

NEW ZEALAND'S ENERGY OUTLOOK

Electricity Insight

Exploring the uncertainty in future electricity demand and supply



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INNOVATION & EMPLOYMENT
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Preview of key insights:

-  Lower demand growth and excess supply should put strong downward pressure on prices for the next decade (see pages 7 and 10)
-  Electricity emissions likely to reach close to 1990 levels by the mid 2020s (see page 9)
-  Geothermal energy is key, potentially limiting price increases (see pages 8 and 10)

This Energy Outlook article explores the long-term future for electricity in New Zealand using scenario analysis. Based on this analysis, we present key insights for investors, grid planners, policy makers and consumers. It presents modelling results to 2040, and is the first part of a series of Energy Outlook Insight publications, which will focus on different parts of the energy system.

This article is focused on electricity and has two main parts. In the first part, we define our four main supply scenarios and three demand sensitivities. We do this by outlining what our key modelling assumptions are, and how they differ between the scenarios and sensitivities.

While no one scenario can be used to predict the future, by considering the scenarios and sensitivities together, we can make general conclusions about the future. In the second part of this article, we present these as 'key insights' about electricity supply, greenhouse gas emissions and prices.

Readers should interpret the results and insights in this article within the modelling framework from which they were produced. In our modelling, we assume the following principles:

- The price of energy reflects the underlying cost of new supply to ensure that new investment occurs and to encourage efficient energy use.
- Timely investment in the lowest cost generation is facilitated through transparent markets and efficient resource allocation mechanisms.
- Competition and careful regulatory scrutiny of network investment decisions ensure that prices reflect underlying costs.

For online data-tables and technical information, please visit our website www.med.govt.nz/sectors-industries/energy/energy-modelling. For further information or assistance please contact us at energyinfo@med.govt.nz.



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On page 11, we present sources of information for further reading, and a list of key terms with explanations in the context of New Zealand's Energy Outlook: Electricity Insight.

This Energy Outlook Insight article has been prepared using preliminary modelling results from the Draft Electricity Demand and Generation Scenarios (EDGS) 2013. The Draft EDGS will include scenarios and demand forecasts that consider several key variables that are uncertain. Once finalised, the EDGS must be used by Transpower when forming major capital expenditure proposals. For further information on the Draft EDGS, please see our website.

Scenario and Sensitivity Overview

The following pages give an overview of our scenarios and sensitivities. We recommend readers give careful consideration to the assumptions made in each scenario or sensitivity before reading the second part of this article.

Last year, the Ministry released a report by Parsons Brinckerhoff (PB) on the future cost of electricity generation for use in energy modelling (see www.med.govt.nz/sectors-industries/energy/energy-modelling/technical-papers/2011-nz-generation-data-update). Using figures in this report we calculate that geothermal energy currently appears to be the cheapest new baseload generation technology in New Zealand, at around 9 c/kWh, followed by wind and then natural gas. However, what generation actually gets built in the future, depends heavily on a number of supply and demand outcomes that may change the absolute and/or relative costs of these technologies.

In forming our four main supply scenarios, we asked which key factors would cause the biggest change in future outcomes for future electricity supply. Similarly, for our demand sensitivities we asked which factors would have the biggest impact on future electricity demand.

By answering these questions, we have identified the following as key uncertainties for future electricity supply and demand in New Zealand:

Generation Supply

- Technology costs (for existing and emerging generation technologies),
- Resource availability and cost (particularly for geothermal energy and natural gas),
- The global response to climate change (particularly the price of carbon emissions).

Demand

- The size and structure of the economy,
- The future of heavy industry in New Zealand, particularly the Tiwai Point aluminium smelter,
- The size and structure of the population,
- The price of electricity compared with alternative energy sources,
- Energy efficiency and demand side participation in the wholesale and retail electricity markets.

Mixed Renewables Scenario

In our view, the Mixed Renewables scenario most closely resembles a business-as-usual scenario. This is a world where we assume there are no significant reductions in the cost of existing generation technologies, and international carbon trading remains limited to those countries which have already committed to carbon markets. Domestically, our available energy supply remains much as it is today.

In the Mixed Renewables scenario, our key assumptions are as follows:

Generation Supply

- Relative technology prices remain where they are today, as technological advances are offset by increases in material prices (e.g. steel) and shipping costs (e.g. diesel).
Source: PB generation cost update.
- Moderate natural gas availability and prices.
Source: Ministry of Business, Innovation and Employment mid-case gas supply projections assume that oil prices will rise to over US\$135 per barrel by 2030 (the International Energy Agency's World Energy Outlook Current Policies scenario) and that exploration rates continue at current levels. We also assume that there will be no natural gas imports or exports.
- In the short term carbon prices remain low. In the long term, prices increase in line with international markets.
Source: Short-term trends are based on current observations; long-term trends are based on the IEA's World Energy Outlook Current Policies scenario.
- A moderate level of geothermal resource availability at current costs.
Source: PB generation cost update.

Demand

- Moderate future household number and population increases.
Source: mid-case Statistics New Zealand projections.
- Moderate levels of economic growth.
Source: Mid-case NZIER projections.
- No changes in heavy industry electricity demand (e.g. aluminium manufacturing).
Current levels will continue (closure of the Tiwai Point aluminium smelter is considered as a demand sensitivity – see page 5 for further information).
- Fuel switching and energy efficiency improvements continue as prices increase.
Historical rates of change will continue in the future.



Three Alternative Scenarios

High Geothermal Access

Changes in assumptions from the Mixed Renewables scenario:

- A higher level of geothermal resources can be accessed economically, while still protecting the environment.

New Zealand sits on the boundary of two active tectonic plates. Even if only a moderate amount of the available geothermal resource can be developed for electricity generation, it is likely that geothermal energy will play a significant role in meeting electricity demand growth, as it currently appears to be the cheapest new generation option available. But what if there was more geothermal resource available for electricity generation?

Low Cost Fossil Fuels

Changes in assumptions from the Mixed Renewables scenario:

- Increased oil and natural gas exploration, leading to more natural gas at cheaper prices.
- The carbon price remains low (we assume a price of \$5 per tonne CO₂ equivalent for the entire projection period).

Since the Kapuni Gas field started production in 1969, natural gas has been an integral part of the New Zealand energy system. In recent times, natural gas prices have increased and supplies have tightened. However, natural gas supplies are starting to look more promising, with record levels of exploration in 2011, and significant interest and investment expected in the sector over the next five years. This is partly due to improvements in the economics of oil production combined with increasing oil prices (natural gas is often found as a consequence of oil-focused exploration). What if we find a lot more cheap natural gas but remain isolated from the international natural gas markets? What if, at the same time, the global response to climate change remains muted and carbon prices remain low, while the oil price increases?



Global Low Carbon

Changes in assumptions from the Mixed Renewables scenario:

- A global agreement to limit climate change is enacted. From 2013 to 2040, carbon prices average over NZD 100/tonne CO₂ equivalent (based on the IEA's World Energy Outlook 450 scenario).
- Lower crude oil prices (based on the IEA's World Energy Outlook 450 scenario). This leads to reduced oil and natural gas exploration, resulting in less natural gas availability.
- Limited availability of geothermal resources.
- Technological advances lead to further reductions in the cost of wind and solar technology, increasing their uptake. Similarly, electric vehicles cost the same as petrol engines, and well over 40% of new private car purchases are electric or (plug-in hybrid electric) vehicles by 2040.

In this scenario, a global agreement to reduce carbon emissions and limit the impacts of climate change is enacted early. Over a short time, the marginal cost of cutting carbon emissions steadily increases. At the same time, oil exploration in New Zealand is limited due to weaker global oil demand. As a consequence, New Zealand's natural gas supply is severely restricted. Fortunately, New Zealand still has an abundance of cheap low carbon electricity generation options to meet demand. Low carbon technologies become cheaper due to increased global research and development, as most other countries look for ways to reduce their heavy dependence on fossil fuels for electricity generation.



Demand Sensitivities

From 1990 to 2004, electricity demand increased rapidly, growing by over 2% per annum on average as a consequence of strong growth in the economy and population. Since then, electricity demand growth has slowed to an average of only 0.5% per annum on the back of a weak global economy and the devastating Christchurch earthquakes.*

Over the next few years, it is expected that the New Zealand economy will grow as the global economy recovers and the Christchurch rebuild takes place. For our four main scenarios, we assume mid-case economic growth and population growth. Here, we present three demand sensitivities to the Mixed Renewables scenario. Our first two sensitivities are:

High Growth – Sensitivity to the Mixed Renewables Scenario

→ What if economic and population growth are higher than expected?

Low Growth – Sensitivity to the Mixed Renewables Scenario

→ What if economic and population growth are lower than expected?

By considering slow incremental changes in demand, these sensitivities are also a proxy for considering uncertainty in future energy prices and energy efficiency. The outcome of high electricity demand in the High Growth sensitivity could have been achieved through a combination of medium growth and a significant reduction in energy prices. If energy is very cheap, more will be used and there is less incentive for consumers to implement energy efficiency incentives. On the other hand, if energy costs are significantly higher than expected, then there will be more incentive for reduced energy consumption and so the outcome for electricity demand would be similar to the Low Growth sensitivity.

** In this article, electricity demand refers to energy demand (in GWh) rather than annual peak energy demand (in MW). However, peak demand projections will be included in the draft EDGS (see page 2).*



Our third sensitivity considers the remaining key demand uncertainty of heavy industry demand. Since 2004, the wood processing industry's energy demand has declined by over 30% from its peak. More recently, the future of aluminium production in New Zealand has come under question. In this analysis, we present a third sensitivity considering this risk:

Tiwai Closure – Sensitivity to the Mixed Renewables Scenario

→ What if the Tiwai Point aluminium smelter (13% of 2012 demand) was to close, gradually declining over 2016–2018?*

** We assume that investment into transmission occurs in the lower South Island to avoid excessive spilling of surplus water within the hydro generation system.*

As well as the three sensitivities, the Global Low Carbon scenario considers a world with more electric vehicles, and distributed generation affecting demand on the transmission grid.

Delivery cost (transmission and distribution) assumptions for all scenarios and sensitivities.

Future wholesale energy prices are a function of our modelling. However, we need to make estimates of future transmission and distribution charges in order to convert wholesale prices into retail prices in our demand models.

Over the next few years, large transmission investments will continue (such as the High Voltage Direct Current link upgrade), and this is reflected in the transmission prices for all scenarios and sensitivities. However, in the longer term, we assume that the cost of transmission and distribution does not increase in real terms. We made this assumption on the basis that on average over the last 20 years, delivery costs have increased at roughly the rate of inflation.

Electricity Insights



In this section, we present two types of results from our analysis. Firstly, for each scenario and sensitivity, we present our projections or 'outlook' of future demand, supply, greenhouse gas emissions and the wholesale electricity price indicator. This is followed by 'key insights' made by considering the 'outlook' for the supply scenarios and demand sensitivities together.

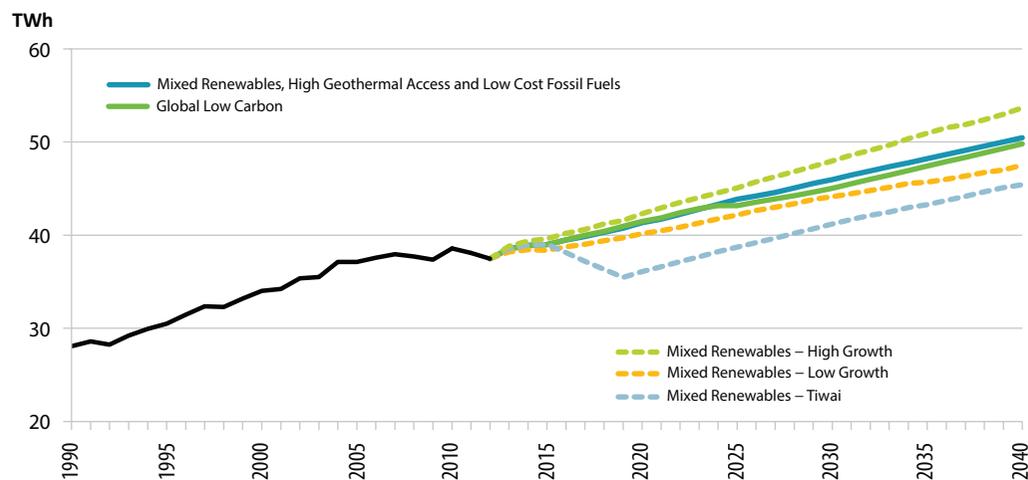
Key insights cover three topics: generation supply, greenhouse gas emissions and electricity prices.

On this page, we present demand projections for each scenario and sensitivity at the transmission grid level. To get final consumer demand from grid demand, you must add distributed generation and subtract distribution line losses.

Considering demand at the grid level helps us understand the impact demand will have on large scale generation investment, emission and prices.

In this article, we do not present peak demand projections. These will be included in the draft EDGS (see page 2).

Figure 1 – Grid level electricity demand by scenario and sensitivity



In 2010, grid electricity demand peaked close to 39 TWh per annum. In our Mixed Renewables scenario, it does not significantly exceed that level until 2016, and no new investment (other than projects already committed) takes place until 2020. Even in our High Growth sensitivity, no new investment is required until 2017, given the amount of new generation already under construction. If all other factors are held constant, continued low demand growth and excess supply should delay the need for new generation, substantially reducing pressure on electricity prices (see page 10).

However, in the longer term, an increase in demand will mean we need new generation investment. In our Mixed Renewable scenario, total electricity demand grows on average by 1.1% per annum to 2040 (grid demand is over 50 TWh in 2040). This compares with an average growth rate of 1.3% per annum in our High Growth sensitivity and of 0.9% per annum in our Low Growth sensitivity.

Even in our High Growth sensitivity, the average growth in gross domestic product over the next 30 years is less than the rapid growth seen from 1990 to 2004. On top of this, over 80% of the assumed economic growth takes place in less energy intensive service sectors. Combined with continued energy efficiency improvements, these factors explain why electricity demand grows at a slower rate than in the past.

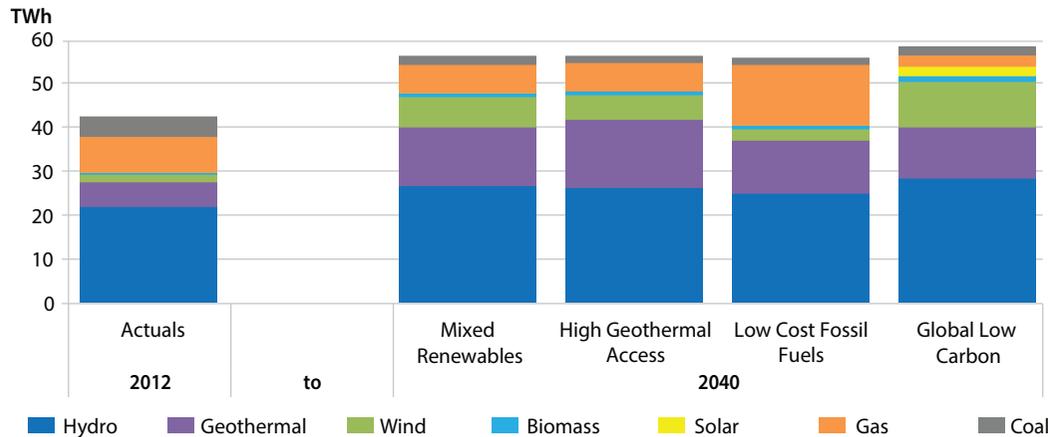
In our Tiwai Closure sensitivity, over 5 TWh per annum generated in the South Island enters the market between 2016 and 2018, and demand only significantly exceeds 2010 levels by 2026. The reduction in demand would be equivalent to the 2012 generation from the Huntly steam units (750 MW of capacity remains) as well as one natural gas CCGT (~400 MW).

Electric vehicles (including plug-in hybrid vehicles) are another area of uncertainty for future electricity demand. At the moment, electric vehicles are not economic when compared with similar petrol or diesel vehicles. If they become economic over the next decade, it will take several decades for electric vehicles to have any significant impact on total electricity energy demand due to slow turnover in the vehicle fleet.

In the Global Low Carbon scenario, we assume electric vehicles do eventually become economic, with over a quarter of new car sales assumed to be electric in 2030, increasing to over 40% of new cars by 2040. Under these assumptions, electric vehicle electricity demand accounts for 3% of total electricity demand in 2040.

Grid demand is marginally less in the Global Low Carbon scenario by 2040 than in the Mixed Renewables scenario. Interestingly, as this scenario assumes a high uptake of electric vehicles (1.4 TWh of demand in 2040), final consumer demand for electricity is 4% higher in this scenario than in the Mixed Renewables scenario. However, this is more than compensated by increased distributed solar generation, which makes up 4% of supply by 2040 (2.2 TWh). For comparison, in 2012, wind contributed 4% of electricity supply.

Figure 2 – Electricity generation by scenario



There is likely to be significant investment in geothermal plants over the next 30 years. In all of our four scenarios, geothermal increases its share of generation from 14% in 2012 to between 21% and 29% in 2040. The growth in new geothermal generation is focused on the central North Island, where the highest quality and lowest cost resources can be accessed.

Hydro generation will continue to make up around half of all generation in 2040. Electricity generation using hydro resources are naturally variable depending on rainfall. In low rainfall years, the shortfall of hydro generation will continue to be made up by flexible thermal generation with high running costs.

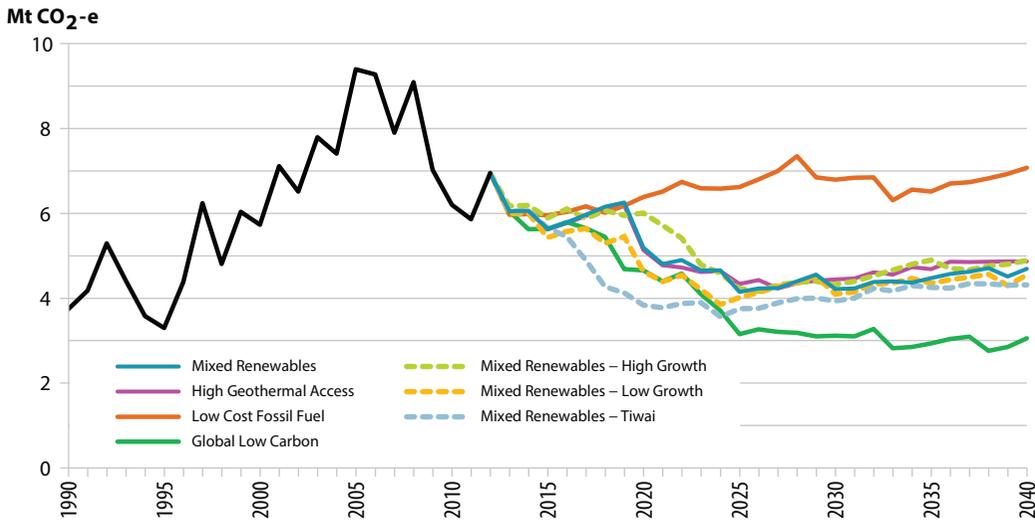
Intermittent generation from wind power will also increase, but for significant quantities to be developed, it will need to continue to reduce in cost. In the Low Cost Fossil Fuel scenario, only 100 MW of new wind generation is built by 2040. Instead, there is increased generation from fossil fuels, with baseload natural gas undercutting wind power in price and flexibility. In the Global Low Carbon scenario, over 2700 MW of wind generation capacity is built by 2040 and in that year, it contributes 18% of generation supply. As well as this, some existing baseload natural gas plants are decommissioned (a net reduction of around 500 MW) and it has a significant uptake of solar electricity.

In the Global Low Carbon scenario by 2040, over 1700 MW of new natural gas and diesel peakers as well as nearly 500 MW of new demand side management is required to provide peak support for the increased level of renewable energy generators, particularly as existing baseload generation and reserve capacity such as the old Huntly steam units are retired.

Generation Supply

- Maintaining a robust central North Island transmission network will be vital to delivering the expected increase in geothermal electricity to our main demand centre in Auckland.
- If geothermal and wind remain the cheapest new generation options, their relative economics will have a large bearing on where future transmissions investments will be required. The cheapest geothermal resources are all in the central North Island; however, quality wind resources are found all around New Zealand.
- Geothermal plants are relatively inflexible and must-run baseload generation. Wind plants also must-run but are highly intermittent. Unlike baseload natural gas CCGTs or hydro generators, geothermal and wind power can only make a minimal contribution to meeting peak demand. Investment in flexible peaking capacity, large scale demand side management, and/or energy storage will be necessary, especially if existing thermal plants are retired. These are likely to add costs to the electricity system.
- At present, the old Huntly steam units provide the reserve capacity needed for dry years with low rainfall. Natural gas CCGTs provide a degree of flexibility. If any of these units are decommissioned, new reserve capacity will be needed. Natural gas and diesel peakers (open cycle gas turbines or OCGTs) are likely to provide this role for years with low rainfall and there is likely to be more natural gas put into storage facilities.
- The impact on supply from emerging technologies such as household solar photovoltaic (PV) panels is highly uncertain. With today's costs and efficiencies, solar panels do not appear to be an economic option for the average household in New Zealand. To become economic for the typical household, solar panels will need to cost less or perform better. This may happen, so we have assumed it does become economic in the Global Low Carbon scenario. Even if the cost of solar power does become competitive, it may take some time to build up the domestic installation and maintenance industry, which may limit its rapid uptake.
- While different future demand levels will not change the merit order of new generation options, it will change the rate at which investment needs to occur. In our Mixed Renewables scenario, over 14 billion dollars of new generation investment is needed by 2030. This compares with 18 billion and 11 billion in the High Growth and Low Growth sensitivities respectively.

Figure 3 – Greenhouse gas emissions in the electricity sector*



In the Mixed Renewables and High Geothermal Access scenarios, the electricity sector manages to reduce its greenhouse gas emissions as the Huntly steam units are decommissioned, which is completed by 2020.

Further progress is made in the Global Low Carbon scenario, where the carbon price continues to increase and baseload natural gas plants are decommissioned. In the Global Low Carbon scenario, the electricity sector's greenhouse gas emissions decline to 22% below 1990 levels by 2040. All new baseload generation is from renewable resources.

In the Low Cost Fossil Fuels scenario, two of the three remaining Huntly steam units are refurbished and remain in operation until the early 2030s. A new natural gas CCGT is built in 2035.

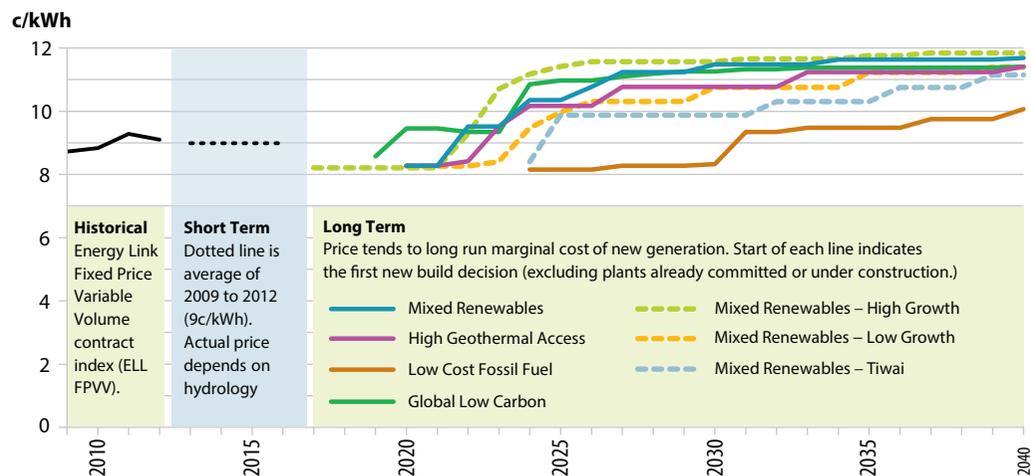
In the long term, the main driver of electricity emissions is the types of generation available. This is shown by all the sensitivities converging towards the Mixed Renewables scenario emission profile from the mid-2020s onwards. However in the short-term emissions are higher in the High Growth sensitivity and lower in the Tiwai closure sensitivity, than they are in the Mixed Renewables scenario.

* Notes for Figure 3: Greenhouse gas emissions in this context includes fugitive emissions from geothermal generation.

Greenhouse Gas Emissions in the Electricity Sector

- Progress is being made to reduce electricity sector emissions, which are around 30% below their 2005 peak. They are likely to continue to decline to close to 1990 levels by the mid 2020s, as long as there is no expansion of baseload gas generation and the Huntly steam units (which run predominantly on coal) are decommissioned. Further significant progress can be made if all baseload gas generation is decommissioned.
- Building new renewable generation is capital intensive relative to building new fossil fuel generators; however building new fossil fuel generation will lock-in carbon-intensive infrastructure for 25 years or more. Once a fossil fuel generator is constructed, it is likely to continue to operate (regardless of the sunk capital cost) as long as the ongoing cost of running the plant (or short-run marginal cost) is less than the present value capital costs and lifetime running costs (or long run marginal cost) of building a new generator.
- If carbon prices were to increase sharply in the longer term, there is potential that a new fossil fuel thermal plant could not cover its short-run marginal cost and would have to be retired early or be retrofitted with expensive carbon capture and storage technology.
- To reduce emissions substantially (and increase renewable electricity generation to more than 90%), existing baseload fossil fuel generators, especially the old Huntly steam units, which run predominantly on coal, need to be decommissioned and replaced with low carbon technologies. Sufficiently high gas and coal prices (including carbon) will be needed to encourage existing thermal plants to be decommissioned.
- In the short to medium term, demand growth will be a very important driver of electricity emissions. This is because the utilisation of existing fossil fuel generation will depend heavily on the future level of demand.
- If the electricity sector reduces its emissions from current levels, this will help us to achieve our emission reduction targets. However, the transport sector's greenhouse gas emissions will still be a far bigger challenge, as long as the transport fleet remains almost entirely dependent on oil. In 2012, emissions from transport were more than double those from electricity. We intend to consider the transport energy system in a future Energy Outlook Insight article.

Figure 4 – Wholesale electricity price indicator (real \$2011)



In an efficient market, long-term wholesale prices will reflect the marginal cost of building new generation (currently, new geothermal generation can be built for around 9c/kWh). In the short term, other factors such as the demand/supply balance and hydrology will set average market prices (the ASX NZ Electricity Futures price sat at just over 7 c/kWh at the time of publication, which primarily reflects short-term demand uncertainty). The variation in long term prices between the scenarios and sensitivities depends heavily on our assumptions.

Out of the four scenarios, the Mixed Renewables Scenario and the Global Low Carbon scenario see the largest increase in prices by 2040. While high carbon prices and limited geothermal access push up the cost of generation sooner in the Global Low Carbon scenario, prices settle at a similar level to the Mixed Renewables scenario.

While the cost of wind technology is lower in the Global Low Carbon scenario (to reflect that there is more potential for wind turbine prices to fall than for more mature technologies), it is not low enough to significantly change the merit order of new generation technologies. If we assumed a substantially lower cost for wind or other low carbon technologies, this scenario could have cheaper prices in 2040, than the other scenarios.

In the Low Cost Fossil Fuels scenario, wholesale price increases are limited because there is cheap natural gas available and a low carbon price. In the High Geothermal Access scenario, increased access to cheap geothermal resources also limit wholesale price increases.

In the High Growth sensitivity, wholesale electricity prices increase faster, partly because more investment is required sooner, but also because existing thermal generation is utilised more, pushing up gas prices and making them more expensive to run. Conversely, the Low Growth and Tiwai Closure sensitivities both see delayed investment and therefore lower electricity prices.

Electricity Prices

- Lower demand growth and an excess supply of committed new generation should put strong downward pressure on prices for next the decade. Even if new investment is needed from 2017 (as in the High Growth sensitivity), the availability of new renewable generation at around 9 c/kWh (real \$2011) should limit real wholesale price increases*.
- The market will adjust if the Tiwai Point aluminium smelter closes. With reduced baseload demand, existing baseload thermal plants will be utilised less. This will lower average prices, which may make older fossil fuel plants uneconomic, forcing their retirement. If plants such as the Huntly steam units are permanently decommissioned, then any future demand growth will need to be met by new generation, with a marginal cost of around 9c/kWh (real \$2011).
- In the long term, wholesale prices may need to increase to support new generation investment, as the cheapest generation resources will usually be developed first.
- Increases may be countered if there are technological advances, or new resources become available. For example, solar PV could reduce in cost and undercut other technologies, or gas supply could be increased, reducing gas prices and making new baseload gas generation cheaper than renewables if carbon prices remain low.
- Access to New Zealand's low-cost geothermal resource is likely to be a key factor in limiting wholesale price increases. Generators, land owners (including iwi) and government will need to continue to work together to maximise the economic, environmental and cultural benefits from geothermal resources.
- While higher carbon prices may lead to higher electricity prices, the increase is likely to be less than for countries that are heavily dependent on fossil fuels, as we still have many relatively cheap renewable resources. This may provide New Zealand an important economic advantage in a low carbon world.
- Even if there are no long-term wholesale price increases, retail prices may still need to accommodate future investment in transmission or distribution infrastructure. For a typical residential consumer, about a third of a power bill is wholesale energy costs, another third transmission and distribution costs, and the remainder is mostly retail costs and margins, and GST. Careful regulatory scrutiny of transmission and distribution investment decisions will continue, to ensure prices reflect underlying costs.
- Solar generation will be an economic option for some households when it reaches retail price parity. If consumers install solar panels (or other types of distributed generation), this is likely to reduce their grid demand (see page 7), helping to delay the need for new large-scale generation investment and limiting wholesale price increases. If uptake is high but households remain reliant on the grid at peak times, then lines companies and retailers may need to review their pricing to ensure that fixed system costs are shared fairly among consumers.

* This is dependent on technology costs not increasing, expected rates of demand growth and the decommissioning of older thermal plants not being accelerated.



Sources for further information

Thank you for reading New Zealand's Energy Outlook: Electricity Insight. If you are interested in learning more, we recommend the following key sources for further information. These sources were used to inform our modelling assumptions and develop our scenarios and sensitivities.

- **Covec (2011). Coal prices in New Zealand markets. Retrieved from Economic Development Information website:** <http://www.med.govt.nz/sectors-industries/energy/energy-modelling/technical-papers/coal-prices-in-new-zealand-markets>
- **Energy Link (2013). Energy Link Energy Trendz. Retrieved from Energy Link:** <http://www.energylink.co.nz/publications/energy-trendz>
- **International Energy Agency (2010). Energy Technology Perspectives 2010 – Free Publications. Retrieved from International Energy Agency:** <http://www.iea.org/publications/freepublications/publication/etp2010.pdf>
- **International Energy Agency (2011). World Energy Outlook 2011 – Free Publications. Retrieved from International Energy Agency website:** http://www.iea.org/publications/freepublications/publication/WEO2011_WEB.pdf
- **International Energy Agency (2012). Tracking Clean Energy Progress – Free Publication. Retrieved from International Energy Agency:** http://www.iea.org/publications/freepublications/publication/Tracking_Clean_Energy_Progress.pdf
- **Ministry of Business, Innovation and Employment (2013). New Zealand Energy Data. Retrieved from Economic Development Information website:** <http://www.med.govt.nz/sectors-industries/energy/energy-modelling/data>
- **Parsons Brinckerhoff (2011). NZ Generation Data Update. Retrieved from Economic Development Information website:** <http://www.med.govt.nz/sectors-industries/energy/energy-modelling/technical-papers/2011-nz-generation-data-update>



Key terms

Fossil Fuels – Gas, oil or coal. These fuels formed over millions of years from the remains of dead plants and animals.

Baseload – Generation that is supplied to meet the underlying demand for electricity. In New Zealand's context, almost all generation types contribute at least some generation to meet the underlying demand for electricity. In this context, we include intermittent generation such as wind and solar, as well as hydro, for which output varies seasonally.

Huntly steam units – The Huntly steam units use relatively inefficient steam turbine technology, originally designed for baseload generation. Today, the Huntly steam units are not normally run as baseload generation, except for when hydro storage levels are low. This is mostly because of their low efficiency relative to other baseload fossil fuel generation (see CCGT). Huntly is still used frequently because of its ability to use coal when natural gas is unavailable or costly. Its continued operation will depend heavily on the future cost of coal (including carbon) and whether it requires any major refurbishment to keep running.

Gas Peaker/Open Cycle Gas Turbine (OCGT) – A fast starting generator, ideal for managing spikes in demand, that runs on natural gas or diesel. OCGTs can reach full output in a matter of minutes to meet peaks in demand. They are less efficient than CCGTs, so are not suitable for steady year round baseload generation. In a New Zealand context, OCGTs running on natural gas are also likely to play an important role in managing seasonal variation in output from hydro generation.

Combine Cycle Gas Turbine (CCGT) – A relatively high efficiency natural gas generator that is designed for baseload generation. CCGTs usually combine an OCGT with a steam turbine. In a normal OCGT, a lot of heat is wasted as the combusted gas is exhausted straight to the atmosphere after driving the turbine. In a combined cycle generator, the waste heat from the gas turbine is used to create steam to drive a second turbine, which increases the overall efficiency. Due to the complex design, the capital cost of a CCGT is more than that of an OCGT.

Carbon capture and storage – The process of capturing waste carbon dioxide from fossil fuel generation, transporting it to a storage site and depositing it in an underground geological formation (e.g. depleted oil and gas reservoirs, unmineable coal beds or deep saline aquifers).

Demand side participation – This refers to the ability of energy consumers to make decisions regarding the quantity and timing of their energy consumption that reflect their value of the supply and delivery of electricity. These decisions include both short-run decisions in response to specific events and longer-run investment decisions about energy efficiency.

Distributed generation – In this report, we are referring to all generation that is not directly connected to the national Transpower grid. Distributed generation units are typically smaller than grid connected generation.



Electricity Demand and Generation Scenarios

This Energy Outlook article has been prepared using preliminary modelling results from a new Ministry energy modelling project, the Electricity Demand and Generation Scenarios (EDGS). For more information on the EDGS, please visit: <http://www.med.govt.nz/sectors-industries/energy/energy-modelling/modelling/electricity-demand-and-generation-scenarios>

Assumptions and Methodology

For more on assumptions and methodology, please see the Energy Outlook technical guide: <http://www.med.govt.nz/sectors-industries/energy/energy-modelling/technical-papers/energy-modelling-methodology>



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