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MARKETS – EVIDENCE AND INSIGHTS BRANCH

ENERGY IN NEW ZEALAND 19

2018 CALENDAR YEAR EDITION

Comprehensive information on and analysis of
New Zealand's energy supply, demand and prices

New Zealand Government

Energy in New Zealand 2019 provides annual information on and analysis of New Zealand's energy sector and is part of the suite of publications produced by the Markets team of the Ministry of Business, Innovation & Employment (MBIE).

The 2019 edition includes information up to the end of the calendar year 2018.

Full data tables may be downloaded from the *Energy in New Zealand* webpage:

www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand

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Authorship

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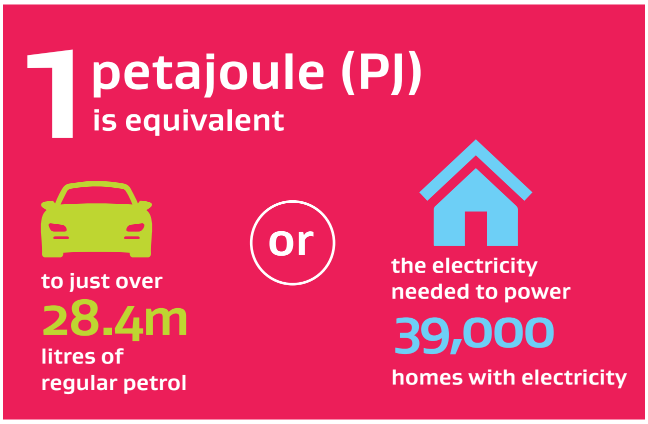
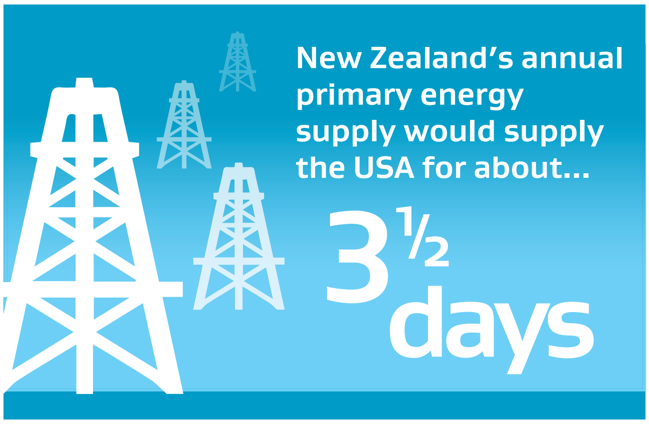
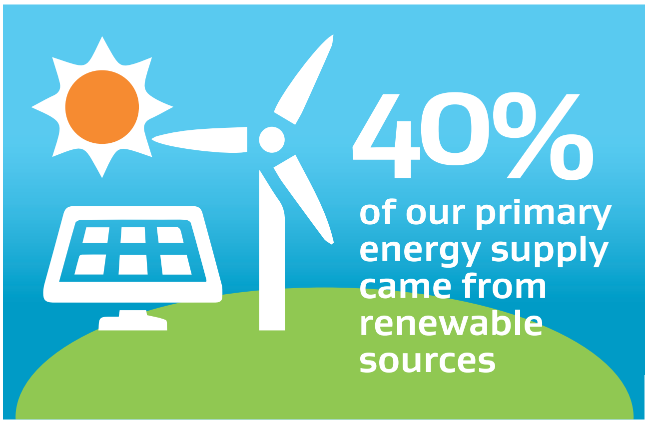
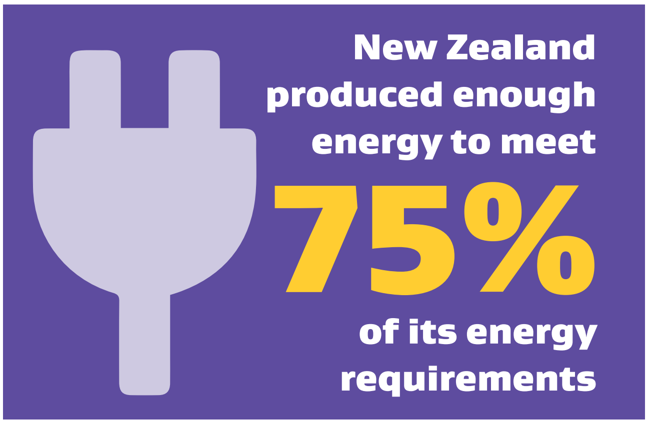
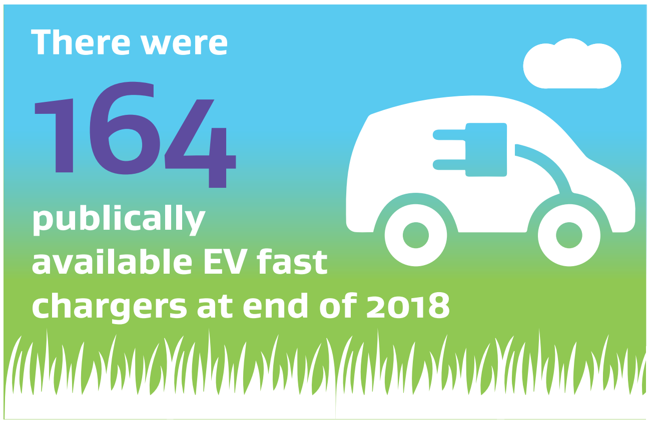
Quick facts for 2018

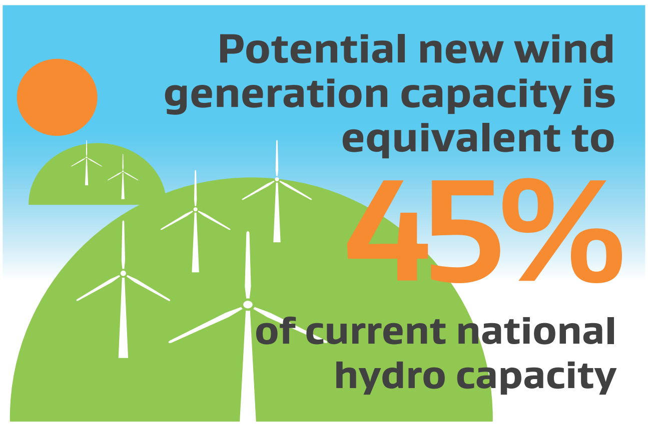


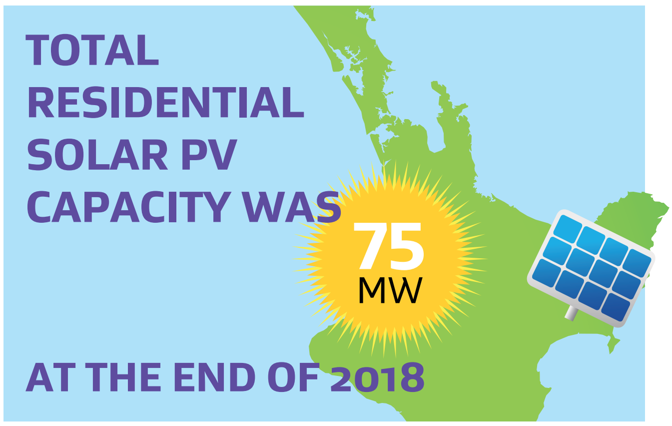












A. ENERGY OVERVIEW

INTRODUCTION

The 2018 calendar year was a significant year for New Zealand's energy sector. In addition to major policy announcements made about the future of fossil fuels, the security of the broader energy system was highlighted by an outage at the country's largest gas field.

Despite increased coal-fired electricity generation during the gas outage, the share of renewable sources in electricity generation and total energy supply both increased in 2018.

International energy prices play a key role in New Zealand's energy system. Higher prices for commodities saw increased domestic petrol prices and greater coal exports.

Other developments in New Zealand saw the Electricity Price Review (EPR) commissioned, and the establishment of the Interim Climate Change Committee (ICCC).

Renewable shares up in 2018 despite increase in coal-fired electricity generation

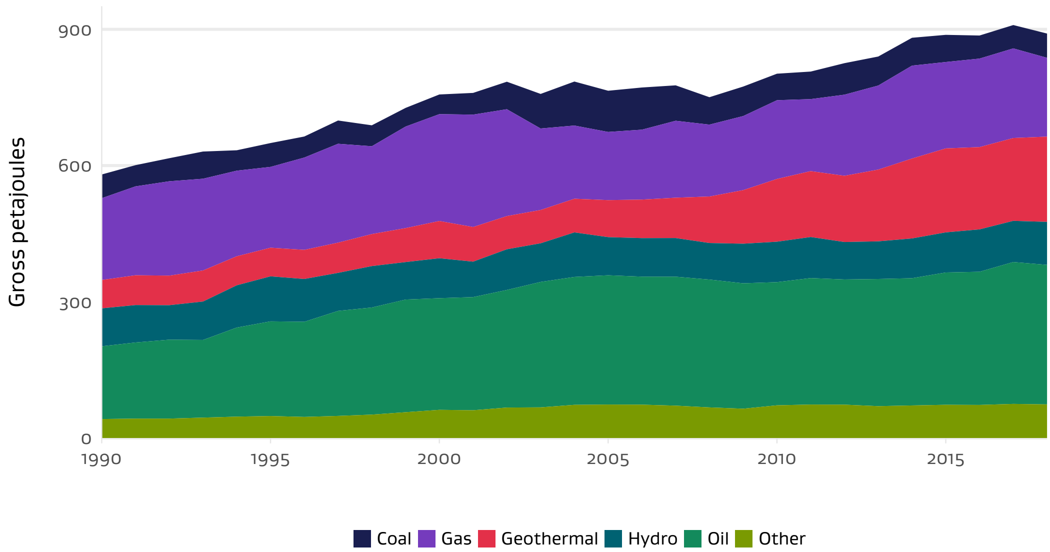
Pohokura, New Zealand's largest natural gas field, had significantly reduced output in 2018 as a result of outages[1]. The second of these in the December quarter had the largest impact on New Zealand's energy sector as it coincided with low hydro storage and low levels of wind generation.

At times of low hydro and wind generation, non-renewable sources are used as a back-up to help meet the shortfall between supply and demand. While it has tended to be gas that has used for this in recent years, the reduction in gas supply meant that coal-fired generation had to be used. Despite this increase in coal-fired generation, total generation from non-renewable sources fell 12 per cent. This resulted in the share of renewable electricity generation increasing from 82 per cent in 2017 to 84 per cent in 2018.

The combination of lower renewable generation and reduced gas supply saw wholesale electricity prices in October 2018 reach their highest level since 2008.

The share of renewables in total primary energy supply reached a new record in 2018 at 40 per cent.[2] This was driven by a fall in non-renewables as the outages led to reduced gas production.

Figure A.1 Total primary energy supply by fuel type



1 For more information, see Box E.4 in the Gas section.

2 Total primary energy supply is the amount of energy available for use in New Zealand accounting for imports and exports.

Gas supply disruptions drove fall in total energy demand

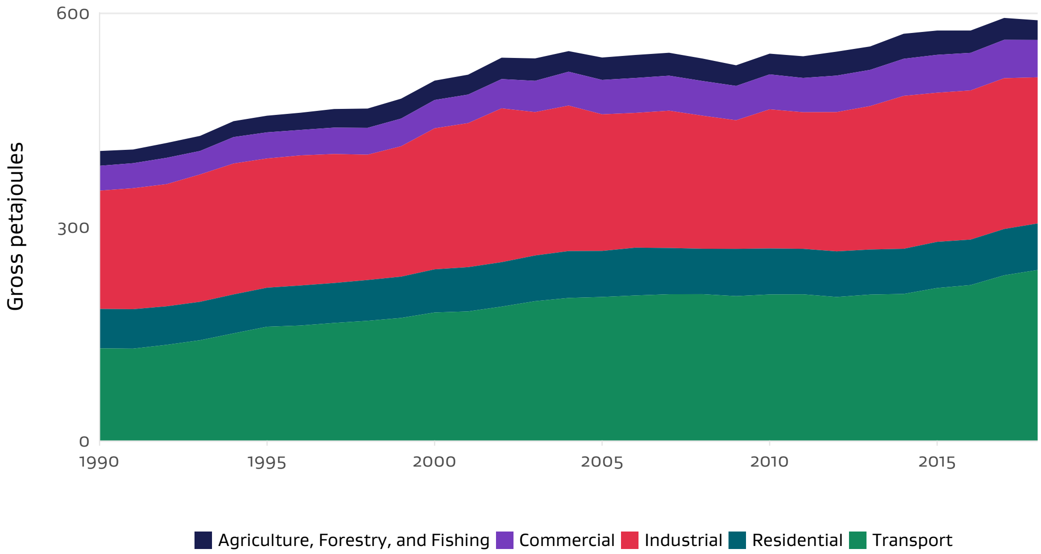
In 2018, total energy demand fell 0.6 per cent from 2017 levels as a fall in gas use more than offset an increase in oil product use.

Methanol production by Methanex, one of the country's largest gas users, fell in 2018 due to the combination of the gas supply constraints and maintenance work at their sites[3]. Lower gas use by Methanex drove a 3.1 per cent fall in total industrial sector demand.

The 2018 calendar year saw continued growth in oil demand in New Zealand with higher diesel and aviation fuel use driving a 3.2 per cent increase in energy used for domestic transport. However this increase was not sufficient to offset the fall in industrial demand.

New Zealand Aluminium Smelters, the country's largest electricity user, announced in 2018 that they would be restarting their fourth potline at their aluminium smelter at Tiwai Point. The fourth potline was closed in 2012 in response to unfavourable market conditions that have recovered in recent years. This process of restarting the potline began towards the end of 2018 but had no material impact on industrial demand for electricity.

Figure A.2 Consumer energy demand by sector



3 www.methanex.com/sites/default/files/investor/annual-reports/2018%20Methanex%20Annual%20Report.pdf

High international commodity prices flowed through to New Zealand markets

Global crude oil prices reached their highest level in 4 years in October 2018. This flowed through to New Zealand retail prices with petrol prices reaching their highest level on record in October before ending 2018 at a similar level to the beginning of the year.

Coal prices continued to rise in 2018 after falling to a low in 2016. These more favourable market conditions, coupled with the structural change in the coal market following the liquidation of Solid Energy, saw coal exports increase 5.0 per cent in 2018.

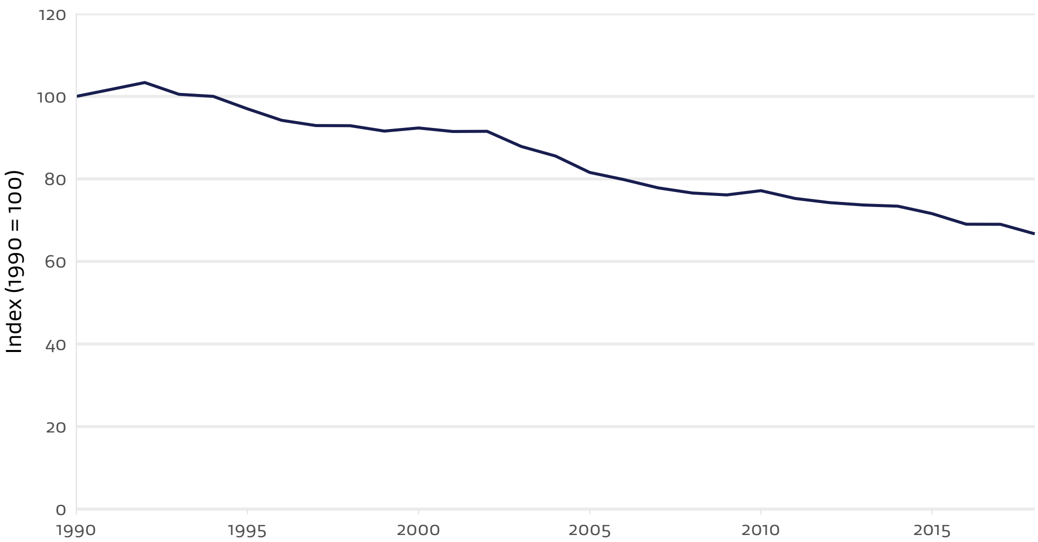
National average energy intensity continues to improve

Energy intensity provides an indication of the relationship between energy use and economic growth. It is calculated as energy use divided by gross domestic product (GDP) and tells us the amount of energy required to produce each dollar of GDP. A fall in the indicator, where less energy is required to produce each dollar of GDP, is viewed as an improvement.

National energy intensity has improved by an average of 1.4 per cent per annum since 1990. This has been driven by continued economic growth in the commercial sector, which being service-based is relatively less energy intensive than other parts of the economy.

In 2017, the latest year for which data is available, New Zealand's energy intensity was the 6th highest of Organisation for Economic Co-operation and Development (OECD) member countries and 18 per cent higher than the OECD average[4].

Figure A.3 Intensity index



4 Source: IEA (2018), *World Energy Balances 2018*, OECD Publishing, Paris

Three-quarters of the country's energy requirements were met with domestic production

Self-sufficiency is a measure of a country's ability to meet its own energy supply requirements. It is calculated as domestic production divided by total primary energy supply[5]. A self-sufficiency value of 100 per cent indicates that a country produces all the energy it needs. Values above or below 100 per cent indicate a net exporter or importer of energy, respectively.

New Zealand meets all of its energy needs for natural gas, renewables, and waste heat through indigenous production. For other energy types, New Zealand engages in trade through exporting and importing. This means that changes in New Zealand's self-sufficiency indicator are driven by changes in the balance between imports and exports of tradable commodities.

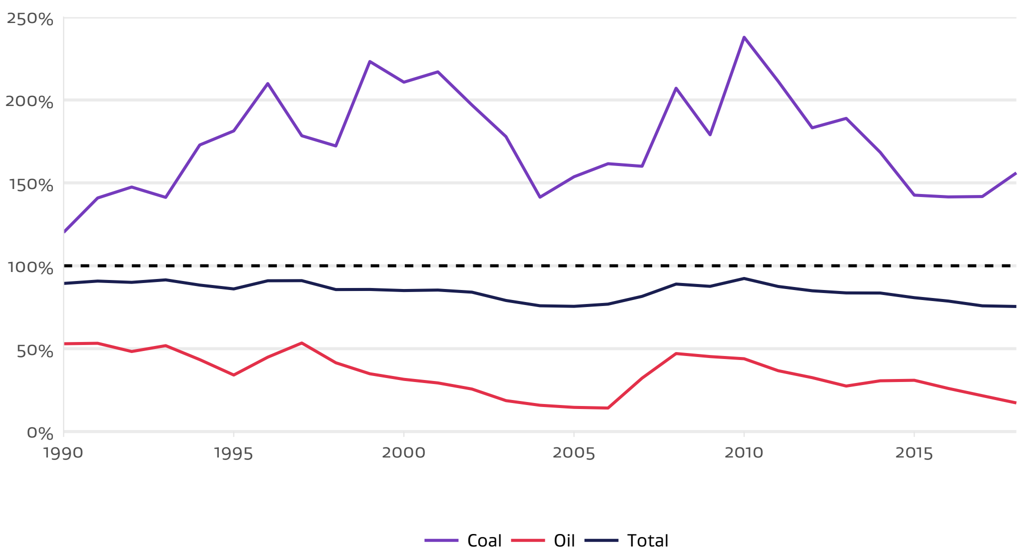
While crude oil is produced in New Zealand, nearly all of this is exported as it is not suited to current refining capabilities. This means all domestic use of oil needs to be met by imports.

Coal produced on the West Coast is mainly exported with approximately half of national coal production exported annually. Some large users in New Zealand choose to import coal for numerous reasons including the quality of the coal they require for their processes and for cost competitiveness.

New Zealand's energy self-sufficiency fell slightly to 75 per cent in 2018, with changes in the self-sufficiency for oil and coal almost offsetting each other. Oil self-sufficiency fell due to a continued reduction in domestic production and an increase in imports. Lower domestic production was driven by ongoing natural field decline meaning that there was less oil available to be exported. The country's only oil refinery at Marsden Point underwent a maintenance shutdown in the middle of the year. To ensure that demand could still be met with reduced activity at the refinery imports of refined oil products increased. This contributed to a 32 per cent increase in diesel imports and a 4.9 per cent increase in petrol imports.

While more coal was imported towards the end of 2018 in order to supply electricity generation, coal self-sufficiency rose in 2018 as production increased in response to favourable export conditions and to meet higher domestic demand.

Figure A.4 New Zealand's energy self-sufficiency



5 Total primary energy supply is the amount of energy available for use in New Zealand. It is calculated as:
Total primary energy supply = Production + Imports – Exports – Stock change

B. ENERGY BALANCES

INTRODUCTION

New Zealand's energy production derives from both renewable and non-renewable sources. New Zealand imports and exports fossil fuels, which generate export revenue, but also results in a dependency and vulnerability to energy commodity prices that vary according to international supply and demand factors outside of New Zealand's control.

The energy balance tables reflect how energy supply and demand by sector varies by energy fuel type. Domestic energy supply is derived from either indigenous production or imported from overseas sources. In turn, fuel types can be transformed into different forms of energy, at the cost of losses and inefficiencies which vary by transformation process. Supply, demand, losses and inefficiencies are reflected in balanced energy supply and demand tables.

Both the energy supply and demand dimensions of the energy balance tables are derived from surveys spanning different sources. An imbalance exists between the value of consumer energy calculated from supply, and the value of consumer energy observed from statistical measure.

Interpretation of Energy Balance Tables

Supply

Total primary energy is the amount of energy available for use in New Zealand. Much of it is converted into other forms of energy before it is used. By convention, fuel used for international transport is excluded from total primary energy. Indigenous gas production does not include gas that is flared, reinjected, or LPG extracted. The primary energy figures presented are actual data, except for some that go into electricity generation as detailed under energy transformation.

Energy transformation

Includes generation of electricity (including cogeneration), oil production (including refinery operations and the manufacture of synthetic fuel from natural gas – Methanex ceased methanol to petrol production in April 1999) and other transformation, primarily steel production.

In the Energy Transformation section of the balance tables, “energy in” is shown as negative values and “energy out” as positive values in the appropriate fuel columns. Transformation of energy from one form to another always results in conversion losses, particularly in thermal electricity generation, as much energy is lost as heat.

Transformation losses in electricity generation are derived from the net electricity generated, with the actual fuel input being used where available and the conversion factors shown in Table B.1 used otherwise. Fuel input to biogas, hydro, wind and waste heat are fully estimated. Quarterly figures for electricity generation are made up of actual data from major generators and the Electricity Authority. Estimates are made where actual data are unavailable at the time of publishing.

Table B.1: Default Electrical Transformation Factors[a]

Fuel	Default Efficiency
Biogas	30%
Coal	30%
Gas (Single cycle)[b]	30%
Geothermal[c]	15%
Hydro	100%
Oil	30%
Waste heat	15%
Wind	100%
Wood	25%

Liquid biofuel production (bioethanol and biodiesel) appears as renewable energy supply in the energy balance tables. As bioethanol and biodiesel are generally blended with motor petrol and diesel before consumption, liquid biofuel also appears in Energy Transformation under Fuel Production.

a Default efficiencies are only used where real data is unavailable.

b For combined cycle plants, the assumed efficiency is 55%. Currently, however, actual fuel input data are collected for all combined cycle plants.

c Geothermal is predominantly based on real plant steam data and uses a 15% efficiency where these are unavailable

Losses and own use in the energy balances include losses before and after transformation, losses and own use in production, transmission and distribution losses, electricity industry own use free of charge, and oil industry losses and own use (which includes distribution tankage losses, stocks, accounts adjustment and own consumption). Transformation losses are excluded.

Non-energy use is primary energy used for purposes other than combustion, e.g. bitumen used in road construction, and natural gas used as chemical feedstock in the production of methanol and ammonia/urea.

Treatment of Solar Photovoltaic Panels

Estimates of the amount of electricity generated using solar photovoltaics (PV) are included in the energy balance tables in this edition of Energy in New Zealand. The total primary energy supply of solar is the sum of the direct use of solar thermal (i.e. for hot water heating), and the amount of solar energy directly converted into electricity via PV panels. Solar PV electricity generation is estimated using data on the total installed capacity of grid-connected solar PV installations in New Zealand , and then converted to output using an assumed capacity factor of 14% (i.e. the solar panels produce their full output 14% of the time). Consumption of solar thermal is included in the demand section of the energy balance table under Renewables – Solar, whereas the consumption of electricity generated by solar PV panels appears under Electricity. Solar PV consumption by sector is apportioned using data from the Electricity Authority.

Demand

Consumer energy is the amount of energy consumed by final users. It excludes energy used or lost in the process of transforming energy into other forms and in bringing the energy to the final consumers. For example, natural gas is a primary energy source (see Total Primary Energy Supply), some of which is transformed into electricity, of which some is lost in transmission to consumers.

Consumer energy statistics can be either calculated from supply-side data or observed from usage data.

Consumer energy (calculated)

forms the top half of the energy balance tables and is calculated as TPES less energy transformation less non-energy use.

Consumer energy (observed)

forms the bottom half of the energy balance tables and it represents reported demand in the agriculture, forestry and fishing; industrial; commercial; transport and residential sectors. With the exception of domestic/national use of energy for on-road, rail, sea and air transport in the transport sector, these sectors follow the Australia New Zealand Standard Industrial Classification 2006 definitions.

Annual figures presented for consumer energy (observed) are actual data except for thermal fuels used for cogeneration in the industrial and commercial sectors and biogas, wastes and wood. Estimates of on-site cogeneration demand are included in electricity end use.

Where the energy end-use is not available or confidential, the “unallocated” category is used.

International transport includes international sea and air transport. It excludes coastal shipping, national air transport and all land transport.

Statistical differences shows the difference between “consumer energy (calculated)” and “consumer energy (observed)”. This difference is shown at the bottom of the energy balance tables.

Table B.2: Energy Supply and Demand Balance, Calendar Year 2018

	Converted into Petajoules using Gross Calorific Values	COAL			OIL							
		Bituminous & Sub-bitum.	Lignite	Total	Crudes/ Feed-stocks/ NGL	LPG	Petrol	Diesel	Fuel Oil	Av. Fuel/ Kero	Others	Total
SUPPLY	Indigenous Production	77.84	5.53	83.37	51.58	8.40						59.98
SUPPLY	+ Imports	13.32	0.00	13.32	249.73	0.63	49.80	61.94	0.04	12.43	6.01	380.58
SUPPLY	– Exports	38.52	-	38.52	49.02	0.32	0.71	-	8.39	-	-	58.44
SUPPLY	– Stock Change	4.70	0.02	4.73	0.98	-0.03	-0.02	0.86	1.35	0.48	0.79	4.42
SUPPLY	– International Transport						0.00	1.54	11.75	57.15	-	70.43
SUPPLY	TOTAL PRIMARY ENERGY	47.93	5.51	53.44	251.31	8.74	49.11	59.54	-21.45	-45.20	5.22	307.27
SUPPLY	ENERGY TRANSFORMATION	-29.34	-0.35	-29.69	-248.68	-0.03	66.50	79.69	27.26	62.30	4.57	-8.39
SUPPLY	• Electricity Generation	-9.92	-	-9.92				-0.13	-			-0.13
SUPPLY	• Cogeneration	-7.28	-0.28	-7.56								
SUPPLY	• Fuel Production				-248.68		66.16	79.79	27.29	62.21	10.28	-2.95
SUPPLY	• Other Transformation	-11.41	-	-11.41								
SUPPLY	• Losses and Own Use	-0.73	-0.07	-0.80	-	-0.03	0.35	0.02	-0.03	0.09	-5.71	-5.31
Non-energy Use											-9.79	-9.79
CONSUMER ENERGY (calculated)		18.59	5.16	23.75	2.63	8.71	115.61	139.23	5.81	17.10	-	289.10
DEMAND	Agriculture, Forestry and Fishing	1.97	0.01	1.98		0.00	1.07	12.78	1.13	-		14.99
DEMAND	• Agriculture	1.97	0.01	1.98		0.00	1.06	8.68	-	-		9.74
DEMAND	• Forestry and Logging	-	-	-			0.00	2.50	-	-		2.51
DEMAND	• Fishing	-	-	-			0.01	1.60	1.13	-		2.74
DEMAND	Industrial	16.66	4.78	21.45		3.45	0.06	14.33	0.92	-		18.76
DEMAND	• Mining	-	-	-			0.00	2.93	0.06	-		3.00
DEMAND	• Food Processing	12.65	4.68	17.33			-	-	-	-		-
DEMAND	• Textiles	0.16	-	0.16								
DEMAND	• Wood, Pulp, Paper and Printing	0.41	0.01	0.42								
DEMAND	• Chemicals	0.03	-	0.03								
DEMAND	• Non-metallic Minerals	2.86	0.10	2.95								
DEMAND	• Basic Metals	0.00	-	0.00			-	-	-	-		-
DEMAND	• Mechanical/Electrical Equipment	0.00	-	0.00								
DEMAND	• Building and Construction	-	-	-			0.01	6.63	0.01	-		6.64
DEMAND	• Unallocated	0.57	-	0.57		3.45	0.06	4.76	0.86	-		9.13
DEMAND	Commercial	0.42	0.32	0.75		1.64	0.42	4.33	0.14	-		6.53
DEMAND	Transport	-	-	-		0.13	111.66	107.24	3.62	16.23		238.88
DEMAND	Residential	0.27	0.03	0.29		3.49	0.00	0.10	-	-		3.59
CONSUMER ENERGY (observed)		19.33	5.14	24.47	-	8.71	113.22	138.79	5.82	16.23	-	282.76
Statistical Differences		-0.73	0.01	-0.72	2.63	-0.00	2.40	0.44	-0.01	0.87	-	6.34

NATURAL GAS	RENEWABLES								ELECTRICITY	WASTE HEAT	TOTAL
Total	Hydro	Geothermal	Solar	Wind	Liquid Biofuels	Biogas	Wood	Total	Total	Total	
172.25	94.63	187.76	0.72	7.44	0.14	3.66	60.77	355.13		1.27	672.00
											393.89
											96.96
-1.32											7.82
											70.43
173.58	94.63	187.76	0.72	7.44	0.14	3.66	60.77	355.13		1.27	890.68
-54.58	-94.63	-179.73	-0.35	-7.44	-0.14	-3.33	-4.16	-289.79	144.24	-1.27	-239.47
-36.38	-94.63	-178.03	-0.35	-7.44		-2.50		-282.95	151.84		-177.53
-12.79		-1.70				-0.84	-4.16	-6.70	7.57	-1.27	-20.75
-					-0.14			-0.14			-3.09
											-11.41
-5.41									-15.17		-26.69
-45.06											-54.85
73.94		8.03	0.36	-	-	0.33	56.61	65.33	144.24	-	596.36
1.36		0.68						0.68	8.55		27.56
1.36		0.68						0.68	8.24		22.00
0.00									0.21		2.72
-									0.10		2.84
57.44		4.58				0.05	47.82	52.45	54.93		205.03
0.16									1.62		4.78
18.31									9.95		45.59
0.51									0.34		1.00
5.82									9.59		15.83
27.17									2.82		30.02
2.20									0.95		6.10
2.42									22.99		25.41
0.26									0.50		0.76
0.48									1.32		8.45
0.11		4.58				0.05	47.82	52.45	4.84		67.09
8.46		2.50				0.28		2.78	33.95		52.46
-						-		-	0.22		239.11
6.72		0.27	0.36				8.79	9.43	45.22		65.25
73.97	-	8.03	0.36	-		0.33	56.61	65.33	142.87	-	589.42
-0.04		-0.00	-	-		-	-	-	1.37	-	6.95

C. ELECTRICITY

OVERVIEW

Electricity generation and demand increased only slightly in the 2018 year. Electricity generated from renewable sources in 2018 was 84 per cent of total generation, an increase from 82 per cent in 2017, which was a dry hydrological year. A gas supply interruption starting in October 2018 caused a significant, but temporary increase in coal use for electricity generation. It also elevated wholesale electricity prices.

Overall national electricity demand increased by 0.3 per cent in 2018 as an increase in residential and industrial use more than offset the decrease in commercial and agriculture use. Electricity demand for industrial use is expected to increase further in 2019 after the re-opening of the fourth potline at the Tiwai Point aluminium smelter in December 2018.

Wholesale electricity prices spiked in October 2018 as the result of the gas shortage and coal being used as a substitute. The monthly average wholesale electricity price in October 2018 was five times the previous year's average. While wholesale prices have since fallen, they have remained slightly elevated. The increased wholesale prices impacted industrial users the most, while the residential users experienced little impact to the retail prices.

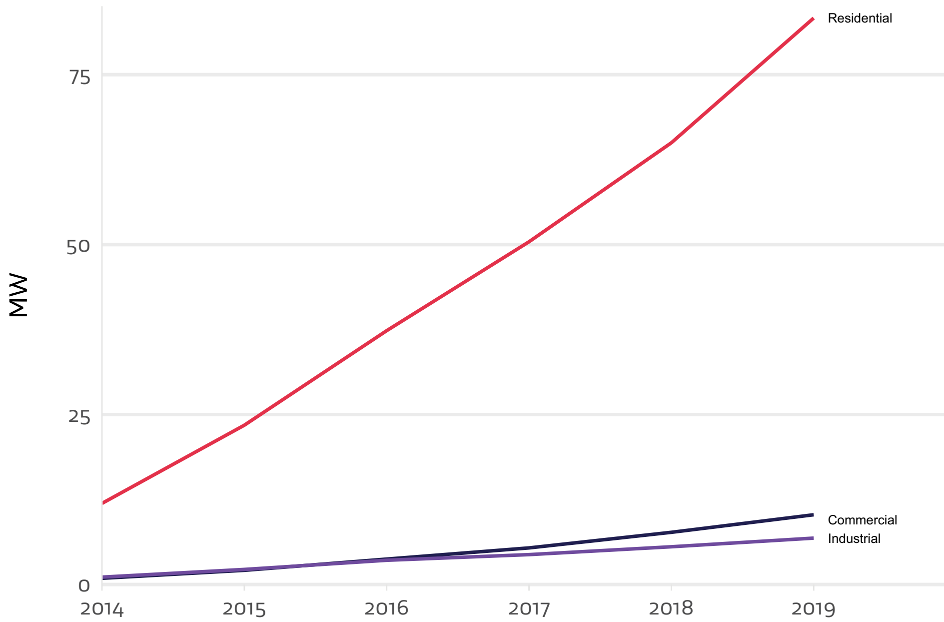
Generation remains stable with little change in demand

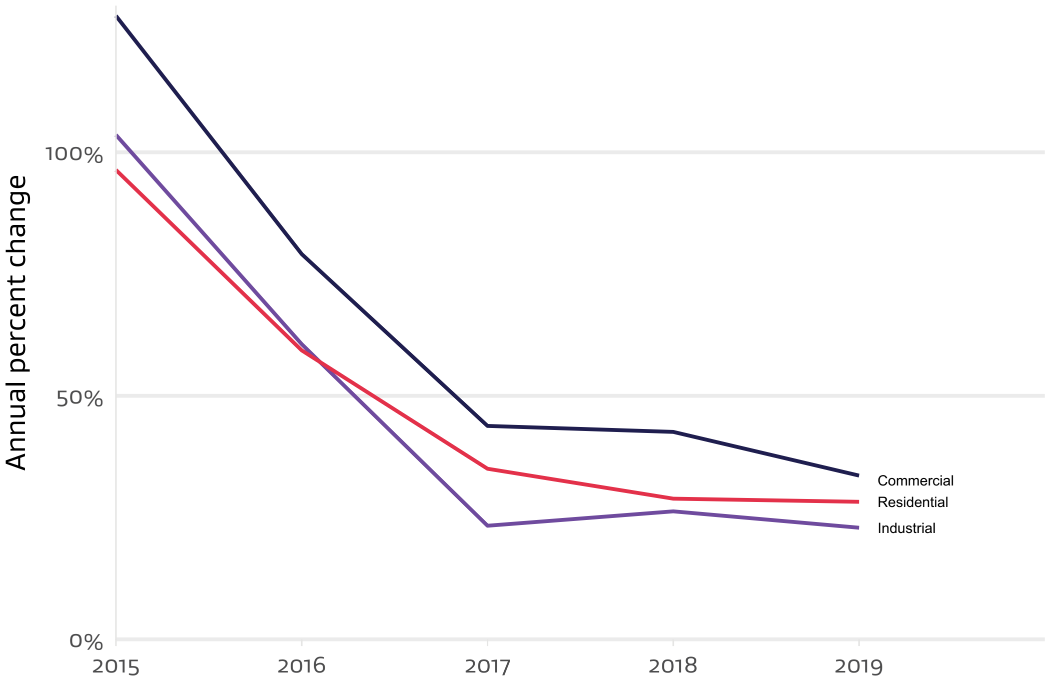
Electricity generation supply was up by 0.6 per cent in 2018 compared to 2017, mirroring demand growth.

Better hydro conditions through most of 2018 resulted in an increase in hydroelectric generation, up by 4 per cent on the previous year – which experienced drier conditions. Generation from other renewable sources, such as wind and geothermal remained relatively static in 2018. However these sources of electricity are expected to grow gradually in future years as new capacity is built to accommodate demand growth and the possible retirement of aging thermal generation plants.

Solar photovoltaic (PV) is growing quickly as a generation source, up 30 per cent in 2018, though from a low base. As shown in Figure C.1, residential use has been the key driver for solar PV installation over the past five years, accounting for more than 80 per cent of installed capacity. On the other hand, the rate of solar uptake by other market segments (commercial and industrial) increased at an even higher or similar rate to residential use, but from a rather lower base.

Figure C.1 Total installed capacity of solar photovoltaic and annual per cent change (June year)



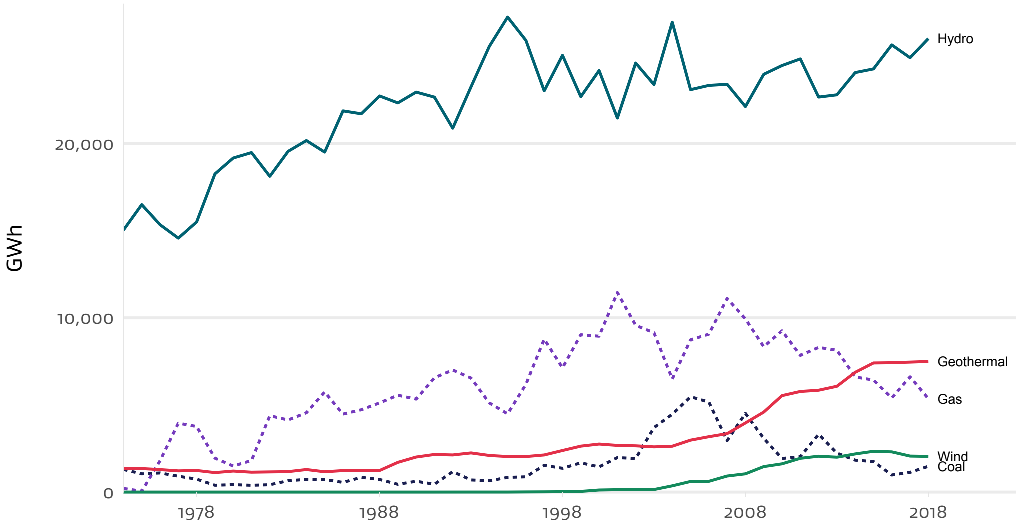


The gas supply interruption during the third quarter in 2018 caused a significant decrease in electricity generated from gas; decreasing 19 per cent on the last year. This shortage was offset by increased generation from hydro and coal. Electricity generation from coal increased by 31 per cent on 2017, and coal imports saw a large increase to cover the gas shortage.

Overall, the renewable share of electricity generation was 84 per cent, bouncing back from 82 per cent in 2017 mainly due to better hydro conditions in 2018. Electricity generation from renewable sources are expected to keep growing as the majority of the potential new capacity in the near future is likely to be from wind, geothermal and hydro.

Generation from renewable sources is expected to increase gradually overtime as new capacities for both will increase in near future. Te Ahi O Maui is a new geothermal plant commissioned in September 2018 with a capacity of 24 MW. As shown in Figure C.2, geothermal and wind are gradually overtaking coal and gas as sources of electricity generation.

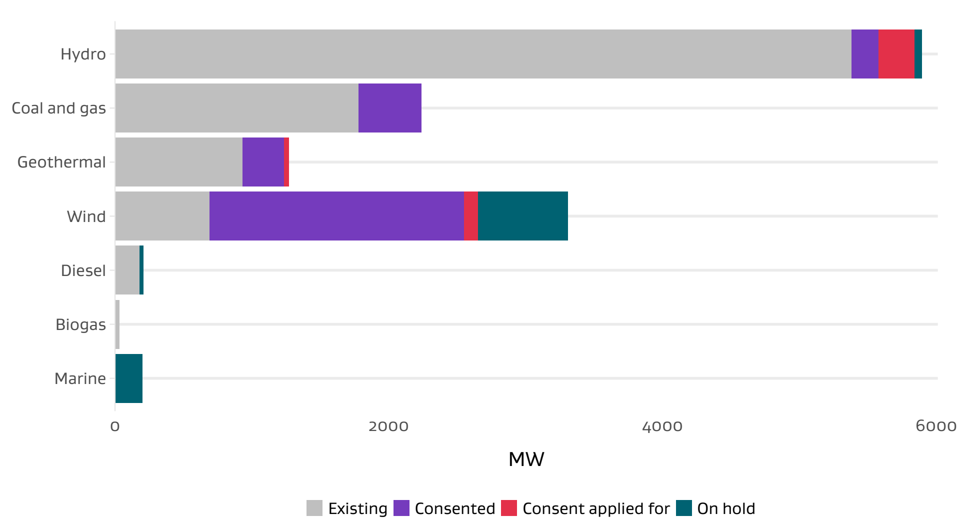
Figure C.2 Generation by fuel type



Box C.1 The majority of proposed generation capacity is from renewable sources

The Electricity Authority keeps track of proposed generation plant using publically available information. It provides the mix of generation plant types that may be built in the future.

Figure 1 Current and proposed generation capacity



Based on the Authority's information, the greatest amount of electricity generation capacity currently consented is wind. Over 1,800 MW of wind generation capacity is consented, with a further 755 MW either applied for consent or on hold. This brings the sum total of potential new wind generation capacity to roughly 2,600 MW, over 45 per cent of current national hydro generation capacity.

Almost 1,300 MW of the consented wind capacity has an earliest commission date within the next five years[6].

It is important to note that these dates are only an indication of when these plants might become operational. A plant that is consented may not necessarily be built. Generation investment decisions and timeframes are based on many factors.

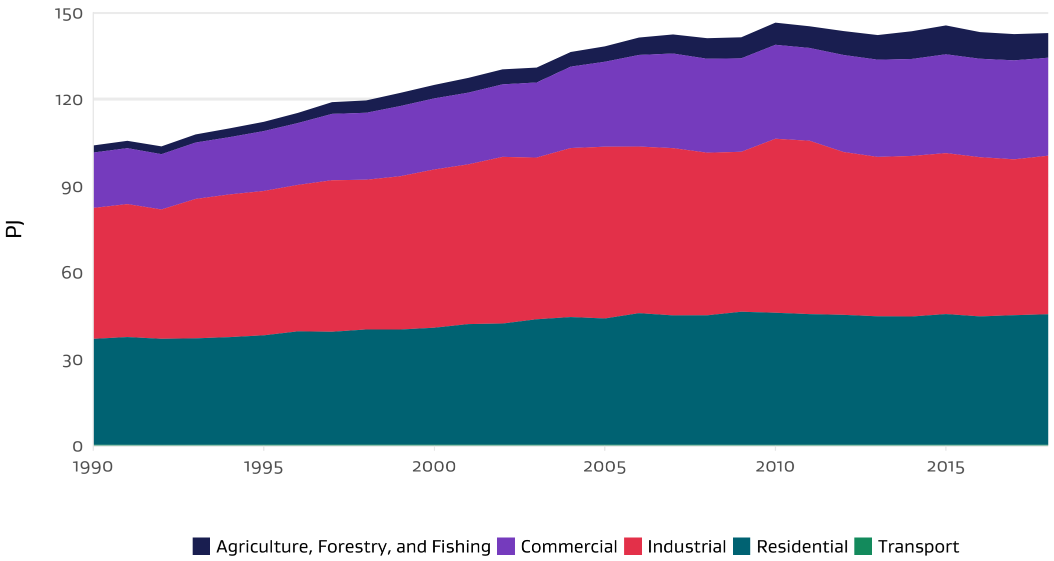
Another factor that will change future generation capacity mix is the potential closure or refurbishment of the Taranaki Combined Cycle Plant in 2022. This 377 MW plant is the second largest gas-fired electricity generation plant in New Zealand. It will require significant investment to stay operating beyond 2022.

Demand remained static in 2018

National electricity consumption remained relatively static in 2018, with a 0.3 per cent (0.36 PJ) increase driven by higher residential and industrial demand offset by lower commercial and agriculture demand.

From the early 1900s to 2007 national electricity consumption increased steadily, with the greatest increase in demand seen in the commercial sector. However over the last decade national demand has remained relatively flat, despite growth in population and GDP. This is partly due to a decrease in industrial sector consumption, but demand from both the commercial and residential sector has also flattened off over this period. Pop-out box C.2 examines the decreasing trend in residential electricity intensity in further detail.

Figure C.3 Electricity consumption by sector



6 www.emi.ea.govt.nz/Wholesale/Datasets/Generation/Generation_fleet/Proposed [08/08/2019]

Higher residential demand offset by lower agriculture electricity use

Demand from the agriculture, fishing, and forestry sectors decreased by 5.9 per cent in 2018. This was due to a reduced need for irrigation as the rainfall was generally normal and above the previous year (summer months in late 2017 were significantly drier than normal for much of New Zealand).

Commercial sector demand decreased by 1.0 per cent, but this reduction in demand was offset by an increase in residential electricity demand of 0.7 per cent.

Tiwai fourth potline re-opened pushing up industrial use in future

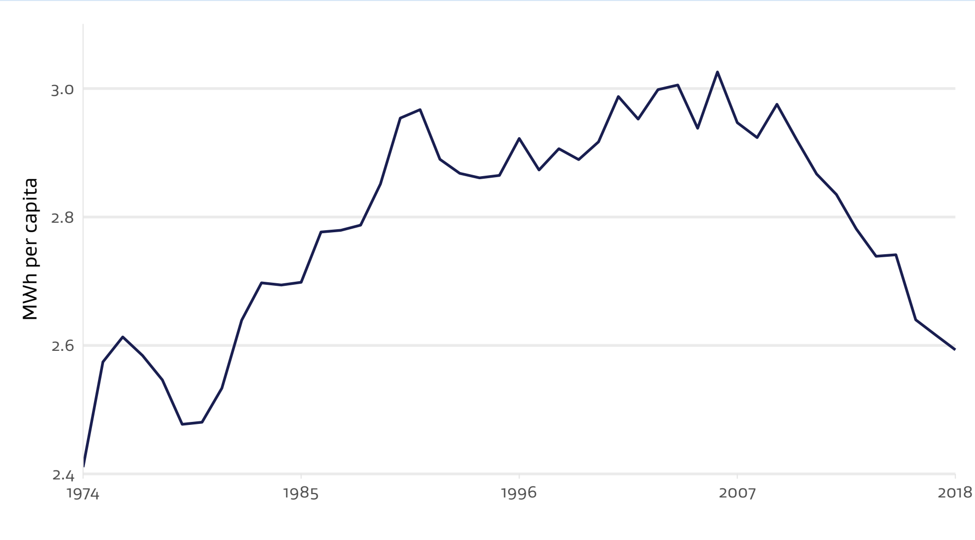
New Zealand Aluminium Smelters (NZAS) is the single largest consumer of electricity in New Zealand. In 2017 the smelter consumed 13 per cent of national electricity demand while operating three potlines. In December 2018, NZAS officially re-opened its fourth potline at Tiwai Point as the international aluminium prices started to recover over 2017[7]. The potline was shut down in 2012 because of low aluminium prices and rising costs such as wholesale electricity prices.

As it was re-opened at the end of 2018, the fourth potline did not make a significant difference to the national annual demand for the year. However the smelter's electricity demand in December 2018 was 7 per cent higher than average December demand over recent years.

Box C.2 **Residential electricity intensity has been trending down in recent years**

Electricity intensity in the residential sector is the measure of residential electricity used per capita. Looking back over a longer historical period, electricity intensity trended upward over the period 1974 to 1990 and then stabilised around 3 MWh per capita for around two decades. Since 2009 electricity intensity has fallen by 13 per cent as shown in Figure 1.

Figure 1 Residential electricity intensity



7 International aluminium prices recovered over 2017, selling for over NZD 3,200 per tonne on the London Metal Exchange in May 2018 when the re-opening was announced, compared to NZD 2,470 in April 2012, and a low of NZD 2,170 in November 2015. However, prices trended downward over 2018 after the NZAS announcement was made, ending the year at NZD 2,780.

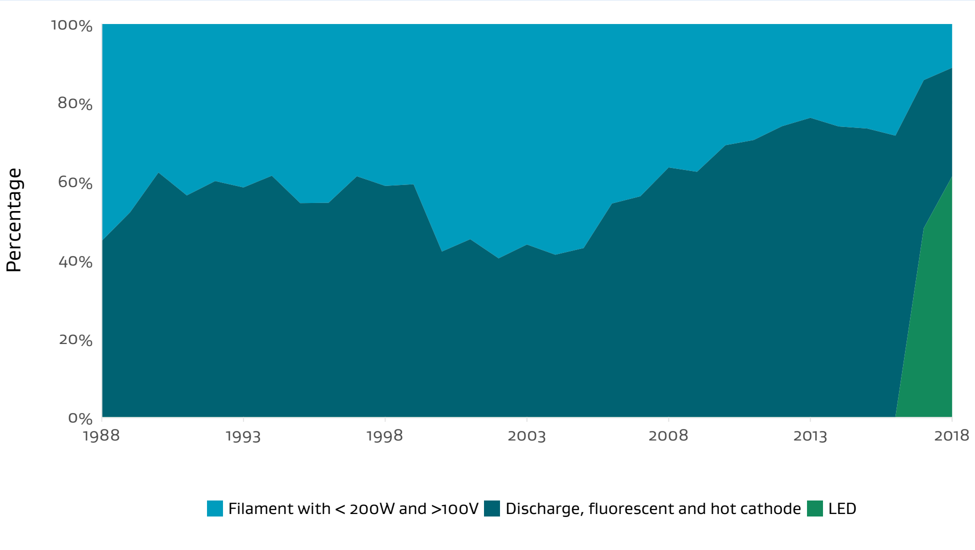
Other advanced OECD countries have displayed similar trends in electricity intensity for the residential sector when the data is normalised[8]. While the reasons for this trend are not fully understood, a common driver has been technology. Between 1974 and 1990 technology had two impacts: making electronic appliances cheaper and increasing the range of appliances available. This led to an increase in electricity intensity over that period. From 2009 onwards, we surmise that greater awareness of environmental issues and more energy efficient appliances have resulted in the declining of the trend.

New Zealand has experienced a sharper decline in electricity intensity compared with other advanced OECD countries. Apart from technology, there are country-specific factors in New Zealand that may be contributing to the falling electricity intensity in New Zealand, including energy efficiency regulations, housing policy on insulation, building code requirements on insulation and more environmentally conscious consumers. Our empirical models suggest that recent increases in household size have also played a part in lowering electricity intensity. In the following sections, we present three key drivers which have contributed about half of the decline in electricity intensity in New Zealand over the past decade.

Adoption of energy efficient light bulbs

The first key driver is the uptake of energy efficient light bulbs. Figure 2 shows the share of imports of different light lamp types by value. Before 2008, the share of filament light bulbs[9] hovered around 50 per cent, but by 2018, the expenditure share of filament bulbs had fallen to around 10 per cent.

Figure 2. Share of imports of different lamps



8 Normalisation is a process of transforming the data to have a mean of zero and a standard deviation of 1.

9 Incandescent bulbs are classified under HS Code filament light bulbs

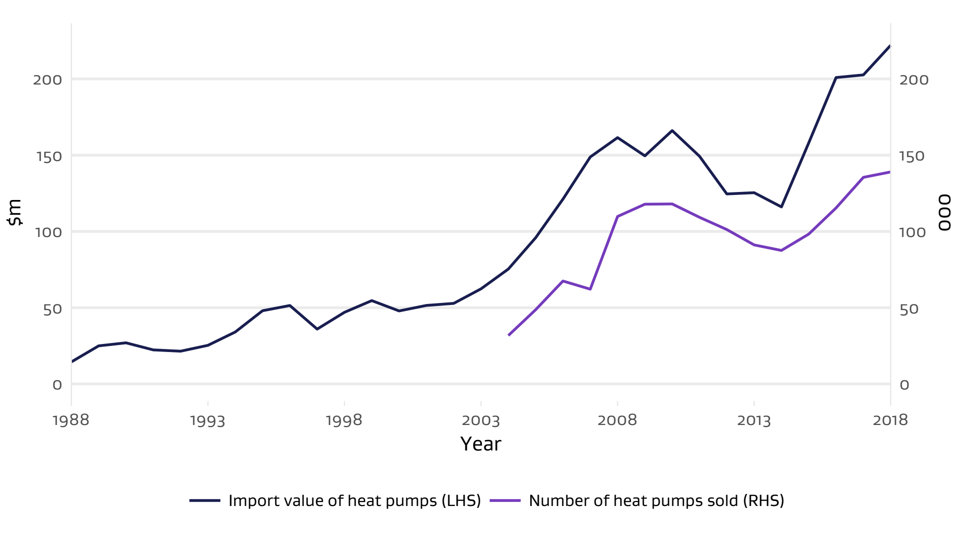
The data on the residential usage of different light bulbs is not available. However a survey by Burgess et al. (2010)[10] found that on average the share of incandescent bulbs for a New Zealand home was estimated to be around 60 per cent in 2009. The most recent BRANZ House Condition Survey (HCS) shows that incandescent bulbs accounted for only 34 per cent of all bulb types recorded in 2015/16.

According to the Household Energy End-use Project, lighting accounts for 12 per cent of household electricity consumption in 2005. Both compact fluorescent lamp (CFL) and light-emitting diode (LED) light bulbs use up to 80 per cent and 85 per cent less electricity than traditional incandescent light bulbs respectively. Using these inputs, we estimate replacing incandescent bulbs with CFL and LED light bulbs over the period from 2009 to 2018 would lower residential electricity consumption in the order of 2-3 per cent.

Heat pumps have become an important part of keeping New Zealand homes warm

The second key driver to the decline in electricity intensity has been the use of heat pumps within New Zealand. In early 1990s, New Zealand imported around $25 million worth of heat pumps. Almost three decades after the first introduction of heat pumps in New Zealand, the value of heat pump imports reached $215 million in 2018 (see Figure 3).

Figure 3. New Zealand heat pump market



For the residential sector heat pumps did not start to become popular until the late-2000s. In 2005, 4 per cent of households had heat pumps. However by 2015/16, 38 per cent of households had heat pumps, and 50 per cent of new homes having installed heat pumps. Although heat pumps have been promoted as being highly energy efficient, their performance depends upon the indoor and outdoor temperature when it is operating. The coefficient of performance of heat pumps in actual use in New Zealand is estimated to be a 2:1 ratio with – one unit of energy input being converted to 2 units of heat output (Burrough et al. (2015)[11]). The performance of traditional electric heaters is a 1:1 ratio with – 100 per cent of electricity being converted to heat.

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10 Burgess, J. Camilleri, M. and Saville-Smith, K. (2010). Lightning in New Zealand homes – lighting efficiency as a sustainability indicator. Sustainable Building Conference SB10.

11 Burrough,L. Saville-Smith,K. and Pollard, A. (2015). Heap pumps in New Zealand. BRANZ Study Report SR329. Judgeford, New Zealand: BRANZ Ltd.

In 2005, electric space heating accounted for about 12 per cent of household electricity consumption. If 50 per cent of households with electric heating in 2005 switched to heat pumps, the total residential electricity consumption would be reduced by 3 per cent. However, the popularity of heat pumps also encourages households to replace solid fuel or gas heating with heat pumps which results in higher electricity consumption. Therefore the net impact of heat pumps on the reduction in electricity demand would be less than 3 per cent.

Higher level of insulation lowers heat loss

The third edition of the New Zealand Building Code Clause H1 *Energy efficiency* came into force on 31 October 2007 – this requires higher thermal performance requirements for housing.

Currently, about 10 per cent of private dwelling were built after the introduction of the third edition of the New Zealand Building Code. In comparison to pre-2008 housing stock, houses built from 2008 onwards have higher thermal performance and are most likely to have heat pumps and energy efficient lighting/appliances.

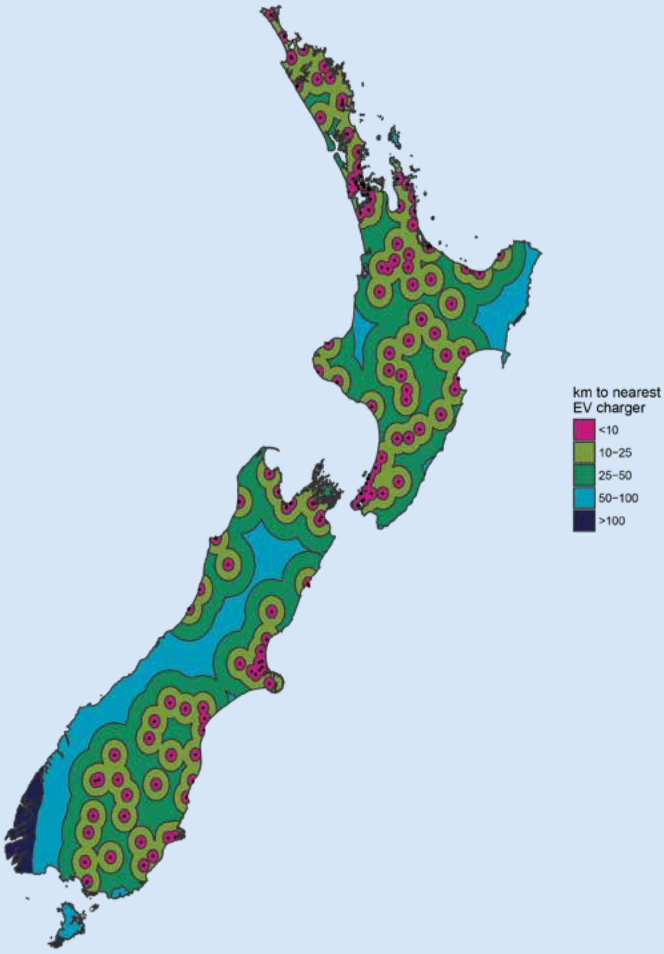
There have been no direct studies done to investigate the impact of new building code on electricity consumption. The recent HCS found that over half of houses in 2015/16 could benefit from retrofitted insulation in the roof space and /or subfloor. Our ad hoc calculations suggest that the new building code could reduce heat loss in the order of 25 per cent in comparison with the previous version (NZS 4218:2004). Accordingly, this leads to a reduction in energy use for space heating per household by 2.5 per cent or more. However, the energy saving could be smaller if households with higher insulation standards pursue higher room temperature.

Box C.3 Publically available electric vehicle (EV) fast charger locations

The following data comes courtesy of the New Zealand Transport Agency (NZTA) EVRoam, a "live cloud based database built from real time information from electric vehicle public charging infrastructure around New Zealand"[12].

There were 145 publically available EV fast chargers registered at the end of July in 2018. That figure grew to 164 publically available EV fast chargers by the end of 2018.

Figure 1 Publically available fast chargers at the end of 2018



Source: NZTA

Figure 1 illustrates the distribution of these EV fast chargers around New Zealand, with the colour representing proximity to the nearest EV fast charging station. As one might expect, the density of EV fast chargers mirrors that of population density with EV fast chargers most concentrated in and around larger cities.

NZTA also monitors public EV rechargers based on an industry established criteria[13] for EV rechargers. Based on these criteria, as at December 2018 there were 204 public EV rechargers nationwide, including the 164 fast chargers aforementioned.

For up to date information on EV fast charging station locations, please visit NZTA's EV charging map.[14]

12 www.nzta.govt.nz/planning-and-investment/planning/transport-planning/planning-for-electric-vehicles/evroam/evroam-faqs/#what-is-evroam

13 This criterion is known as the Open Charge Point Protocol. The criteria includes only rechargers that are monitored in real time, have 24/7 public access and meet certain technical standards. These are mostly fast or rapid chargers, but it also includes a small number of slow rechargers.

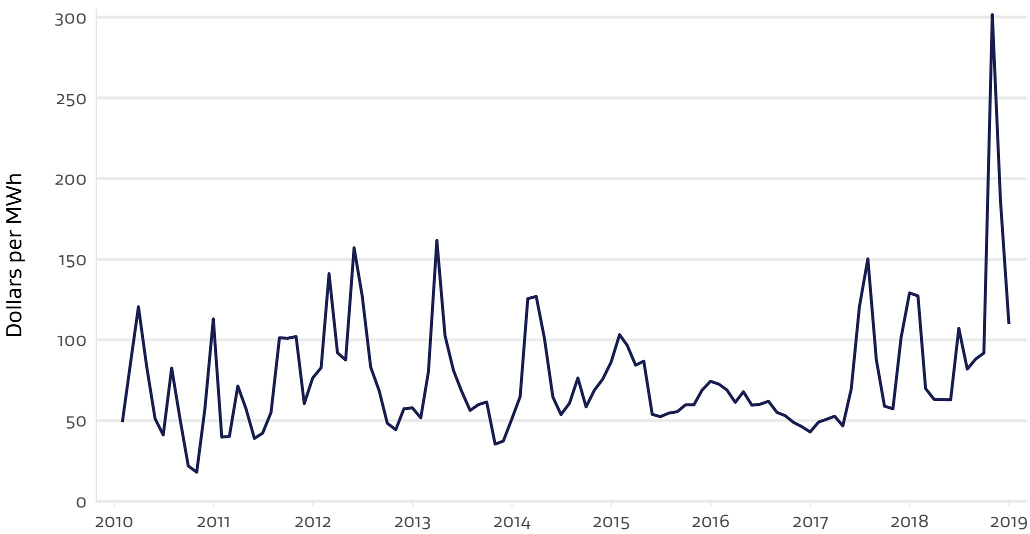
14 www.journeys.nzta.govt.nz/ev-chargers

Wholesale electricity prices spiked and have remained elevated since October 2018

Gas shortage and low hydro levels resulted high electricity wholesale prices

Wholesale electricity prices spiked in October 2018. The monthly average wholesale electricity price in October 2018 was five times the October 2017 average. This was due to lower levels of generation from hydro and natural gas (due to low reservoir levels, and the Pohokura outage discussed in **Section E Gas**) which were required to be offset by generations from other more expensive fuels. Uncertainty as to when Pohokura would be restored also contributed to the increase in prices. Wholesale prices remained elevated at the end of 2018, as shown below.

Figure C.4 Monthly average wholesale electricity prices



High wholesale prices drove increased costs for the industrial sector and smaller electricity retailers

MBIE uses sales-based data to calculate average residential, commercial, and industrial electricity costs. This data is collected from electricity retailers and calculated by dividing income from electricity sales by the volume of electricity sold. This analysis is referred to as the cost per unit as it is what was actually paid relative to the quantity of electricity consumed. The term "cost" is used to distinguish the data from the other electricity price indicator series that MBIE produces the Quarterly Survey of Domestic Electricity Prices (QSDEP). The QSDEP shows how residential electricity tariffs have changed over time.

The impact of the high wholesale electricity prices in the electricity cost series was reflected mostly in the industrial sector as some industrial users purchase their electricity directly on the wholesale market.

The average nominal cost faced by industrial users over the year ending March 2018 was 21.6 per cent higher than in 2017. 2017 also saw high wholesale electricity prices due to dry weather and low South Island generation.

Residential electricity costs increased 0.9 per cent over the year ending March 2018. Residential retail prices are relatively insulated from spikes in the wholesale electricity price as retailers purchase the majority of their electricity via contracts rather than on the wholesale market. In addition, the cost of wholesale electricity is only one factor considered by retailers when setting residential tariffs.

However, some smaller retailer companies cited the high wholesale electricity prices in 2018 as a contributing factor to their closure. Additionally, some retailers who were offering residential plans reflective of wholesale prices recommended these customers consider switching to fixed price tariffs[15].

More electricity distribution companies are moving toward time-of-use pricing

The installation of smart meters in New Zealand households is becoming increasingly common. A smart meter records a household's electricity consumption each half hour and sends this information to the electricity retailer directly. This is opposed to analogue meters which require a meter reader to visit the house and manually record electricity consumption.

With the accurate consumption data that smart meters provide, retailers and distribution companies are able to set electricity prices based on the time that the electricity was used, rather than have a fixed price per unit. These plans are called "Time-of-Use" (TOU) pricing plans.

In recent years a number of distribution companies have introduced TOU tariffs for electricity distribution.[16] This trend has been continuing in 2019 with more distribution companies offering TOU plans (or some variant of TOU pricing) in their April 2019 pricing schedule updates. Retailers are also starting to offer TOU tariffs to end consumers which reflect the distribution pricing, but currently most residential consumers are still on fixed price plans.

Box C.4 **Electricity Price Review commissioned in 2018**

In April 2018, the Minister of Energy and Resources commissioned an independent review into New Zealand's electricity market. This was because electricity prices, especially for residential consumers, increased faster than inflation for many years putting pressure on household budgets. In comparison, prices faced by commercial and industrial customers remained relatively flat.

The objective of the review was to ensure that the New Zealand electricity market is not only efficient and competitive, but that prices delivered to consumers are fair and equitable as well. Additional objectives were to assess also how adoption of new technologies could be facilitated in the future without disadvantaging consumers as a result of these changes.

The review has now completed its Final Report, including 32 final recommendations. It was provided to the Minister of Energy and Resources on 29 May 2019. Its recommendations include reducing energy hardship, improving the competitiveness and efficiency of the industry, improving the regulatory systems, and preparing for a low carbon future[17].

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15 At the time, around 1 per cent of household electricity consumers were on wholesale price contracts, www.ea.govt.nz/about-us/media-and-publications/media-releases/2018/23-october-2018-wholesale-electricity-market/

16 Distribution companies own the low voltage distribution networks that distribute electricity from the national grid to end consumer. They typically do not engage with the end consumer; rather this is left to the consumer's electricity retailer.

17 For more information on, and available publications from the Electricity Price Review, visit www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-consultations-and-reviews/electricity-price/

D. RENEWABLES

INTRODUCTION

New Zealand achieved its highest recorded renewable share in 2018, hitting 40 per cent of primary energy produced from renewable sources. This places us as the fourth highest renewable primary energy supply in the OECD after Iceland, Norway and Latvia[18]. The average for the OECD was just 10 per cent.

The contribution of renewable sources to total primary energy supply rose to 355 PJ in 2018, up 8 PJ from the previous year. Hydro and geothermal energy were the largest contributors to renewable energy supply. This more than offset falls in primary energy from both wood and wind.

While still a small share of the New Zealand electricity system, residential rooftop solar capacity increased by 29 per cent with an additional 4,067 units (17 MW) installed. As at the end of 2018, there were 21,037 residential connections with solar, with a combined capacity of 75 MW.

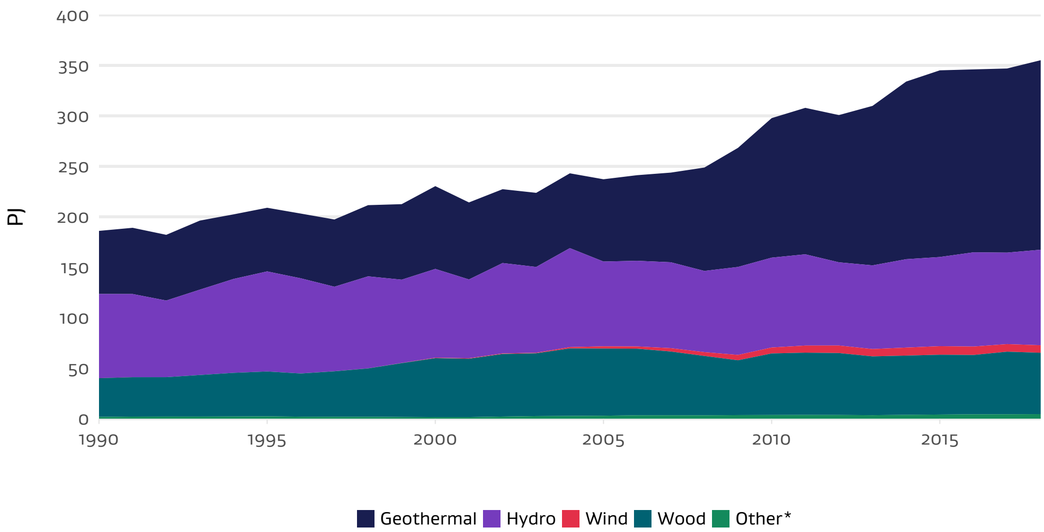
18 Latest data available from the International Energy Agency (IEA) (for 2017)

Renewable energy is integral to New Zealand's energy supply

Renewable energy is an important and significant part of New Zealand's energy supply. New Zealand is a world leader in terms of harnessing renewable resources, with a very high proportion of our primary energy supply sourced from renewables compared to other countries.

Supply overview

Figure D.1 Renewable primary energy supply



*Other includes biogas, liquid biofuels, and solar

MBIE has revised historical figures for geothermal based on expert advice. This is described later in this section.

Electricity generation is the largest use of renewable sources

Most of New Zealand's renewable energy supply is used to generate electricity, with 84.0 per cent of electricity coming from renewable sources in 2018. This is up from 81.8 per cent in 2017. Dry weather conditions in 2017 lowered hydro generation, reducing the percentage of renewable generation. By comparison, the latest data from the IEA (for 2017) shows that the average for the OECD was 25 per cent renewable generation with only Iceland and Norway having higher levels than New Zealand.

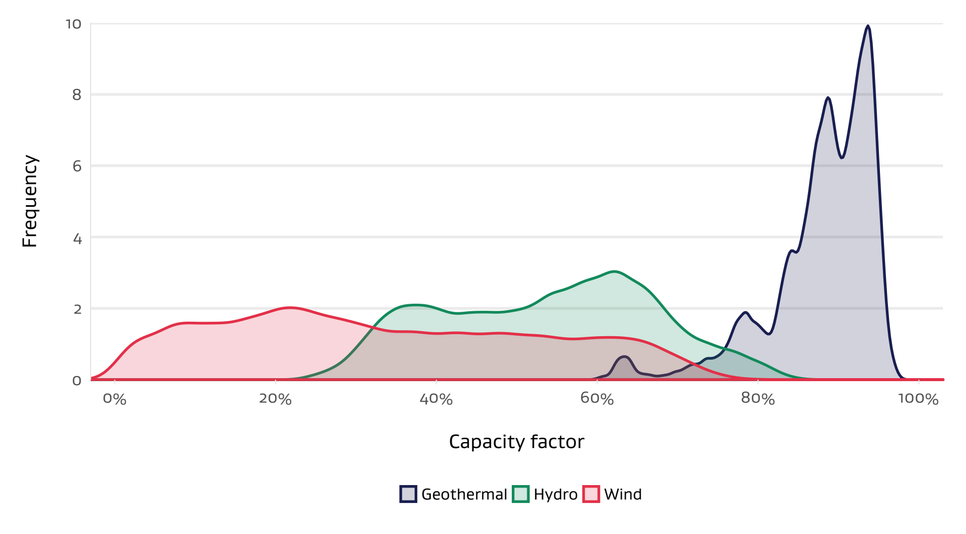
Box D.1 Renewables need to be balanced with other generation types

A distinguishing feature of many renewable forms of generation, compared to thermal generation, is the level of intermittency. Intermittency refers to the extent to which a power source is unavailable or output unintentionally reduced.

One way to measure this variability is to calculate a capacity factor for a generation type. Capacity factors tell us how much electricity was generated by a source over a period of time relative to the maximum amount that could have been generated based on its installed capacity. For instance, over a year wind generation will typically have an average capacity factor between 30-40 per cent due to the highly variable nature of wind. Geothermal, which operates as baseload generation, usually operates with a capacity factor above 80 per cent. Hydro generation is very flexible and the output can be controlled to balance the electricity system.

These points are illustrated in Figure 1, which shows the frequency of capacity factors for each of these three renewable generation types during 2018. This illustrates the range that each generation type operates within, and highlights the most frequent capacity factors over the year.

Figure 1 Capacity factor of wind, hydro and geothermal generation over 2018

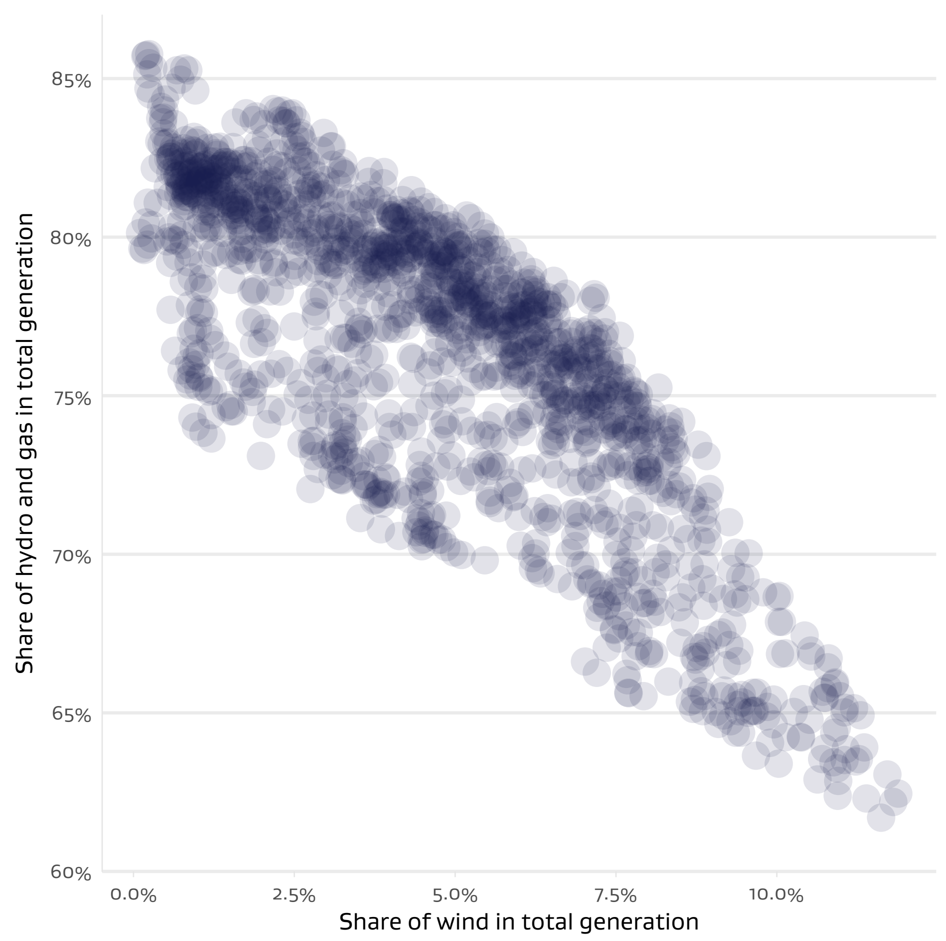


Hydro and gas provide the electricity system with flexibility

Any power system with intermittent and uncontrollable generation sources such as wind will require some form of back-up to maintain supply and ensure demand is met. This back-up generation needs to be 'dispatchable', meaning that it can be called on to generate on demand when required by the electricity system. This back-up role is primarily filled by hydro and gas-fired generation in the New Zealand electric power system.

The relationship between intermittent (wind) generation and these dispatchable forms of generation (hydro and gas) is illustrated in Figure 2. This shows how when wind generation is low, the dispatchable sources of gas and hydro are required to ensure supply of electricity meets demand. The graph shows data for every trading period during July 2018 clearly shows how the flexible generation picks up the shortfall when wind drops off, and also thatgas and hydro may not need be to be dispatched when there is sufficient wind generation.

Figure 2 Output of wind vs hydro and gas-fired generation during July, 2018



Hydro generation among the highest on record

2018 was a strong year for hydro generation. The 26,027 GWh (94 PJ) of generation was the highest in 14 years and the third highest on record. Improving upon a dry 2017, hydro generation was up 4.4 per cent, reflecting good inflows to hydro catchments across the year.

As at December 2018, there was over 5,000 MW of installed hydro capacity spread over approximately one hundred sites. This is dominated by major power stations such as Manapouri (800 MW), Benmore (540 MW), the Upper Waitaki Scheme (848 MW), and Clyde (432 MW).

Hydro generation typically provides 55 per cent to 60 per cent of New Zealand's electricity supply, or around 24,000 GWh each year to help meet an annual average demand of around 40,000 GWh.

Unfortunately New Zealand's hydro storage lakes are relatively shallow and can only store around 4,000 GWh when full. This means that regular inflows are required to maintain lake levels. Without significant amounts of hydro storage and careful management of hydro resources, an alternative back-up is required in New Zealand to ensure security of supply during dry periods when hydro-generation is constrained.

Wind generation eased again in 2018

Wind provided 2,047 GWh of electricity, or 4.7 per cent, of total electricity supply in 2018. This was down 0.9 per cent on the 2017 level and 11 per cent lower than the 2016 level. Continuing refurbishment work at the Te Āpiti wind farm meant reduced capacity for the second year in row.

Future wind generation significantly raised by new developments

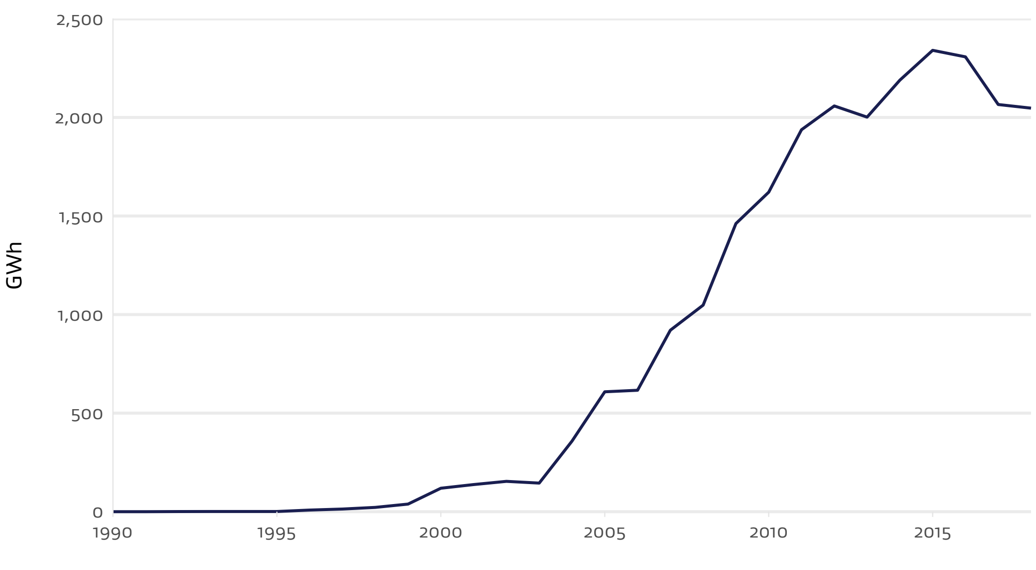
New Zealand has a world class wind resource. There are currently 17 wind farms operating in New Zealand, comprised of 490 turbines with a total capacity of 690 MW.

Electricity generator and retailer, Mercury has committed to the construction of a $256 million wind farm at Turitea near Palmerston North. The 119 MW Turitea wind farm will generate around 470 GWh per year. When commissioned in late 2020 it will be New Zealand's third largest wind farm and the first large-scale generation addition to New Zealand's capacity since 2014. The first stage of the wind farm will consist of 33 turbines with future expansion allowing for a further 27 to be added as required. The Puketoi site, east of Pahīatua, is also consented for 53 turbines.

Tilt Renewables have approved investment in the 133 MW Waipipi Wind Farm (formerly known as the Waverley Wind Farm) in South Taranaki. The project, estimated to cost $276 million, will comprise of 31 turbines that will each have a capacity of 4.3 MW. Annual electricity generation from Waipipi is expected to be 455 GWh on average.

Taken together, these developments will raise total installed wind capacity by over a third.

Figure D.2 Annual wind generation



Geothermal output sets records

The main use of geothermal energy in New Zealand is for electricity generation. In 2018 electricity generation from geothermal accounted for over 17 per cent of New Zealand's total electricity supply. Total output of 7,510 GWh was the highest on record, and its share of total electricity supply was surpassed only in 2016.

Most of New Zealand's installed geothermal generation is in the Taupo Volcanic Zone and another 25 MW is installed at Ngawha in Northland. The temperature and conditions of particular geothermal reservoirs determine which type of generation technology is used: dry steam, flash steam, binary cycle, or a combination.

Geothermal is currently one of New Zealand's lowest cost sources of new electricity generation. It is likely that additional new capacity will be brought online in the medium term. In May 2019, Contact Energy started a drilling programme of four appraisal wells at their Tauhara site near Taupo. A final investment decision for the consented 250 MW power station is due in 2020. Construction would take over three years if given the go-ahead.

In Northland, Top Energy has been moving forward with the expansion of its current 25 MW Ngawha geothermal power station. Drilling of new wells has been completed and commissioning of the additional new 32 MW binary unit is due before the end of 2020. Top Energy could also add an additional 32 MW unit by 2026 which would bring the total capacity up to 89 MW.

Extraction of colloidal silica could spur further geothermal development

In 2018 Contact Energy partnered with Geo40 to extract silica from the geothermal fluid at the Ohaaki geothermal power station. This first commercial plant follows on from successful pilot plants at Wairakei, Kawerau, and Ohaaki. The extracted colloidal silica can provide a valuable revenue stream by tapping into the international speciality chemicals market with the colloidal silica segment reportedly worth more than $1.7 billion. The additional symbiotic benefit is the potential to generate more electricity as the extraction of silica helps to prevent scaling in geothermal pipework.

Revisions made to geothermal primary energy supply

This edition incorporates revisions to the geothermal primary energy supply time series following an expert review of MBIE's methodology. These revisions are due to improvements that have been made to align MBIE's statistical framework with the IEA's definition of geothermal primary energy[19]:

> ***Production of geothermal energy is measured by subtracting the heat of the fluid reinjected into the earth's crust from the heat of the fluid or steam upon its extraction from the earth's crust.***

Geothermal electricity plants typically pump the fluid back into the reservoir after using it. Previously, fluid reinjection was not was included in data reported to MBIE by some operators. The energy contained in the reinjected fluid has now been subtracted from energy of the extracted fluid, and has resulted in a reduction in geothermal primary energy from what was previously reported.

This data has been revised back to 2002, with a 10 per cent reduction in geothermal primary energy for 2017. These revisions are largest in recent years, and of decreasing size further back in time. This change does not affect the renewable share of electricity generation.

19 Source: IEA (2004), *Energy Statistics Manual*, OECD Publishing, Paris

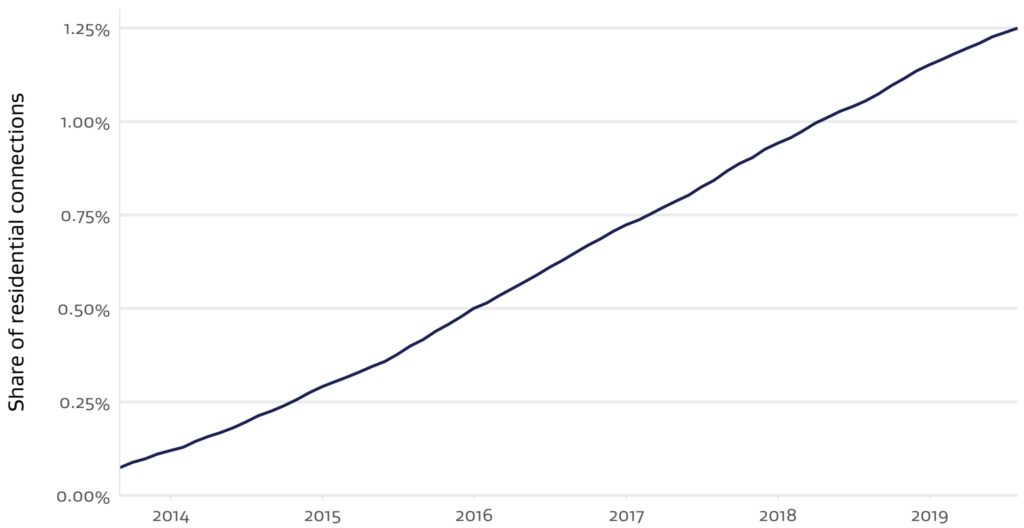
Solar generation starts shining

Solar energy sources include solar thermal and solar PV systems both of which are predominately used by households on their rooftops (distributed generation):

- Solar thermal systems collect heat and directly store it in water for later use as space heating or hot water supply. Data on the quantity of energy utilised is not collected, and so the number of systems is estimated.
- Solar PV systems use photovoltaic panels to convert sunlight directly into DC electricity and then convert this to AC using an inverter. As residential systems have become cheaper their uptake has increased. MBIE estimates electricity generation from solar PV panels using data on installed capacity from the Electricity Authority.[20]

In 2018 an additional 4,067 units (17 MW) were installed bringing the total number of residential connections with solar to 21,037 (75 MW) by the end of the year (and up to 22,989 (84MW) in July 2019). Residential solar makes up over 80 per cent of total solar capacity which was 90 MW at the end of 2018.

Figure D.3 Residential solar PV uptake



Despite this recent growth, solar PV currently accounts for less than 0.3 per cent of total electricity generation.

Currently, the average residential PV system is around 3.5 kW, while New Zealand's single last largest solar array (installed at the Yealands Estate winery in Marlborough) is rated at 412 kW.

Refining NZ, the operator of the Marsden Point oil refinery, has announced they will soon apply for consent to build a 26 MW solar array on land adjacent to the refinery. The proposed 31 hectare solar farm would be New Zealand's largest if given board approval for the estimated $36-39 million project.

20 www.emi.ea.govt.nz/Retail/Reports/GUEHMT?_si=v|3

Other Sources of Renewable Energy

While reliable data is available on the quantity of renewable energy used by large industrial users, information on the direct use of renewable energy and use for distributed generation is more difficult to obtain. Information on the input energy source (e.g. geothermal or solar) is often used without being purchased and hence it is not well recorded. Estimates of the direct use of renewable energy have been made based on research and the knowledge of experts in this field.

Geothermal energy for direct use

In 2018, an estimated 8 PJ of geothermal energy was used directly. Just under 60 per cent of this was in industrial applications, 30 per cent in commercial, and the remainder in residential and agricultural applications. Direct use refers to using geothermal heat directly without a heat pump or power plant.

Geothermal energy is extracted from heat deep beneath the earth's surface. New Zealand is particularly rich in geothermal energy especially in the Taupo and Kawerau regions.

Geothermal energy has been used in New Zealand for hundreds of years – first by Māori and then by European settlers and tourists. Since the 1950s, geothermal energy has been used increasingly as direct energy for such uses as heating homes or to generate electricity. Kawerau, where geothermal steam is a significant source of energy for pulp and paper mills, was until recently the world's largest direct geothermal heat use at one location.

Other examples of geothermal direct use in New Zealand includes:

› Timber drying – Tenon's wood processing plant near Taupo uses geothermal energy to heat its timber-drying kilns;

› Aquaculture and tourism – The Huka Prawn Park, near Taupo, is the only geothermally-heated prawn farm in the world. Heated discharge water from the nearby Wairakei geothermal power station helps heat the ponds;

› Horticulture – The use of geothermal energy to heat the glasshouses of Rotorua-based PlentyFlora and Taupo-based Gourmet Mokai has reduced production costs for flowers (PlentyFlora) and tomatoes/capsicums (Gourmet Mokai);

› Milk drying – The Māori-owned dairy company (Miraka) based near Taupo, is the first milk drying facility in the world to use geothermal energy; and

› Space heating – Rotorua Hospital uses geothermal energy – via a heat exchanger – for space heating and hot water heating. The system, commissioned in 1977, has proven to be a very reliable source of energy.

Woody biomass used predominantly for process heat

The majority of woody biomass is used by pulp and paper mills and wood processors to provide heat energy and to generate electricity (cogeneration). A smaller quantity is used by households for space heating. Reasonable quality data exists for the former (48 PJ), while the latter (8.8 PJ) is estimated using census data on the proportion of households with wood burners and other basic assumptions.

Woody biomass is also being increasingly used for process heat requirements by businesses outside the wood processing industry. Some notable examples include Fonterra's Brightwater milk processing plant in Nelson, the Golden Bay Cement plant in Whangarei and the Danone Nutricia dairy plant in Balclutha. A number of public institutions, including Nelson and Christchurch hospitals, are also using moving to use biomass boilers for heating.

Black liquor

Also called sulphite lyes, black liquor is a by-product derived from wood and is utilised for energy at several industrial sites in New Zealand. Black liquor is an alkaline spent liquor from the digesters in the production of sulphate or soda pulp during the manufacture of paper where the energy content derives from the lignin removed from the wood pulp. It is burnt through recovery boilers to produce process heat and recover chemicals that can be reused in chemical pulp production.

Biogas

Coming from a variety of non-fossil sources, biogas is primarily a mixture of methane and carbon dioxide which is combusted to produce heat and/or electricity.

■ Sludge gas

Sludge gas is derived from the anaerobic fermentation of biomass and solid wastes from sewage. Sludge gas is produced at the Tirau dairy processing facility. Cattle effluent is utilised to produce sludge gas that is used to raise heat for the milk processing facility which is open from September through to December each year. Sludge gas is also produced at a number of municipal wastewater treatment plants around the country where it is used to generate electricity.

■ Landfill gas

Landfill gas is derived from the anaerobic fermentation of biomass and other organic solid wastes in landfills. There are around a dozen or so sites around the country which collect landfill gas and use internal combustion engines to produce electricity.

Liquid Biofuels

■ Bioethanol

In New Zealand bioethanol is produced and imported from sustainable sources. Bioethanol is produced by fermenting whey, a cheese by-product, and also from the waste of beer fermentation, with some of the resulting ethanol purchased by fuel companies. This, along with imported ethanol, produced from sustainable sugarcane, is blended with regular petrol. A typical blend is 10 per cent ethanol, which results in a 5-6.5 per cent reduction in greenhouse gas emissions per litre compared with those from regular petrol.

■ Biodiesel

In New Zealand, biodiesel is currently produced from tallow, oilseed rape and used cooking oil, resulting in life-cycle greenhouse gas emissions 40 per cent to 50 per cent lower than those from fossil diesel. Since used cooking oil is a waste product and oilseed rape is grown as a break crop on grain fields to increase soil quality, they do not compete with food production or compromise biodiversity or soil quality.

Tallow can be used in food such as shortening and pemmican, and using it as a biofuel can be controversial due to the food versus fuel dilemma. While pure biodiesel (B100) can be used in some equipment, it is commonly blended at 5 per cent with petrodiesel (B5) for use in vehicles.

E. OIL AND GAS

OVERVIEW

The 2018 calendar year saw several major developments across the oil and gas sector. Most notable was the Government's announcement that they would put an end to future offshore oil and gas exploration. This has led to increased attention placed on remaining reserves, in particular for gas.

Other events during the year included the maintenance shutdown of the refinery at Marsden Point, the ongoing outages of the Pohokura field, and the departure of Shell from New Zealand.

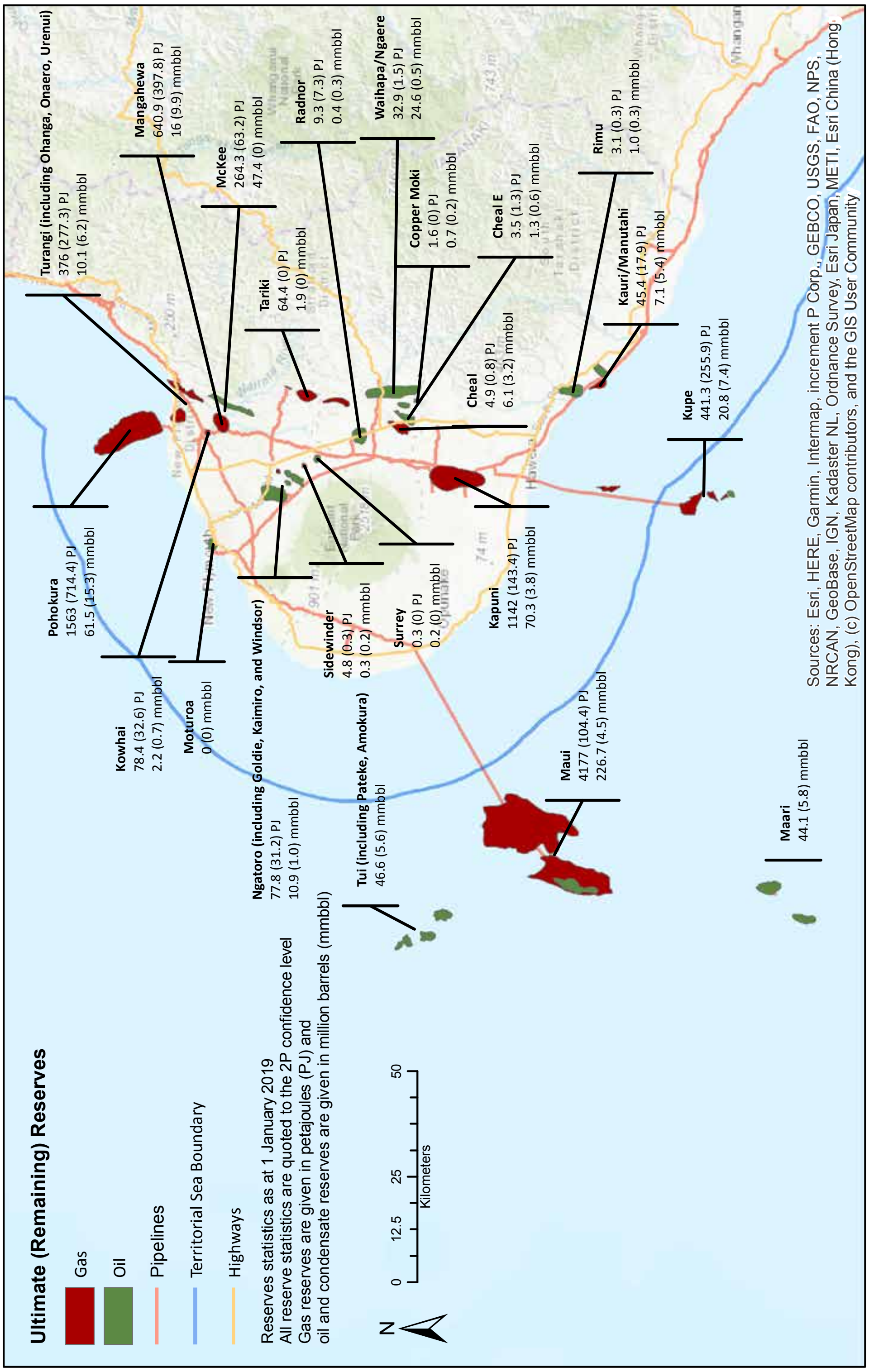
New Zealand's oil fields are aging and production is declining. Development is continuing in several key fields to ensure ongoing supply for as long as possible.

After operating in New Zealand for more than a century, Royal Dutch Shell sold their assets to OMV. The purchase of these assets has resulted in OMV owning 69 per cent of the Maari field, 74 per cent of the Pohokura field, and 100 per cent of the Maui field.

This purchase has resulted in approximately of 80 per cent of New Zealand's gas reserves and 50 per cent of New Zealand's oil reserves now being owned by two companies – OMV, and Todd Energy. The remaining assets are spread across Beach Energy, Cue Energy, Genesis Energy, Greymouth, Horizon Oil, New Zealand Energy Corp, New Zealand Oil and Gas, Tamarind Resources, and Westside Corporation.

Reserves

Figure E.1 Overview of Taranaki offshore and onshore oil and gas fields



As part of their regulatory obligation as permit holders, operators are required to submit information on their oil and gas reserves to MBIE. These figures are important because they show how much oil and gas is remaining in New Zealand. Gas reserves are an important indicator of energy security, as unlike oil, all use is currently met with domestic production.

In 2018 the Government announced it would end offshore oil and gas exploration

The announcement that there would be no further offshore oil and gas permits granted after 2018 was followed by an amendment to the Crown Minerals Act in November 2018[21]. The key amendments were as follows:

› There will be no **new** offshore permits granted, but existing permits will be honoured.

› No **new** permits will be issued for any land area outside of the Taranaki region.

› Applications for **subsequent** permits will be unaffected by the Amendment bill.

  – This means that if an operator were to find an economically viable reservoir somewhere in the area currently covered by exploration permits, that operator could apply to exchange the exploration permit for a mining permit which would allow development of that asset[22].

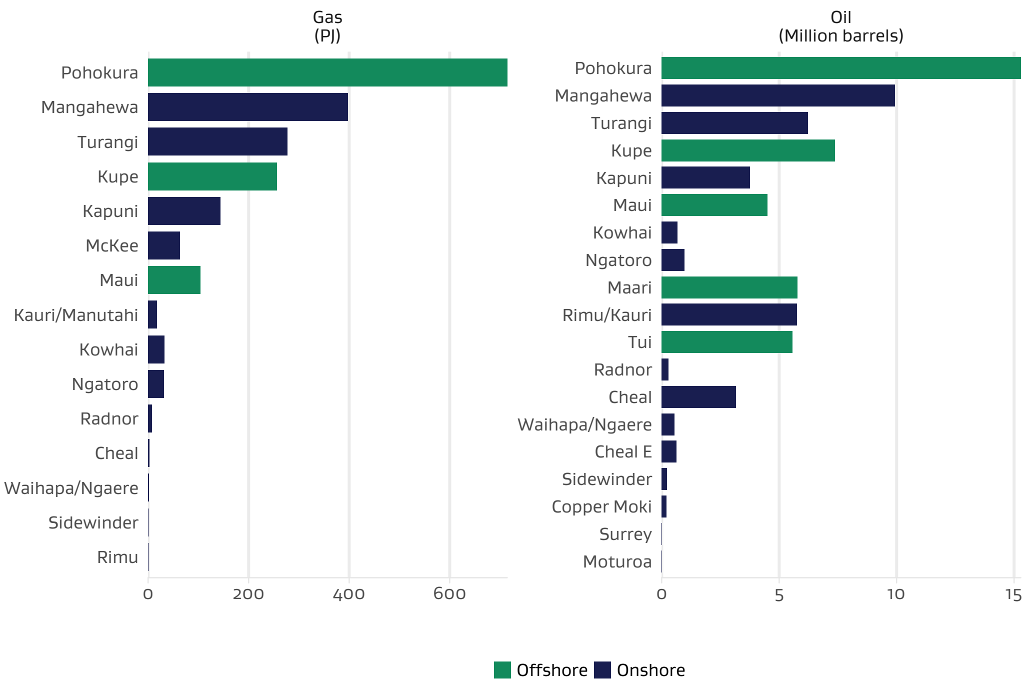
The Block Offer 2018 opened on 30 April 2019 and closed on 28 August 2019. Acreage in this block offer was limited to the onshore Taranaki region.

Development to focus on existing fields

Under the non-legislative environment, the focus for oil and gas production has moved to development of existing fields.

Figure E.2 shows New Zealand's remaining reserves (2P) at 1 January 2019. These volumes represent what can be expected to be extracted from each field given existing technologies and economic conditions.

Figure E.2 Remaining gas and oil 2P reserves as at 1 January 2019



21 www.legislation.govt.nz/act/public/1991/0070/latest/DLM242536.html

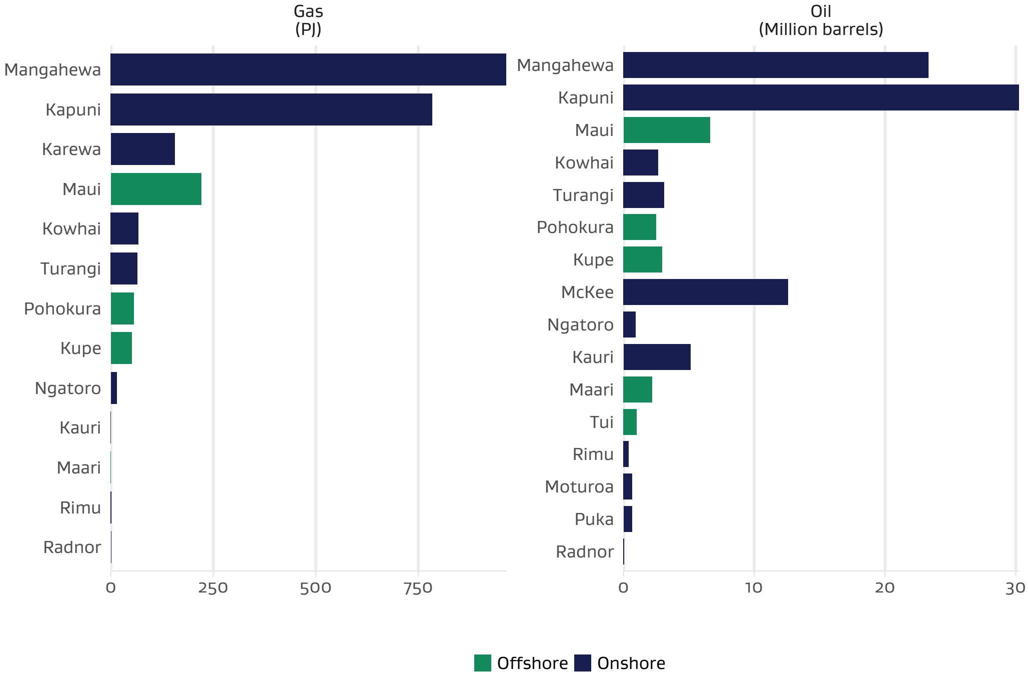
22 At the time of the amendments 100,000 km^2 was covered. This fell to 80,000 km^2 following the surrender of some permits.

Most of the remaining reserves exist in four key fields – Pohokura, Mangahewa, Kupe, and Turangi. OMV is investing $500 million in New Zealand to further develop current assets including Pohokura and Maui. Despite Maui being an older field, it is still an important part of the energy supply to New Zealand. In 2018 Maui accounted for 18 per cent of New Zealand's net gas supply (29.6PJ of 167.5PJ).

Investment in existing fields is important because remaining reserves are only part of the picture of how much oil and gas is remaining. Contingent resources are also important in understanding how much oil and gas still exists. Contingent resources are defined as quantities of petroleum which could be potentially recoverable, but which are not currently considered to be commercially recoverable.

As exploration in New Zealand tails off, the focus on contingent resources is likely to increase.

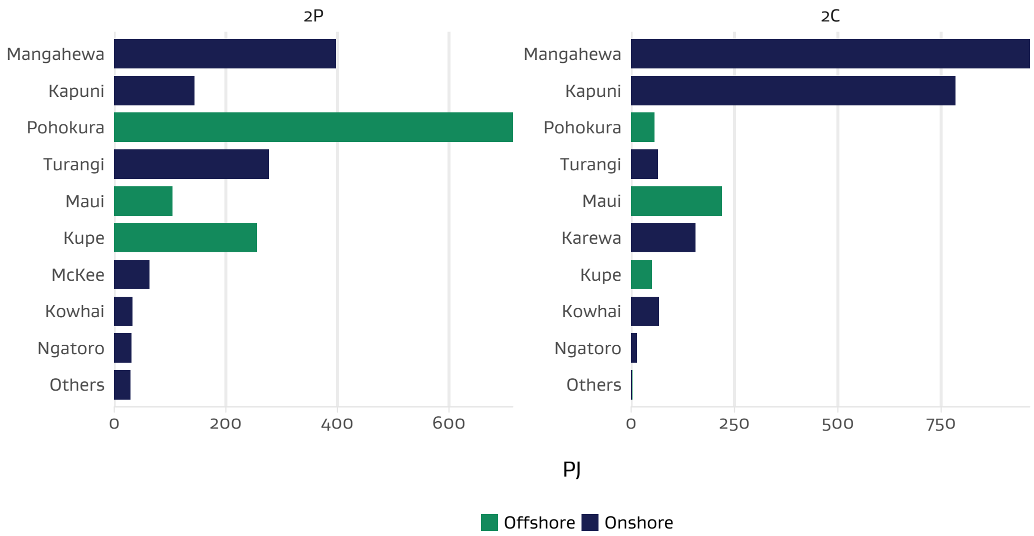
Figure E.3 Gas and oil 2C contingent resources as at 1 January 2019



In 2018, Todd Energy reported a much higher estimate for contingent resources of gas at the Mangahewa field – up 756PJ from 208PJ the year before. The Mangahewa field has been the subject of significant development work over the past few years and this increase in the contingent resources estimate reflects a better understanding of the field. While it is important to understand that high contingent resources will not necessarily translate into future supply, it is generally accepted that some contingent resources will be transferred to remaining reserves at some point.

Figure E.4 compares remaining gas reserves to contingent resources by field. While Pohokura has the reported the largest volume of remaining gas reserves, it also has very little contingent resources.

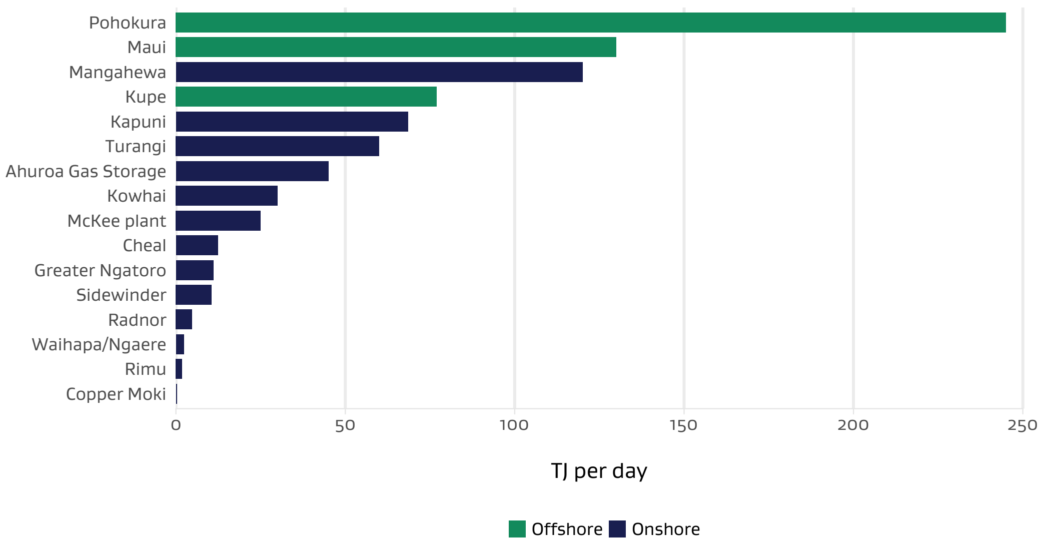
Figure E.4 Comparison of 2C and 2P gas reserves



Deliverability a key component of gas supply

Deliverability is an important factor to consider when assessing a field's utility. Figure E.5 shows the maximum deliverability of each field. This is the maximum amount of gas that each field can potentially produce each day.

Figure E.5 Gas deliverability



Pohokura is currently the most capable field NZ has in operation. It is capable of producing up to 245 TJ of gas per day. This is why disruptions at Pohokura have large impacts on New Zealand gas supply.

The next biggest producer is Maui, which can produce up to 130 TJ per day. Maui is an aging field and its deliverability has been declining since 2014. OMV believes development work could extend Maui's production life by five to ten years.

Box E.1 Overview of exploration and development process

The process of exploring, identifying and developing a petroleum resource can take many years, often more than a decade from commencement of prospecting to initial production. The stages in oil production are:

1) Prospecting
2) Exploration
3) Appraisal
4) Development

Prospecting generally begins with preliminary research of an area including analysis of existing acreages, researching known wells in an area, review of publically available data and other activities that can be undertaken without a specific permit.

Once the decision has been made to progress to physical prospecting, a prospecting permit must be sought. In New Zealand applications for a prospecting permit can be made at any time over an available area. These permits are generally non-exclusive and do not guarantee subsequent rights to exploration permits[23].

Once a prospecting permit has been granted the company can then start physical prospecting activities. This normally includes a variety of surveys such as seismic, gravimetric and magnetic surveys. In New Zealand drilling is not allowed under a prospecting permit. If the initial prospecting activities support more detailed exploration then a company may decide to apply for an exploration permit, which would allow them to drill exploration wells. In New Zealand this is achieved through the Block Offer process[24].

An exploration permit grants the right to drill as part of exploration activities. An exploration permit can be issued for up to 15 years, with two possible extensions of four years each for additional appraisal activities. An exploration permit also carries subsequent rights to apply for a mining permit.

Exploratory wells are drilled to confirm the presence of a petroleum accumulation. If an exploratory well successfully identifies an accumulation subsequent wells may be drilled to clarify the size and extent of the accumulation. This is the appraisal phase of petroleum exploration.

If the appraisal activities show sufficient promise for further development a company may apply for a mining permit to allow development of the discovery. A mining permit is required to allow development and extraction of petroleum. Size and duration of a mining permit is limited to the extent of the discovery[25].

23 www.nzpam.govt.nz/permits/petroleum/types/
24 www.nzpam.govt.nz/permits/petroleum/block-offer/
25 www.nzpam.govt.nz/permits/petroleum/types/

Exploration and Development

Drilling activity increased in 2018 with a 96 per cent growth in total metres made, and two new development wells being drilled.

After a significant amount of activity in 2017, 3D seismic acquisition fell 79 per cent. This drove reductions in expenditure on seismic acquisition and capture.

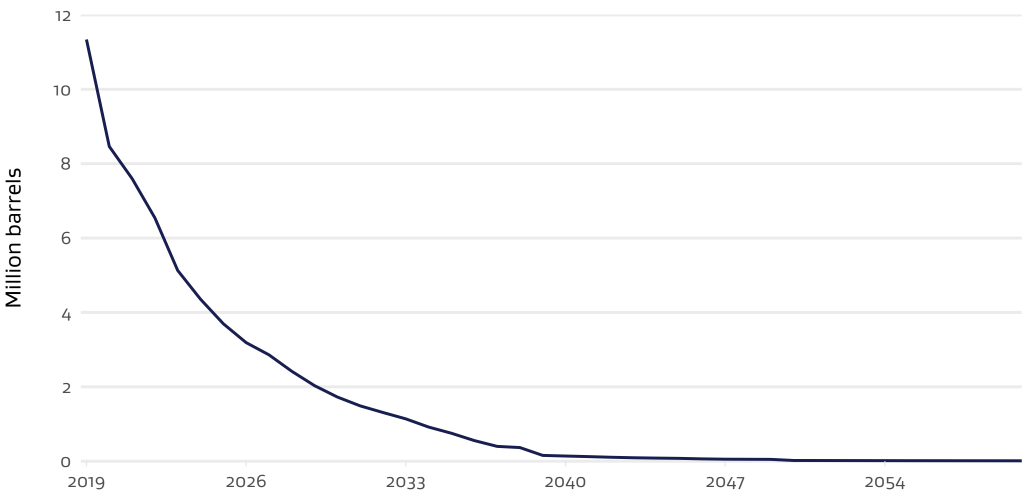
Permits

In 2018, four permits were surrendered and one permit expired. One mining permit was granted. This saw 56 remaining permits at granted status – 29 of which were exploration and prospecting permits and 27 mining permits.

Expected production

Overall, production of crude oil continues to decline as New Zealand oil fields age. Development is continuing in several key fields to ensure ongoing supply for as long as possible. Current forecasts show operators are expecting a fall off in production from oil fields in the near future, followed by a more gradual decline over the remainder of the forecast horizon.

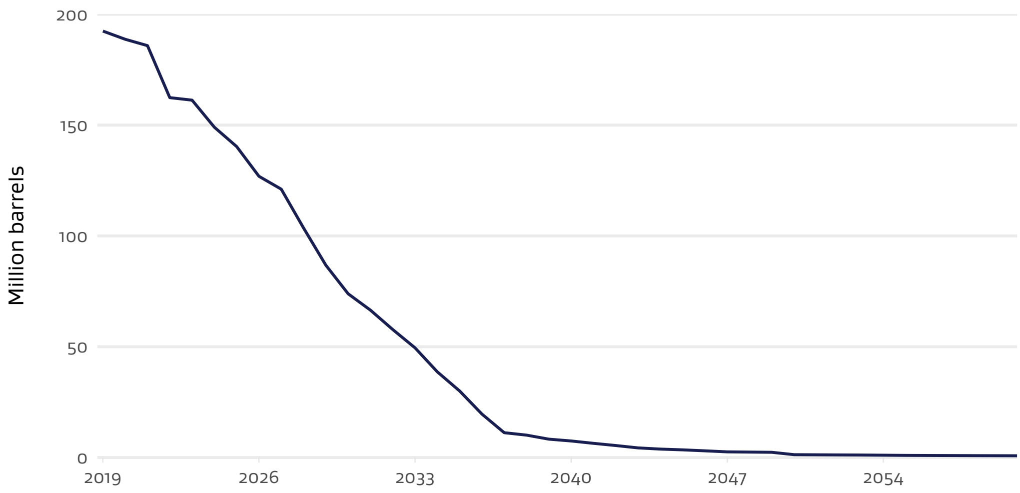
Figure E.6 Forecast oil production profile



As reported to MBIE by field operators

As all of New Zealand's domestic demand of gas is currently met with local production, remaining gas reserves and expected production received increased attention following the announcement that there would be no further offshore exploration in New Zealand.

Figure E.7 Forecast gas production profile

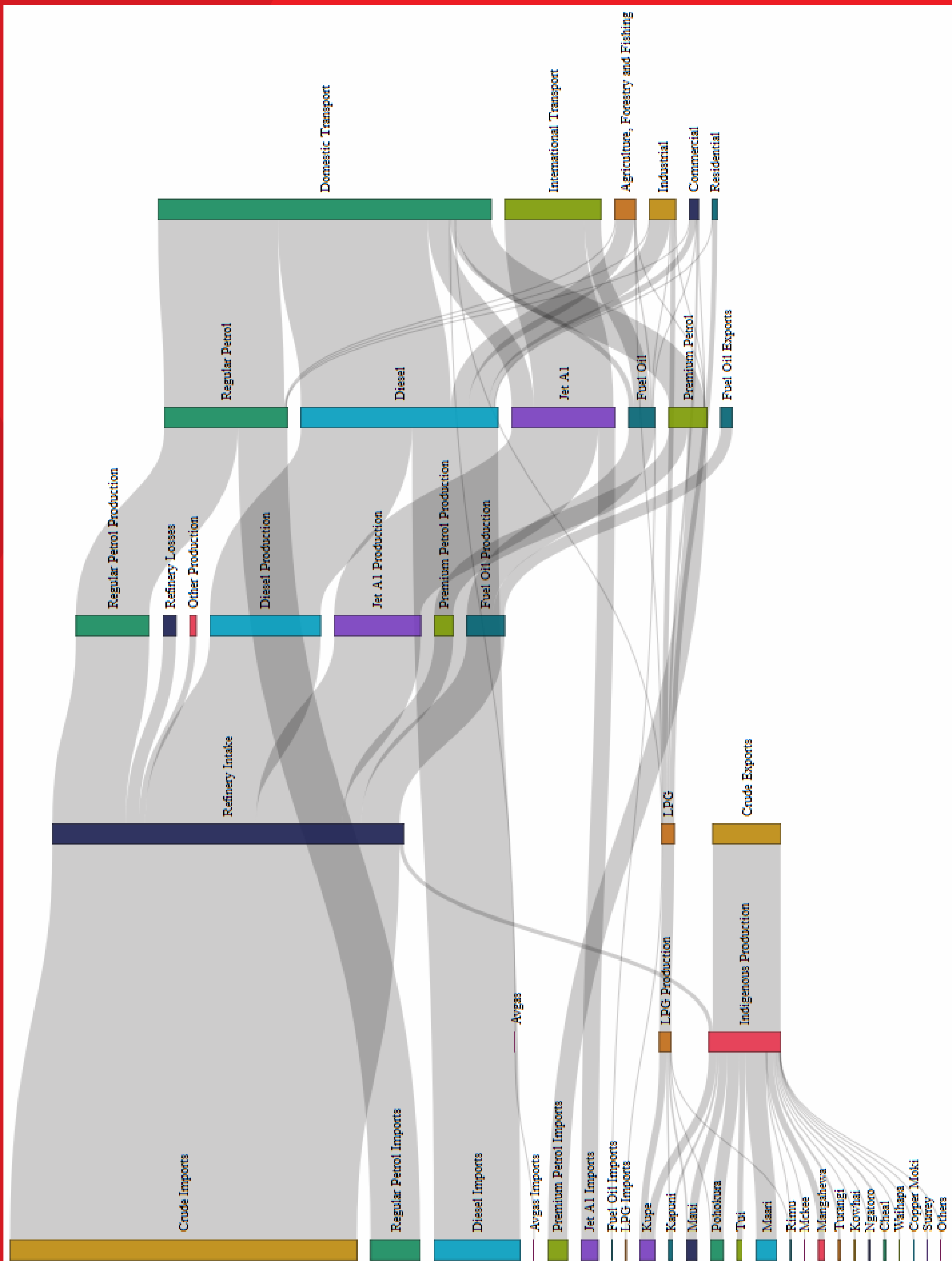


As reported to MBIE by field operators

Oil and Gas

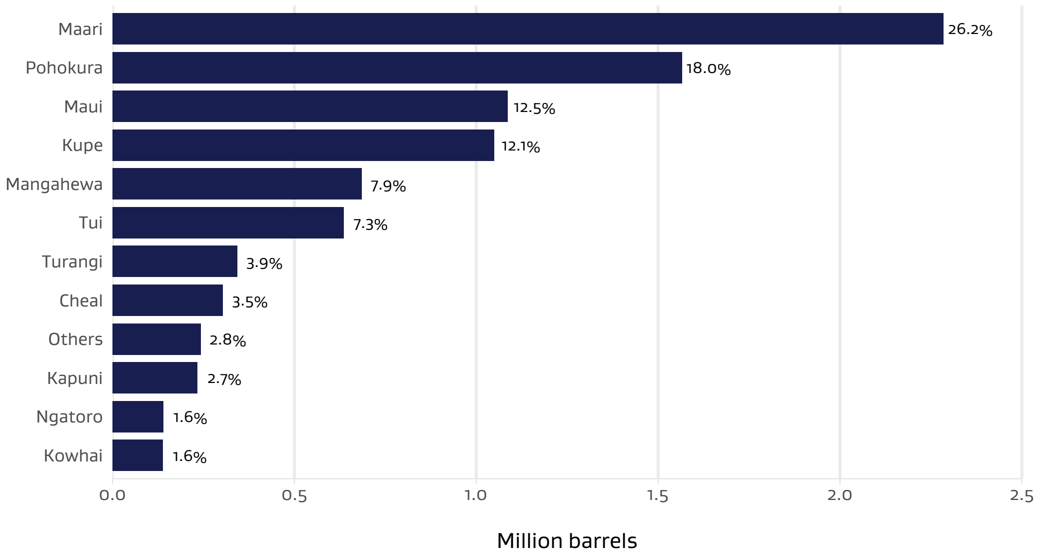
OIL

Figure E.8. Oil flows in 2018



Outages at the Pohokura field drove a fall in oil production

Figure E.9 Indigenous oil production in 2018



New Zealand's oil fields have been largely in decline for the past several years. Approximately 94 per cent of domestic oil production is exported as it is not suited to current refining capabilities at New Zealand's only oil refinery. Maui, despite being well into its end of life, is still producing a large proportion of New Zealand's oil and condensate.

In 2018 production by Pohokura, one of the country's largest oil and gas fields was down 44 per cent from the previous year due to outages that occurred during 2018. For more information on the Pohokura outages and their impact on the New Zealand energy sector, see pop-out box E.4 in the Gas section.

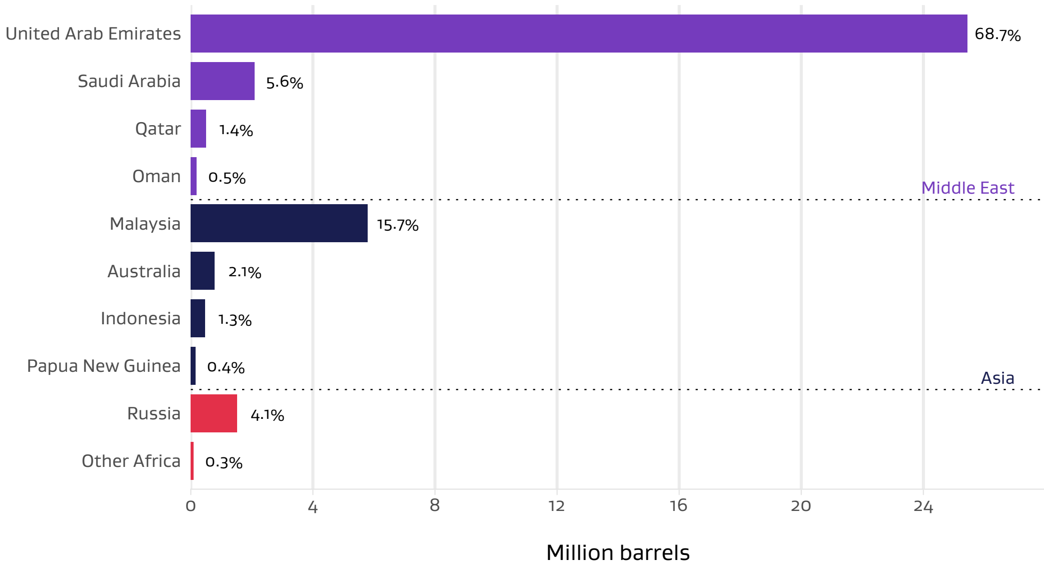
Maintenance shutdown at Marsden Point refinery drove an increase in refined product imports

The country's only refinery at Marsden Point shutdown for an extended period in 2018 to undergo a major refurbishment. One of the key improvements made to the refinery during the upgrade was a refurbishment of the hydrogen manufacturing unit. The refinery, currently the country's largest producer of hydrogen, has signalled that this could enable future development of hydrogen infrastructure[26].

The reduction in refining capacity due the shutdown led to a reduction in crude oil imports and an increase in refined product imports. Crude oil intake at the refinery fell from 40 million barrels in 2017 to 38.5 million barrels in 2018. The majority of New Zealand's crude oil imports are sourced from the Middle East, with the remainder primarily coming from Asia and Russia.

26 www.refiningnz.com/refininglogin/wp-content/uploads/2019/03/Annual-Report-2018.pdf

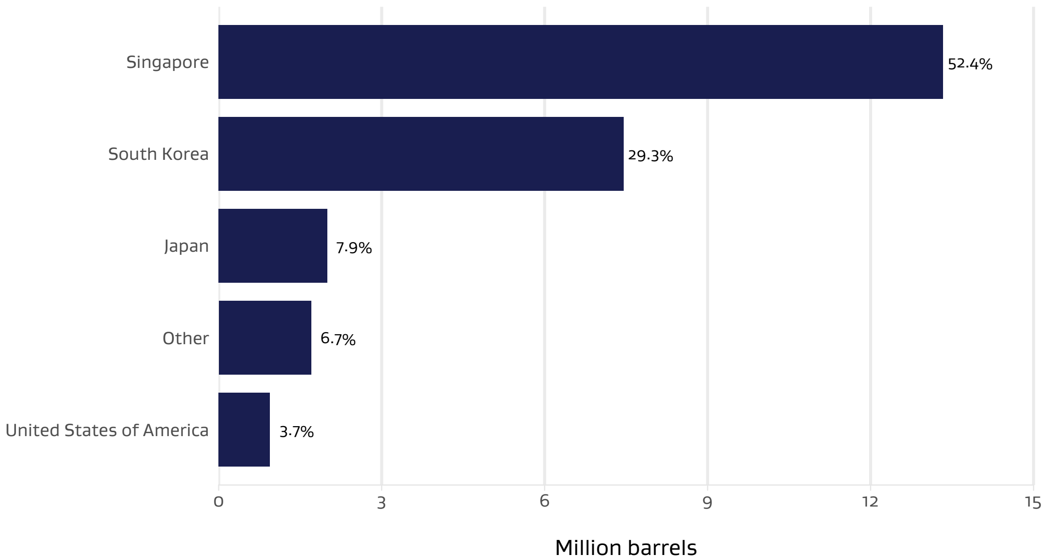
Figure E.10 Crude imports by origin in 2018



Imports of most refined products increased in 2018, with diesel imports up 32 per cent and petrol imports up 5 per cent. This was partially in response to the refinery shutdown, with increased import activity seen in the first half of 2018 in order to ensure that demand could still be met during the shutdown period. Even though aviation fuel imports were down slightly in 2018, the refinery was able to meet increased demand for aviation fuel despite the maintenance shutdown.

The majority of New Zealand's refined products are loaded in Singapore and South Korea, with over 80 per cent of refined product imports in 2018 originating at these two ports.

Figure E.11 Refined products by port of loading in 2018

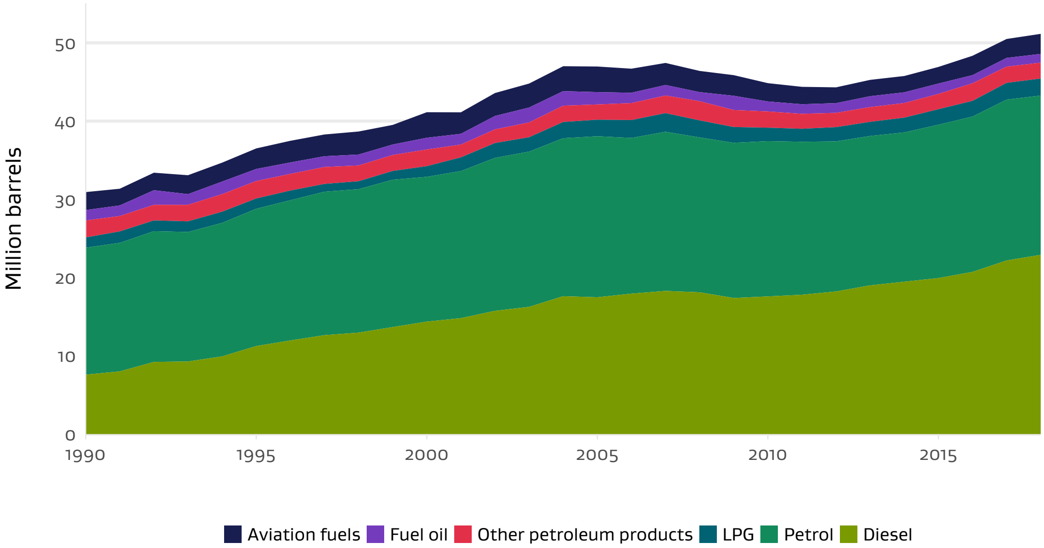


While refinery output of products such as petrol, diesel and aviation fell in the June quarter of 2018, annual refinery output of these commodities were down slightly from previous years.

Diesel and aviation fuel continue to drive growth in oil consumption

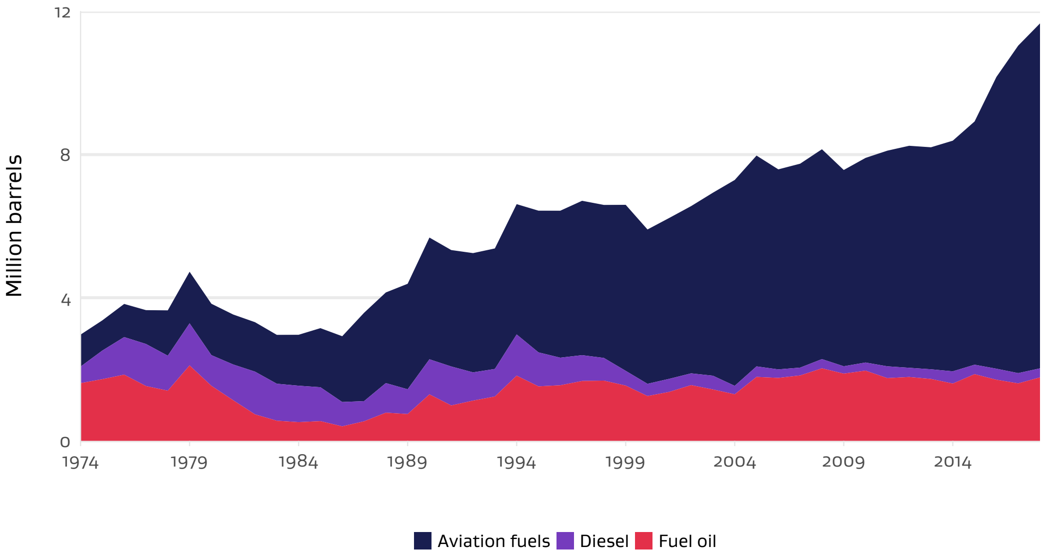
Domestic oil consumption, covering use of oil products within New Zealand's borders, has increased in recent years as a result of sustained growth in diesel use for land transport.

Figure E.12 Domestic oil consumption by fuel



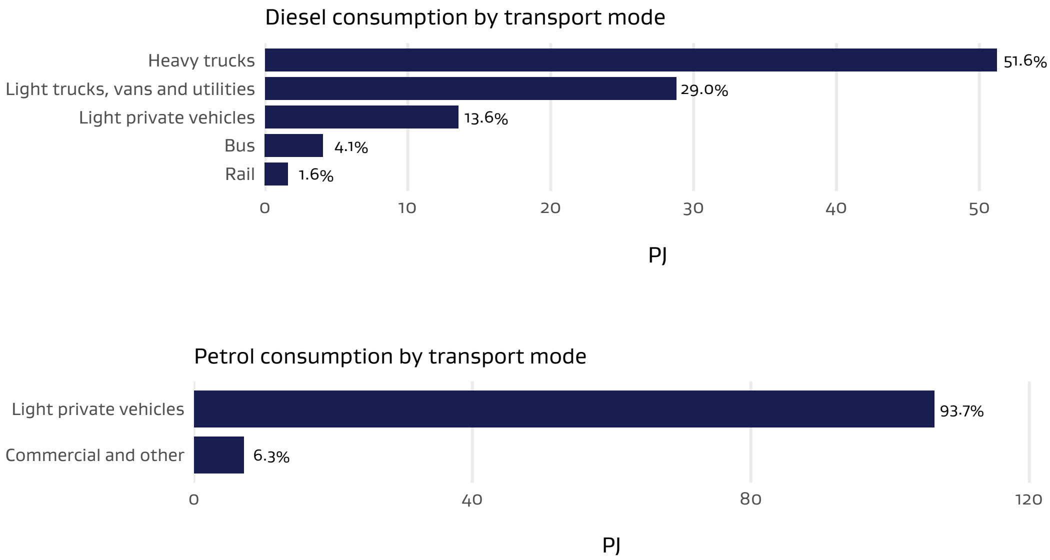
The strong growth in tourist numbers that New Zealand has experienced since late 2014 continued in 2018. This led to further increases in aviation fuel use for international transport.

Figure E.13 Oil consumption for international transport



The Ministry of Transport (MoT) maintains the New Zealand Fleet Model. This includes estimates of energy consumption by different vehicle types, with these calculations based on the type of vehicle, efficiencies, and kilometres travelled[27]. In 2018, heavy trucks accounted for over 50 per cent of diesel consumption, while the majority of petrol consumption was in light passenger vehicles.

Figure E.14 Diesel and petrol consumption by road transport mode



Source: Ministry of Transport, August 2019

Port offtakes can be used as a proxy measure of fuel demand by region. However, care should be taken in interpreting in this data, as oil products are transported between regions. Figure E.15 shows actual offtakes of petrol, diesel, jet fuel at New Zealand terminals in 2018.

27 There are slight differences between total diesel consumption in the fleet model and MBIE's collected sales data. These differences are due to several factors including the definition of domestic transport, variances in fuel efficiency, and model specification.

Figure E.15 Port offtakes by fuel in 2018

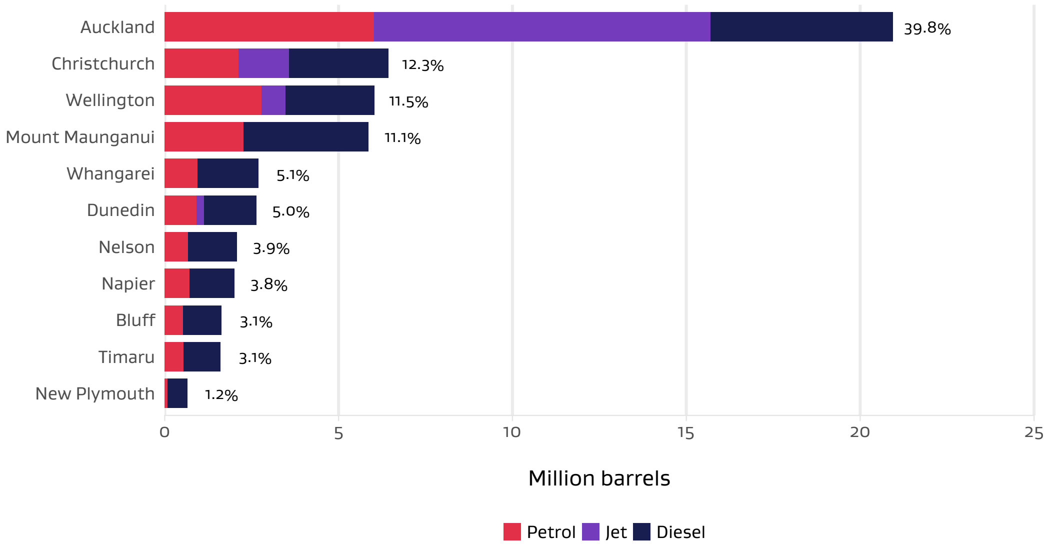
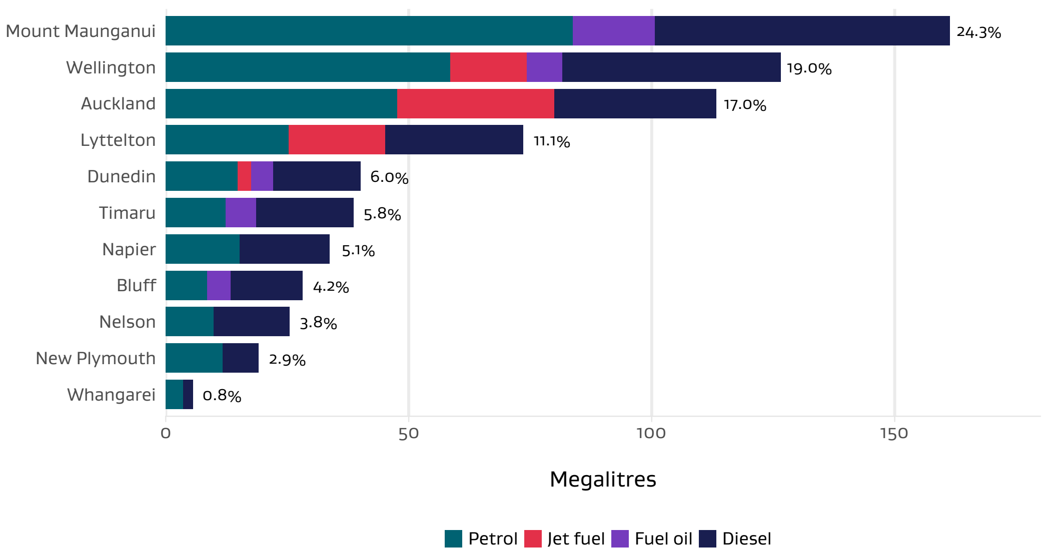


Figure E.16 shows the net fuel capacities by type and terminal. Tank capacities include some volume of fuel at the bottom of a tank that is not generally accessible. Net fuel capacities subtract this volume from the overall volume of the tank. Tank volumes were unchanged in 2018.

Figure E.16 Terminal capacities by fuel



Box E.2

Box E.2 Stock tickets and days of cover

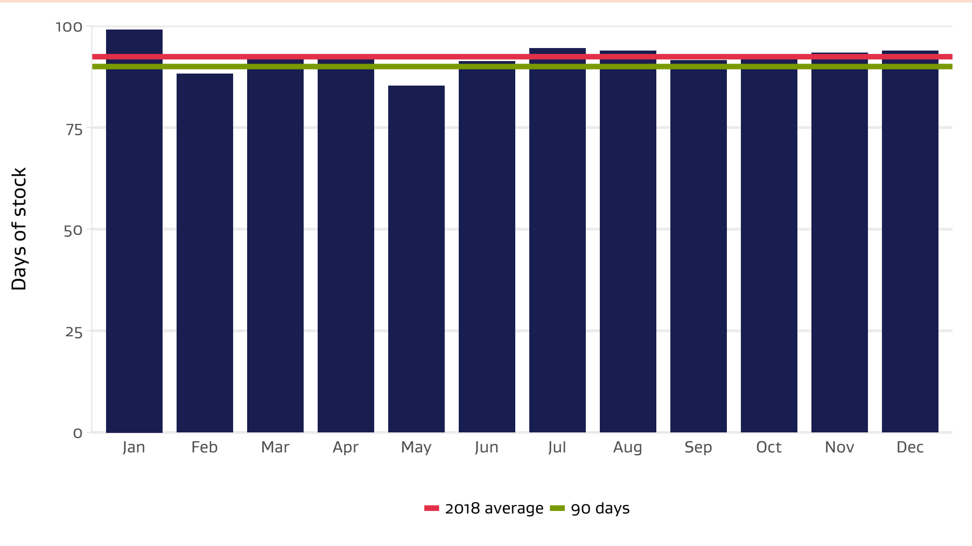
The International Energy Agency (IEA) was established in 1974 with the primary purpose of ensuring energy security around the world. It was formed in response to the oil crisis of 1973, where global oil prices increased significantly.

To enable a secure energy supply, member countries are required to maintain oil stocks that are equivalent to at least 90 days of net oil imports. This can be achieved through a combination of physical oil stocks present within a country's borders, and also stock tickets purchased from other member countries.

Stock tickets are essentially contracts with other countries to hold a certain amount of oil in reserve for New Zealand should we have a need to rapidly increase our stock levels. Stock ticket purchases are funded through fuel levies. As stock ticket prices have increased, the levies have also increased to ensure there are sufficient funds available to maintain New Zealand's stock holding.

In 2018, New Zealand held on average 92.4 days of oil stocks. Monthly stock holdings can fluctuate around 90 days, depending on the timing of vessels arriving in New Zealand waters.

Figure 1. New Zealand's monthly holdings in 2018



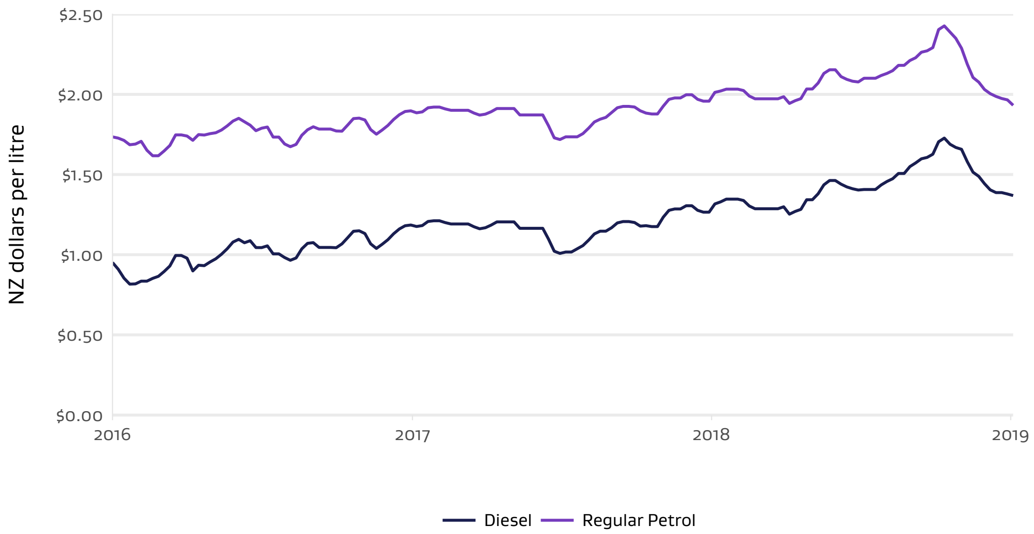
Crude oil prices and exchange rates drive high retail prices

New Zealand retail prices for petrol and diesel rose over the 2018 year and peaked in October. MBIE carries out weekly monitoring of retail price components of regular petrol and automotive diesel[28]. MBIE's modelled retail price for petrol reached over $2.40 per litre in October, the highest nominal value since monitoring started in 2004.

After peaking in October, prices for both international crude and local retail fell sharply with the retail price for petrol ending the year at $1.97 per litre, a level similar to the beginning of the year.

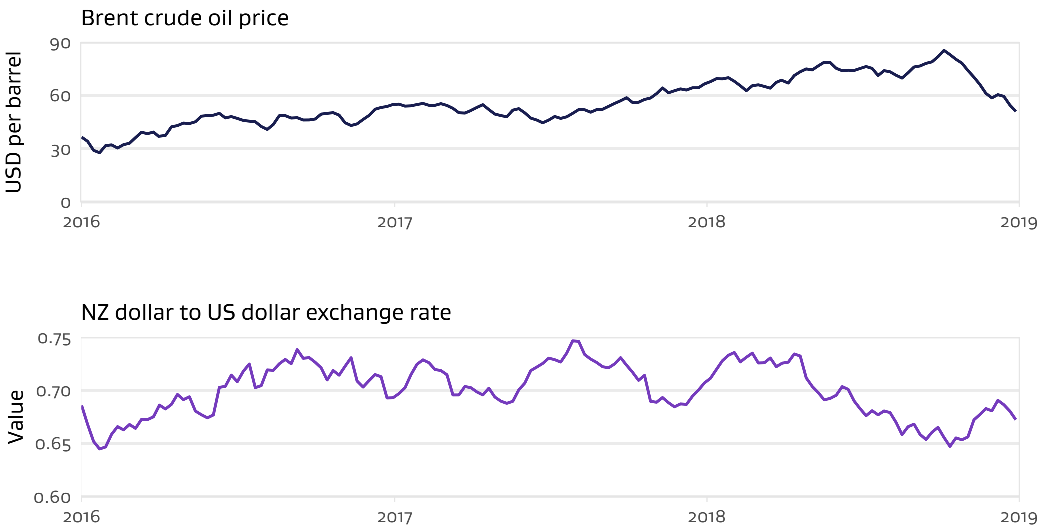
28 www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/weekly-fuel-price-monitoring/

Figure E.17. MBIE discounted retail prices of petrol and diesel



The spike in New Zealand retail prices reflected the increasing price of crude oil internationally, which also peaked in October. The impact on retail prices of the increasing international price of crude was strengthened by a falling exchange rate for the New Zealand Dollar.

Figure E.18 Brent crude oil prices and exchange rate



Box E.3 Market study into retail fuel commenced

In December 2018, the Government announced that the Commerce Commission would commence a market study looking into factors that may affect competition in retail fuel markets.

Matters to be considered in the study could include (but were not restricted to):

› the structure of the industry;

› the extent of competition at the refinery, wholesale and retail levels, including the role of imports;

› any factors that may hinder competition between industry participants;

› the conditions for entry by potential competitors, including independent suppliers, and/or the conditions for expansion;

› whether wholesale and retail price and service offerings of petrol and diesel are consistent with those expected in workably competitive markets; and

› features of retail petrol and diesel markets that are not in the long-term interests of consumers.[29]

The Commerce Commission released draft findings from the study on 20 August 2019. The final report is to be publicly available by 5 December 2019. For more information, visit **https://comcom.govt.nz/about-us/our-role/competition-studies/market-study-into-retail-fuel**.

29 https://gazette.govt.nz/notice/id/2018-go6158

Oil and Gas

GAS

Figure E.19. Gas flows in 2018

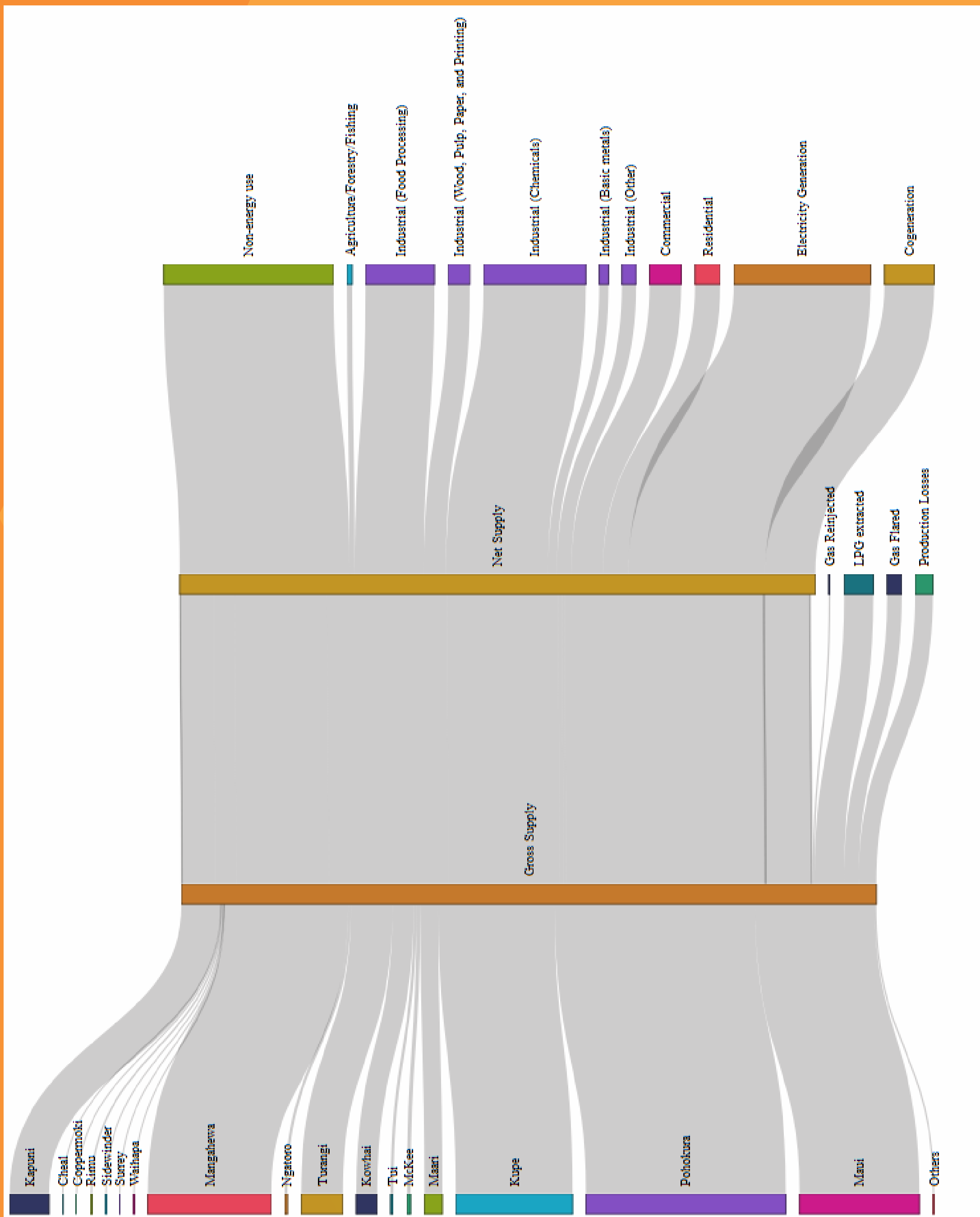
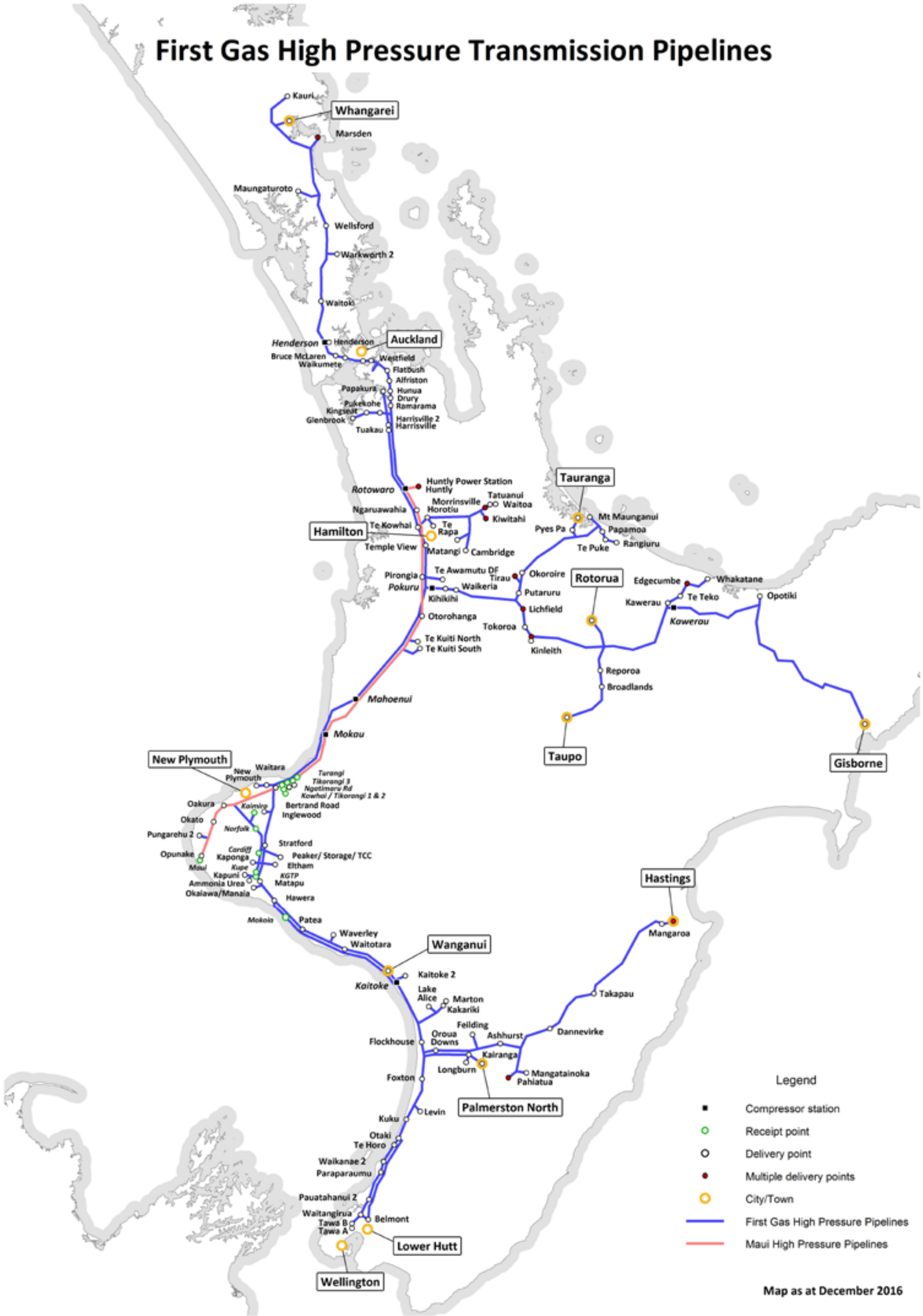


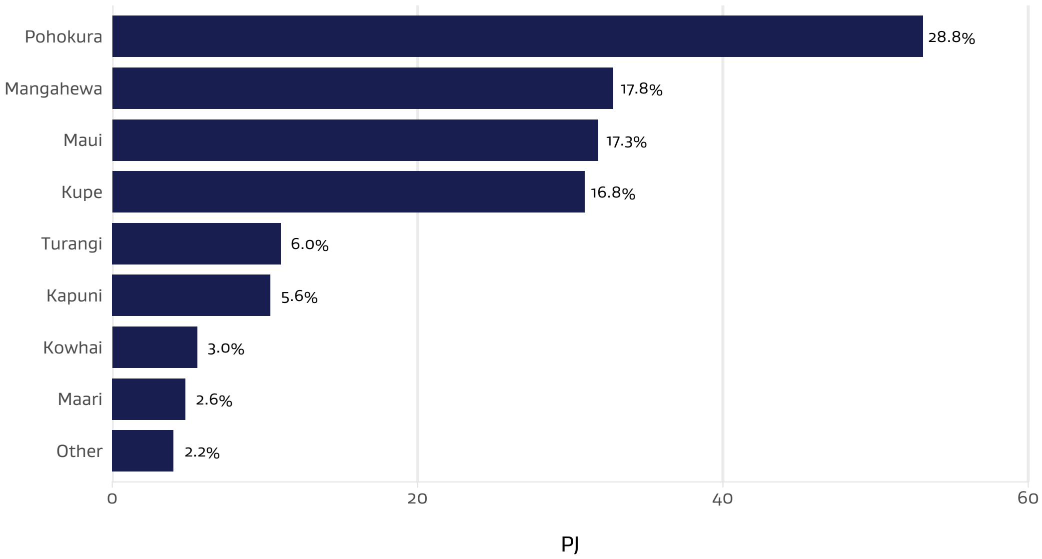
Figure E.20 New Zealand gas transmission pipelines



Pohokura outages drove an 11 per cent fall in total gas supply

Outages during the year saw output from the Pohokura field down 34 per cent (or 26.8 PJ) from 2017 levels. While some fields such as Kowhai and Kapuni increased production in 2018, reductions at Maui in addition to those at Pohokura meant that total gas supply fell 11 per cent.

Figure E.21. Gross gas production by field in 2018



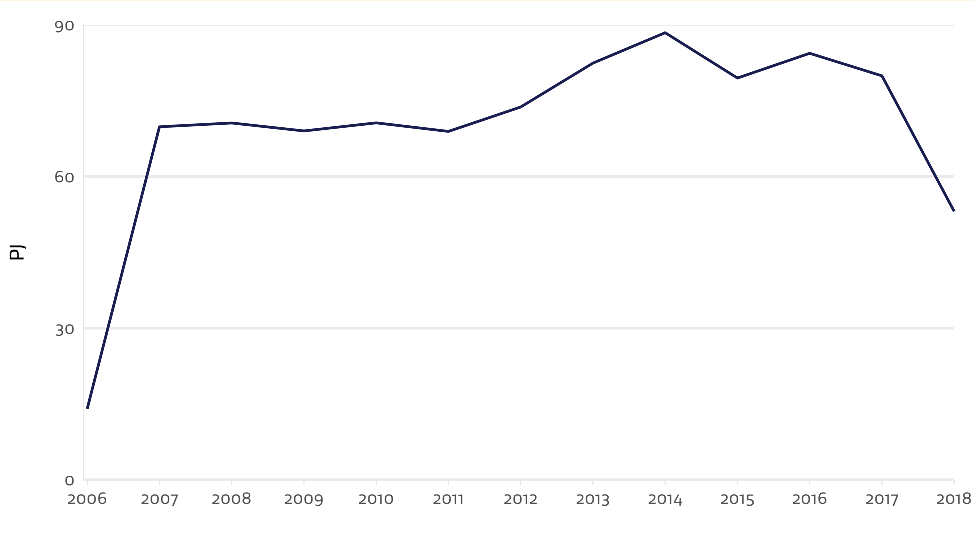
Box E.4

Pohokura outage and impact on energy markets

In March 2018 a regular inspection of a piece of offshore pipeline from the Pohokura field found bubbling. This led to an immediate halt to production at the field. A second outage at the field, coupled with periods of low electricity generation from hydro, saw high wholesale electricity prices in 2018.

Between 2007 (the first full year of production) and 2017, annual production from Pohokura has averaged 76 PJ. The reduction in response to the outages saw output of the field falling 34 per cent from 2017 levels to 53 PJ.

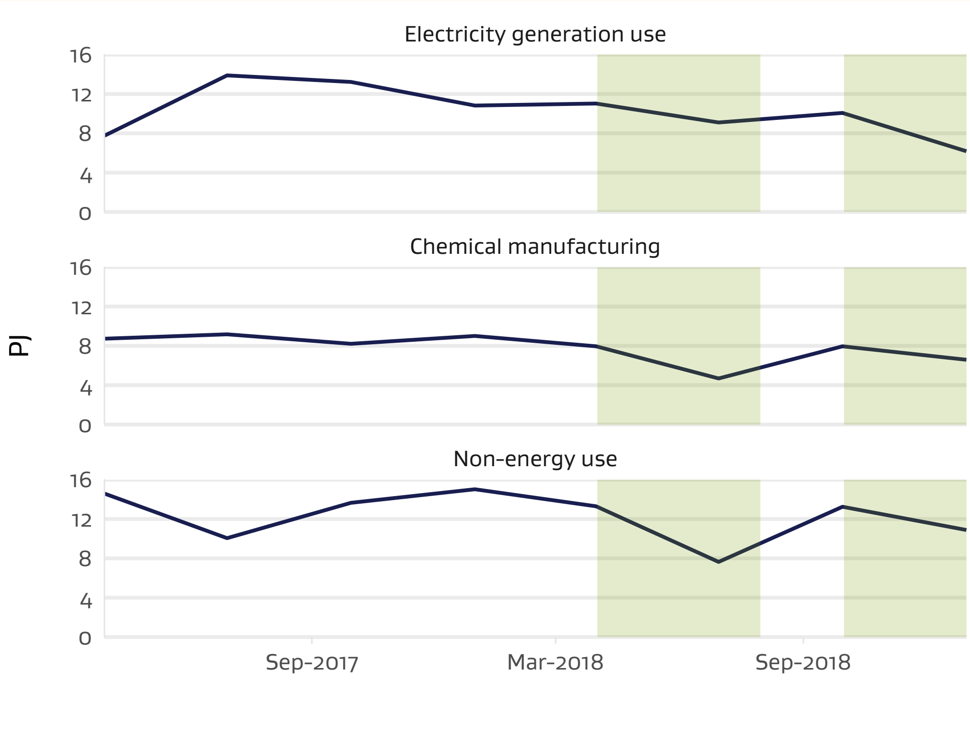
Figure 1 Pohokura annual gross production



Pohokura experienced two main outages during 2018. These were from March to July, and from September to December. During these periods the Pohokura field was still operational but at a reduced capacity. As Pohokura usually produces around 40 per cent of all gas used in New Zealand, this reduction in production had a large impact on sectors where gas is used – in particular electricity generation and chemical manufacturing.

Figure 2 shows how use in these sectors responded to the reduction in available supply, with the shaded areas indicating times at which Pohokura was operating at reduced capacity. Non-energy use refers to use of gas where rather than being combusted, it is transformed into other products such as methanol and urea.

Figure 2 Gas use during Pohokura outage

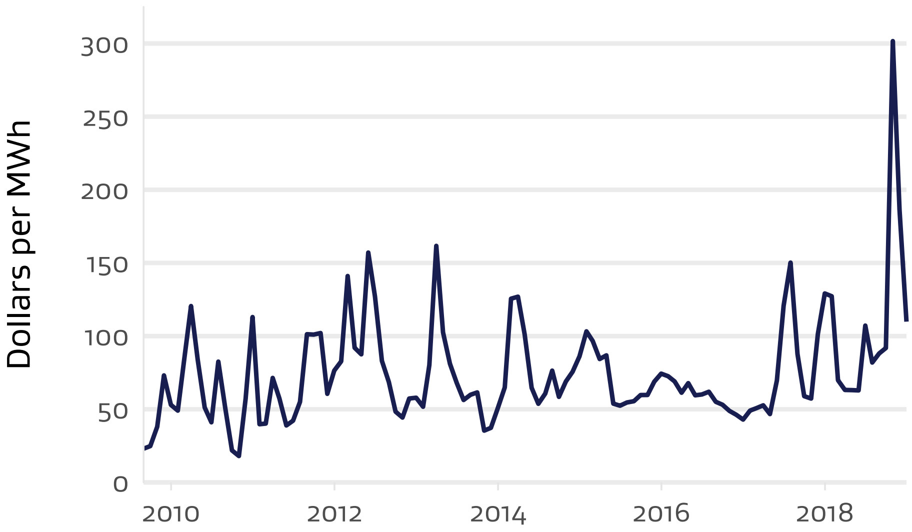


Both the top panel of Figure 2 and Figure 3 show the impact of the Pohokura outages on electricity prices during 2018. Gas use for electricity generation tends to increase in winter to meet electricity demand, which is higher at that time of year.

During the first outage, there was a slight increase in wholesale prices in June 2018. Prices did not rise significantly during this outage as there was a sufficient level of controlled storage in hydro reservoirs. In October 2018, during the second outage, wholesale prices increased to their highest level in 10 years. This was a result of the outage coinciding with reduced levels of controlled hydro storage[30].

30 For more information see the report on hydro risk curves and controlled storage on the Electricity Authority's Electricity Market Information (EMI) website at: www.emi.ea.govt.nz/Environment/Reports/3UN1KD?_si=v|3

Figure 3 Average wholesale electricity prices



Box E.5 **Zero Flaring Initiative**

In the normal process of oil production, natural gas is often also produced. Under good oil field practice, much of this natural gas is used or conserved to avoid wastage. Flaring is the process by which natural gas is burned off in a controlled manner when extracting oil. 'Routine flaring' refers to the flaring of natural gas during normal oil production operations in the absence of sufficient facilities or amenable geology to re-inject the produced gas, use it on site, or sell it to a market.

In 2018, New Zealand flared 100 million cubic metres of its total gas production of 4,591 million cubic metres.

Globally, gas flaring accounts for more than 350 million tonnes of carbon dioxide (CO_2) equivalent emissions. The World Bank estimates that 145 billion cubic metres of natural gas was flared in 2018[31].

In 2015, the United Nations Secretary-General and World Bank President launched a global initiative to end the practice of routinely flaring gas at oil production sites around the world. The "Zero Routine Flaring by 2030" Initiative (the ZRF Initiative) aims to eliminate existing "legacy'' routine flaring over time, and to help ensure that all new oil fields are developed with plans that include a gas utilisation solution without routine flaring or venting. New Zealand endorsed the Initiative in January 2019.

Gas consumption fell as Methanex responded to reduced gas supply

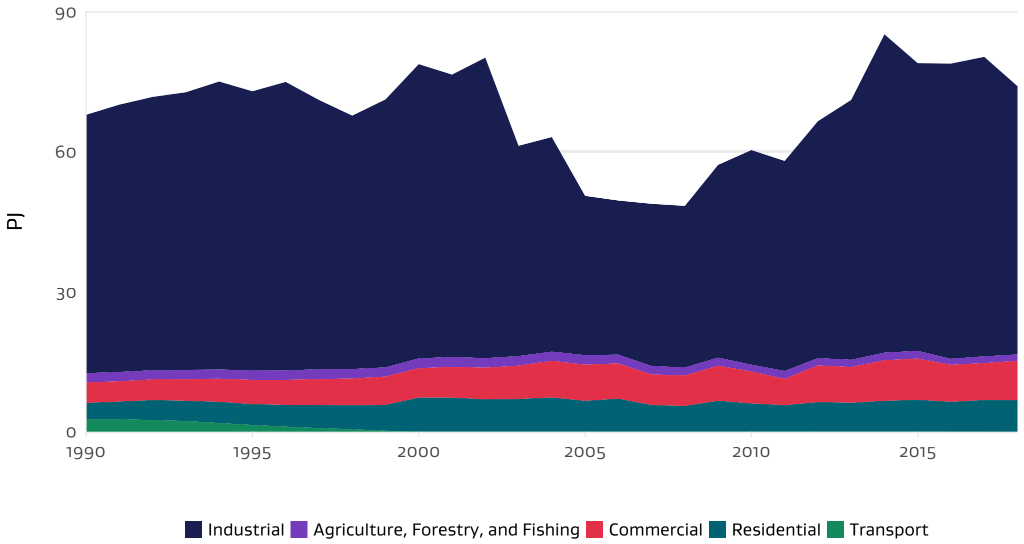
Methanex, one of the country's largest gas users, took the opportunity to undertake maintenance activities during the periods that Pohokura was operating at reduced output. This combination of maintenance work and a reduction in available gas supply saw Methanex's 2018 production of methanol in New Zealand fall 17 per cent[32].

Overall, consumption fell 8 per cent due to the reduction in Methanex's gas use. Apart from a slight increase in commercial sector demand, use by all other sectors was relatively unchanged from 2017.

31 www.worldbank.org/en/news/press-release/2019/06/12/increased-shale-oil-production-and-political-conflict-contribute-to-increase-in-global-gas-flaring

32 www.methanex.com/sites/default/files/investor/quarterly-reports/2018%20Q4%20---FS%20and%20Notes%20-%20FINAL.pdf

Figure E.22 Gas consumption by sector



Methanex announced in July 2018 that it had signed agreements with suppliers to secure some of its gas supply until 2029. These agreements will ensure that Methanex has enough gas to cover at least 50 per cent of its annual production.

F. COAL

OVERVIEW

Coal production experienced an increase which was driven by energy demand to cover lower gas supply, stable elevated international prices for coking coal, and efficiency gains from former Solid Energy mines after being transferred to new owners.

As a result of the reduced gas supply, coal imports increased significantly for electricity generation. Coal exports largely remained steady with a minor increase on the back of stable elevated international coking coal prices. Coal consumption remained steady throughout.

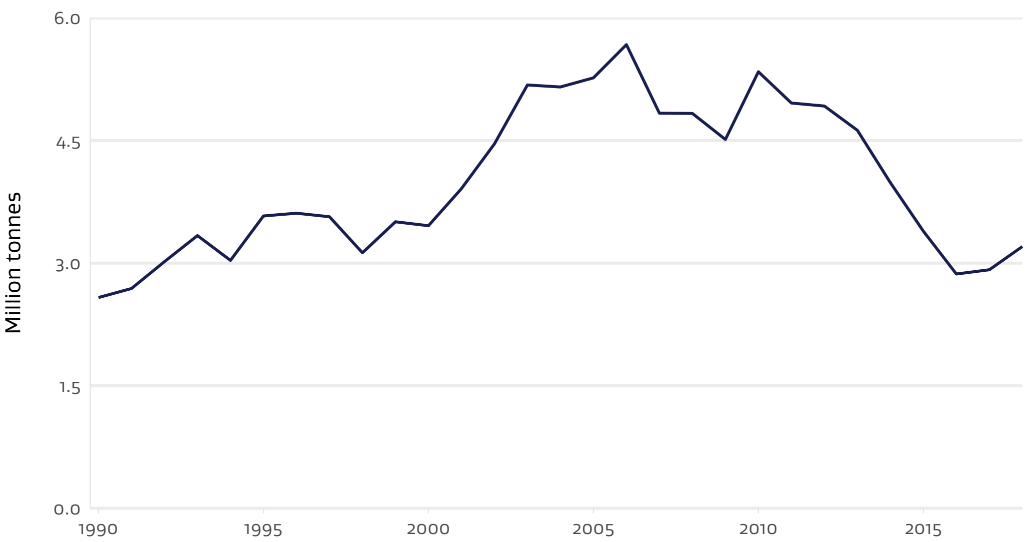
There were 18 operating mines at the end of 2018 after the closure of three operating mines and the resumption of two mines.

In 2017, New Zealand signed up to the Powering Past Coal Alliance which aims to accelerate clean growth and climate protection through the rapid phase-out of unabated coal power in a sustainable and inclusive way. This involves a moratorium on any new coal fired power stations without operational carbon capture storage.

Coal Production

Coal production increased by 10.0 per cent on 2018 reaching 3.2 million tonnes, the second consecutive increase since its lowest production level in 2016

Figure F.1 New Zealand Coal Production



Coal production in New Zealand for the year of 2018 was 3.2 million tonnes (83.4 PJ), an increase of 10.0 per cent from 2017. This was due to an increase in domestic demand for energy amid the gas shortage, and stable elevated international prices for coking coal.

Other aspects of New Zealand's coal production in 2018 include:

› Sub-bituminous coal production from both islands increased in 2018 by 14.2 per cent. Production from North Island mines was up 22.3 per cent on 2017 figures, driven by increased demand for coal from Genesis' Huntly power plant. Sub-bituminous coal production from South Island also increased slightly by 1.9 per cent, likely due to increased industrial (dairy processing) demand;

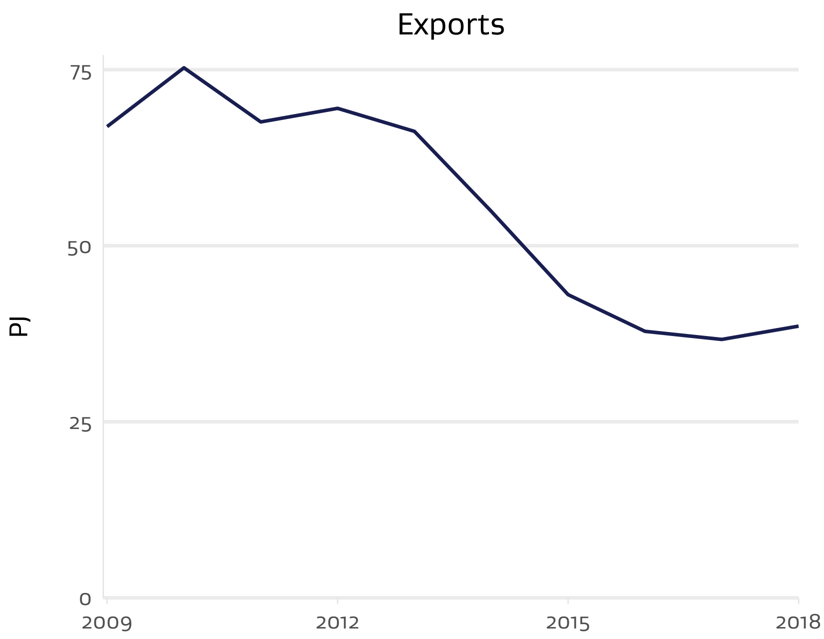
› Bituminous coal production increased 11.7 per cent due to stable elevated international prices for coking coal in 2018, and efficiency gains in production. It has now been approximately a year since Solid Energy transferred its operating mines to new owners. The new owners have had an opportunity to assess the operations and implemented changes which have likely resulted in productivity increases; and

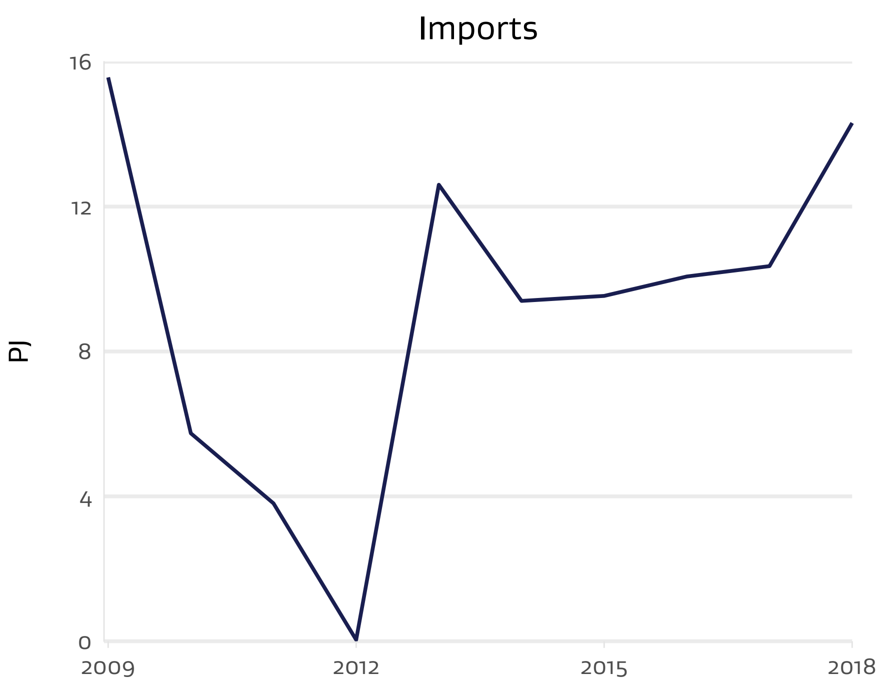
› Lignite production was relatively unchanged, down 4 per cent on last year.

Trade

Both coal exports and imports increased in 2018 due to possible efficiency gains in production with stable prices, and increased energy demand respectively

Figure F.2 Coal exports and imports





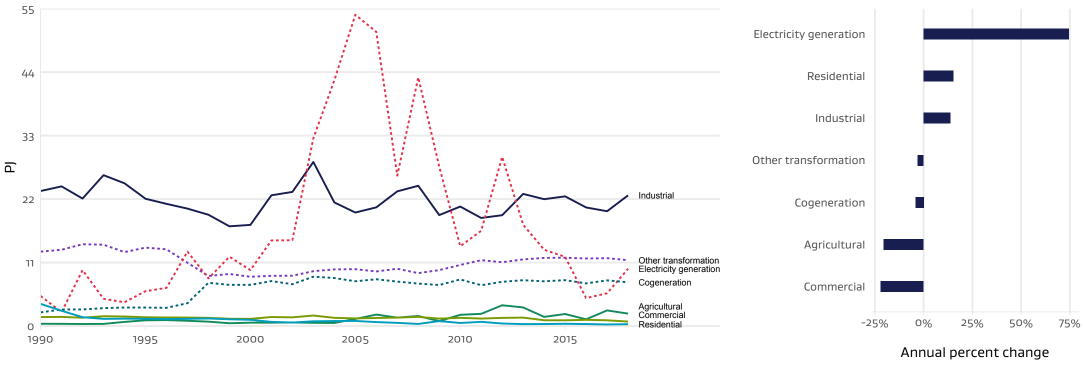
Coal exports increased by 5 per cent to 39 PJ in 2018, reversing a seven year downward trend. This was due to stable elevated international coking coal prices throughout the year. It has now been approximately a year since Solid Energy transferred its operating mines to new owners. The new owners have had an opportunity to assess the operations and make changes which have likely resulted in productivity increases.

Coal imports increased by 29 per cent to 13 PJ. This was due to the increased demand for electricity generation to make up the gas shortage.

Coal Use

Coal use for electricity generation increased significantly in 2018 to cover the gas shortage. Other coal use remained relatively stable

Figure F.3 Coal use and annual percentage changes



Coal use can be divided between consumption (which is further divided into Industrial, Agricultural, Commercial, and Residential consumption) and transformation (which is divided into Electricity Generation and Other Transformation).

The total primary energy supply of coal (calculated as production and imports less losses and exports) for 2018 was 53 PJ, an increase of 3.9 per cent on the previous year. Coal accounted for approximately 4.0 per cent of New Zealand's total consumer energy supply.

■ Consumption

Coal consumption was relatively steady, with downturns in commercial and agricultural use offset by an increase in industrial and residential use.

Coal use within New Zealand is currently dominated by industrial sector consumption which includes dairy and meat processing, food product manufacturing, wood and pulp processing, metal and mineral processing, and chemical manufacture.

Almost half of all coal consumed in New Zealand is used in industrial sector activities. Agricultural, Commercial, and Residential consumption make up approximately 10 per cent of coal use in aggregate.

Coal consumption in the Industrial sector increased by 7.8 per cent on 2017 levels driven by demand from the dairy sector. Total consumption for 2018 was 24 PJ, an increase of 2.5 per cent on the previous year.

■ Transformation

Coal use for electricity generation rose 75 per cent due to the gas shortage.

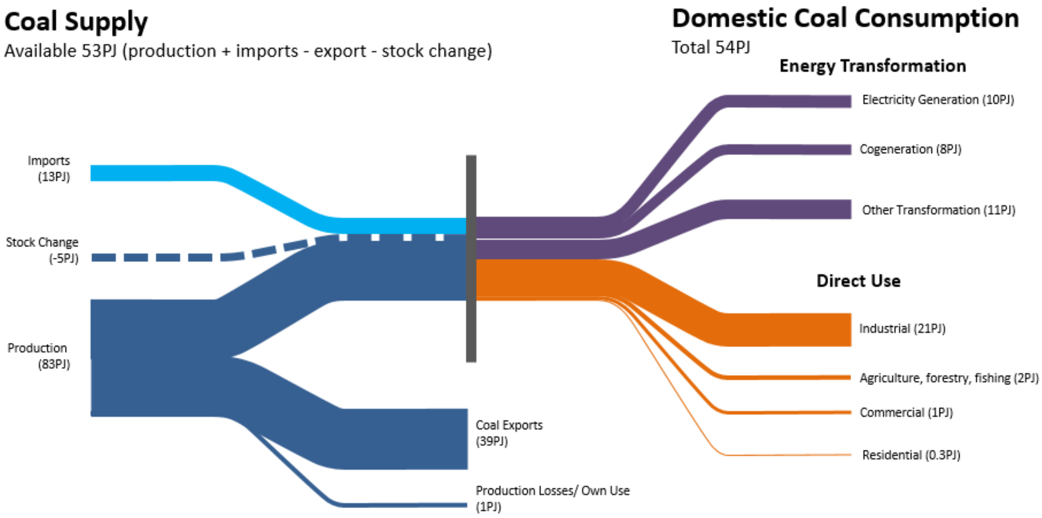
Changes in coal use in the North Island are heavily influenced by Genesis' Huntly power plant. This power plant is the only coal-fired power plant in New Zealand, and is important for New Zealand's security of electricity supply requirements in dry years and amid gas shortages to meet winter energy and peak demand requirements.

Coal use for other transformation processes (e.g. iron and steel use) remained steady on 2017 figures.

Coal sector overview

Background information on New Zealand's coal industry can be found on the New Zealand Petroleum and Minerals website: **www.nzpam.govt.nz/our-industry/nz-minerals/minerals-data/coal/**.

Figure F.4 Coal overview for 2018



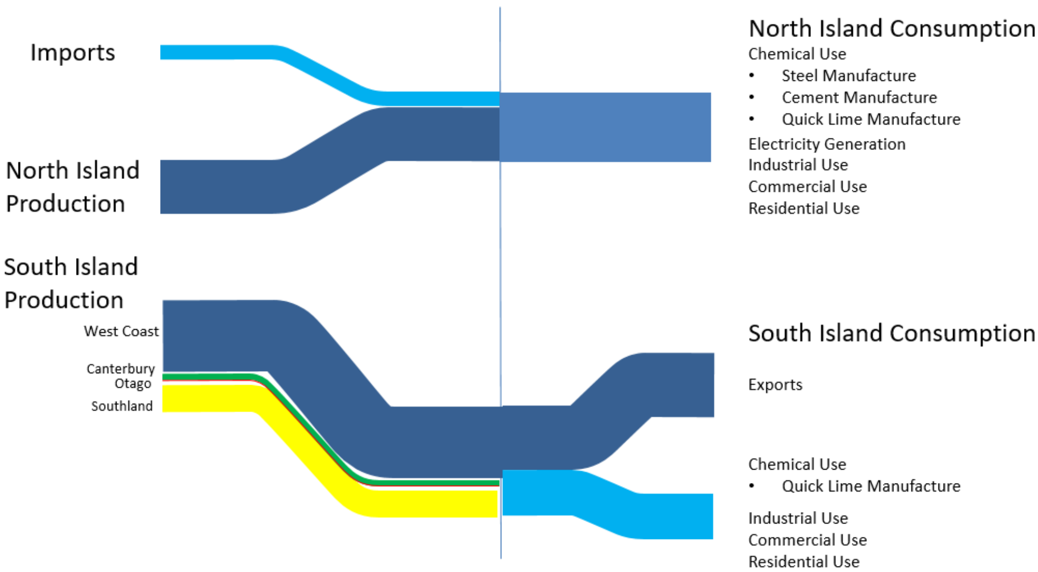


Table F.1 Coal supply, transformation and consumption (Petajoules)

Measure	Coal Use	31/12/2017	31/12/2018	Dec-on-Dec	% Change
Supply	Production	72.88	83.37	10.49	14.4%
	Imports	10.36	13.32	2.96	28.6%
	Exports	-36.69	-38.52	-1.83	5.0%
	Stock Change	-4.86	4.73	9.59	-197.1%
	Production Losses and Own Use	3.07	0.8	-2.27	-73.9%
Transformation	Electricity Generation	5.68	9.92	4.24	74.6%
	Cogeneration	7.91	7.56	-0.35	-4.5%
	Other Transformation	1176	11.41	-0.35	-3.0%
Consumption (Observed)	Agriculture, Forestry and Fishing	2.71	1.98	-0.72	-26.8%
	Commercial	0.99	0.75	-0.25	-24.9%
	Industrial	19.90	21.45	1.55	7.8%
	Residential	0.27	0.29	0.02	7.3%

Coal sector background

New Zealand has extensive coal resources mainly in the Waikato and Taranaki regions of the North Island, the West Coast, Otago, and Southland regions of the South Island.

New Zealand's coal market can be divided into three distinct geological areas:

› **North Island:** In the North Island coal production is centred on the Waikato region where large coalfields like Awaroa and Rotowaro produce **sub-bituminous coal**. This coal is an excellent candidate for heating and energy generation, although it is generally not high enough quality to be used in metallurgical applications (that is, the production of iron and steel).

  The main consumers of this "thermal coal" in New Zealand are Genesis' Huntly coal power plant and the Glenbrook steel mill south-east of Auckland. Unlike the vast majority of steel mills, the Glenbrook mill can use thermal-grade coal in the production of iron and steel due to the unique processes employed at the facility.

› **West Coast:** The majority of the coal extracted on the West Coast of the South Island is generally classified as **bituminous**, with higher energy content than the sub-bituminous coal mined in the North Island. The majority of this bituminous coal is exported for metallurgical applications. Sub-bituminous coal from the West Coast is used locally or within the northern half of the South Island; and

› **Rest of the South Island:** The rest of the South Island tends to produce either sub-bituminous coal or the even lower-energy lignite. This low-energy coal is generally sold to dairy and meat processing plants throughout the South Island and to households and companies for heating.

It has been estimated that national in-ground resources of all coal are over 15 billion tonnes although 80 per cent of this is lignite in the South Island. Sub-bituminous and bituminous in-ground resources are around 4 billion tonnes but economic reserves are much smaller.

The majority of coal used in New Zealand is consumed for **energy use**: the coal is burned to provide heat whether that heat is used to dry milk powder, power a steam engine, run a boiler, or heat a house.

There are also two major **non-energy uses** for coal in New Zealand:

- At the Huntly power plant the energy in the combusted coal is used to drive turbines which generate electricity. As the energy contained within the coal is not used directly at Huntly, but merely **transformed** into a different form, we do not consider this to be “energy use”; and
- At the Glenbrook steel mill coal is used as a **reducing agent** converting magnetite in ironsand to metallic iron. While it may provide energy, its primary purpose is as a reagent in a chemical reaction. As such, this is also not considered to be “energy use”.

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