1.6% per annum above the rate of inflation (or ~40% in real terms by 2030).
- Total energy sector emissions flatten off, but remain ~40% above 1990 levels in 2030.
- Emissions from transport continue to grow while emissions from electricity decline.
- New Zealand remains addicted to oil, but demand growth slows significantly compared to historical rates. Growth is expected to be in diesel rather than petrol.
- No additional fossil-fuelled baseload electricity generation plants are expected.
- Electricity demand is forecast to grow at 1.5% per annum, down from the historical growth rate of 1.8%.
- Energy intensity improvements are forecast to increase slightly from ~1.0% to ~1.2% per annum, partially offsetting demand growth.

Want a closer look?

For detailed data visit www.med.govt.nz/energyoutlook

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Ministry of Economic Development
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Energy intensity reflects the relationship between energy use and GDP and is influenced by both the composition of industry within an economy and energy-efficiency improvements. Energy intensity is measured here as gigajoules of energy required to contribute $1,000 towards New Zealand's economy ($1,000 of GDP).

New Zealand's energy intensity has been reducing at an average rate of ~1% per annum since 1990 – we now use less energy to support economic growth. While New Zealand's GDP growth since 1990 has been spread across the economy, much of the growth has been in less energy-intensive sectors. For example, retail trade, communication services, finance and insurance, and real estate and business services accounted for almost 50% of the increase in GDP since 1990, where the share of these four industries to total GDP has increased from ~25% to almost 35%.[1] Energy-efficiency improvements in heavy industry have also contributed to New Zealand's improving energy intensity.

The trend of improving energy intensity is forecast to continue in the *Reference Scenario*. A key factor influencing this trend is the ongoing efficiency gains now expected in our vehicle fleet. Recent high fuel prices and overseas trends towards efficient light vehicles appear to be influencing New Zealand's vehicle choices and at least have halted our previous tendency towards larger vehicles. Other factors influencing this trend include a greater uptake of energy efficiency measures and increased energy conservation in the face of higher energy prices.

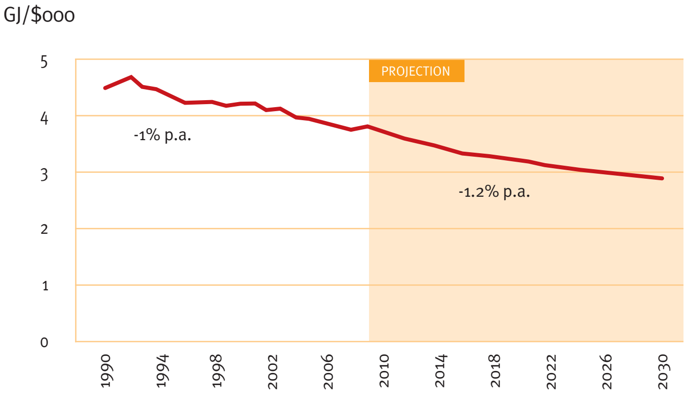
By 2030, New Zealand's energy intensity is expected to have significantly improved from around 4GJ/$000 to less than 3GJ/$000. However, there may be physical limitations for efficiency improvements, which results in a tapering off in efficiency gains post 2030. This result also implicitly includes a continued uptake of energy-efficiency measures in stationary energy at historical rates.

Primary fossil fuel demand[2] provides an indication of how reliant on fossil fuels a country is.

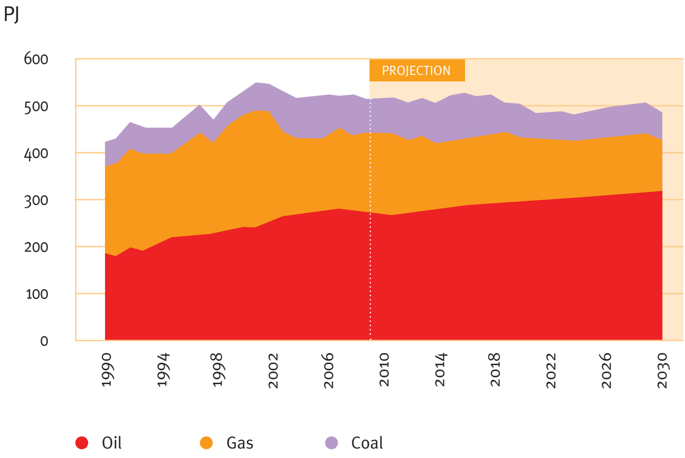
New Zealand's fossil fuel consumption experienced strong growth up until a peak in 2001, underpinned by strong growth in transport and a cheap supply of natural gas for methanol production and electricity generation. Coal consumption grew steeply post 2001 as coal was substituted for gas in electricity generation. Following 2001, growth in fossil fuel consumption has been largely flat as a consequence of higher oil and gas prices, tightening gas supply and the recent recession.

Until 2030, total primary demand for fossil fuels is forecast to remain relatively flat. The forecast demand increase for transport fuels is expected to be offset by reductions in coal and gas use in electricity generation,[3] and non-energy use of gas (methanol and urea production).

Consumer Energy Intensity



Primary Fossil Fuel Demand by Fuel Type



[1] Statistics New Zealand Chain-Volume Series 95/96 Prices – Gross Domestic Product by Industry.

[2] Primary fossil fuel demand includes consumer demand, fuel used for electricity generation and oil production, and non-energy uses (e.g. natural gas used for methanol and urea production, coal used for steel making).

[3] We assume no additional baseload gas electricity generation due to fuel supply uncertainty and the prospect of increasing gas prices post 2020. We also assume no new coal generation due to the impact of an emissions trading scheme.

Energy sector greenhouse gas emissions have been growing steeply since 1990 due to strong growth in transport energy demand and through the increased use of fossil fuels (coal and gas) for electricity generation. Since 1990, energy sector emissions have increased by almost 40%, or by around 2% per annum.

Although emissions in the *Reference Scenario* are forecast to flatten, largely as a result of switching to renewable forms of electricity generation, they remain ~40% above 1990 levels. Note this *Reference Scenario* includes an emissions price of $25 per tonne of carbon dioxide equivalent (CO_2-e).

Although total emissions flatten, the sub-sector shares of emissions change. In the near term, transport emissions are forecast to flatten due to the dual effect of the current economic climate and fuel price increases. In the longer term, transport emissions rebound and continue to grow, albeit at lower than historical rates. Worldwide, as in New Zealand, controlling transport emissions is a key challenge.[4]

Emissions from electricity generation remain constant in the near term but reduce significantly post 2015 as increasing amounts of renewable generation are built and coal generation units at Huntly begin to be phased out.

Post recession, emissions from manufacturing industries increase slightly above historical rates driven by growth in dairy and wood processing[5] and light industry. Emissions from the other sectors[6] and transformation industries[7] are projected to remain relatively constant.

Wholesale electricity prices have increased by nearly 60% (in real terms) since 2000, driven largely by substantial gas price increases over this period.[8]

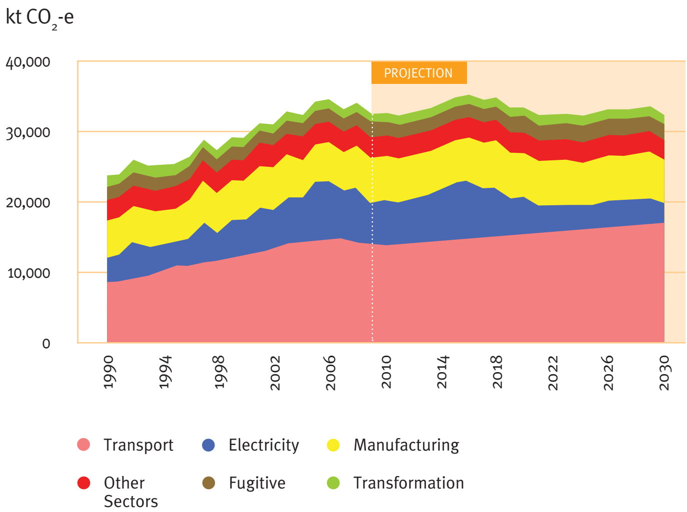
Wholesale electricity price forecasts reflect the long-run marginal cost (LRMC) of new generation. This cost represents the return a generator must earn to cover the costs of new generation investment. In the *Reference Scenario,* most new baseload generation is forecast to be renewable – geothermal, wind and hydro.

Geothermal is currently the most economic option for new electricity generation, and we could see a flattening in prices over the next 5 years if the available resource can be consented and built in time to meet demand growth. Wind and hydro are more expensive options, and we can see their impact on wholesale price projections as we move towards 2020 and beyond.

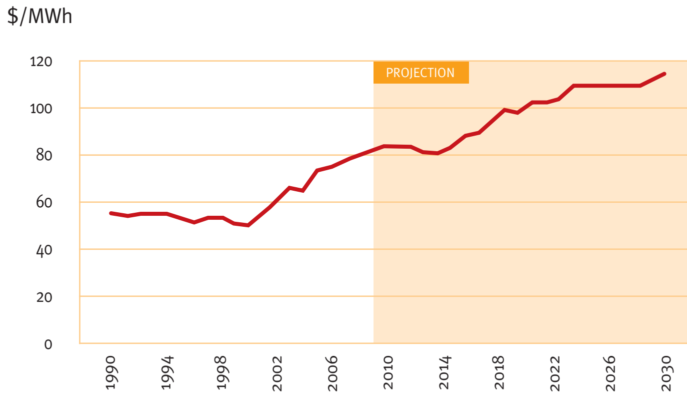
We have assumed that, without major new gas discoveries,[9] there is insufficient security of gas supply to support additional baseload gas-fired electricity plants. Existing plants are assumed to be able to access gas at prices of around $8.5/GJ (in real terms) until ~2020. Post 2020, tightening supply sees gas prices begin to rise gradually towards the opportunity cost of alternative energy sources for electricity generation[10] of ~$13/GJ (including emission pricing) by 2035.

In the *Reference Scenario*, the wholesale electricity price increases 40% by 2030 in real terms. Wholesale prices currently represent around a third of retail prices, so there will be upward pressure on retail electricity prices in the longer term.

Energy Sector Greenhouse Gas Emissions



Average Wholesale Electricity Price (real)



[4] We will be considering the potential impact of biofuels and electric vehicles in the *Seeking Solutions* scenarios.

[5] We have made an assumption that heavy industry will be slowly exposed to emissions pricing over a period of 15 years and will also respond through energy-efficiency improvements. No assumptions have been made on profitability, expansion or closures.

[6] Other sectors = residential, commercial and primary industries.

[7] Transformation industries = petroleum refining and oil and gas extraction.

[8] We have estimated historical wholesale prices using the average energy component of the price paid by industrial users.

[9] See assumptions page for details about production from new discoveries.

[10] The most cost-effective alternatives to baseload gas generation are renewable options such as geothermal, wind and hydro.

Consumer Energy Demand

Around half of the energy used by New Zealand consumers is in the form of refined oil products (e.g. petrol and diesel). Most of these oil products are used for transport and in other mobile off-road uses, for example, in the construction industry and on farms. Stationary uses such as in diesel generators are minor compared with mobile use. While New Zealand produces some oil, most of this is exported as it is of premium quality. Therefore, most of the oil used in New Zealand is imported as crude or as refined products.

The next largest source of consumer energy is supplied as electricity. This provides close to a quarter of total consumer energy while the direct use of gas, coal, geothermal, wood and other renewables makes up the balance.

Demand by sector is dominated by transport[11] and industry (such as dairy and wood processing and aluminium smelting), which collectively represent over 80% of the country's demand. Residential and commercial make up the balance.

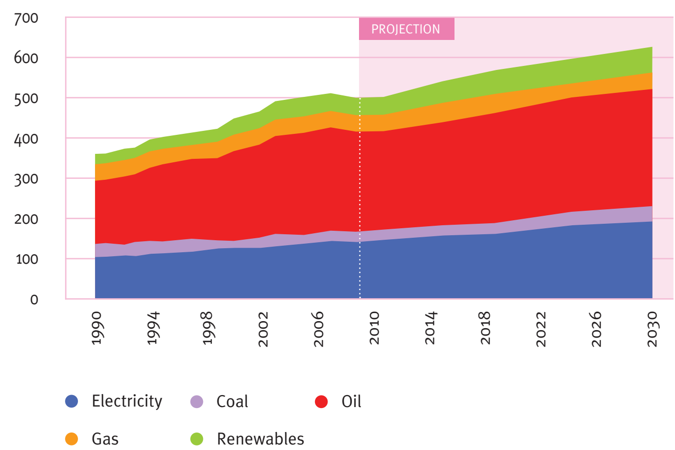
Historically, consumer energy demand has been increasing by ~1.9% per annum. This growth has been driven by increasing oil and electricity consumption (2.5% and 1.8% per annum respectively), offset by reduced consumer demand for other energy sources. In the *Reference Scenario*, growth in overall consumer demand is forecast to reduce to an average long-term growth rate of ~1.1% per annum.

In the near term, energy demand is strongly influenced by the economic recession, which is expected to flatten demand growth. Following this, a strong rebound in energy demand growth is expected, especially for electricity. However, the longer-term outlook is for New Zealand to move to lower than historical rates of population and economic growth, which, combined with higher energy prices, leads to a reduced long-term energy demand growth forecast compared to historical rates.

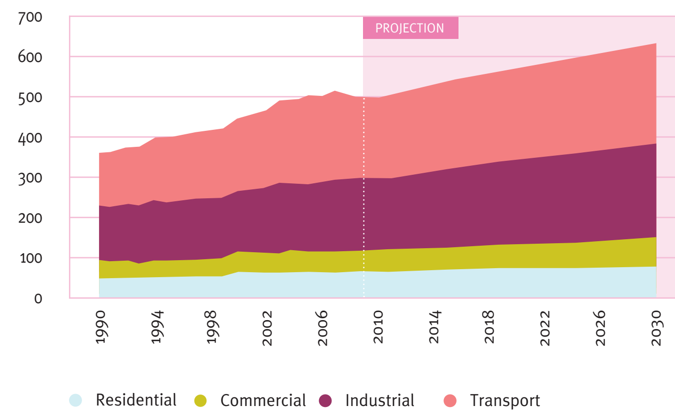
The other factor significantly reducing future demand growth rates is the ongoing switching from petrol to diesel[12] and efficiency improvements in New Zealand's vehicle fleet. This is expected to reduce growth in oil demand from historical rates of 2.5% per annum to ~1% per annum.

Although growth in oil demand is seen to slow, it will remain New Zealand's dominant consumer energy source, reflecting its high value as a versatile transport fuel. Until a widespread, cost-competitive alternative becomes available, oil will continue to dominate New Zealand's energy demand and remains a key challenge for reducing energy sector emissions and improving energy security.

Consumer Energy Demand by Fuel Type



Consumer Energy Demand by Sector



[11] Transport includes all on-road transport from all sectors of the economy, including private motorists.

[12] For vehicles of similar engine size, diesel vehicles are ~20% more efficient than petrol equivalents.

Transport Demand

Oil and the internal combustion engine provide a convenient and cost-effective means of transporting people and goods. As a consequence, economies in the industrialised world are susceptible to the economic impacts of rising oil prices; environmental impacts of oil production, refining and using oil; supply disruptions; and long-term resource availability.

Modern economies put up with these consequences because oil has a combination of attractive factors – high energy density, convenient liquid form and historically low cost – all of which make it hard to beat as a transport fuel. Today, oil products provide close to 98% of New Zealand's transport energy.

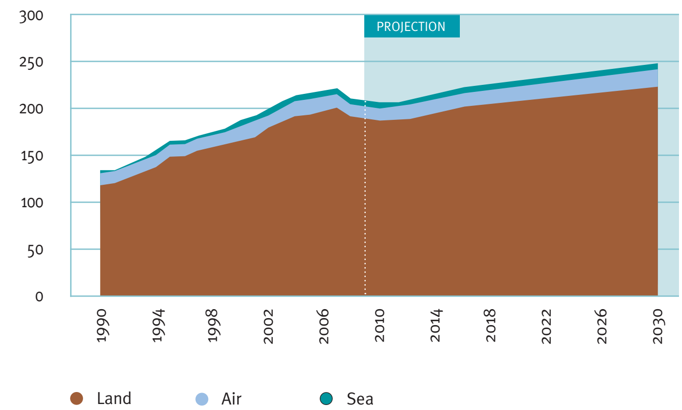
The wide availability of affordable vehicles and limited public transport networks have helped to give New Zealand one of the highest per capita car ownership rates in the world.[13] The strong growth in land transport over the previous two decades has seen total transport demand increase by almost 60% since 1990 – a rate of around 2.5% per annum. Land transport currently accounts for over 90% of total transport energy demand.

Transport's[14] energy demand is strongly linked to economic growth and has also been influenced by the relatively low prices of vehicles and fuel. During the 1990s, low oil prices and average economic growth of 3% per annum led to a rapid increase in demand, particularly for diesel. Over this period, petrol demand increased by an average of 1.5% per annum, while diesel grew by ~10% per annum. Steeply increasing international oil prices since 2003 have contributed to demand growth for both petrol and diesel slowing to per annum growth of -0.3% and 2.2% respectively. In 2008, the combined effect of high prices and the recession resulted in a demand reduction in the transport sector. The level shift in prices from the 1990s and earlier 2000s has significantly influenced the outlook for transport demand growth.

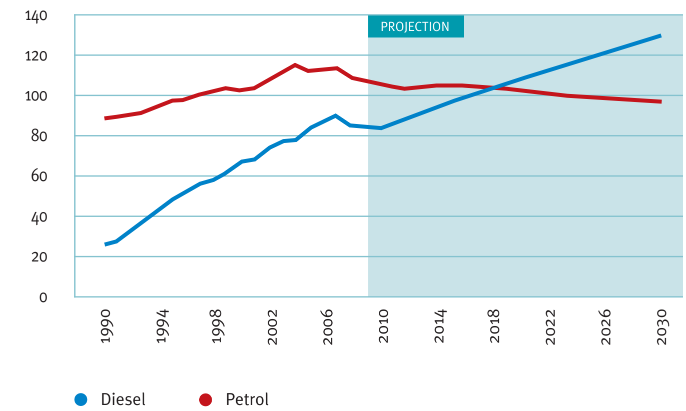
In the near term, the *Reference Scenario* projection sees total transport demand remain relatively flat due to the recession. In the mid to long term, demand growth will recover, albeit at lower than historical rates, due to lower than historical economic growth, higher oil prices, the shift towards smaller more efficient vehicles and increased numbers of diesel vehicles. By 2015, diesel vehicles are expected to provide 20% of new light private vehicles. However, the travel and energy demand of the heavy fleet (›3.5 tonnes) is expected to continue to grow at higher levels, helping to contribute to total transport demand reaching close to double 1990 levels by 2030.

Interestingly the *Reference Scenario* forecasts petrol demand to remain flat for the foreseeable future. Growth in land transport fuel demand is almost entirely in the diesel fleet, reflecting the relative insensitivity to price of commercial transportation and a shift towards diesel private passenger vehicles. In energy terms, diesel is forecast to become the dominant transport fuel post 2020.

Transport Demand by Mode



Land Transport Demand by Fuel



[13] In a study of 17 of the IEA member countries, New Zealand had the second highest per capita car ownership, at ~700 cars per 1,000 people, compared to an average of ~570 cars per 1,000 people. This average is heavily weighted by the USA – if the USA was removed, the average is closer to 500 cars per 1,000 people.

[14] Transport includes all on-road fuel demand from all sectors of New Zealand's economy including private motorists, commercial and industrial transport. It excludes land based mobile off-road fuel consumption.

New Zealand's electricity supply is currently dominated by hydro generation, supported by gas, coal, geothermal and wind. As a percentage of total generation, renewable generation peaked in 1980 at 91%. However, increasing thermal generation since 1990 has resulted in the proportion of renewable generation decreasing to 65% in 2008.[15]

Demand for electricity has been growing at an average rate of ~1.8% per annum since 1990. This growth resulted from relatively strong economic growth (~3% per annum on average) and relatively low electricity prices.

In the near term, electricity demand growth is forecast to flatten due to the economic recession. This is followed by a rebound in demand growth of around or above historical rates out to ~2014. In the longer term, economic growth lowers to around 2% per annum by 2030, and prices increase by 40% (refer to earlier section). This combination of lower economic growth and higher prices serves to limit electricity demand growth, predominantly in the productive sectors of the economy. In the *Reference Scenario*, the long-term average electricity demand is forecast to grow at a rate of ~1.5% per annum.

Industrial electricity demand slows from historical growth rates of 1.9% per annum to a forecast rate of 1.5% per annum. We assume there will be capacity constraints preventing further growth in some heavy industries.

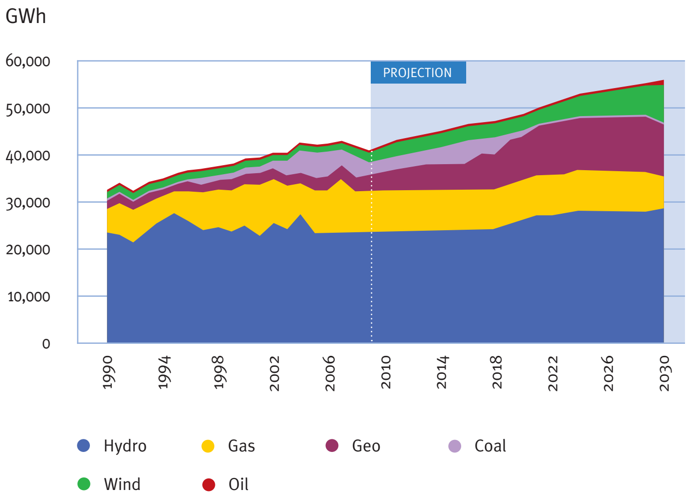
Commercial demand is forecast to slow from historical rates of over 2.5% per annum to less than 2% per annum in response to a slower growing economy and higher electricity prices.

Historically, residential electricity demand has been growing at 1.1% per annum in line with population growth. This is forecast to increase slightly to 1.3%, which reflects the recent (pre-recession) trend and switching from gas to electricity. The impacts of government-led energy-efficiency programmes are implicitly included in these demand forecasts.

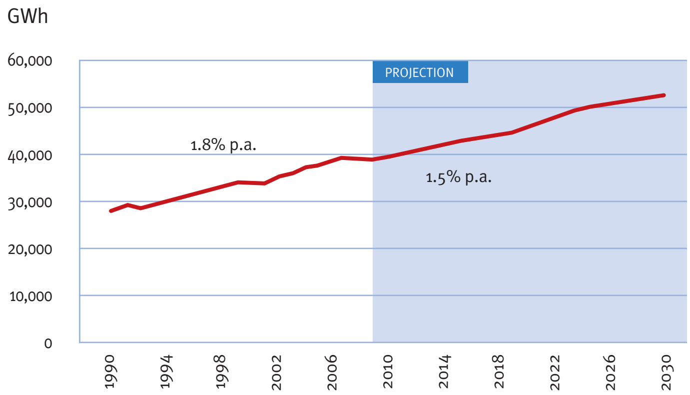
Demand growth is forecast to be met by nearly 4,000MW of new baseload generation from geothermal, wind and hydro plant. An additional 1,000MW of new gas and diesel peaking plant is also required to support the new renewable generation.

Emissions pricing is a substantial risk for thermal plant, especially coal. We assume that no new coal plant is built. We also assume that there is insufficient security of gas supply to support additional baseload gas plant.[16] Further analysis of the implications of a large gas find in New Zealand will be further explored in future *Energy Outlook* articles.

Electricity Generation by Fuel



Electricity Demand



Growth in Electricity Demand in relation to Wholesale Electricity Price and GDP Growth

Period	GDP (p.a. growth)	Average Wholesale Electricity Price $/MWh	Electricity Demand (p.a. growth)			
			Residential[17]	Commercial	Industrial	Total
1990–2008	**2.9%**	**58**	**1.1%**	**2.8%**	**1.9%**	**1.8%**
1990–2000	2.8%	52	1.1%	2.0%	2.4%	1.8%
2000–2005	3.8%	60	1.5%	3.6%	2.1%	2.2%
2005–2008	1.8%	75	0.7%	3.9%	0.1%	1.2%
2009–2030	**2.4%**	**95**	**1.3%**	**1.7%**	**1.5%**	**1.5%**
2009–2012	2.4%	81	1.8%	1.5%	2.3%	1.9%
2012–2020	2.9%	87	1.3%	2.0%	1.1%	1.4%
2020–2030	1.9%	105	1.1%	1.6%	1.6%	1.4%

[15] Hydrological conditions can result in this percentage varying by around +/-5% each year.

[16] We assume annual gas production of 100PJ from new discoveries starting in 2017. This is sufficient to maintain the current fleet of gas plant and also meet a substantial portion of industrial demand; however, we have assumed that there is insufficient security of gas supply to support additional baseload gas plant.

New Zealand's non-transport energy demand can be split into three broad sectors: industrial, commercial and residential (~35%, 10% and 13% of total demand respectively).

The industrial sector includes New Zealand's light industry (including agriculture and construction) and heavy industry (wood and dairy processing, steel making etc).

Electricity makes up the largest share of industrial demand at ~30% of total demand. The remaining demand is relatively evenly spread between coal, oil, gas and direct use of renewables (predominantly wood waste and geothermal).

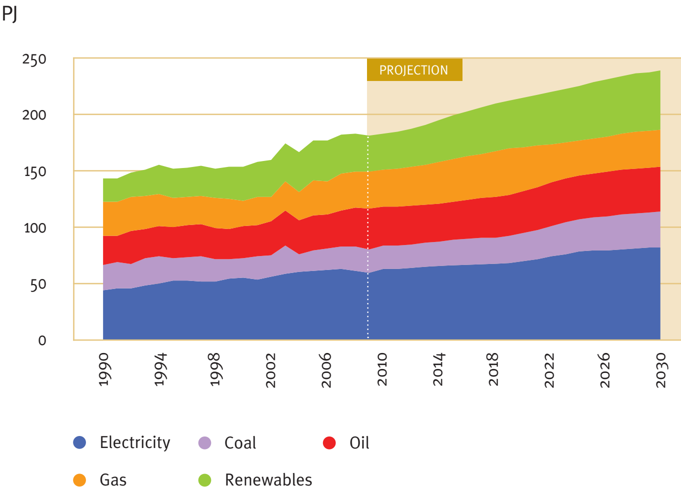
The commercial sector includes wholesale and retail trade, telecommunications, financial institutions etc. Electricity dominates energy demand in the commercial sector at around 65% of the total. Electricity has also experienced the greatest demand growth in this sector.

The residential sector reflects household use of energy and excludes households' energy use for transport, which is covered in the transport demand section. Residential energy demand is dominated by electricity, with almost all of the growth in demand being accounted for by electricity.

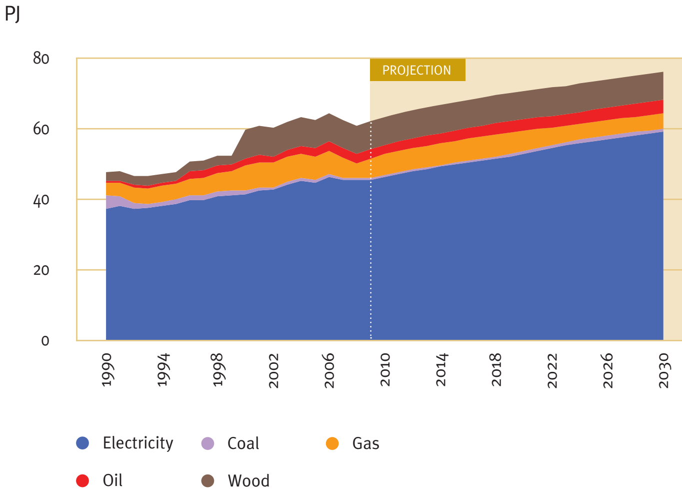
In the *Reference Scenario,* long-term energy demand for all of these sectors is forecast to increase. Industrial and commercial demand growth is expected to be lower compared with historical rates in the very near term due to the effects of the recession. In the longer term, growth rebounds, albeit at lower than historical rates.

Residential demand is not expected to be significantly affected by the recession due to the relative insensitivity of residential demand to economic growth.[17]

Industrial Demand by Fuel



Residential Demand by Fuel



Growth in Energy Demand in relation to GDP and Household Numbers

Period	GDP (p.a. growth)	Household Numbers (p.a. growth)	Energy Demand (p.a. growth)		
			Residential	Commercial	Industrial
1990–2008	**2.9%**	**1.4%**	**1.3%**	**1.6%**	**1.4%**
1990–2000	2.8%	1.4%	2.2%	2.7%	0.7%
2000–2005	3.8%	1.5%	0.9%	-0.4%	2.9%
2005–2008	1.8%	1.4%	-0.9%	1.5%	1.1%
2009–2030	**2.4%**	**1.2%**	**1.0%**	**1.3%**	**1.3%**
2009–2012	2.4%	1.3%	1.6%	0.5%	1.2%
2012–2020	2.9%	1.2%	1.0%	1.7%	1.7%
2020–2030	1.9%	1.0%	0.8%	1.1%	1.1%

[17] Growth in household numbers is the most important driver of residential demand in our model. Note the large increase in wood use in 2000 is due to an improvement in the source information.

Assumptions

The information included in this article is based on an integrated approach, combining modelling from the Supply and Demand Energy Model (SADEM), Generation Expansion Model (GEM) and the Vehicle Fleet Model (VFM).

Like most economic and engineering modelling techniques, the complex supply and demand dynamics within New Zealand's energy sector are broken down into a series of mathematical relationships based on observations of past behaviour, key macroeconomic drivers and engineering estimates. This is supplemented by information supplied by market participants.

While models are useful tools to help inform our understanding about the relationships between different variables, there are inherent limitations that need to be borne in mind when interpreting results. In particular, the future is uncertain and our models cannot always take into account the subtleties of commercial decision making or barriers to investment. Such models also consider only a sub-set of the economy so wider implications are ignored.

The key assumptions included in this modelling are listed below:

- GDP growth follows the projections produced by Treasury; in the short term, from the Budget Economic and Fiscal Update (BEFU) 2009, and in the longer term, from the Long Term Fiscal Model where rates trend down towards the long-run labour productivity rate of 1.5%.
- Exchange rates to 2013 are also based on Treasury's updated forecast. For the period 2014 to 2020, exchange rates trend towards the long-term rate of 0.60 US$/NZ$ and remain at this rate indefinitely.
- Oil prices are assumed to follow the New York Mercantile Exchange (NYMEX) futures price in the near term, trending towards the International Energy Agency's World Energy Outlook mid-case projection of US$120/bbl (real) by 2030.
- Production from new gas discoveries is assumed to average 100PJ/year, with production from new discoveries starting in 2017. As a consequence, we have assumed that there is insufficient certainty of future gas supply to support additional baseload gas-fired electricity generation.
- Gas prices are assumed to remain relatively shallow, rising to around $8.5/GJ (in real terms) by 2020. Post 2020, tightening supply sees gas prices begin to gradually rise to the opportunity cost of alternative energy sources for electricity generation of ~$13/GJ (including emissions pricing) by 2035.
- An emissions price of $25 per tonne of carbon dioxide is included. Heavy industry is assumed to be slowly exposed to emissions pricing over a period of 15 years and also responds through improved energy efficiency. No assumptions around industry expansion or closure as a result of emissions pricing have been made.
- Two Huntly coal units are switched to dry year reserve plant in 2015 and 2017 respectively, with the remaining two units decommissioned in 2019 and 2021.
- Existing baseload gas plant at Stratford and Otahuhu is decommissioned in 2025 and 2030 respectively. Note that a new baseload gas plant is built in 2025 (Otahuhu C) which replaces Stratford.

WEBSITE

More detailed information is available on the MED website www.med.govt.nz/energyoutlook

Authorship

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New Zealand Government

New Zealand's Energy Outlook 2009

Economic Growth Sensitivity

Welcome

This article explores the effect of four alternative economic growth outlooks on New Zealand's energy sector. It extends the analysis contained in the *Reference Scenario* article.

A country's energy demand is strongly related to economic growth. For example, the relatively strong economic growth experienced by New Zealand in the decade from the mid-1990s was coupled with strong growth in energy demand. We now find ourselves amidst a recession, with much lower expectations for growth in the immediate years. It is therefore interesting to explore how economic growth influences our forecasts of energy supply, demand, prices and greenhouse gas emissions.

The *Reference Scenario* assumes a central economic outlook for New Zealand based on projections produced by Treasury, where rates trend down towards the long-run labour productivity rate of 1.5%. This article explores the effect of four alternative economic outlooks on New Zealand's energy sector relative to the *Reference Scenario*.

The sensitivity cases tested include two cases thought to place upper and lower bounds around the possible level of GDP growth foreseen in the *Reference Scenario* and two more realistic sensitivities.

The *Reference Scenario* annual GDP growth forecasts have been adjusted as follows:

a. Very low growth (-1.5% points per annum).
b. Low growth (-0.75% points per annum).
c. High growth (+0.75% points per annum).
d. Very high growth (+1.5% points per annum).

With **very low growth,** we may envisage that innovation, technology and productivity stagnate and New Zealand's economy shifts to a bleaker future, growing at a rate of less than half of that in the *Reference Scenario*. This scenario effectively assumes a labour productivity growth rate of zero, with GDP only growing at the rate of labour market growth. Alternatively, in the **very high growth case,** New Zealand's economy experiences a structural shift to higher growth and a more service/technology-based economy. Economic gains are also expected in the primary production and energy-intensive sectors through technological and energy-efficiency improvements.

Reference Scenario and the *Economic Growth Sensitivity*

Please read this *Economic Growth Sensitivity* publication in conjunction with the *Reference Scenario* publication shown above.

Key messages

- New Zealand's energy consumption increases strongly with long-term increases in economic growth.
- Emissions in 2030 are over 50% higher than 1990 levels in the highest growth sensitivity.
- Very low or low economic growth reduces electricity demand growth to ~0.9% or ~1.2% per annum respectively.
- High or very high economic growth sees electricity demand grow by ~1.7% or ~2.0% per annum.
- Transport demand for diesel grows considerably in the higher economic growth cases.
- Petrol demand appears to have already peaked under all economic outlooks.
- Even with significantly reduced year-on-year economic growth in the low growth case, by 2030, emissions from the energy sector are still 15% above 1990 levels.
- In the near term (until ~2014), wholesale electricity prices are expected to plateau at around $80–85/MWh irrespective of different electricity demand forecasts.

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Energy intensity reflects the relationship between energy use and GDP and is influenced by both the composition of industry within an economy and energy-efficiency improvements. Energy intensity is measured here as gigajoules of energy required to contribute $1,000 towards New Zealand's economy ($1,000 of GDP).

Energy intensity is very sensitive to the different economic outlooks.[1] In all cases, we face a brief plateau in intensity improvements in the near term as the recession restricts investment, but as growth returns, each of the different economic outlooks produces further improvements in national-level energy intensity.

Although New Zealand's GDP growth since 1990 has been spread across the economy, a lot of the growth has been focused in less energy-intensive sectors. For example, retail trade, communication services, finance and insurance, and real estate and business services accounted for almost 50% of the increase in GDP since 1990, where the contribution of these four sectors to total GDP has increased from ~25% to almost 35%.[2] This trend of a shift towards service-based economic growth is assumed to continue, resulting in ongoing reductions in energy demand per unit of GDP. Also contributing to improved (reduced) future energy intensity are improvements in the vehicle fleet as newer more efficient vehicles progressively replace those scrapped.

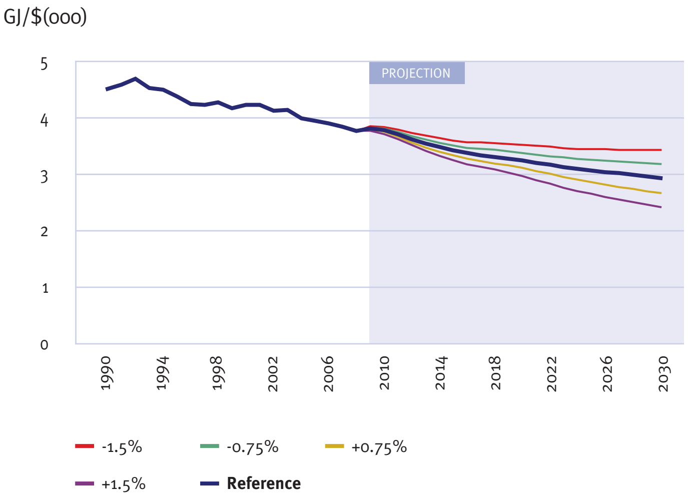
Energy-intensity improvements are greater in the higher growth scenarios as growth occurs in less energy-intensive sectors. Whereas the lower growth scenarios have a greater reduction in economic growth compared with reduced energy demand. In the lowest growth sensitivity, improvements in energy intensity all but cease by 2015.

Primary demand for fossil fuels[3] has remained relatively flat since about 2003 and, in the *Reference Scenario,* remains flat until around 2030. The reasons for this flattening of growth include the reduced availability of cheap natural gas, expected lower coal use for electricity generation and lower growth in demand for oil.

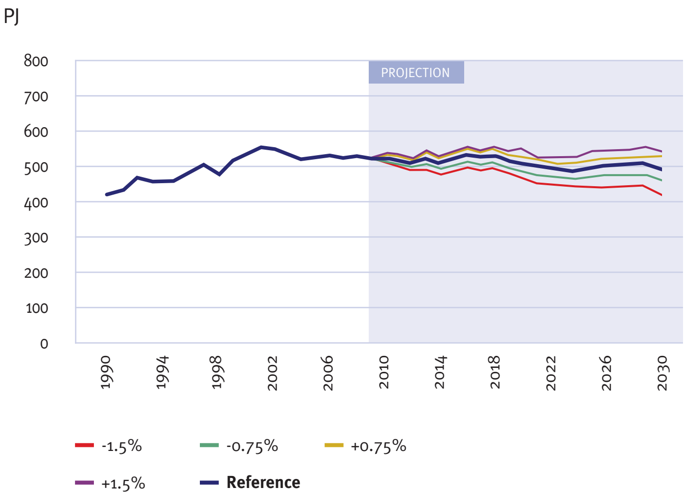
Due to the link between energy demand and economic growth, the sensitivity cases considered here produce relatively symmetrical results around the flat fossil fuel demand in the *Reference Scenario*. By 2030, primary fossil fuel demand in the highest growth sensitivity is 10% higher than that in the *Reference Scenario*.

The flattening off of fossil fuel demand in all of the sensitivities explains why, in the graphs that follow, total energy demand continues to grow but emissions flatten off.

Consumer Energy Intensity



Primary Fossil Fuel Demand



1 Energy-intensive industries directly contribute around 10% of GDP. Also, a considerable amount of energy is used in non-productive parts of the economy, for example, over 15% of our consumer energy consumption is used in our homes so changes in GDP will result in proportionally smaller changes in energy consumption (i.e. an extra 1% of GDP does not require an extra 1% of energy if GDP growth is spread throughout all service/manufacturing/industrial/agricultural sectors).

2 Statistics New Zealand Chain-Volume Series 95/96 Prices – Gross Domestic Product by Industry.

3 Primary fossil fuel demand includes consumer demand, fuel used for electricity generation and oil production, and non-energy uses (e.g. natural gas used for methanol and urea production, coal used for steel making).

Energy sector greenhouse gas emissions have been growing steeply since 1990 due to strong growth in transport energy demand and thermal electricity generation through increased use of gas and coal. Since 1990, energy sector emissions have increased by almost 40%, or by around 2% per annum.

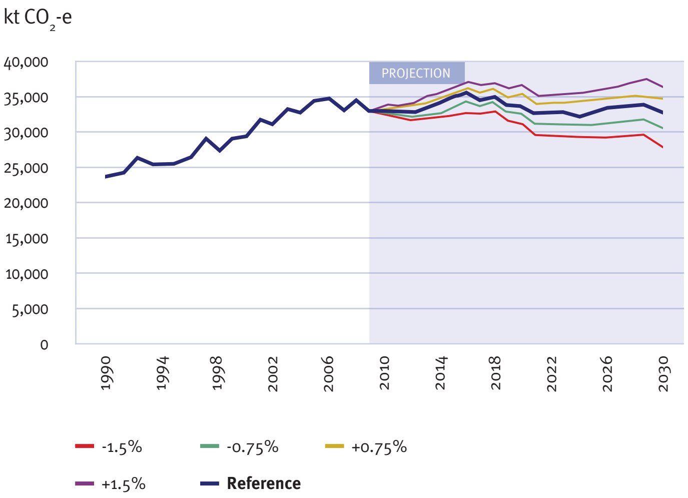
Energy sector greenhouse gas emissions result directly from fossil fuel combustion. Therefore, we find similar growth in emissions as we do for fossil fuels consumption for each of the economic growth sensitivity cases.

Annual emissions in the *Reference Scenario* are forecast to remain constant at ~40% higher than 1990 levels (~34,000kt CO_2-e +/- 10%, or ~2006 levels). The highest growth sensitivity case sees somewhat higher emissions in the near term reaching around 50% higher than 1990 levels by 2030. Even with significantly reduced year-on-year economic growth in the very low growth case, by 2030 emissions from the energy sector are still ~15% above 1990 levels.

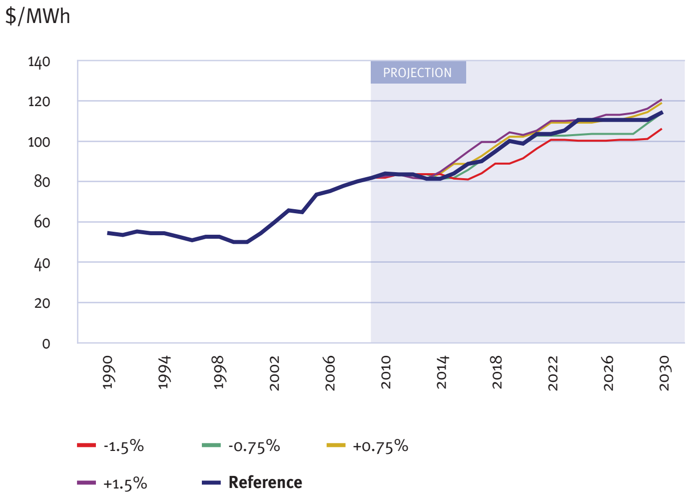
Projected **wholesale electricity prices**[4] are also influenced by the different economic outlooks. Higher economic growth increases electricity demand, which, in turn, requires the earlier development of more costly new generation plant, resulting in higher prices. In the short term, all of the economic sensitivity cases see electricity prices remaining around $80–85/MWh until ~2014 as new geothermal generation meets demand growth. After 2015, the various electricity demand profiles start to have a greater influence on price as more expensive wind and hydro plant needs to be built to meet the different levels of demand. In the longer term, higher economic growth results in prices reaching around $115–120/MWh by 2030 – 5% higher than in the *Reference Scenario* and nearly 50% higher than current prices (in real terms).

Historically, wholesale electricity prices have been increasing by ~2.1% per annum since 1990 in **real** terms. In the sensitivities explored here, future per annum **real** growth rates range from 1.2% per annum in the lowest growth sensitivity to 1.8% per annum in the highest growth sensitivity.

Energy Sector Greenhouse Gas Emissions



Average Wholesale Electricity Prices (Real)



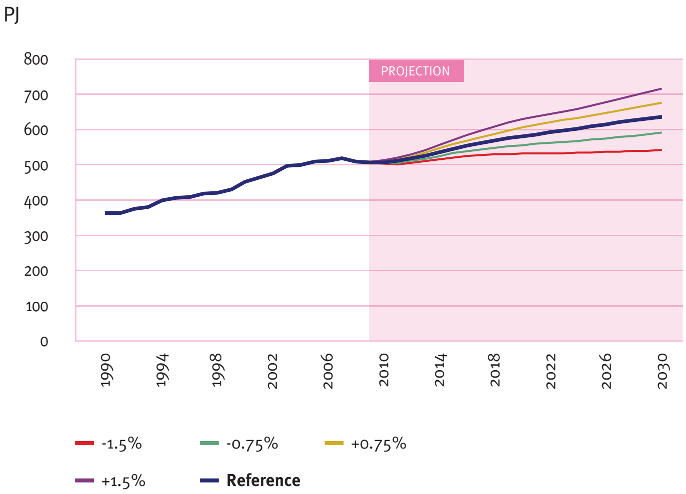
[4] Price projections are based on the long-run marginal cost (LRMC) of new generation plant. The LRMC reflects the return a generator must earn to cover the costs of new generation investment.

Historically, consumer demand for energy has been strongly correlated with GDP. The highest growth sensitivity case sees consumer energy demand picking up after the current recession so that, by 2030 demand is almost 60% higher than current levels. Conversely, very low economic growth significantly reduces energy demand growth, producing an almost flat energy demand profile.

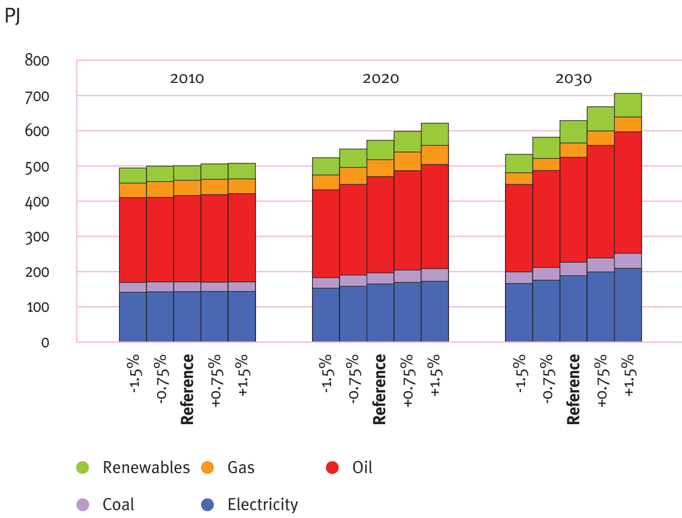
The historical annual average energy demand growth rate since 1990 has been ~1.6% per annum. The sensitivity cases have energy demand growth rates ranging from 0.4% to 2.1% out to 2030. These growth rates represent the average across the entire period (which includes relatively low growth rates in the near term). With the exception of the highest economic growth sensitivity, long-term average energy demand growth rates are not expected to exceed growth rates experienced in the 1990s due to reduced average economic growth, lower projected population growth in the longer term, significantly higher energy prices (especially for oil) and ongoing energy-efficiency improvements.

In all of the sensitivity cases, oil remains the dominant energy source and experiences the greatest demand growth due to its close relationship with economic activity. Electricity accounts for the next largest energy source in each of the sensitivity cases, at around a quarter of total demand, and also has a close relationship with economic growth.

Total Consumer Demand



Total Consumer Demand by Fuel

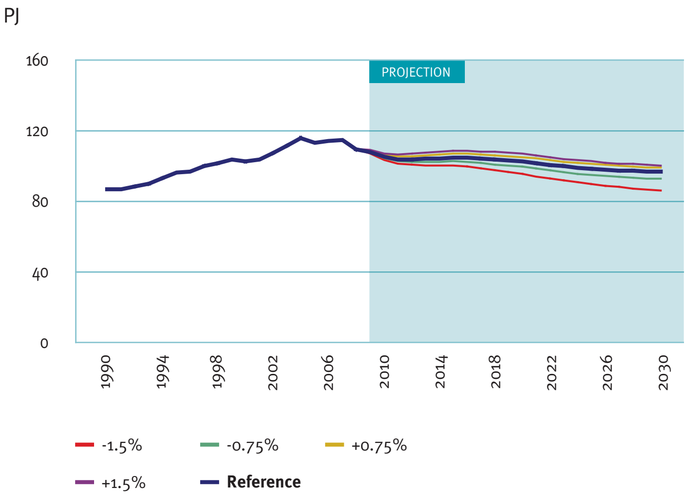


New Zealand's dependence on oil as an energy source is highlighted by the fact that, 98% of New Zealand's transport energy is from oil. The sensitivity cases considered here assume no wholesale move to alternative fuel or vehicle technologies.[5]

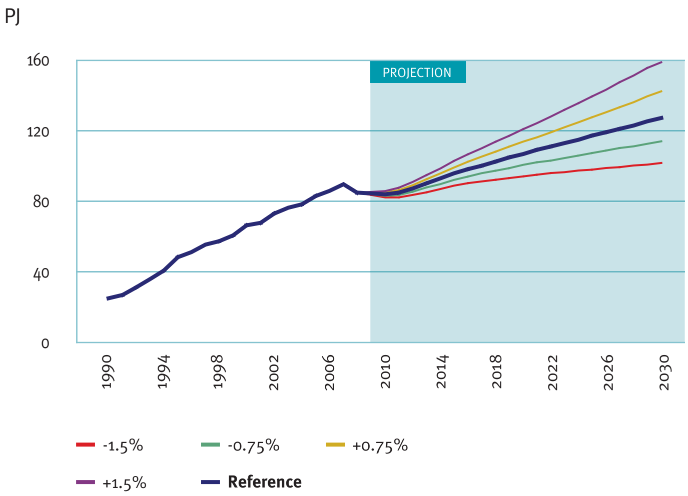
There is a shift from petrol to diesel as the dominant fuel in all of the economic growth sensitivities by around 2020. Historically, petrol has been the primary fuel of the light passenger fleet in New Zealand, with diesel the choice of the heavy fleet of trucks and buses. Since the early 1990s, there has been strong growth in on-road freight in New Zealand following its deregulation. In recent years, there has also been increasing use of diesel for light commercial vehicles and in private motoring, firstly in a range of heavier passenger vehicles such as sports utility vehicles (SUVs) and more recently in a move to light diesel cars mirroring trends in Europe. This latter trend, along with a move away from the largest petrol vehicles, explains this shift from petrol to diesel. It appears that, even under the different GDP growth assumptions explored in this article, transport demand for petrol has already peaked. Future demand growth for petrol is essentially flat and even reducing in the lowest economic growth sensitivity.

Growth in diesel demand continues post recession, with average growth rates between 1–1.5% for the low economic growth sensitivity cases and 2.5–3.1% in the higher growth cases. Interestingly, even the high economic growth sensitivities produce lower diesel demand growth rates than those experienced in the 1990s, where the rapid increase in road freight was coupled with strong economic growth and cheap oil. By 2030, the highest economic growth case sees diesel demand almost double current levels.

Land Transport – Petrol Demand



Land Transport – Diesel Demand



[5] Alternative fuels will be explored in *Seeking Solutions* scenarios to be released in the next *Energy Outlook* issue.

The range of different GDP growth assumptions explored in this article produce long-term average electricity demand growth rates ranging between ~0.9% per annum in the lowest growth sensitivity to ~2.0% per annum in the highest growth sensitivity.

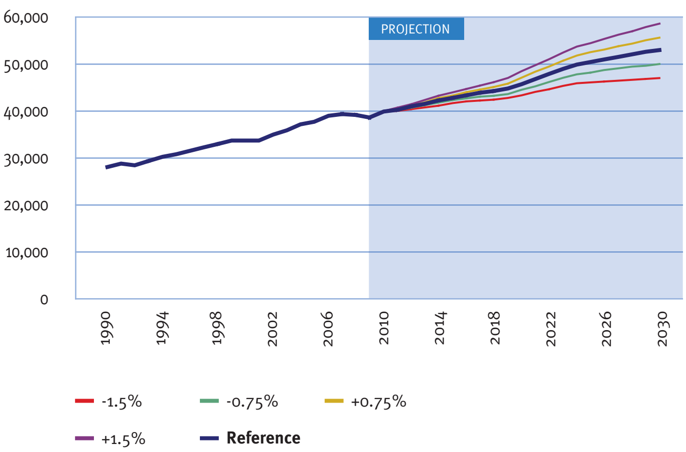
Forecast electricity growth rates are generally lower than the historical average rate of ~1.8% per annum. This reflects that GDP (in the *Reference Scenario*) is forecast to grow at lower than historical rates and that electricity prices are forecast to be significantly higher than historical prices.

For the period 1990 to 2008 GDP grew, on average, by 2.9% per annum, and real wholesale electricity prices across the period averaged around $55–60/MWh.

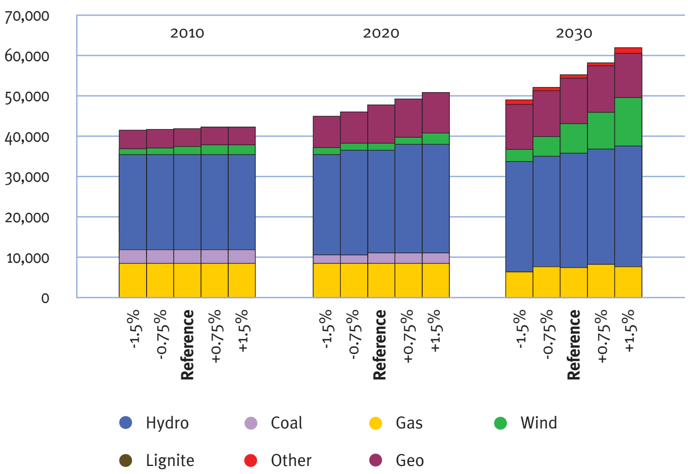
In the lowest growth forecast, GDP growth averages 0.9% out to 2030 and wholesale electricity prices average ~$90/MWh, giving an average electricity demand growth of ~0.9% per annum. In the highest growth sensitivity, GDP growth averages 3.9% per annum and wholesale electricity prices average $105/MWh across the period, producing electricity demand growth of 2% per annum.

The table below shows that, given the expected wholesale electricity price rises, only GDP growth rates above historical rates achieve demand growth comparable to that seen in the past. This is, in part, due to the assumption that a significant proportion of future economic growth is expected to come from less energy-intensive sectors.

Electricity Demand



Electricity Generation by Fuel



Electricity Demand Growth versus GDP Growth and Electricity Price

Period/ Sensitivity	GDP growth (p.a.)	Averaged Wholesale Electricity Price ($/MWh)	Electricity Demand growth (p.a.)
1990–2008	**2.9%**	**58**	**1.8%**
2004–2008	**2.0%**	**73**	**1.2%**
Very Low GDP	0.9%	90	0.9%
Low GDP	1.6%	93	1.2%
Reference	**2.4%**	**95**	**1.5%**
High GDP	3.1%	97	1.7%
Very High GDP	3.9%	98	2.0%

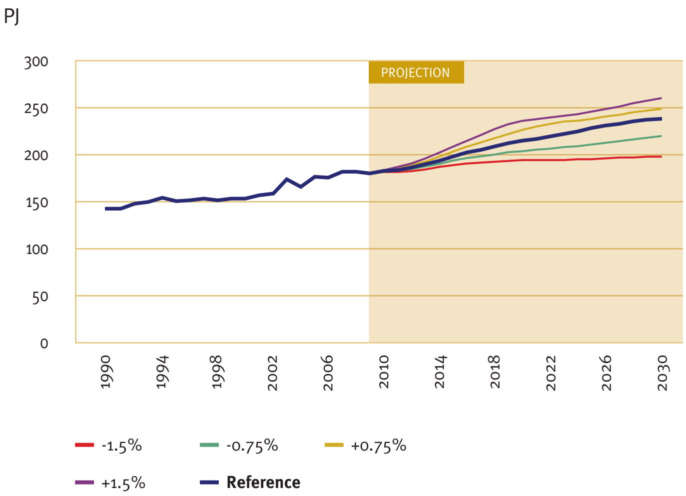
Non-transport demand is split into three broad sectors: industrial, commercial and residential. The industrial sector includes both heavy and light industry including agriculture and construction through to wood and dairy processing and steel making. The commercial sector includes the likes of wholesale and retail trade, telecommunications and financial institutions. The residential sector is energy use within homes.

New Zealand's projected industrial energy demand growth ranges from 0.4% to 1.8% per annum growth (lowest to highest economic growth sensitivities). This compares to the historical rate of 1.4% per annum since 1990. We assume some of the nation's largest energy users are constrained in terms of capacity increases, which sees a tapering off of industrial demand growth in some of the higher growth sensitivities.

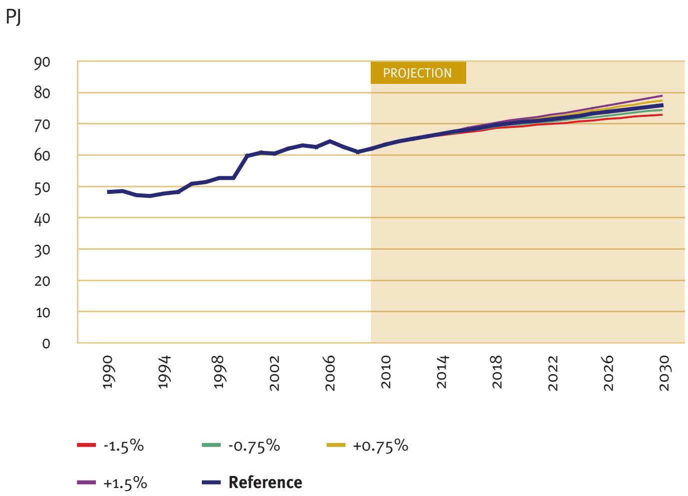
The commercial sector shows the strongest energy demand growth in relation to high GDP growth. This is, in part, due to the commercial sector not having the same capacity constraints as in the industrial sector. Out to 2030, electricity demand growth rates in the commercial sector range between 0.4% to 2.2% per annum (lowest to highest economic growth sensitivities).

Non-transport residential energy demand is less strongly linked to economic growth. This can be seen in the historical growth series, and this relationship is continued into the future, albeit at slightly lower rates due to increased prices.

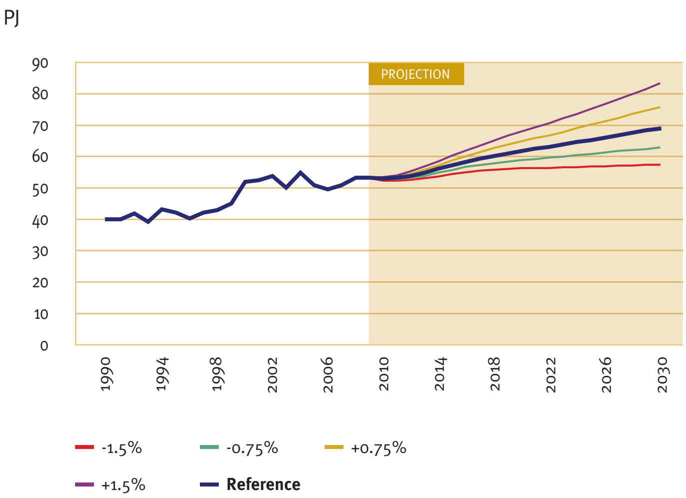
Industrial Demand



Residential Demand



Commercial Demand



The information included in this article is based on an integrated approach combining modelling from the Supply and Demand Energy Model (SADEM), Grid Expansion Model (GEM) and the Vehicle Fleet Model (VFM).

This article is a sensitivity analysis of the *Reference Scenario* to economic growth (GDP). The only assumptions changed in this article from the *Reference Scenario* are the GDP forecasts. This approach assumes GDP growth is not driven by increased population growth relative to the *Reference Scenario* so results in increased GDP per capita.

The central economic outlook in the *Reference Scenario* follows projections produced by Treasury; in the short term, from the Budget Economic and Fiscal Update (BEFU) 2009, and in the longer term, from the Long Term Fiscal Model where rates trend down towards the long-run labour productivity rate of 1.5%. In the sensitivity cases, we have explored two more extreme sensitivities (+/-1.5% points per annum) and two more realistic sensitivities (+/-0.75% points per annum):

a. Very low growth (1.5% per annum below the central GDP forecast).

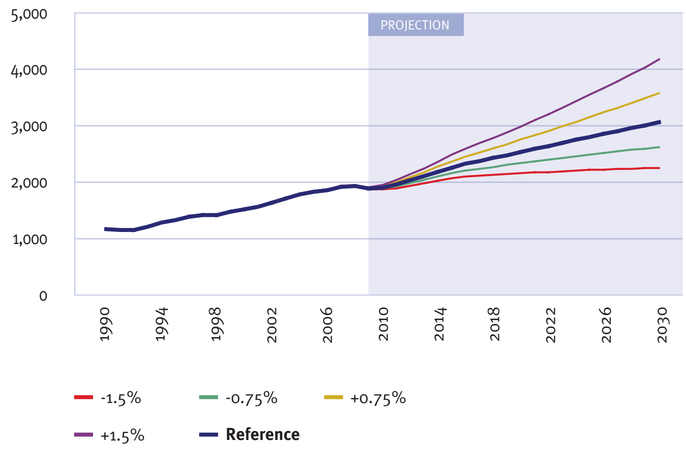
b. Low growth (0.75% per annum below the central GDP forecast).

c. High growth (0.75% per annum above the central GDP forecast).

d. Very high growth (1.5% per annum above the central GDP forecast).

Refer to the *Reference Scenario* for a description of other assumptions.

GDP Index



WEBSITE
More detailed information is available on the MED website www.med.govt.nz/energyoutlook

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Ministry of Economic Development
Manatū Ōhanga

New Zealand Government

Oil Price Sensitivity

Welcome

Since 1990, increased oil demand has been the major source of growth in New Zealand's energy demand and energy sector greenhouse gas emissions. Oil currently provides over half of New Zealand's consumer energy demand and almost 98% of our transport fuel. Given oil's central role in the economy, this article explores the sensitivity of the energy sector, and particularly transport, to variations in the future oil price, extending the analysis contained in the *Reference Scenario*.

The *Reference Scenario's* oil price projection is based, in the short term, on the New York Mercantile Exchange (NYMEX) oil futures market and, in the longer term, on the prices modelled in the International Energy Agency's (IEA) World Energy Outlook 2008 (WEO) reference scenario. In this WEO scenario, real oil prices are projected to rise steadily from current prices up to US$120/bbl by 2030 (in real dollars).

In the 2008 WEO, the IEA detailed a thorough re-examination of global energy trends, including an outlook for the oil market, reporting that lower demand growth can be expected as a result of the recession. It also emphasised that, while oil is ultimately a finite resource, the immediate risks to supply, and therefore price, are more likely to be investment constrained rather than resource constrained. These immediate risks will potentially produce price volatility in the near term. However, in the long term, it is the underlying cost of accessing increasingly expensive oil resources that explains the upward oil price path through to 2030.

This article is not intended to predict future oil prices. Rather, it sets out a series of sensitivities testing how the energy sector would respond to different oil prices. The sensitivities tested in this article are set out below. Note that these are real prices.

a. Very low oil prices (flat US$50/bbl).
b. Low oil prices (25% lower than the *Reference Scenario*, reaching US$90/bbl by 2030).
c. High oil prices (25% higher than the *Reference Scenario*, reaching US$150/bbl by 2030).
d. Very high oil prices (50% higher than the *Reference Scenario*, reaching US$180/bbl by 2030).

Reference Scenario and the *Oil Price Sensitivity*

Please read this *Oil Price Sensitivity* publication in conjunction with the *Reference Scenario* publication shown above.

Key messages

- The *Reference Scenario* already presents a significant reduction in New Zealand's petrol and diesel demand growth due to the higher oil price path modelled.
- Until a widespread competitive alternative is available, oil will continue to dominate New Zealand's energy consumption, even in the face of high prices.
- An oil price 50% higher than the *Reference Scenario* produces a reduction in total oil demand of around 5% per annum (~6% reduction for petrol and ~2% reduction for diesel).
- Sustained higher oil prices are assumed to encourage purchases of more fuel-efficient vehicles.

Want a closer look?

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Primary fossil fuel demand includes consumer demand, fuel used for electricity generation and oil production, and non-energy uses (e.g. natural gas used for methanol and urea production, coal used for steel making).

Although New Zealand's economy is heavily reliant on oil, it has been observed historically that small or gradual changes in the price of oil have had limited impact on the growth in demand for oil products (i.e. low price elasticity[1]).

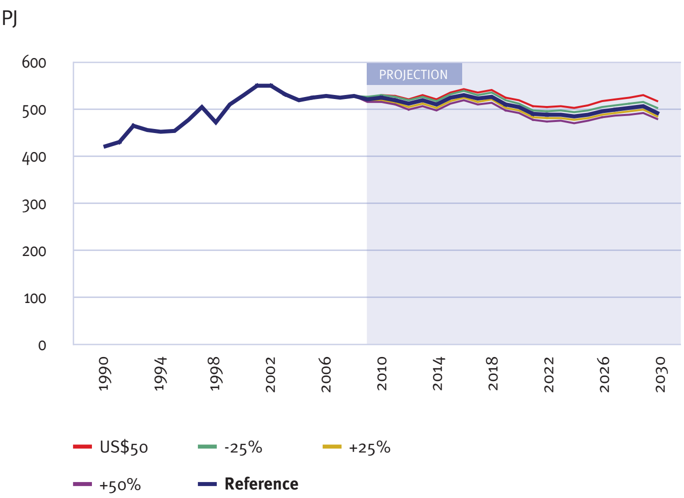
It took more than doubling of oil prices post 2003, to a peak of over US$140/bbl, to significantly influence petrol and diesel growth rates (down from 1.4% and 6% per annum to 0.3% and 2.4% respectively). Although prices have dropped to the US$60–70/bbl range, the *Reference Scenario* sees prices increase to US$120/bbl (real) by 2030. This expected price path sees reduced petrol and diesel growth continue into the future in the *Reference Scenario* and all of the sensitivities.

Compared to the rapid doubling of oil prices that has already occurred, movements in price in the sensitivity cases from the *Reference Scenario* are less pronounced, with a maximum movement of +/-50%. Thus, in comparison to the *Reference Scenario,* the sensitivity cases presented here see limited further reductions in primary fossil fuel demand.

There are two key reasons why apparently large oil price increases have a limited impact on the demand for oil products. Firstly, taxes and distribution costs contribute a significant share of the total price faced by the consumer, and these do not increase proportionally with increases in oil prices (e.g. a 50% increase in the underlying oil price will lead to just a 25–30% increase in retail petrol prices).

Secondly, the lack of widespread, cost-effective transport alternatives and the high value we place on access to transport means that oil consumption is relatively insensitive to price. This is particularly the case for commercial users, where fuel may only be a small part of overall costs and where there may be some ability to pass higher fuel costs on to customers. Without viable public transport alternatives, even the private motorist will only have limited ability to reduce their oil consumption in the short term. In the longer term, demand for oil is found to be more sensitive to sustained price rises because consumers are able to modify consumption decisions, e.g. by purchasing more fuel-efficient vehicles. It is worth noting that the *Reference Scenario* and the sensitivity cases are based on current transport technologies. We have not included the potential for fuel switching to alternative motor fuels or developing technologies such as electric vehicles and hydrogen fuel cell vehicles. Alternative fuels and vehicle technology will be explored further in the *Seeking Solutions* scenarios to be released later.

Primary Fossil Fuel Demand



[1] It is important to remember that oil price elasticities are unlikely to remain at constant levels. At very high oil prices, they may be quite different to those observed in the past at lower price levels. At very high prices, there may be some price above which many motorists may respond more quickly to price changes than has been included in this modelling.

Energy intensity measures the amount of energy consumed (in gigajoules) to produce $1,000 of GDP.

The modelling framework utilised here does not include the ability to consider the impact of higher/lower oil prices on projected GDP growth. Given that oil demand is relatively insensitive to price changes from the *Reference Scenario* (and that GDP is the same in all cases), energy intensity barely changes in the sensitivity cases.

The effect of oil price changes on **energy sector greenhouse gas emissions** mirrors the small fossil fuel demand responses relative to the *Reference Scenario*. In future *Energy Outlook* scenarios, we will consider a move away from business as usual and investigate the potential for fuel switching from petroleum products to alternatives, including biofuels and plug-in electric vehicles.

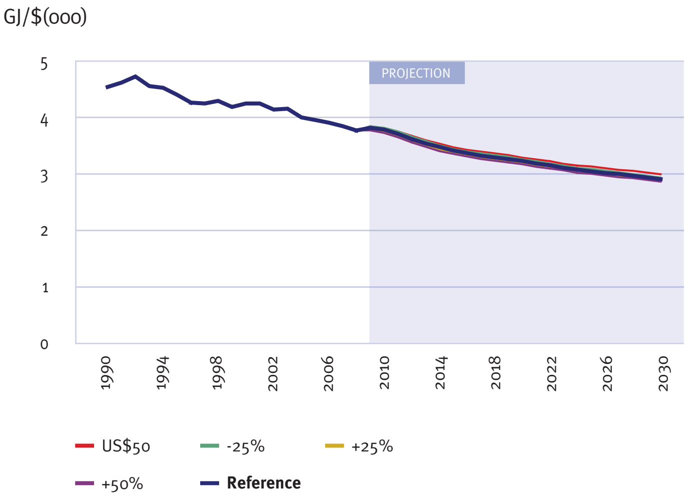
The only sensitivity case to show much variation from the *Reference Scenario* is where oil is assumed to remain cheap at US$50 a barrel. Here, emissions would be slightly higher in the short term, increasing in the medium term and around 6% per annum higher post 2030 than the *Reference Scenario*.

Wholesale electricity price projections are based on the long-run marginal cost (LRMC) of expected new generation plant. In all sensitivity cases, future new generation is dominated by renewables.

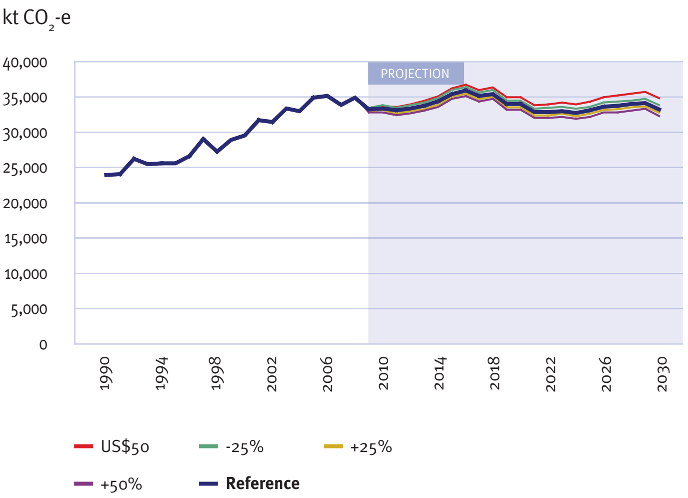
Whirinaki is New Zealand's only grid-connected power plant that uses oil (in the form of diesel). Whirinaki is a reserve station used to provide dry year capacity and, as such, contributes only very small amounts to total New Zealand generation.

If New Zealand had to import gas (LNG), domestic gas prices would become linked to international oil and gas prices. If this situation occurred, existing gas-fired electricity plant would become uneconomic (compared to renewable alternatives) at an LNG import parity price. This analysis does not allow for imported LNG so changing oil prices will not have any material impact on wholesale electricity prices.[2]

Consumer Energy Intensity



Energy Sector Greenhouse Gas Emissions



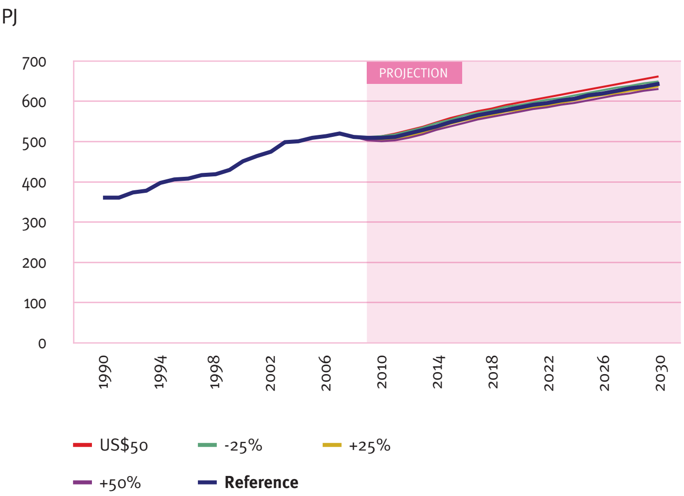
[2] There will be subtle fuel-switching impacts, as some commercial and industrial users of oil may be able to switch to electricity. However, we have not considered these impacts in our wholesale electricity price forecast.

As has already been discussed, New Zealand's demand for oil has been found to be relatively insensitive to small or gradual price changes. Therefore, with oil providing close to half of consumer energy demand, we find that consumer energy demand is also relatively insensitive to oil price changes.

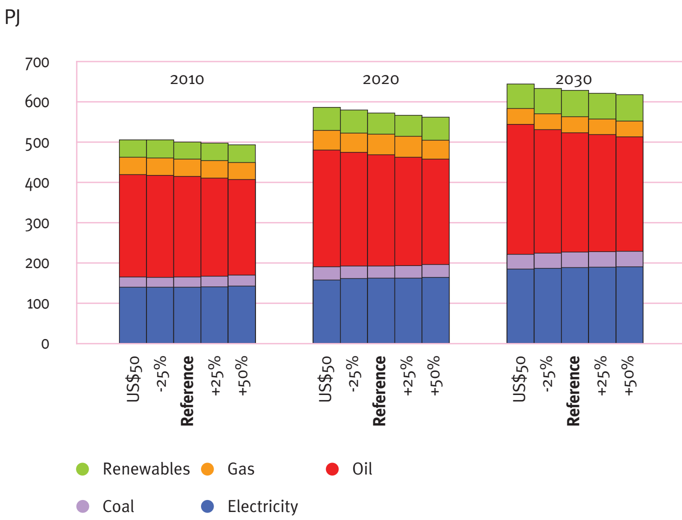
If oil prices remained flat at US$50/bbl, we could expect around a 3% per annum demand increase from the *Reference Scenario* post 2020. (While this is difficult to observe in the graph, the underlying data shows a total consumer demand in 2030 of 643PJ in the US$50/bbl sensitivity case versus 624PJ in the *Reference Scenario.*)

It is forecast that oil will continue to account for approximately half of all consumer energy demand. The higher oil price scenarios reduce oil demand by around 2.5–5% compared to the *Reference Scenario,* with the market share of oil seen to be reduced by just 1–2%.

Total Consumer Demand



Total Consumer Demand by Fuel



New Zealand's non-transport energy demand can be split into three broad sectors: industrial, commercial and residential (~35%, 10% and 13% of total demand respectively in 2008).

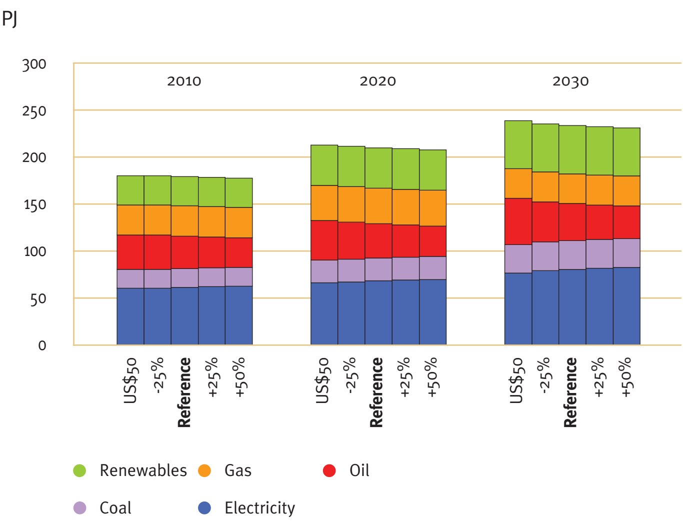
The industrial sector includes New Zealand's light industry (including agriculture and construction) and heavy industry (wood and dairy processing, steel making etc). Of the three non-transport sectors, industrial energy demand is the only one significantly influenced by higher oil prices. This is because a considerable amount of diesel is used for mobile off-road purposes, such as tractors on farms, trucks in forestry and mining, and boats for fishing.

Smaller quantities are also used for stationary applications such as boilers and generators in industry. These non-transport uses of oil account for ~20% of the industrial sector's non-transport energy demand.

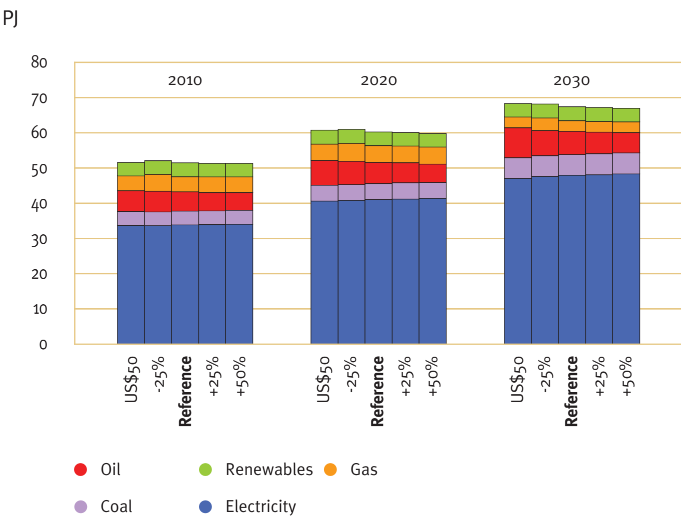
In the highest oil price sensitivity case, there is an approximate 2% per annum reduction in total industrial energy demand (from the *Reference Scenario*).

Oil products provide only a small proportion of the non-transport energy demand of the commercial and residential sectors. Therefore, these sectors are found to be unresponsive to oil price changes. The majority of energy demand in these sectors is in the form of electricity, which provides some 90% of the demand in the residential sector and greater than 60% of commercial demand.

Industrial Demand by Fuel



Commercial Demand by Fuel



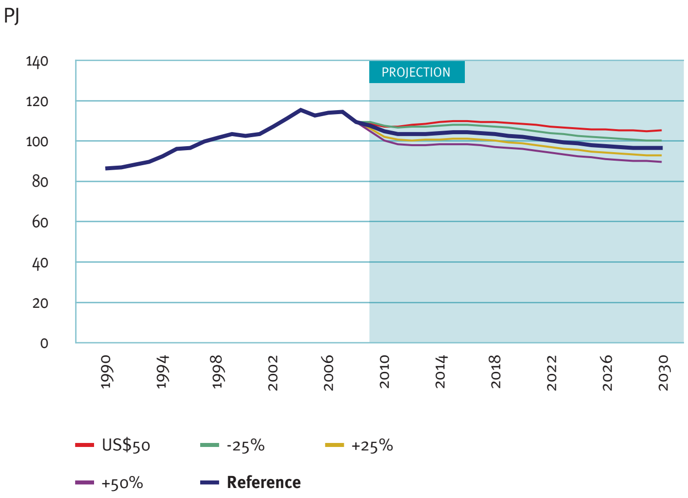
Oil products currently provide around 98% of New Zealand's transport[3] energy, and it is clearly this sector that has the greatest potential to be influenced by changing oil prices. However, historical observation and research agree that the price elasticity of demand for petrol is low and even lower for diesel. As a result, in our modelling, we identify only small changes in projected transport demand between the various oil price sensitivity cases.

An interesting aspect of modelling higher oil prices (compared to those in the *Reference Scenario*) is how these price changes influence land transport's[4] demand for petrol and diesel differently. In the highest priced sensitivity case, we find that a 50% increase in oil prices triggers a ~5% demand reduction in total oil products demand but with most of this reduction seen in petrol demand. In fact, petrol demand is reduced by ~6% per annum, whereas demand for diesel is only reduced by ~2% per annum. This is explained (at least in part) by the fact that the majority of diesel used for transport is used by commercial vehicles. This fuel consumption is relatively less responsive (compared to private motorists) to oil price changes as these costs can often be overshadowed by the value of the goods moved or, in some cases, be passed on as part of higher costs to customers.

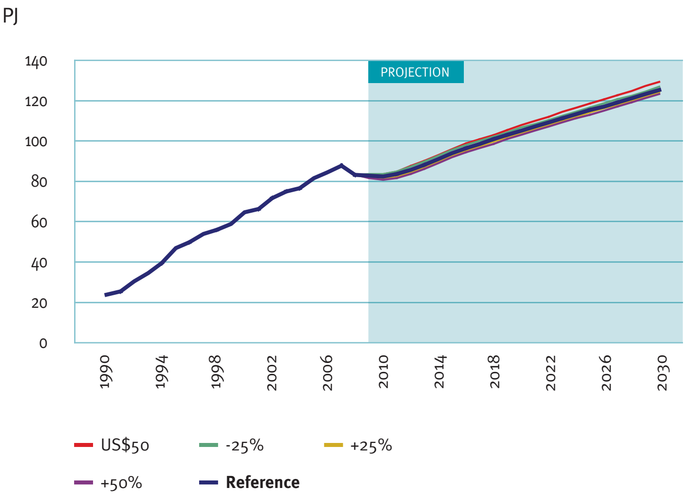
This result significantly influences the future market share of the two fuels. All future growth in energy demand for land transport is expected to be seen in diesel demand. This will be caused by the travel of the heavy fleet (vehicles over 3.5 tonnes) returning to growth rates experienced pre recession and by growth in the number of increasingly popular light diesel vehicles.

As mentioned earlier, the higher than historical oil prices included in the *Reference Scenario* have already significantly reduced demand growth rates for both petrol and diesel (compared to both historical rates and previously projected growth rates). For example, current forecasts of petrol and diesel demand in 2030 are ~22% lower than those included in the 2006 edition of *Energy Outlook*. These lower demand projections are the combined result of higher projected fuel prices[5] and the observed flat transport demand for the period 2006 to 2008. Over these recent years, there have been fuel price rises, the beginning of the recession and perhaps we are also seeing increased public consciousness over the climate change issue resulting in some move towards more efficient light vehicles.

Land Transport – Petrol Demand



Land Transport – Diesel Demand



[3] Transport includes all on-road fuel demand from all sectors of New Zealand's economy including private motorists, commercial and industrial transport. It excludes mobile off-road fuel consumption (tractors etc).

[4] Land transport accounts for ~90% of all transport energy demand, and nearly all its energy is provided by petrol and diesel.

[5] Oil prices included in the current *Reference Scenario* increase from current prices to US$120/bbl, whereas oil prices in the 2006 edition of the *Energy Outlook* remained at US$60/bbl.

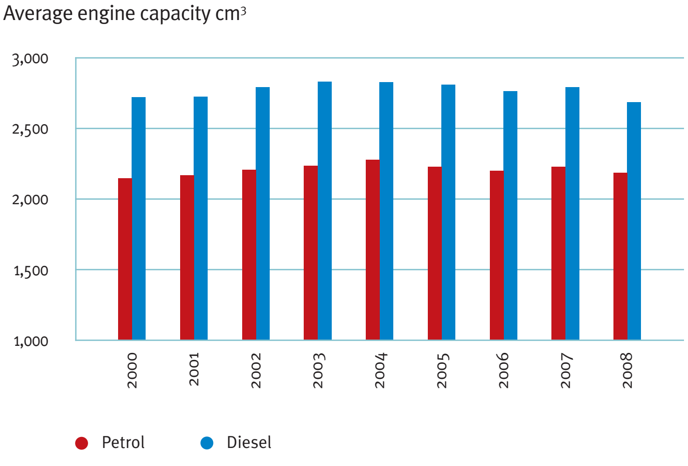
To add some context, New Zealand's light vehicle fleet[6] grew strongly, both in terms of numbers and average engine size during the first half of the current decade. However, it seems that the trend towards larger engines has reached a plateau and has started to reverse, reflecting international vehicle fashion as manufacturers increasingly produce vehicles offering improved fuel efficiency and improved performance at lower engine sizes. These manufacturing trends can be seen in nearly all OECD countries and are being driven by both industry initiatives and government policies including regulations on fleet efficiency and incentives promoting the purchase of efficient, low-emission vehicles.

Although the average size of new entrant vehicles is beginning to reduce, the slow turnover of New Zealand's vehicle stock means that efficiency improvements to the total fleet are slow and muted. In addition, the improvements will only register an immediate total fleet improvement where the new vehicles are more economic than those being replaced. For example,[7] despite the drop in average engine size of new vehicle purchases since 2004, the average engine size of the entire light fleet has continued to grow, as the new vehicles purchased have been larger than those being scrapped.

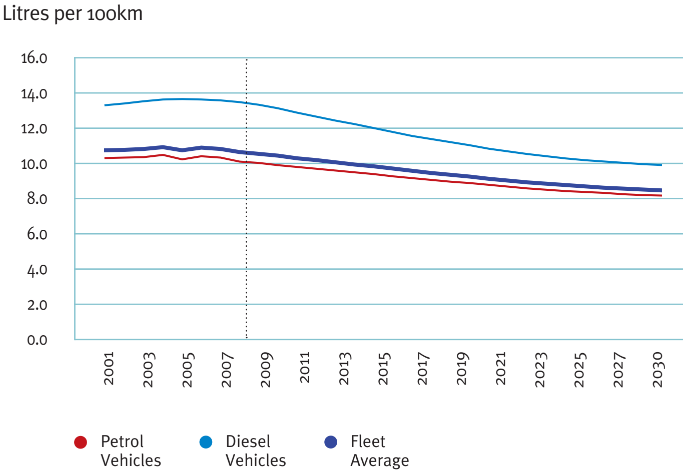
New Zealand has close to 3 million registered light vehicles in its fleet, and each year, there are some 200,000 new vehicle registrations, with almost half of these being used imports aged 6 years or more. These statistics combine to give an average age of the fleet of over 12 years and that future fleet growth is limited by the level of population growth (i.e. we assume that the level of car ownership of 0.7 cars per capita is close to saturation level). The implication is that, at the current replacement rate, any future uptake of more economic vehicles will require about 20 years before the potential benefits from these vehicles will be fully realised across the entire fleet.

The modelling behind this article includes this progressive roll over of the vehicle stock. With the trend to larger vehicles reversed, we now expect to see ongoing efficiency improvements in the fleet averaging ~1% per annum through to 2030. The difference seen in fuel economy between diesel and petrol light vehicles is explained by the generally greater vehicle mass of the diesel vehicles in the light fleet, which includes many of the nation's vans, SUVs[8] and utes. The greater improvement projected in the diesel fuel economy reflects increased purchases of diesel passenger vehicles improving the overall average fuel economy. Modern diesel vehicles do, in fact, offer a significant efficiency advantage over similar sized petrol vehicles and are currently extremely popular in Europe for this reason.

Average Engine Size of Vehicles Entering the **Light Fleet**



New Zealand **Light Vehicle Fleet** Fuel Economy



[6] Less than 3.5 tonnes.

[7] Vehicle size is referred to here as a proxy for fuel economy. Fuel economy of the existing fleet is hard to estimate and requires fleet travel modelling and fuel allocations. Vehicle engine size data is recorded through the New Zealand vehicle registry.

[8] Sports utility vehicle.

The information included in this article is based on an integrated approach combining modelling from the Supply and Demand Energy Model (SADEM), Grid Expansion Model (GEM) and the Vehicle Fleet Model (VFM).

The *Reference Scenario* assumes oil prices will follow the New York Mercantile Exchange (NYMEX) futures price in the near term, trending towards the International Energy Agency's World Energy Outlook mid-case projection of US$120/bbl (real) by 2030. In this central projection, diesel prices reach ~180c/l excluding GST (in today's dollars) by 2030, and petrol reaches ~225c/l excluding GST. (Both prices include the effect of a $25/t emissions price of ~6–7c/l.)

This article explores four oil price sensitivities, all of which are expressed as real prices:[9]

a. Very low oil prices (flat US$50/bbl).

b. Low oil prices (25% lower than the *Reference Scenario*, reaching US$90/bbl by 2030).

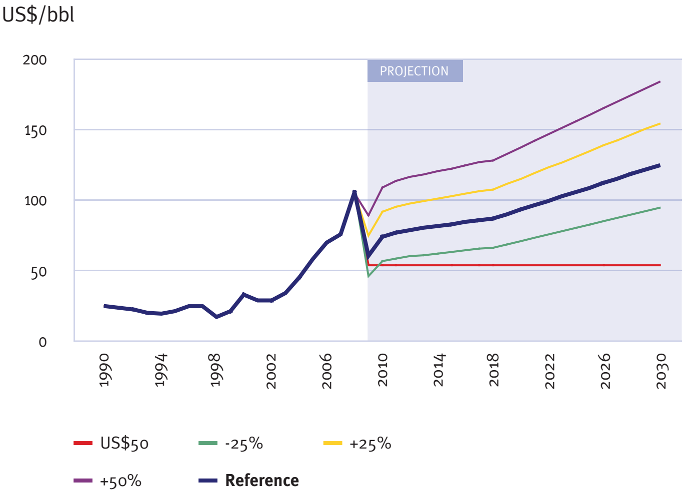
c. High oil prices (25% higher than the *Reference Scenario*, reaching US$150/bbl by 2030).

d. Very high oil prices (50% higher than the *Reference Scenario*, reaching US$180/bbl by 2030).

These are the only assumptions that have been changed from the *Reference Scenario*. Refer to the *Reference Scenario* for a description of other assumptions.

We have assumed that oil price elasticity remains similar to historically observed rates. It is important to keep in mind that this assumption may not hold true with sustained higher prices, where further increases in price may produce greater demand responses than has been experienced in the past. There may also be tipping points that lead to more dramatic reductions in demand with even further price increases. These effects and the lack of available alternative fuels are not addressed in this article. Inclusion of these possibilities could be expected to provide substantially different results in the higher oil price sensitivity cases, especially post 2020.

Oil Price



[9] For example, in 2030, a US$50/bbl real price would be around US$95/bbl in nominal terms (i.e. the actual price that would be observed in 2030 after including annual inflation increases).

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Ministry of Economic Development
Manatū Ōhanga

New Zealand Government

New Zealand's Energy Outlook 2009

Emissions Pricing Sensitivity

Welcome

This article extends the analysis contained in the *Reference Scenario* by exploring the effect on New Zealand's energy sector of four levels of international greenhouse gas emissions prices.

New Zealand is investigating options to reduce greenhouse gas emissions and combat the challenge of climate change. The government's preferred measure is to establish an emissions trading scheme that provides a price signal to incorporate the environmental cost of emissions.

The *Reference Scenario* assumes an emissions price of $25 per tonne of carbon dioxide equivalent (CO_2-e) emitted. The four alternative sensitivities included in this article are:

a. no emissions price
b. $50/t emissions price
c. $75/t emissions price
d. $100/t emissions price.

The first sensitivity contains no limitations on carbon-intensive activities. The key implication is that it allows investment in new coal-fired electricity generation. For the other sensitivity cases (and the *Reference Scenario*), it has been assumed that the existence of an emissions price and the associated commitment to reducing emissions makes investment in new coal-fired generation too risky a proposition.

Note also that the influence of emissions pricing on New Zealand's heavy industry has been muted for two key reasons:

- It is assumed that, in time, all international trade will face the same cost increase through worldwide emissions pricing.
- New Zealand's heavy industries are assumed to receive temporary government support to aid the transition to full exposure to the emissions price.

More detail on these assumptions is included on the back page of this article.


New Zealand's Energy Outlook 2009
Reference Scenario

Reference Scenario* and the *Emissions Pricing Sensitivity

Please read this *Emissions Pricing Sensitivity* publication in conjunction with the *Reference Scenario* publication shown above.

Key messages

- In the long term, emissions pricing of up to $100/t results in only limited emissions reductions from the energy sector relative to the *Reference Scenario*.
- Transport emissions continue to grow, even with an emissions price of $100/t.
- Post 2020, the level of emissions price makes little difference to wholesale electricity prices.
- Under the no emissions price scenario, new investment in coal-fired electricity generation results in energy sector emissions almost doubling 1990 levels by 2030; however, wholesale electricity prices are considerably lower than the reference scenario post 2015.

Want a closer look?

For detailed data visit www.med.govt.nz/energyoutlook

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Manatū Ōhanga

New Zealand's energy demand is dominated by oil and electricity, which are both relatively insensitive to price increases. This and the relatively low energy cost increases associated with emissions pricing result in limited consumer demand response. For example, an emissions price of $25/t would add around 6 cents to the price of a litre of petrol, which is not expected to have a significant effect on consumption. Therefore in the long term, with the exception of the unconstrained case, emissions pricing only has a small influence (up to 5% per annum) on **primary fossil fuel demand**.[1]

We assume emissions pricing has a muted impact on New Zealand's heavy industry (refer to the assumptions section). As a result, the demand for coal and gas by heavy industry is relatively similar across all sensitivity cases.

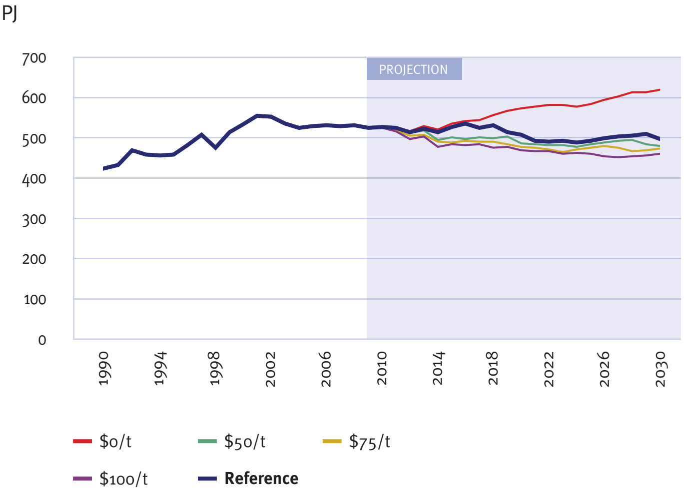
Emissions pricing will add significant cost and additional risks for investors in thermal electricity generation, especially coal. As discussed earlier, we assume that, with emissions pricing, no new coal plant is built. We also assume that, without major new gas discoveries,[2] there is insufficient security of gas supply to support additional baseload gas-fired electricity plants. Therefore, the influence of the level of emissions pricing between sensitivity cases is limited to its influence on the running and decommissioning of existing baseload coal and gas-fired electricity plant. We assume that higher emissions prices bring forward the staggered decommissioning of Huntly units by 1 year for each $25/t increase in the emissions price. (See the assumptions section of this article.)

The net result of these assumptions is that the use of coal for electricity generation is removed from our electricity system considerably earlier with higher emissions prices. There is also a 15–20% reduction in gas used for electricity generation in the higher emissions price sensitivities compared to the *Reference Scenario*.[3]

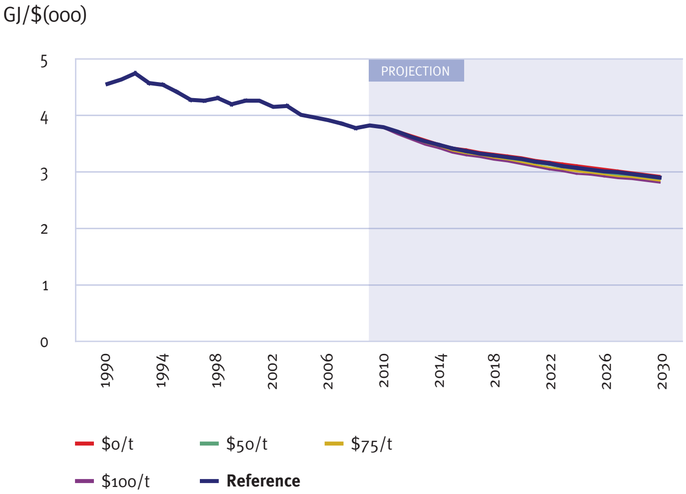
In the absence of an emissions price, we expect 1,500MW of new coal and lignite plant to be built, which results in a substantial increase in fossil fuel demand. We assume a large amount of relatively cheap domestic coal and lignite is available.

Energy intensity measures the amount of consumer energy demand (in gigajoules) to produce $1,000 of GDP. Given that consumer demand is relatively insensitive to price (and that GDP is the same in all cases[4]), **energy intensity** barely changes[5] from the *Reference Scenario*.

Primary Fossil Fuel Demand



Consumer Energy Intensity



[1] Primary fossil fuel demand includes consumer demand, fuel used for electricity generation and oil production, and non-energy uses (e.g. natural gas used for methanol and urea production, coal used for steel making).

[2] Over and above the assumed additional annual production of 100PJ starting in 2017 from new discoveries.

[3] Also refer to the electricity supply and demand section of this article for more details.

[4] We have not considered the impact of higher/lower carbon prices on GDP growth.

[5] Fossil fuel usage increases in the unconstrained emissions scenario; however, this does not affect consumer energy intensity because the GJ amount of electricity consumed has not changed.

The most significant observation from this sensitivity analysis is the trade-off faced in the electricity sector between emissions and prices. That is, without a price on emissions, we could see large expansion of cheap coal-fired electricity generation. This would see electricity prices stabilise but large increases in emissions. The influence of emissions pricing on transport, residential and commercial energy demand and therefore emissions is minor due to the relatively small cost increase in fossil fuels due to the emissions pricing.[6]

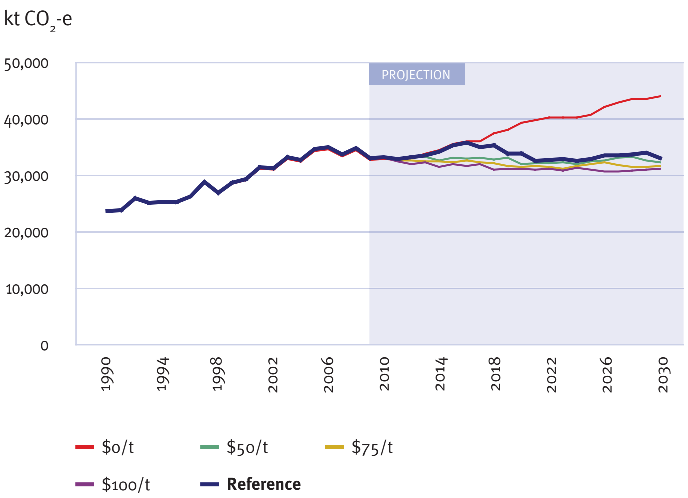
Energy sector emissions in the no emissions price sensitivity could reach almost double 1990 levels, compared to an increase of around 40% above 1990 levels in the *Reference Scenario*. The no emissions price sensitivity results in 1,500MW of new coal and lignite plant by 2030.

In the *Reference Scenario* and all the higher emissions price sensitivities, there is no new coal plant built, with all new baseload generation being renewables. In addition, the higher emissions prices are expected to lead to the earlier decommissioning of units at Huntly and the earlier commissioning of new geothermal plant. This effect is noticeable in the period 2012 to 2020 where the higher emissions price sensitivity cases present considerably lower emissions profiles compared to the *Reference Scenario*. Post 2020, the level of the emissions price has a reduced impact on total emissions production in the higher priced cases. This mirrors the fossil fuel consumption forecasts under each of the emissions prices considered.

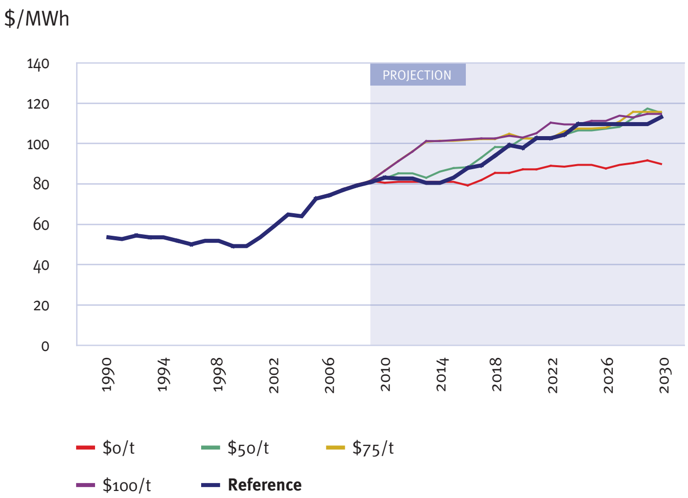
Wholesale electricity prices in the *Reference Scenario* are forecast to increase by around 40% in real terms by 2030. However, in the no emissions price sensitivity, prices increase by less than 15%, with the availability of relatively cheap coal generation.

The lowest cost renewable option in New Zealand is currently geothermal plant, which drives pricing over the next few years in the *Reference Scenario*. Note that geothermal is also economic compared to coal in the no emissions price case. Therefore, in the near term, lower emissions prices (up to ~$50/t) do not significantly impact on wholesale electricity prices, since geothermal has a low emissions intensity.[7] However, in the higher emissions price sensitivities, the earlier decommissioning of units at Huntly results in more expensive renewable generation commissioned earlier, with associated increases in wholesale electricity prices.

Energy Sector Greenhouse Gas Emissions



Average Wholesale Electricity Prices (real)



6 The impact of the emissions price on industrial demand and therefore emissions could potentially be larger but, as described in the assumptions, has been deliberately muted.

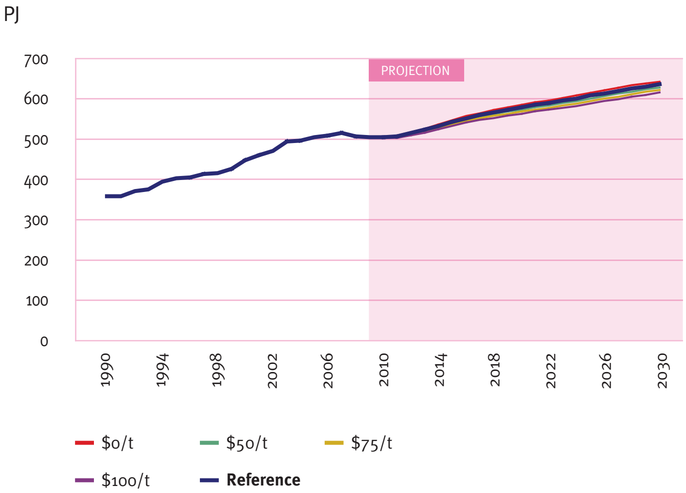
7 Note that the short-run marginal cost (SRMC) of existing thermal plants will increase; however, our price forecasts are based on the long-run marginal cost (LRMC) of new plant. LRMC is the average price (in $/MWh) that a generator needs to obtain in the wholesale market to cover operating costs, recover initial capital outlays, and earn a return on investment.

Total consumer energy demand is relatively insensitive to emissions pricing. Demand reductions do occur, but the dominance of oil (with low price elasticity) and electricity means that the reductions are small at the national level.

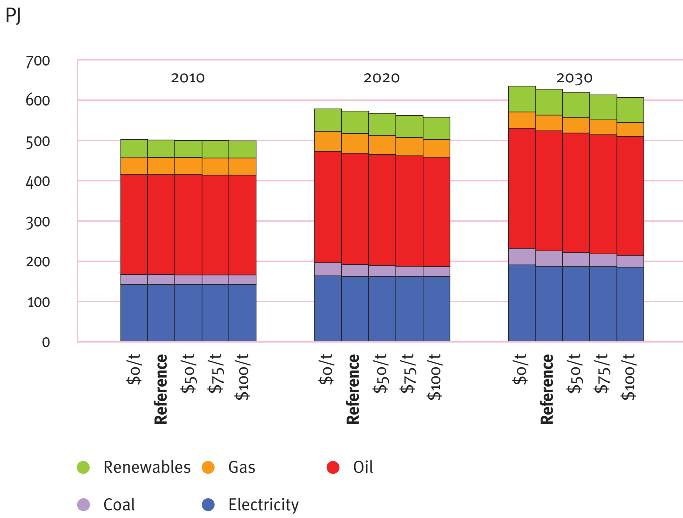
Emissions pricing will significantly influence the cost of coal and, therefore, reductions in the direct use of coal occurs (i.e. excluding coal used as a fuel for electricity generation or in industrial processes). Compared to the *Reference Scenario*, by 2030, direct use coal consumption is reduced by ~25% with emissions pricing of $100/t.

Reductions in gas demand are more modest as emissions pricing affects gas prices less than coal due to the lower emissions intensity of gas use. Oil consumption is only influenced by emissions pricing in a very minor way due to low price elasticity and the current lack of cost-effective alternatives.[8]

Total Consumer Demand



Total Consumer Demand by Fuel



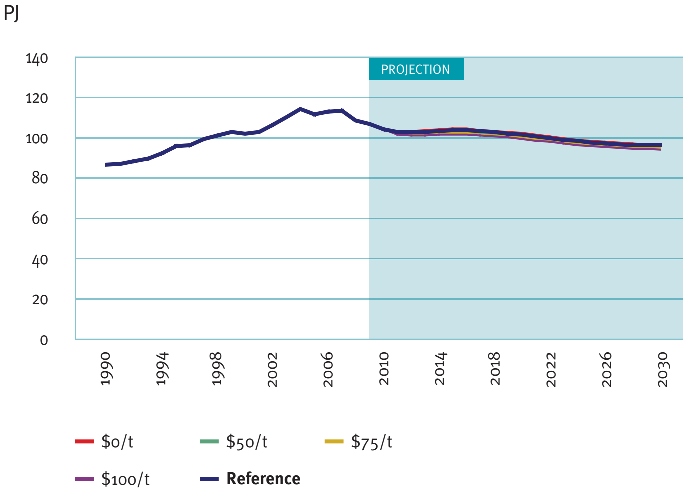
[8] In this business as usual view, alternatives such as biofuels or electric vehicles are assumed to remain relatively uneconomic. Such alternatives, including assumptions as to improved economics, will be explored further in *Seeking Solutions* scenarios to be released later.

As shown in the table below, the impact of different emissions prices on the retail prices of petrol and diesel is relatively minor. The price increase of 6–27c/l for petrol and diesel (for emissions prices increasing from $25–$100/t) are not expected to significantly alter driver behaviour or vehicle choices. Therefore, emissions pricing is only seen to produce a small change in transport energy demand.

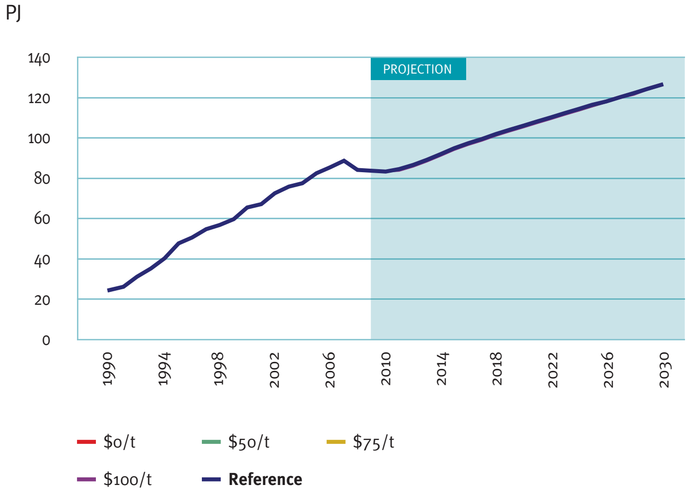
The retail price of regular petrol increased by almost 50 cents per litre in the first half of 2008, peaking in July at $2.18. For diesel, the increase was around 40 cents per litre. This increase is significantly above the effect of any conceivable emissions price and resulted in a demand reduction of less than 5% for petrol and less than 3% for diesel by the end of 2008.

Indeed, until there is a viable alternative to oil as a transport fuel, emissions pricing is expected to have a minimal effect on energy demand and emissions from transport. In this sensitivity analysis, we have not allowed for the uptake of non-traditional transport fuels. In future scenario work, we will consider further the opportunity for biofuels and electric vehicles. Biofuels will benefit from emissions pricing as they will only face this cost on the limited fossil carbon emissions required in their production. As the levels of biofuel emissions will be significantly lower than that of the existing oil products, biofuels will become relatively more cost-competitive as the emissions price rises.

Land Transport – Petrol Demand



Land Transport – Diesel Demand



Additional Cost to Petrol and Diesel with Increasing Emission Prices

	$25/t	$50/t	$75/t	$100/t
	Additional Cost (c/l)			
Petrol	5.8	11.6	17.5	23.3
Diesel	6.7	13.4	20.1	26.8

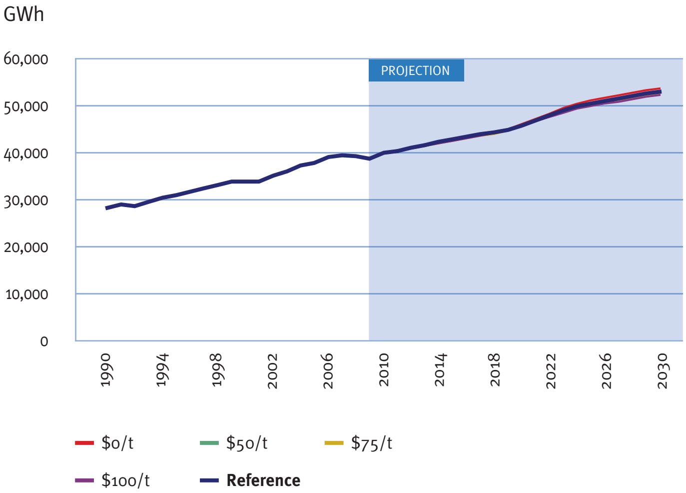
Although emissions pricing has an influence on wholesale electricity prices, it is not large enough to significantly change the electricity demand forecasts from the *Reference Scenario*.[9] The wholesale electricity price typically contributes around a third of retail tariffs, so the percentage increases in the wholesale price do not necessarily equate to equivalent percentage increases in prices faced by residential consumers.

In terms of supply, emissions pricing influences electricity generation through the earlier decommissioning of existing gas and coal plant.[10] This results in a reduction of gas and coal usage in existing plant in the higher emissions price sensitivities and also requires the earlier commissioning of new renewable plant.

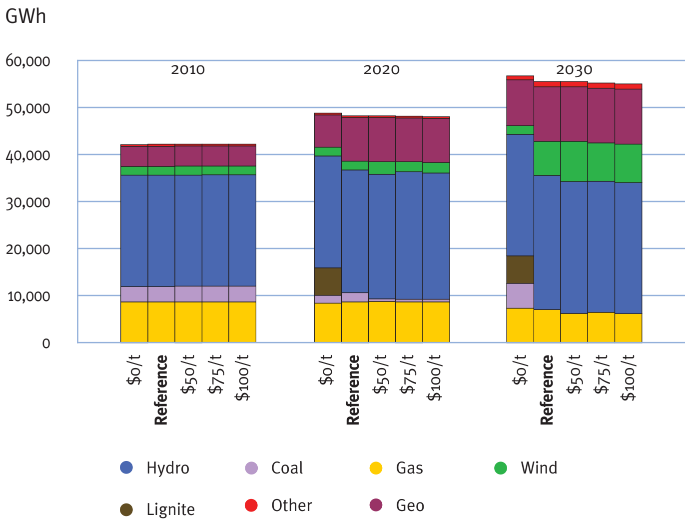
The table below shows that generation from renewables increases considerably under emissions pricing. This reflects the substantial investment in new baseload renewable generation (supported by thermal peaking plants), decommissioning of existing thermal plants (see assumptions for details) and switching Huntly to dry-year reserve.

In the case where we have allowed for new coal generation (no emissions price), it is expected that an additional 1,500MW of new coal and lignite would be built by 2030. This would result in 20% of the country's total electricity generation being sourced from coal or lignite by 2030 (compared with zero in the *Reference Scenario*).

Electricity Demand



Electricity Generation by Fuel



% Renewable Electricity Generation

Sensitivity	2010	2015	2020	2025	2030
No Emissions Pricing	71%	69%	67%	68%	66%
Reference Scenario	**71%**	**70%**	**77%**	**82%**	**86%**
$50/t	71%	74%	80%	82%	87%
$75/t	71%	76%	80%	81%	87%
$100/t	71%	76%	80%	82%	87%

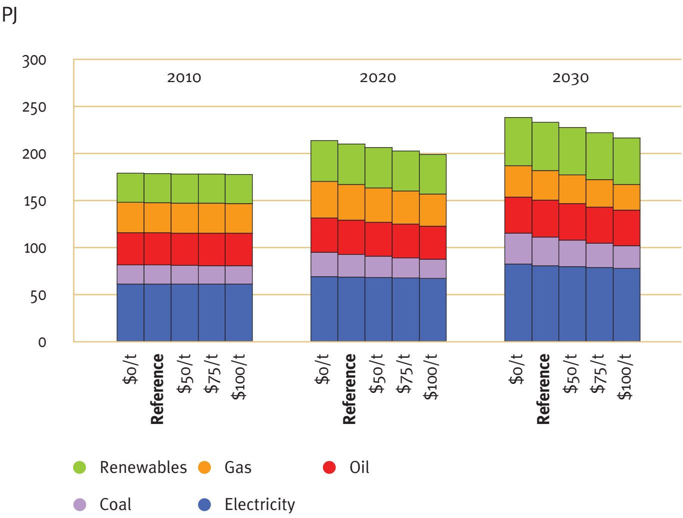
[9] We have assumed no major industrial energy users will significantly reduce their demand for electricity. This is dependent on all internationally competing firms facing similar emissions prices.
[10] See assumptions for detailed description of decommissioning.

Of the non-transport sectors, the industrial sector has the greatest sensitivity to emissions pricing. Whereas fossil fuels make up a small component of residential and commercial energy demand, fossil fuels represent a significant component of energy consumption in the industrial sector. However, the consequential price increases for fossil fuels associated with higher emissions prices flow through to only small changes in industrial energy consumption.[11]

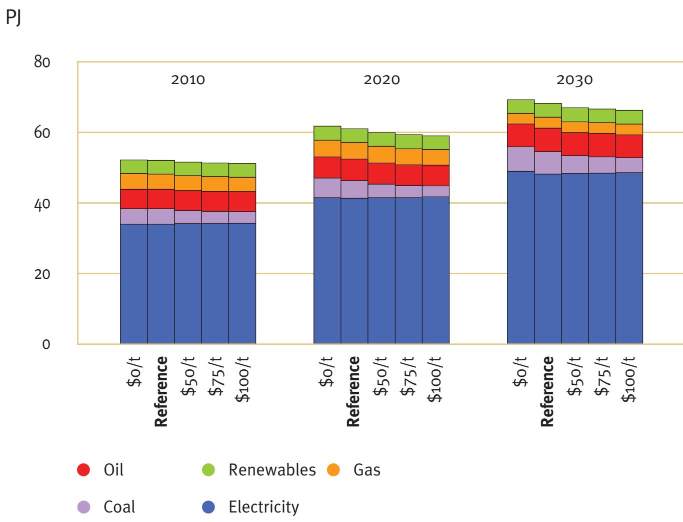
Longer-term demand reductions in the industrial sector due to emissions pricing are in the order of 2–5% per annum from the *Reference Scenario* (for emissions prices up to $100/t). This is over and above a longer-term demand reduction of ~2% per annum already present in the *Reference Scenario* due to the inclusion of a $25/t emissions price.

The impacts on energy consumption in the commercial and residential sectors of emissions pricing is limited. This is largely due to the lack of alternative fuels, low demand response from price changes (especially for oil) and the dominance of electricity in these sectors.

Industrial Demand by Fuel



Commercial Demand by Fuel



[11] The assumptions section explains how we treat industrial demand in the face of an emissions trading scheme.

Assumptions

The information included in this article is based on an integrated approach combining modelling from the Supply and Demand Energy Model (SADEM), Grid Expansion Model (GEM) and the Vehicle Fleet Model (VFM).

The *Reference Scenario* assumes a flat emissions price of $25/tonne from 2010 for stationary energy and electricity generation and from 2011 for liquid fuels. Compared to this scenario, we have explored four sensitivities:

a. No emissions price.

b. $50/t emissions price.

c. $75/t emissions price.

d. $100/t emissions price.

In each case, we also assume that the price of emissions is one faced by the majority of the international community and in particular by New Zealand's major trading partners. With all firms and their international competitors facing the same carbon cost, its imposition in New Zealand results in no direct loss of industry.[12]

The first sensitivity contains no limitations on emission-intensive activities. The key implication is that it allows investment in new coal-fired electricity generation. For the other sensitivities, it has been assumed that the existence of an emissions price and associated commitment to reducing emissions make investment in new coal-fired generation a risky proposition, and therefore, we exclude new coal plant from the analysis.

In modelling the effect of emissions pricing on heavy industries, we have assumed that heavy industry in New Zealand as a whole becomes more energy-efficient in response to emissions pricing. We have also assumed that the increased energy costs faced by New Zealand's heavy industry as a result of emissions pricing will be phased in over a long period.

Huntly coal plant phase-out assumptions for the *Reference Scenario* are as follows:

- Unit 1 switches to a dry year reserve plant in 2015 (i.e. is available but at a cost of nearly $200/MWh).
- Unit 2 switches to a dry year reserve plant in 2017.
- Unit 3 is decommissioned completely in 2019.
- Unit 4 is decommissioned completely in 2021.

For every $25/t increase in the emissions price in the sensitivities, these decommissioning dates have been brought forward by 1 year. For example, in the $100/t case, the dates are 2012, 2014, 2016 and 2018.

In the *Reference Scenario*, existing baseload gas plant at Stratford and Otahuhu is decommissioned in 2025 and 2030 respectively. For every $25/t increase in the emissions price in the sensitivities, these decommissioning dates have also been brought forward by one year.

Refer to the *Reference Scenario* for a description of other assumptions.

[12] It is beyond our modelling framework to project any reduced production that may result from the additional emissions costs.

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Authorship
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