MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

MARKETS – EVIDENCE AND INSIGHTS BRANCH

ENERGY IN NEW ZEALAND

20

2019 CALENDAR YEAR EDITION

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

New Zealand Government

Energy in New Zealand 2020 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 2020 edition includes information up to the end of the calendar year 2019.

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

www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-publications-and-technical-papers/energy-in-new-zealand/

Prepared by:

Markets

Evidence and Insights

Ministry of Business, Innovation & Employment

PO Box 1473, Wellington 6140

New Zealand

Email: energyinfo@mbie.govt.nz

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Authorship

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Availability

A free electronic version of this publication can be downloaded from: www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/

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*All statistics are year-ending annual measures. "Dec-on-Dec" refers to absolute changes between annual values.

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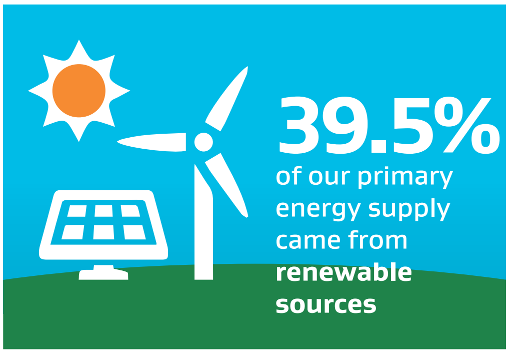
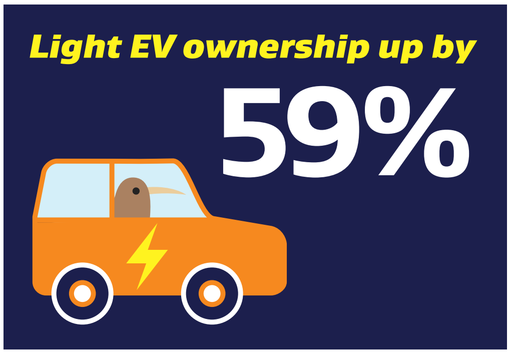
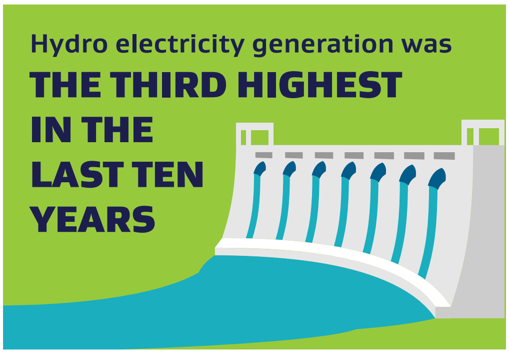
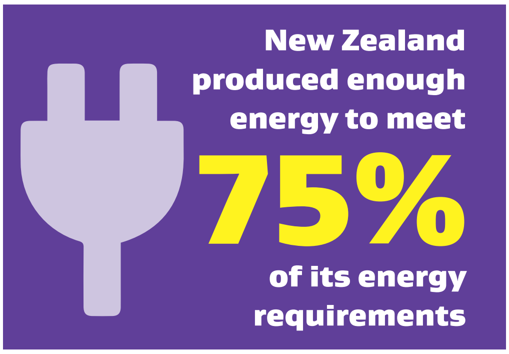
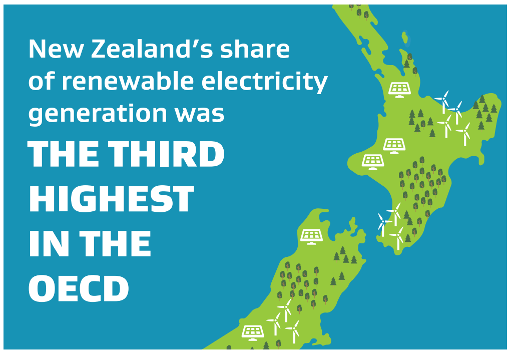
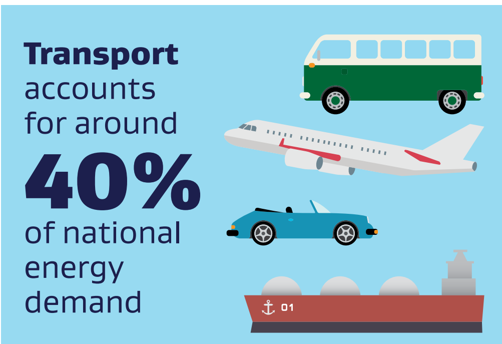












A. ENERGY OVERVIEW

The 2019 calendar year was between two major events that had significant impact on the energy sector – the Pohokura gas field outages in 2018, and the coronavirus (COVID-19) pandemic in 2020. Despite being sandwiched between two significant years, 2019 was filled with noteworthy movements towards a sustainable energy sector.

The Climate Change Response (Zero Carbon) Amendment Act came into force, and established an independent Climate Change Commission.

The share of renewable energy sources came off last year's peak, but is still the second highest in the series. Renewable electricity generation decreased while the total energy supply increased in 2019.

International energy prices play a key role in New Zealand's energy system. Fluctuations in commodity prices and international geopolitics led to a rise in crude oil prices and domestic transport fuel prices.

As at the time of writing, disruptions to demand due to COVID-19 have significantly impacted parts of the energy sector. However, the sector has been resilient. This publication will largely cover the 2019 calendar year. For more information on the impact of COVID-19 on the energy sector please refer to the Energy Factsheet published on the Ministry's website.

Renewable shares down due to poor hydro conditions

Most of the country had a dry year in 2019, with a central Pacific El Niño event lasting from January to July. This led to low inflows and a three per cent drop in hydro generation from 2018. However, 2019 reached the third highest hydro generation record in the last ten years.

Wind power was used to make up for the low hydro generation, however it was not enough to offset the drop in hydro. At times of low renewables sourced generation, non-renewable sources are used to meet the shortfall between supply and demand. As gas and coal are normally used to meet this shortfall, electricity generation from gas increase 2.6 per cent, while electricity generation from coal increased by 43 per cent.

The combination of low hydro generation and high coal-fired generation led to a lower share of renewables in total electricity generation. The renewables decreased from 84 per cent in 2018 to 82.4 per cent in 2019. The share of renewables in total primary energy[1] was 39.5 per cent in 2019.

While wholesale electricity prices decreased from a high in 2018, the combination of low renewable generation and some additional gas production outages saw prices remain high compared to 2017.

Volatile international commodity prices flowed through to New Zealand markets

Geopolitical tensions were high in 2019, with events such as the drone attacks on oil facilities in Saudi Arabia. This led to volatile international crude oil prices. Increased crude oil prices flowed through to New Zealand markets, with retail petrol ending the year 10 per cent higher and diesel 4 per cent higher than at the same time a year earlier. However, prices in 2019 were still lower compared to the peak reached in October 2018.

Global prices for South African and Australian thermal coal fell by 27 per cent from 2018, and hard coking coal prices followed a downward trend too. However, strong demand from the Asia Pacific region led to an increase in coal exports.

A green future for transportation

The transportation sector currently accounts for 39 per cent of all energy demand, and 20 per cent of all greenhouse gas emissions. 2019 saw several announcements regarding using renewable energy for transportation. The interim Climate Change Commission released the *Accelerated Electrification*[2] report which recommends that the government prioritises the electrification of transport and process heat[3] over decarbonising the electricity generation sector.[4]

There were significant advances in the hydrogen powered transportation sector. The first hydrogen powered SUV was launched in New Zealand, and two companies announced their intention to jointly develop New Zealand's first nationwide hydrogen refuelling station network. Electric vehicle uptake is still growing strongly, with over 7,000 new registrations in 2019.

Gas supply and consumption mostly back to normal

In 2018, bubbling was found during a regular inspection of offshore pipelines from the Pohokura gas field. This led to an immediate halt to production at the field while maintenance was carried out. After a year of outages, 2019 saw gas production return to near normal levels as Pohokura returned to operation. Pohokura, one of the country's largest oil and gas fields, increased production by 28 per cent from the year before. However production did not return all the way to 2017 levels. Gas consumption on the other hand, increased by 14 per cent following Pohokura reopening.

Methanex, one of the country's largest gas users, increased their production by 16 per cent in 2019 after a year of gas supply constraints and maintenance at their sites.[5] Despite shutting down one of their plants for maintenance in 2019, Methanex drove a six per cent increase in national industrial sector demand.

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

2 Source: Interim Climate Change Committee (2019), Accelerated Electrification

3 Process heat is heat energy used for industrial processes, manufacturing and space heating, often in the form of steam, hot water or hot gases.

4 For more information, see pop-out box C.2 for modelling done on accelerated electrification.

5 www.methanex.com/sites/default/files/investor/annual-reports/2019%20Methanex%20Annual%20Report.pdf

National average energy intensity continues to improve

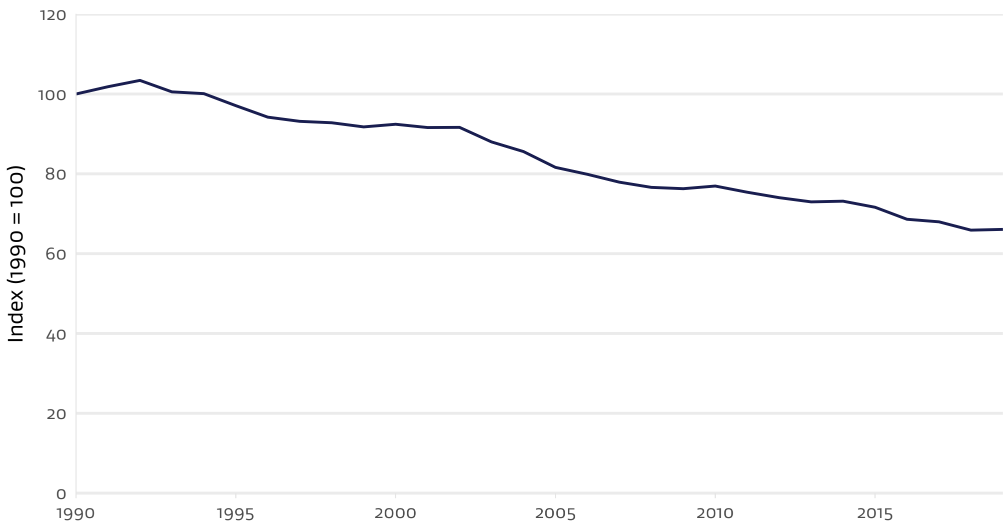
Energy intensity provides an indication of the relationship between energy use and economic growth. It is calculated as energy use divided by gross domestic product (GDP), and tells us the amount of energy required to produce each dollar of GDP. A fall in the indicator, where less energy is required 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 in the OECD, and 18 per cent higher than the OECD average.

Figure A.1 Energy intensity

Figure: National average energy intensity expressed as an index (based to 1990)



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, and is calculated as domestic production divided by total primary energy supply. A self-sufficiency value of 100 per cent indicates that a country produces all the energy it needs, whereas values above or below 100 per cent indicates it is a net exporter or importer of energy, respectively.

New Zealand meets all of its energy needs for 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.

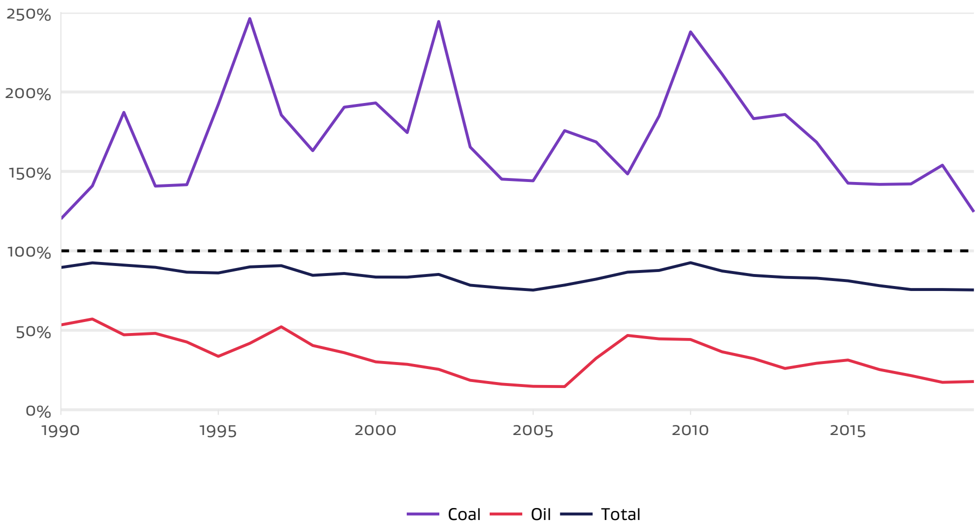
› While crude oil is produced in New Zealand, nearly all of this is exported as it is not suited to current refining capabilities and can achieve a higher price on international markets. This means all domestic use of oil needs to be met by imports.

› 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.

Overall, New Zealand's energy self-sufficiency in 2019 was unchanged at 75 per cent as changes in the self-sufficiency for oil and coal offset each other. Oil self-sufficiency fell due to a continued reduction in domestic production, and an increase in imports. Lower domestic production driven by ongoing natural field decline meant that there was less oil available to be exported. The country's only oil refinery at Marsden Point underwent a maintenance shutdown in 2018 for an extended period. As 2019 saw the refinery back to full production, refinery output was up 1.67 million barrels on 2018 levels. With increased activity at the refinery, imports of refined oil products decreased. This contributed to a 3 per cent decrease in diesel imports, and an 11 per cent decrease in petrol imports. In 2018, the latest year for which data is available, New Zealand's energy self-sufficiency was the ninth highest in the OECD, and six per cent lower than the OECD average.

Coal self-sufficiency decreased in 2019 in response to favourable export conditions and to meet higher domestic demand.

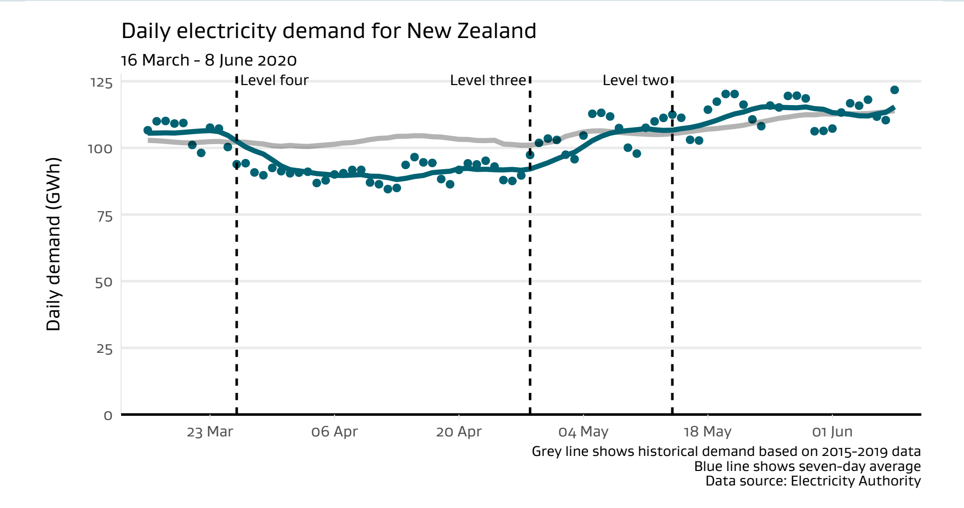
Figure A.2 New Zealand's Self-sufficiency



Box A.1 COVID-19 Impact

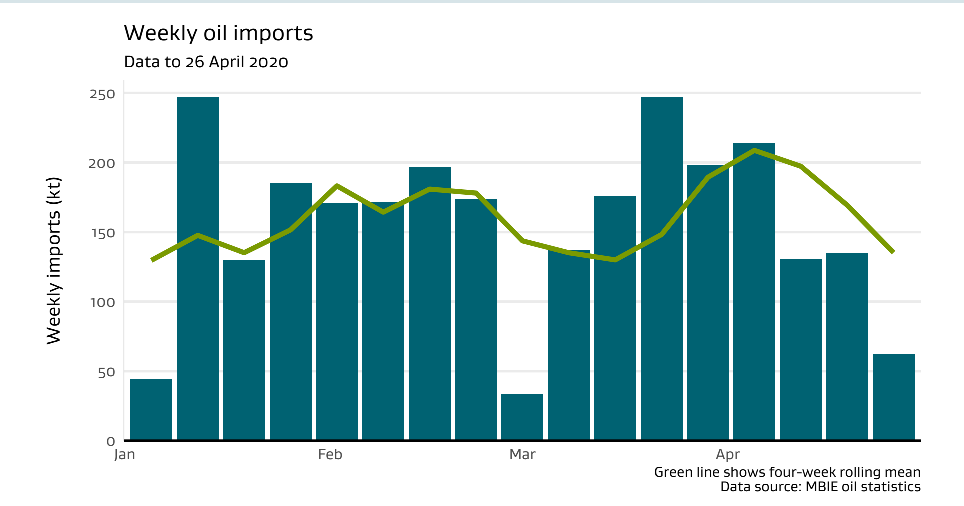
In February 2020, COVID-19 arrived on our shores. While this publication only covers the 2019 calendar year, COVID-19 has heavily impacted the energy sector. As part of MBIE's COVID response, a bi-weekly publication was launched. The Energy factsheet[6] uses a range of real time data to present a current state picture on electricity demand, oil stocks, retail fuel and gas use and production.

Box A.1 Figure 1 COVID electricity demand



New Zealand's electricity demand was at 89 per cent of historical levels (an average of demand on each day across 2015-2019) when the country entered alert level four. At the time of writing this publication, electricity demand has recovered to pre-lockdown levels.

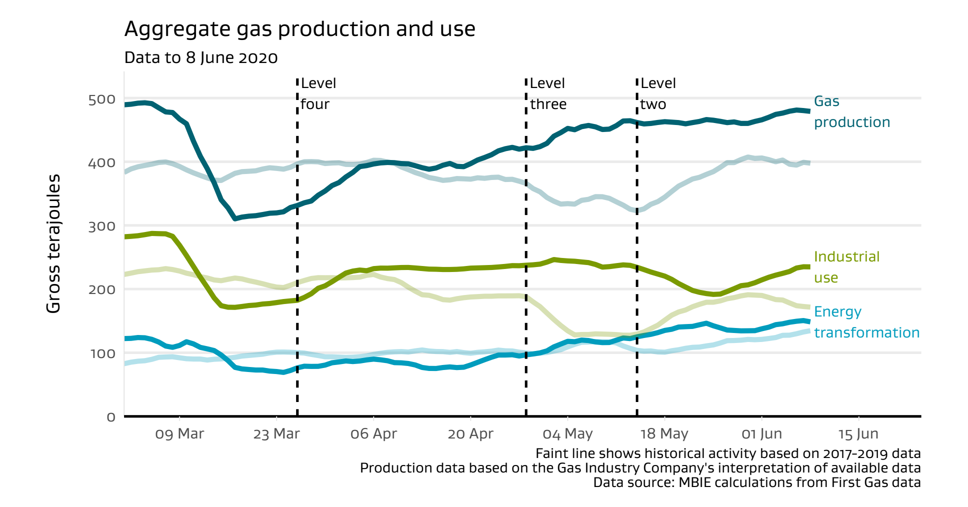
Box A.1 Figure 2 Oil imports



6 Available at www.mbie.govt.nz/business-and-employment/economic-development/sector-reports-series/#energy

While New Zealand continued to maintain oil stocks to ensure that the country has at least ninety days of net oil imports available, there was a decline in oil imports in April 2020. This was due to reduced demand for oil products during alert levels three and four.

Box A.1 Figure 3 Aggregate gas



Similar to the movements in oil and electricity demand, gas production and use both dropped as the country moved into alert level four. It should be noted that the historical average (an average of demand on each day across 2015-2019) includes 2018, which saw reductions in production and use for both planned and unplanned reasons. For more information, please visit MBIE's website.

B. Energy balances

New Zealand’s energy production derives from both renewable and non-renewable sources.

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.

Table B.1: Default Electrical Transformation Factors

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%

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 – New Zealand Synthetic Fuels Corporation Limited 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 data from major generators and the Electricity Authority. Estimates are made where actual data are unavailable at the time of publishing.

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.

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 annual capacity factor of 14 per cent (i.e. the solar panels produce their full output 14 per cent of the time). The capacity factor is then scaled using solar-hour data from NIWA to introduce seasonal variation. 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 the sum of energy transformation and 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.

Figure B.2 Energy balance table

Converted into Petajoules using Gross Calorific Values	Coal					Oil					
	Bituminous	Sub-bitum.	Bituminous & Sub-bitum.	Lignite	**Total**	Crudes/ Feedstocks/ NGL	LPG	Petrol	Diesel	Fuel Oil	Av. Fuel/ Kero
SUPPLY											
Indigenous Production	39.19	35.61	74.80	5.19	**79.99**	50.93	8.07				
+ Imports	3.40	23.55	26.95	0.00	**26.95**	236.17	1.08	42.13	57.55	0.98	9.30
- Exports	43.71	0.24	43.95	-	**43.95**	51.12	-	-	1.28	8.47	-
- Stock Change	-	-	(1.28)	0.03	**(1.25)**	(11.22)	0.01	1.96	2.26	0.49	(0.02)
- International Transport								-	1.90	11.94	56.41
TOTAL PRIMARY ENERGY	**(1.12)**	**58.92**	**59.08**	**5.17**	**64.24**	**247.20**	**9.14**	**40.17**	**52.10**	**(19.92)**	**(47.08)**
ENERGY TRANSFORMATION	**(0.04)**	**(35.46)**	**(35.49)**	**(0.26)**	**(35.76)**	**(249.48)**	**(0.00)**	**69.85**	**88.18**	**26.70**	**61.58**
Electricity Generation	-	(16.36)	(16.36)	-	**(16.36)**				(0.04)	-	
Cogeneration	-	(8.15)	(8.15)	(0.26)	**(8.41)**						
Fuel Production						(249.48)		66.99	87.66	25.87	61.56
Other Transformation	-	(10.26)	(10.26)	-	**(10.26)**						
Losses and Own Use	(0.04)	(0.68)	(0.72)	-	**(0.72)**	-	(0.00)	2.86	0.56	0.83	0.02
Non-energy Use											
CONSUMER ENERGY (calculated)	**(1.16)**	**23.46**	**23.58**	**4.90**	**28.49**	**(2.28)**	**9.14**	**110.02**	**140.28**	**6.78**	**14.50**
DEMAND											
Agriculture, Forestry and Fishing	**0.05**	**2.15**	**2.19**	**0.01**	**2.21**		**0.11**	**1.02**	**14.36**	**1.02**	**-**
Agriculture	0.05	2.15	2.19	0.01	2.21		0.11	1.01	10.93	0.04	-
Forestry and Logging	-	-	-	-	-			0.00	1.68	0.07	-
Fishing	-	-	-	-	-			0.01	1.75	0.91	-
Industrial	**3.96**	**15.15**	**19.11**	**4.72**	**23.83**		**3.68**	**0.07**	**17.25**	**1.08**	**-**
Mining	-	-	-	-	-			0.00	4.49	0.07	-
Food Processing	0.34	13.72	14.06	4.64	18.70			-	0.00	-	-
Textiles	0.16	0.06	0.22	-	0.22						
Wood, Pulp, Paper and Printing	0.05	0.46	0.51	0.00	0.51						
Chemicals	-	0.02	0.02	-	0.02						
Non-metallic Minerals	3.40	0.80	4.20	0.08	4.28						
Basic Metals	-	-	-	-	-			-	0.00	-	-
Mechanical/Electrical Equipment	-	-	-	-	-						
Building and Construction	-	-	-	-	-			0.01	7.38	-	-
Unallocated	0.01	0.10	0.10	-	0.10		3.68	0.07	5.37	1.01	-
Commercial	**0.10**	**0.55**	**0.65**	**0.23**	**0.88**		**1.75**	**0.74**	**5.72**	**0.47**	**-**
Transport	**-**	**-**	**-**	**-**	**-**		**0.14**	**111.33**	**104.19**	**4.50**	**12.45**
Residential	**0.00**	**0.23**	**0.23**	**0.03**	**0.27**		**3.73**	**0.00**	**0.13**	**-**	**-**
CONSUMER ENERGY (observed)	**4.11**	**18.07**	**22.18**	**4.99**	**27.18**	**-**	**9.41**	**113.17**	**141.64**	**7.08**	**12.45**
Statistical Differences			**1.40**	**(0.09)**	**1.31**	**(2.28)**	**(0.27)**	**(3.15)**	**(1.37)**	**(0.30)**	**2.05**

		Natural Gas	Renewables								Electricity	Waste Heat	TOTAL
Others	Total	Total	Hydro	Geothermal	Solar	Wind	Liquid Biofuels	Biogas	Solid Biofuels	Total	Total	Total	
	59.00	**184.39**	92.07	195.80	0.82	8.12	0.18	3.63	55.45	**356.06**		**1.17**	**680.61**
13.69	**360.90**								0.10	**0.10**			387.95
-	**60.88**												104.83
(0.60)	**(7.13)**	**(0.70)**											(9.07)
-	**70.25**												70.25
14.29	**295.90**	**185.09**	**92.07**	**195.80**	**0.82**	**8.12**	**0.18**	**3.63**	**55.55**	**356.16**		**1.17**	**902.55**
5.67	**2.50**	**(56.92)**	**(92.07)**	**(187.76)**	**(0.45)**	**(8.12)**	**(0.18)**	**(3.30)**	**(4.23)**	**(296.11)**	**145.53**	**(1.17)**	**(241.91)**
	(0.04)	**(37.03)**	(92.07)	(186.33)	(0.45)	(8.12)		(2.48)		**(289.45)**	**152.84**		(190.04)
		(12.56)		(1.42)				(0.82)	(4.23)	**(6.48)**	**8.02**	**(1.17)**	(20.60)
7.62	**0.23**	**-**					(0.18)			**(0.18)**			0.05
													(10.26)
(1.95)	**2.31**	**(7.33)**									**(15.33)**		(21.06)
(18.73)	**(18.73)**	**(50.79)**											**(69.52)**
1.23	**279.67**	**77.38**		**8.04**	**0.36**	**-**	**-**	**0.33**	**51.31**	**60.05**	**145.53**	**-**	**591.12**
	16.52	**1.35**		**0.45**						**0.45**	**9.16**		**29.69**
	12.10	1.35		0.45						0.45	8.80		24.90
	1.76	0.00									0.22		1.98
	2.67	-									0.14		2.81
	22.08	**67.86**		**4.78**				**0.05**	**43.78**	**48.62**	**54.46**		**216.85**
	4.56	0.16									1.62		6.34
	0.00	21.74									10.11		50.54
		0.69									0.35		1.25
		4.68									9.28		14.47
		34.85									2.88		37.75
		2.13									0.99		7.40
	0.00	2.77									23.68		26.45
		0.25									0.50		0.75
	7.39	0.49									1.37		9.25
	10.13	0.11		4.78				0.05	43.78	48.62	3.69		62.66
	8.69	**8.51**		**2.60**				**0.28**		**2.88**	**34.27**		**55.22**
	232.60	**-**						**-**		**-**	**0.39**		**232.99**
	3.86	**6.83**		**0.21**	**0.36**				**7.53**	**8.11**	**45.54**		**64.61**
-	**283.75**	**84.55**	**-**	**8.04**	**0.36**	**-**		**0.33**	**51.31**	**60.05**	**143.83**	**-**	**599.35**
1.23	**(4.08)**	**(7.17)**		**0.00**	**-**	**-**		**-**	**-**	**-**	**1.70**	**-**	**(8.24)**

C. Electricity

Electricity demand and generation increased slightly in 2019. While electricity generation from wind increased, the total share of renewables in electricity generation fell to 82.4 per cent in 2019 from 84 per cent in 2018. It was primarily due to low rainfall in the North Island and as a result less hydro electricity generation than usual. To compensate for the lower hydro generation, coal and gas use for electricity generation increased. Generation from coal increased in particular, up 43 per cent from 2018 due to relatively tight gas supply.

Electricity consumption in the agricultural sector increased by 11 per cent in 2019 over 2018. It was driven by higher demand for electricity in irrigation due to 2019 being a dry hydrological year compared to 2018.

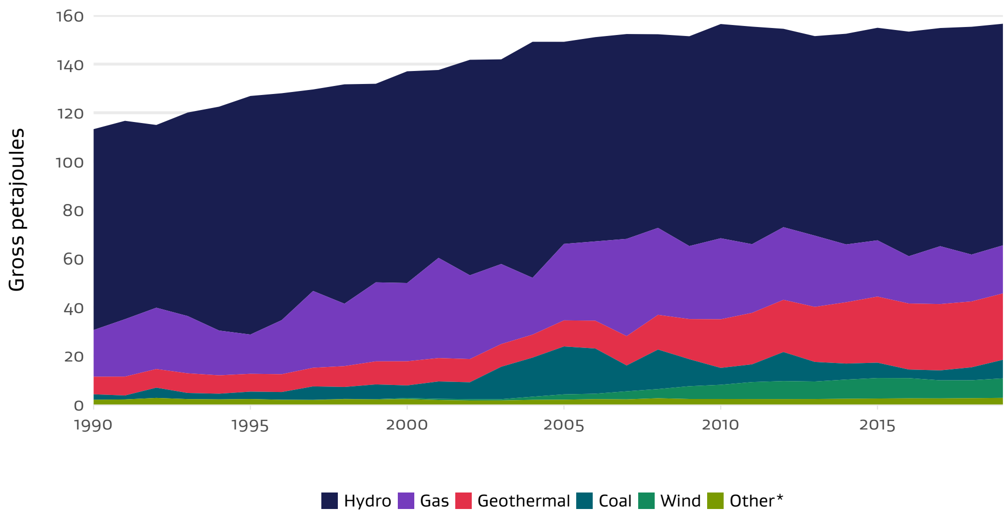
Wholesale prices remained elevated from historical averages over 2019, falling sharply in December as heavy rain in the South Island increased already high lake levels there.

Generation matching growing demand

The annual electricity generation for 2019 increased slightly by 0.8 per cent over 2018. Although there was not much change to the total generation, there was a significant change in the fuel mix compared to the previous year. Figure C. 1 illustrates electricity generation by different fuel types.

The share of renewables came down to 82.4 per cent from 84 per cent in 2018. It suffered primarily due to a decline in hydro generation. The first half of the year saw hydro generation fall due to a dry spell in the North Island. Annual rainfall in the Waikato catchment fell below the long term average affecting hydro generation on the Waikato River. In March 2019, hydro storage in New Zealand hit the 1% Electricity Risk Curve.[7] However, it was not as low as 2017 when New Zealand experienced much drier conditions.

Figure C.1 Generation by type



*Other includes oil, waste heat, biogas, wood, and solar

Electricity generation from geothermal remained static. Generation from wind showed an upward trend through most of the quarters in 2019 taking the annual growth to 9.1 per cent For the first time in a September quarter, generation exceeded 600 GWh. During the same period, the capacity factor[8] for wind also grew by about 9.0 per cent over 2018 when refurbishment work at the Te Āpiti wind farm led to reduced capacity . Overall, it was a good year for wind power after successive drops in generation over the last two years. However, the increase in wind generation, among other renewable sources, was not enough to offset the 2.7 per cent drop in hydro generation, leading to a 1.6 per cent drop in renewable electricity generation as a share of total generation.

The growth in solar photovoltaic (PV) uptake for electricity generation has been steady. However, the rate of growth in New Zealand is lower than it is globally. With 126 GWh of solar electricity generation, 2019 saw an increase of 27 per cent over 2018. Last year saw two big announcements on new solar power investments in New Zealand. Arataki Honey, one of New Zealand's largest honey producers, has invested $169,000 in a new solar system at its Havelock North processing facility. Also, Refining NZ announced plans to build what would be the country's largest solar farm at the Marsden Point oil refinery near Whangārei. But, with the recent developments due to COVID-19, uncertainty looms over the future of the solar farm. In April 2020, Refining NZ announced the commencement of a strategic review of its operations at Marsden Point due to losses suffered during the pandemic.

7 Risk Curves reflect the risk of extended energy shortages. www.transpower.co.nz/system-operator/security-supply/electricity-risk-curves

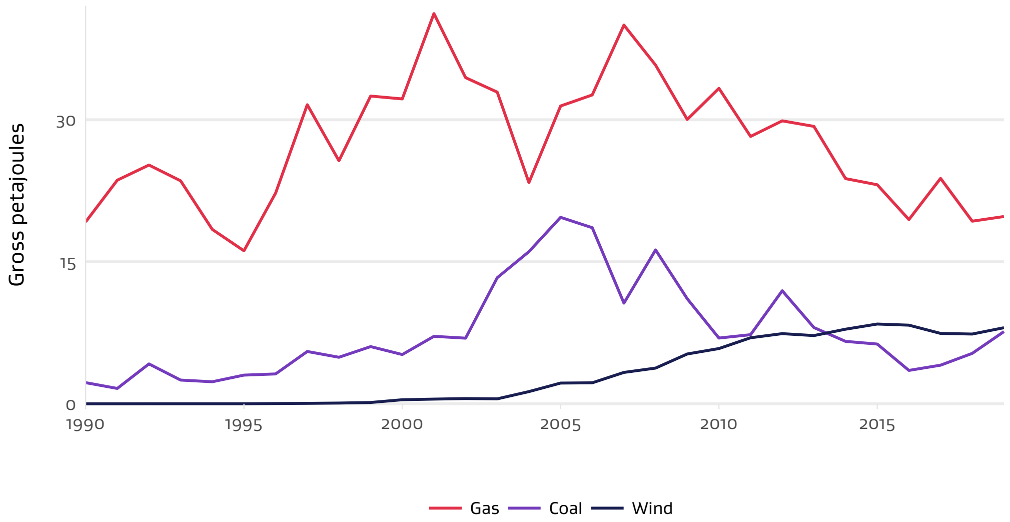
8 Capacity factor is the amount of electricity generated in relation to the maximum output capable of being generated over a period of time assuming no fuel constraints and no downtime for maintenance.

Increased use of non-renewables

Electricity generation from gas was up 2.6 per cent from 2018. Since 2019 was considered a dry hydrological year for hydro generation, an increase in gas use is expected. However, as a result of planned and unplanned outages and maintenance shutdowns, gas use in electricity generation was lower than it could have been. Chief among these shutdowns was the Pohokura field maintenance which began in the third quarter of 2018 and continued until the second quarter of 2019. This was the main reason electricity generation from gas fell by 15 per cent in the March quarter 2019 compared with March 2018.

In contrast, electricity generation from coal increased by 43 per cent in 2019. This was due to the need for non-renewable generation as a result of less favourable hydrological conditions, and gas outages meaning that there was less gas available for electricity generation use. Figure C.2 shows the upward trend of electricity generation by coal, gas and wind. With further maintenance outages taking place at Pohokura and the inter-island High Voltage Direct Current (HVDC) link during the early part of 2020, electricity generation is likely to be affected again.

Figure C.2 Generation by wind, coal and gas

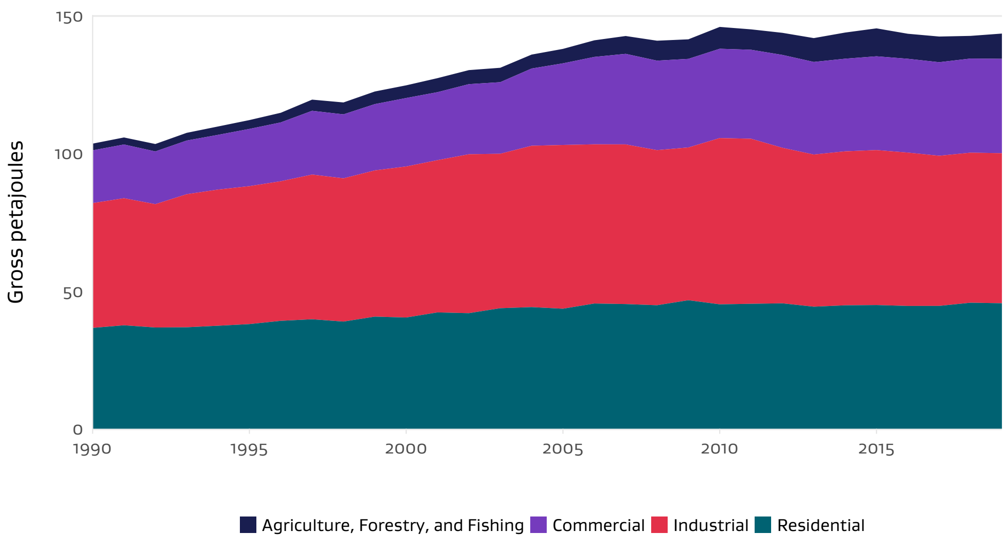


Steady demand

Consumption of electricity remained relatively static in 2019, with a slight increase of 0.6 per cent over 2018 which was driven mainly by higher demand in the agricultural, industrial and transport sectors. Demand in the commercial and residential sectors remained quite stable. Figure C.3 illustrates electricity consumption by sector.

Demand from the agricultural sector increased by 11 per cent over 2018. Dry conditions during 2019 compared to the previous year, when rainfall was around normal levels, led to increased demand for electricity in irrigation. However, the demand in 2019 was about two per cent less than what it was in 2017 when the weather was drier.

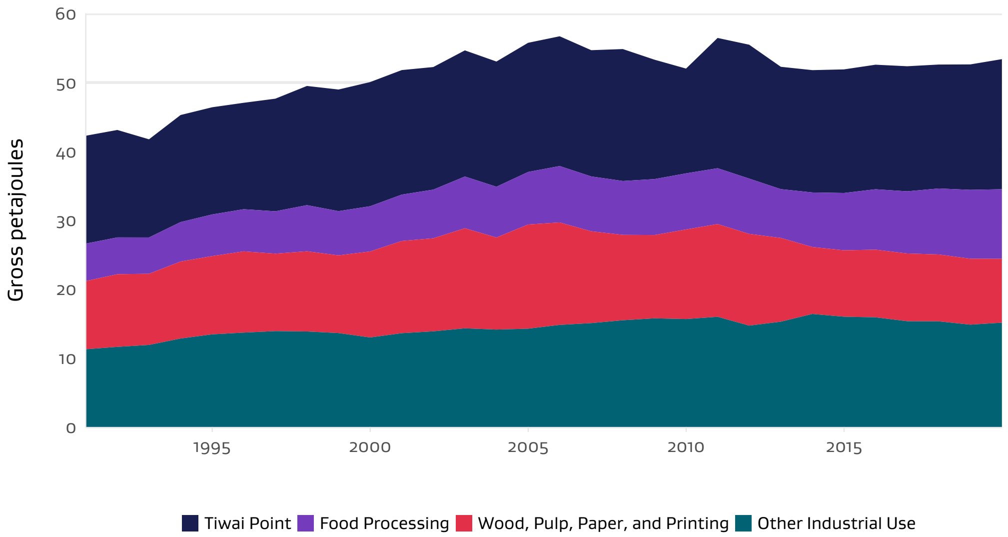
Figure C.3 Consumption by sector



Industrial consumption increased by 1.5 per cent in 2019, driven by higher demand in the food processing and basic metals industries. Demand in the food processing has been growing since 2013, and expected to grow further with a move towards electrification of industrial processes. Synlait, a dairy processing company, announced it had commissioned New Zealand's largest electrode boiler in 2019. Another dairy processor, Fonterra, previously announced its intentions to switch to electricity, and since July 2019 stopped installing new coal boilers.

New Zealand Aluminium Smelter (NZAS) is the single largest consumer of electricity in New Zealand. It uses about 35 per cent of total industrial demand and 13 per cent of total electricity demand in New Zealand (for 2019). Figure C.4 presents electricity demand by NZAS and other industrial sectors. With the reopening of the fourth potline at Tiwai Point in December 2018, increased demand from the smelter had increased national demand for electricity. However, in October 2019, Rio Tinto, which owns about 80 per cent stake in the NZAS, announced a strategic review of its interest to determine the viability of its ongoing operations. With the recent decision in 2020 to close the smelter due to unprofitability, electricity demand is likely to have a significant impact when the smelter closes.

Figure C.4 Industrial demand



Residential electricity use remained stable in 2019. Increasing uptake of energy efficient technologies such as LED lighting and heat pumps is likely to bring down electricity demand in the future. Further, the impact of minimum insulation requirement for rental homes that came into force on 1st of July 2019 is yet to become visible. However, factors that lower demand can be offset by residential users switching to electric appliances from wood or coal burners as well as by increasing uptake of electric vehicles (EVs) having charging facilities at home.

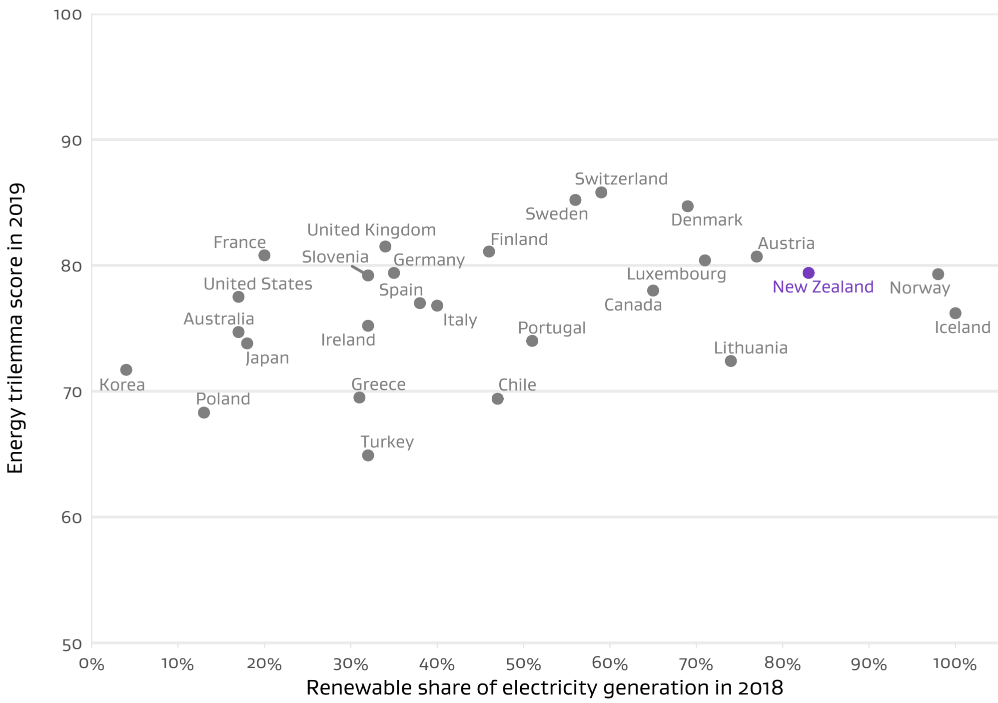
Electricity demand in the transport sector has been showing an upward trend for the last five years driven by rail and electric vehicles. In 2019, it increased by 17 per cent over 2018. While EV registration in 2019 grew by 59 per cent over 2018, demand for electricity in transport increased by 16.7 per cent over the same period. In 2019, the uptake of new light EVs grew by 88 per cent. While on average the number of new light EV registrations per month was about 200, during September alone it increased to 608. In the coming years, use of electricity for transportation is expected to continue increasing reflecting growing popularity of new modes of transportation like electric bikes and scooters, and plans to introduce electric ferry services and more electric buses for public transport.

New Zealand vs Other OECD countries – Renewable electricity and Security, Equity, Sustainability

Renewable energy generation takes the centre stage in the discourse on climate change and the transition to a low emissions economy. Increasing the share of electricity generation from renewable sources and meeting energy end-uses with electricity are both in focus. According to the International Energy Agency (IEA), the share of renewables in electricity generation globally reached almost 27 per cent in 2019 and the renewable electricity generation capacity is expected to expand by 50 per cent between 2019 and 2024, driven by solar PV.[9] New Zealand too is making strides with it being one of the leading nations, ranked third in the OECD, in using renewables for electricity generation.

9 IEA (2019), Renewables 2019: Analysis and forecasts to 2024, IEA, Paris

Figure C.5 Energy trilemma comparison



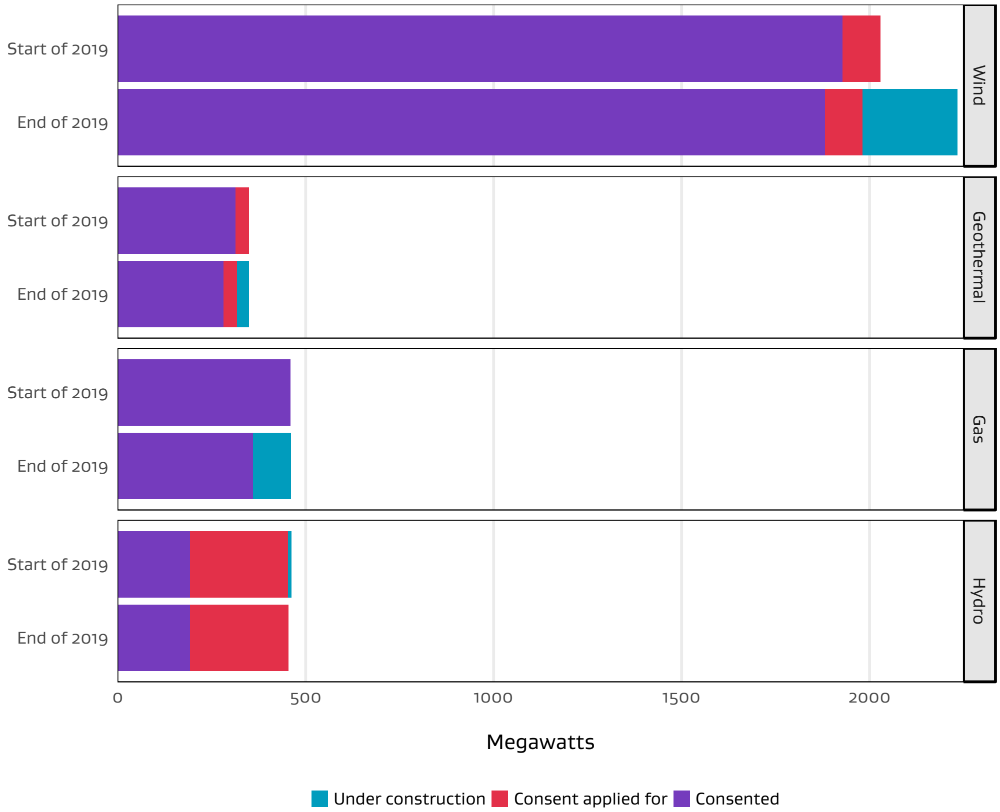
The World Energy Council's Energy Trilemma Index, which ranks countries based on their ability to provide sustainable energy, ranks New Zealand at the tenth position. The ranking shows how well a country has managed the trade-offs of the trilemma of achieving energy security, energy equity and environmental sustainability. During the past decade New Zealand's energy equity index, which measures accessibility and affordability of energy, has remained quite stable. While energy security has experienced some fluctuations due to dependence on imported oil products and a minor reduction in fossil fuel stocks, the sustainability index has seen a stable growth due to increasing generation from renewables as well as New Zealand's ability to manage emissions. Figure C.5 shows ranking of New Zealand and selected OECD countries for their share of renewables in electricity generation and Energy Trilemma score.

New developments in Electricity Generation

The 2019 calendar year saw numerous developments in new and existing electricity generation capacity. There was a mix of announcements around the intention of companies as well as the commencement of construction of some plants.

It is important to note that some renewable sources of electricity generation, such as wind and solar, are intermittent. With new solar and wind capacity announced and underway, increasing penetration of these generation types further highlights the need to manage the intermittency of renewable resources as part of New Zealand's electricity generation mix.

Figure C.6 Electricity generation developments



This chart is based on information published by the Electricity Authority, supplemented with public announcements by companies. The Ministry has attempted to ensure the information presented is correct, however there may be instances where generation capacity and consent stage is misreported.

The following summarises the developments by fuel type since the beginning of 2019 and up to August, 2020. It is important to note that all of the developments listed below are subject to change due to a range of factors that may either bring forward their implementation or put them on hold. This includes changes in electricity demand (such as the closure of the Tiwai Point aluminium smelter, or increased electrification), and the risk appetite of investors.

Wind

› Mercury has committed to the construction of a two stage 221 MW, $464 million wind farm at Turitea near Palmerston North. The first stage (expected to be operational in late 2020) will be 119 MW, while the second stage (expected to start construction in early 2021) will be 103 MW.

› The Waipipi Wind farm (formerly known as the Waverley Wind Farm) in South Taranaki is being constructed at a cost of $277 million. The 133 MW wind farm is expected to be operational in the first quarter of 2021.

› Tilt Renewables is planning to repower the first two stages of its Tararua wind farm in the coming years. It is expected that this will increase the capacity from 68 MW to 140 MW.

› MainPower announced its $200 million, 93 MW Mt Cass project in Hurunui. This is expected to be commissioned by late 2021, with financial close and take-off arrangements expected to be finalised around late 2020 to early 2021.

Geothermal

- In May 2019, Contact Energy started a $30 million drilling programme of four appraisal wells at their planned 250MW Tauhara site near Taupō. As at the time of writing, it was shovel-ready but was put on hold due to Rio Tinto's announcement in July 2020 about the future of the Tiwai Point aluminium smelter. Construction would take over three years if given the go-ahead.
- In Northland, Top Energy is looking to expand its current 28 MW Ngāwhā geothermal power station with two new 32 MW units. The expected investment is $175 million. Drilling of new wells has been completed and commissioning of the first 32 MW binary unit is expected to be completed before the end of 2020. The additional 32 MW unit is expected to be ready by 2026.

Hydro

- The Upper Fraser project, an 8 MW power station was commissioned in September 2019 by Pioneer Energy. It is located three kilometres upstream of the existing Fraser Dam and cost between $15-20 million.

Coal and Gas

- Todd Generation began construction of its 100 MW peaking plant near Junction Road just south of New Plymouth. Work on the plant began in early 2019.

Solar

- Arataki Honey invested $169,000 in a new solar system at its Havelock North processing facility.
- Refining NZ, the operator of the Marsden Point oil refinery, has put its plans for a 26.7 MW solar array on hold
- Hawke's Bay Airport and Centralines are planning a 10MW solar farm next to the runway. The partners expect the initial stage of construction would be operational by the end of 2021.
- Genesis Energy announced in February 2020 that it was in advanced talks to construct a 300 MW solar farm in North Waikato with a planned completion of 2023.

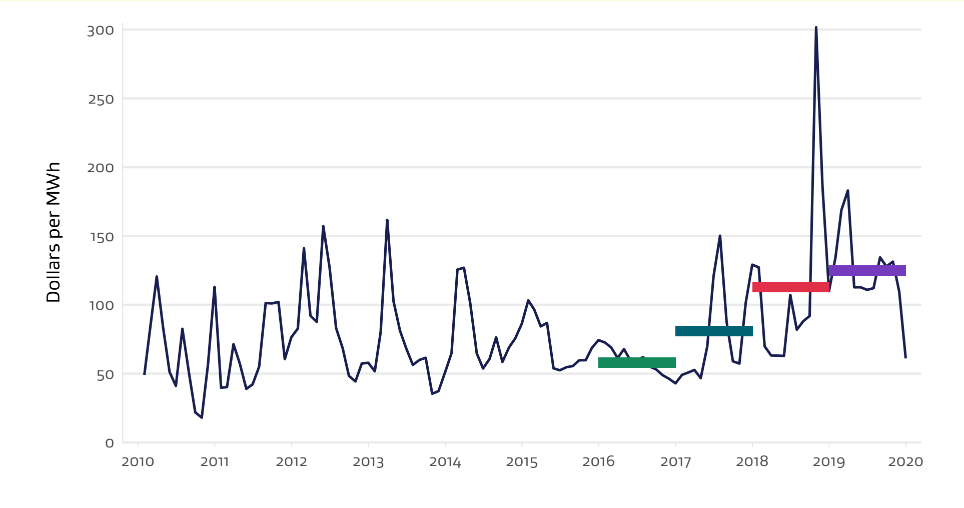
Box C.1

Electricity wholesale spot prices

Electricity wholesale spot prices have been unusually high recently

The annual average wholesale electricity spot price reached a new high of $125 per MWh in 2019 which is almost a 120% increase from a low of $58 per MWh in 2016. Low levels of hydro storage and a lack of gas supply are possible explanations for the elevated wholesale electricity spot prices in 2019.

Box C.1 Figure 1 Monthly wholesale price



How is the wholesale electricity spot price determined?

Generators make offers to supply electricity at 52 grid injection points, and retailers and major industrial users made bids for each half-hour trading period. If generators set their offer prices too low, they risk not making enough revenue to cover costs and make a return on their investment. If they set their offer prices too high, they risk losing potential sales to competitors.

In New Zealand, the market operator ranks all the offers from generators and sets the market clearing price at the level needed to meet the demand. In other words, the clearing price (also called the system marginal price) is set by the offer price of the last producer needed to cover all load.

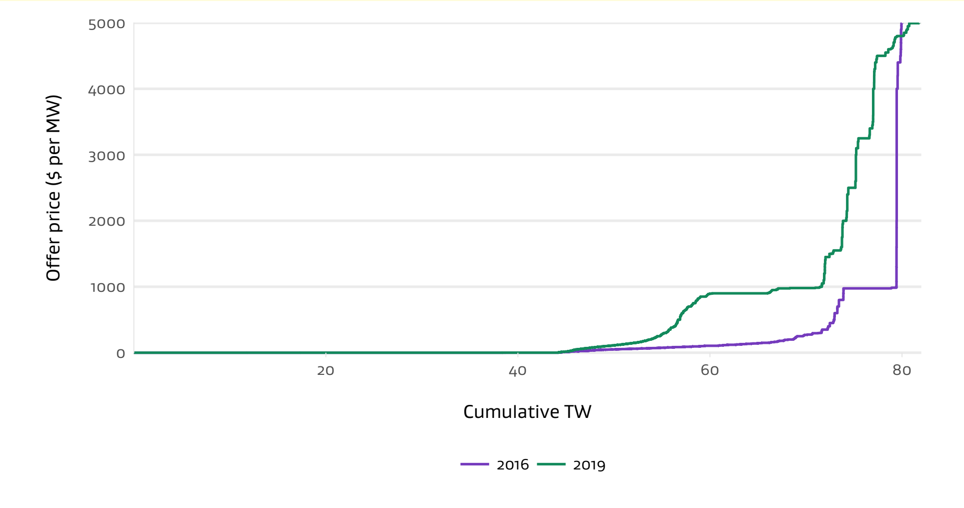
In general, plants with the lowest variable operating costs are dispatched first, subject to availability, and plants with higher variable operating costs are dispatched next as electricity demand increases Dispatching generation in this way minimizes the cost of electricity production.

However, the exact order of dispatch is rather complex and there are many factors that may lead it to deviate from this hypothetical outcome. For example, wind has very low operating costs but the intermittent nature of wind affects their availability. Similarly, hydroelectric generators have also very low operating costs. However hydroelectric dispatch pattern can be complex because hydroelectric generators with controllable storage may set their offer prices taking into account the opportunity cost of their stored water (whether to use water to generate today or store water for use later when it may be more valuable). For these reasons, wholesale electricity spot prices are influenced by each generator's expectations about future market conditions, including future demand, inflows, planned generation outages and planned transmission outages.

Marginal cost of electricity production

The following figure summarises the price offered by hydro generators for each trading period in 2019 and 2016. The horizontal axis represents the cumulative electricity generation offered by hydro generators. There are 17,520 trading period each year.

Box C.1 Figure 2 Hydro generation offers



In 2016, hydro generators supplied 60 per cent of total annual production but hydro generators set the system marginal price 87 per cent of the time. Even during peak-demand hours (7:00am to 9:00am and 5:00pm to 7:00pm), hydro generators set the marginal price 86 per cent of the time.

In 2019, hydro generators accounted for 58 per cent of total annual production. Hydro generators set the marginal price 84 per cent and 83 per cent of all the trading periods and peak-demand periods respectively. Overall, electricity generation mix by fuel source as a percentage has not changed much from 2016 to 2019.

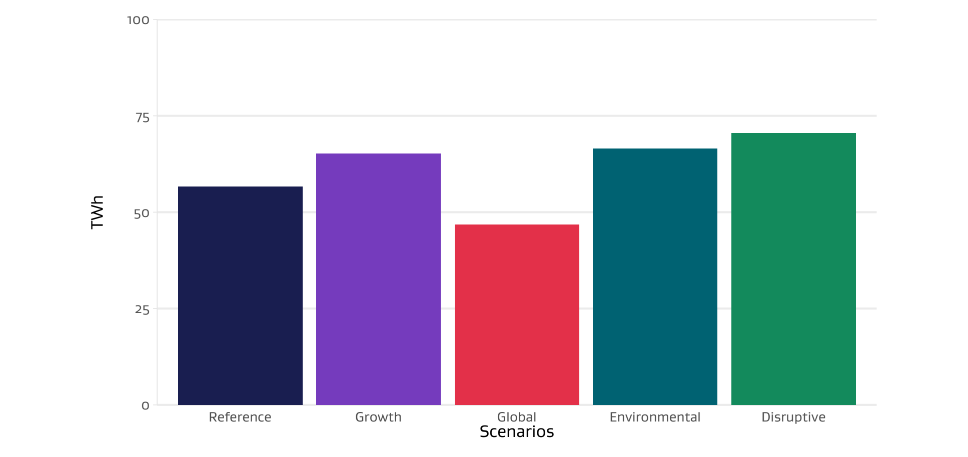
However, on average the marginal offer price of hydro generators in 2019 is 120 per cent higher than that in 2016. The data confirms that higher electricity wholesale spot prices in 2019 were mainly due to higher marginal offer prices of hydro generators. Note that although average wholesale electricity spot prices have been persistently elevated, retail electricity price increases in 2019 remained subdued.

Box C.2 Electricity Demand and Generation Scenarios

MBIE released updated Electricity Demand and Generation Scenarios (EDGS) in July 2019.[10] The purpose of the EDGS is to enable the Commerce Commission to assess Transpower's planning proposals for future capital investment in the electricity transmission grid.

In comparison with previous EDGSs, the range of projections in this report is large, reflecting uncertainty in technological progress, policy and economic growth. The highest demand scenario shows total electricity demand is expected to grow 78 per cent over the projection period 2018 to 2050. In the lowest demand scenario, total electricity demand rises just over 18 per cent. Under the Reference scenario which assumes a continuation of current trends, total electricity demand grows on average at a rate of 1.1 per cent per year and increases 43 per cent by 2050.

Box C.2 Figure 1 Electricity demand projections



New Zealand is on the way toward a greener future

The Government has passed the Climate Change Response (Zero Carbon) Amendment Act and set a target of net-zero carbon emissions by 2050 (except biogenic methane). Future demand for electricity will depend heavily on the path of decarbonisation and the extent of changes in electricity using technologies and supply technologies over the next 30 years.

Process heat is the energy used as heat mainly by industrial and commercial sectors for industrial processes, manufacturing, and warming spaces. Process heat contributes about 8 per cent of New Zealand's total greenhouse gas emissions. Therefore, the ability of organisations to switch to lower-emission fuel is crucial for New Zealand to meet the target of net-zero carbon emissions. However, the ability and incentives for organisations to switch to electricity is dependent on both the relative price of electricity and the future of process heat technology.

Getting a price signal right

Apart from the Environmental scenario, carbon prices are assumed to increase from NZD$25 per tonne of carbon dioxide in 2019 to NZD$66 per tonne by 2050 in all the scenarios. In the Environmental scenario, carbon prices rise to NZD$154 (USD$100) per tonne by 2050. In all

10 Available at www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-modelling/electricity-demand-and-generation-scenarios/

scenarios, we assume that some low grade heat will be electrified. Much of this electrification can be accomplished using heat pumps that have a relatively high coefficient of performance. In the Environmental and Disruptive scenarios, we assume that additional measures are introduced that further increase the level of electrification.

New Zealand is electrifying its vehicle fleet

Another approach to reduce CO2 is to electrify our vehicle fleet as nearly 20 per cent of emissions in New Zealand come from road transport. The uptake of new transport technologies such as EV and hydrogen fuel cell cars, and biofuels, will have important impact on CO2 emissions as well as the future demand for electricity.

The Reference scenario assumes that EVs comprise 44 per cent of the light vehicle fleet, and 13 per cent of the heavy vehicle fleet by 2050. In the Disruptive scenario, EVs comprise 74 per cent of the light vehicle fleet, and 45 per cent of the heavy vehicle fleet by 2050, reflecting the falling costs of both batteries and EVs. High uptake of EVs in the Environmental scenario is driven by policy and regulations.

The share of renewable generation is projected to rise

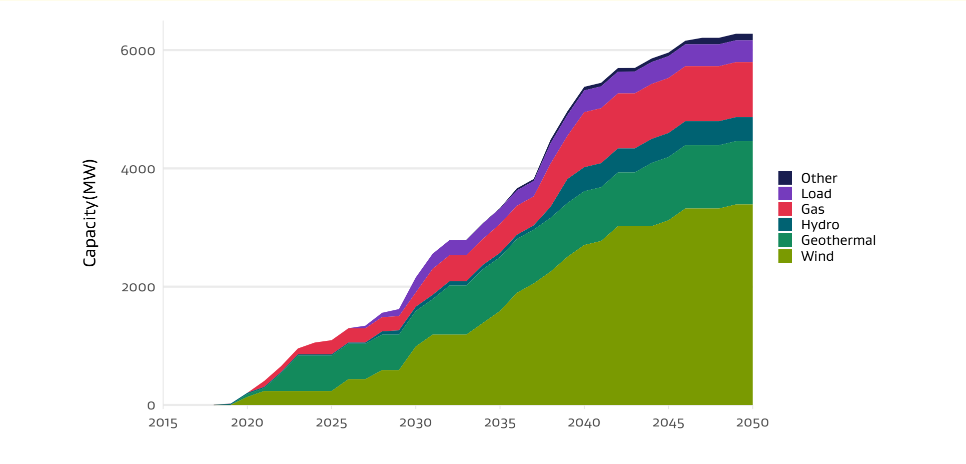
An increase in electricity demand means we need to build more generation capacity on top of replacing aging generation plants. The combination of continued declines in the cost of solar and wind technology, and limited supply of gas, means that the majority of new build generation is expected to be renewable.

The share of electricity generation from renewable sources is expected to rise from 84% in 2018 to over 90 per cent and 95 per cent by 2035 and 2050 respectively. Owing to the intermittent nature of wind power, there is a limit to the share of wind in total generation without overbuilding wind capacity or without other economic means to compensate for that intermittency.

Cleaner future is promised but with a cost

In the Reference scenario, 6,250 MW of electricity generation capacity is needed by 2050, with 55 per cent of the new build being wind generation. All of the gas new build capacity operates as peaking plants, generating electricity when peak demand needs to be met. The capital expenditure for all the new generation capacity is estimated to be around $13b in 2017 dollars. For other scenarios, the new build generation capacity needed ranges between 3,800 MW and 10,600 MW across other scenarios in 2050. The capital expenditure lies in the range of $7b to $24b.

Box C.2 Figure 2 Cumulative new build generation



Changes in electricity pricing

Wholesale electricity prices remained elevated for most of 2019, plunged in December

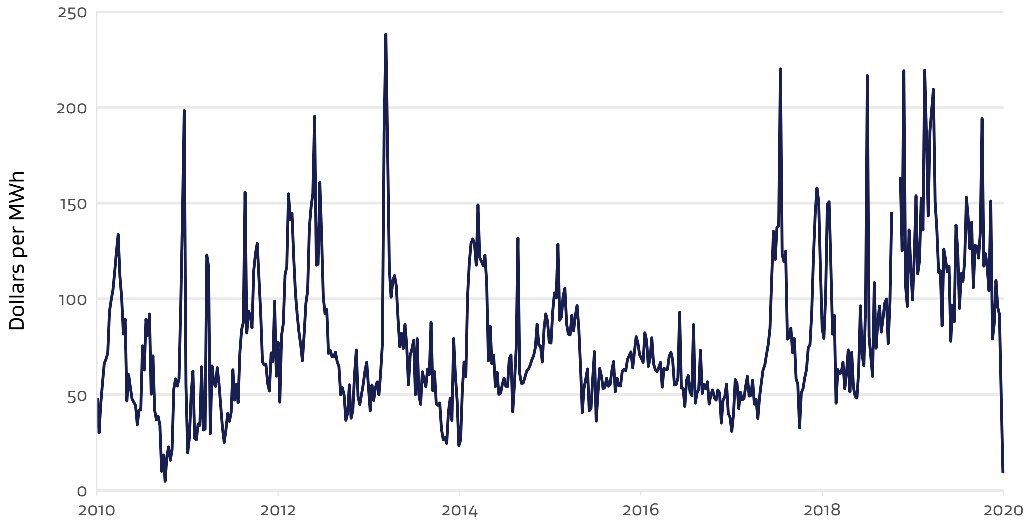
After high spikes in electricity spot prices in 2018, wholesale prices were elevated over most of 2019 relative to the historical average, before falling significantly toward the end of the year.

Wholesale prices had trended upwards over 2018, driven by a combination of planned and unplanned gas production outages and low inflows to hydro generation reservoirs. Elevated prices continued for most of 2019. Additional gas production outages in 2019 due to ongoing maintenance at gas fields meant that supply of gas remained relatively tight. Dry weather also continued across the country for the beginning of the year.

Hydro storage decreased so far as to reach the threshold for moving the New Zealand Hydro Risk Meter from "Normal" to "Watch" status in March 2019. However significant rain events in the South Island saw levels recover to above average in the same week. In contrast, dry conditions in the North Island continued.

Wholesale prices fell dramatically in December 2019, as heavy rain in the South Island increased already high lake levels there. Nationally hydro storage levels rose to 162 per cent of the 20 year average.

Figure C.7 Weekly wholesale electricity price



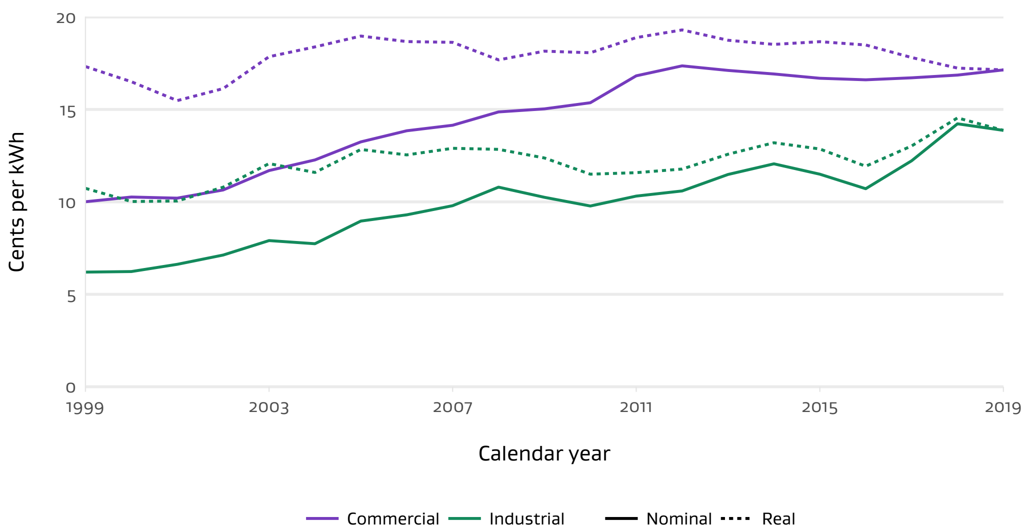
Slight fall in average electricity prices for industrial users, relatively steady for commercial users

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. The retail income includes prompt payment discounts, lower fixed term prices, loyalty rewards, and acquisition/retention payments. This analysis is referred to as the cost per unit as it is what was actually paid relative to the quantity of electricity consumed

While the wholesale price was elevated over 2019, the average nominal cost faced by industrial users over the 2019 calendar year[11] was 2.8 per cent lower than in 2018. This decrease follows two years of increasing prices for the industrial sector. There are a number of other factors that influence the average price that industrial consumers pay. These factors include distribution and transmission lines charges, the wholesale price paid for any electricity purchased on the wholesale market, and the contracted price for electricity that is purchased from retailers.

The average nominal cost faced by commercial users increased by 1.7 per cent from 2018. Nominal commercial costs have been relatively stable since 2011, and have been decreasing in real terms over the same period.

Figure C.8 Average electricity costs, industrial and commercial sector



Costs faced by the residential sector did not change significantly over 2019. The nominal residential cost in the December quarter of 2019 was 0.6 per cent higher compared to the 2018 December quarter.

The Ministry also monitors changes in electricity prices using the Quarterly Survey of Domestic Electricity Prices (QSDEP). The QSDEP is an indicator of publically available prices advertised in the retail electricity market to new customers on a particular date. It shows how residential electricity tariffs have changed over time, and how these may affect households. The average national QSDEP indicator for 2019 increased by 1.9 per cent compared to 2018, or 0.3 per cent when adjusted for inflation. This increase was driven by increases in the 'energy and other' component of the retail price, rather than the lines component.

11 Sales-based data is reported on a March year-end basis, so the majority of the 2019 calendar year is reported under the year ending March 2020. The Ministry also estimates calendar year costs from the March-year end data for the industrial and commercial sectors. These estimates have been used here, so as to avoid reporting on changes that occurred in either the 2018 or 2020 calendar year.

Decrease in overall allowable revenue for electricity distributors for 2020-2025 period

In November 2019, the Commerce Commission set the new default price path (DPP) for the 17 electricity distribution businesses (EDBs) subject to price-quality regulation.[12] Known as DPP3 (as it is the third DPP that the Commerce Commission has set), the new default price path determines the maximum allowable revenue these EDBs can recover over the five year period beginning 1st April 2020.

Electricity distribution businesses are subject to specific regulation by the Commission as they are natural monopolies. Of the 29 EDBs in New Zealand, 17 are subject to price-quality regulation. Every five years the Commerce Commission sets the maximum revenue that these EDBs are allowed to earn from their customers, as well as minimum quality standards that they must meet in providing their service. The other 12 EDBs are 'consumer-owned' and exempt from this regulation as they are assumed to act in the best interest of their customers.

While different maximum allowable revenues are set for each regulated EDB, most saw a decrease in maximum allowable revenue in DPP3. The overall allowed revenues for EDBs on the DPP3 in the year starting 1st April 2020 decreased by 72 million dollars (6.7 per cent) compared to the previous year.[13] This decrease was largely driven by the Commission reducing the cost of capital (WACC) used in their calculations, to reflect falling interest rates across the economy.

The allowable revenue impacts the distribution prices that EDBs set for consumers connected to their networks over this period. MBIE's QSDEP indicator showed a decrease of 5.7 percent in the national average distribution component[14] after the new regulatory period came began on the 1st April 2020.

Some EDBs have historically charged below the maximum they were allowed to under their previous price paths. This means that while there are changes in the amount of revenue that these EDBs can earn under DPP3, these changes may not necessarily be mirrored in the changes in both the distribution charges and retail prices that customers face.

12 Two EDBs (Powerco and Wellington Electricity) are currently on a Customised price-quality path (CPP) and will transition back to a Default price-quality path (DPP) when their CPPs expire.

13 Commerce Commission New Zealand (2019), 2020–2025 price-quality paths for EDBs and Transpower Final decisions: Presentation to Stakeholders. https://comcom.govt.nz/__data/assets/pdf_file/0028/191764/Analyst-briefing-slides-EDB-DPP3-final-determination-27-November-2019.pdf

14 This is an estimation of the distribution part of the total lines charge, excluding transmission charges.

Box C.3

Electricity Price Review: Final Report and Government Response Released

In October 2019 the Government announced its response to the Electricity Price Review's final report findings and recommendations. The Review's final report, delivered to the Minister of Energy and Resources in May 2019, was released alongside the Government's response in October 2019.

The objective of the 13-month 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. Another objective was to consider how to future-proof the sector and its governance as technology and business models evolve, and we transition to a lower emissions future. The Review was commissioned 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 review considered the entire electricity supply chain, including both monopoly elements (transmission and distribution) and competitive elements (generation and retailing).

The Review found that New Zealand's electricity sector was reliable, and sustainable by world standards, and that the regulatory framework generally works well. However it recommended some improvements to the wholesale and retail markets, and to the performance and regulation of the sector which could benefit consumers. It found that while electricity in New Zealand was affordable for many, it was not as fairly priced as it could be, and that consumers struggled to make their voices heard. It also noted energy hardship to be a pressing problem, with children over represented in households experiencing energy hardship.

Recommendations were made in the following areas:

› Strengthening the consumer voice
› Reducing energy hardship
› Increasing retail competition
› Reinforcing wholesale market competition
› Improving transmission and distribution
› Improving the regulatory system
› Preparing for a low-carbon future

The Government proposed to action most of the Review's recommendations immediately. Those remaining were to be further developed, with consideration given to scale, timing, and financial implications. Many of the recommendations for immediate action fell to the Electricity Authority to address, particularly those relating to market improvements. Actions for the Ministry of Business, Innovation and Employment included establishing a cross-sector energy hardship group; developing a framework for measuring and monitoring energy hardship; establishing a Consumer Advocacy Council; and addressing concerns with prompt payment discounting practices. Cabinet subsequently agreed to progress amendments to the Electricity Industry Act to implement regulatory improvements including: giving the Electricity Authority an explicit customer protection function; improving the Electricity Authority's powers to regulate network access and gather information; and a regulatory backstop if there is unsatisfactory progress by the Electricity Authority and industry to address certain Review recommendations for the wholesale and retail markets.

All reports published by the Electricity Price Review, along with the Government's response can be accessed at: www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-consultations-and-reviews/electricity-price/

D. Renewables

In 2019, 82.4 per cent of electricity generation came from renewables, down from a record high of 84 per cent in 2018. Also, 39.5 per cent of our primary energy supply came from renewable sources. This was down from last years record high of 39.8 per cent. These changes were largely a result of less favourable hydrological conditions in 2019. Meanwhile, solar, geothermal and wind generation increased on the previous year, a result of new solar and geothermal capacity, and favourable weather conditions for wind.

The latest data from the IEA (International Energy Agency) shows that New Zealand had the second highest share of renewables in primary energy of IEA member countries in 2018 – only Norway was ahead. Also, New Zealand's share of renewables in electricity generation was the third highest among OECD countries.

Developments in the use of renewable energy in process heat are underway, which will be important if New Zealand is to reach its goal of becoming Net Zero by 2050.

Renewable primary energy as a measure of supply

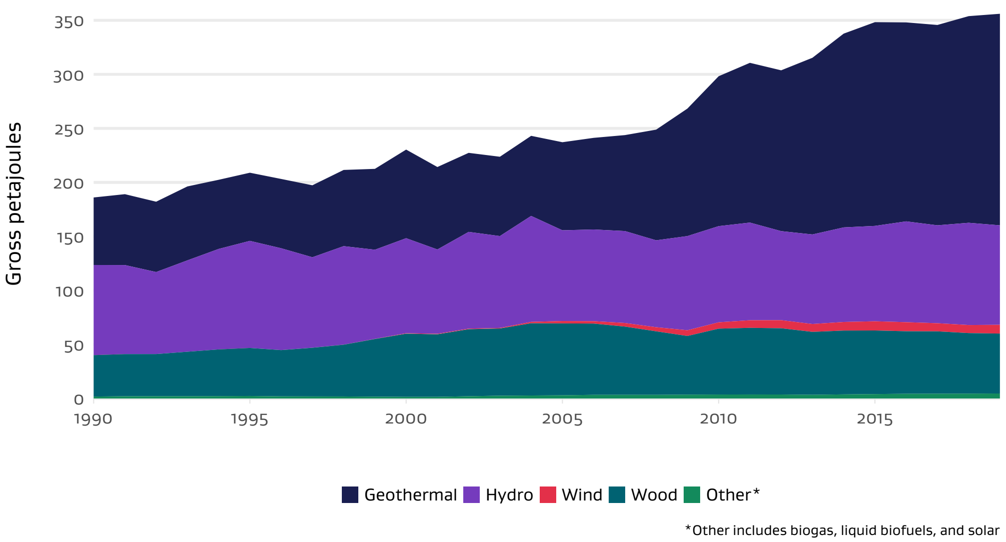
Renewable energy can be split into two general categories: Energy used in large scale electricity generation and then all other uses for renewable energy. Both of these use total primary energy as a measure of supply. However, compared to primary energy for non-renewables, measuring primary renewable energy supply is difficult.

To address this, the primary energy supply of wind, hydro, and solar energy is assumed to be equal to their output as electricity, though this does not account for losses involved in converting primary energy into electricity. For example, wind turbines converting kinetic energy into electricity.

Additionally, primary supply of geothermal energy is estimated based on the supply of hot water and/or steam being extracted and its conversion to energy. It is important to note that due to the relatively low conversion of geothermal heat to energy, the primary energy supply of geothermal is relatively higher in comparison to other energy types.

You can see the effect of the problems explained above in Figure D.1 below.

Figure D.1 Renewable Primary Energy Supply



Electricity generation is the largest use of renewable sources

Whereas the latest data from the IEA shows that the average for the world was 27 per cent renewables used in electricity generation in 2019. Furthermore, in 2018 according to the IEA, New Zealand was ranked third highest for share of renewables used in electricity generation. Only Iceland and Norway had higher levels of renewable electricity generation than New Zealand.

Box D.1 Renewable energy strategy work programme launched

In July 2019 the Interim Climate Change Committee (ICCC) released their final report from their inquiry into *Accelerated Electrification*.[15] This inquiry examined the potential for New Zealand to meet 100 per cent of its electricity generation with renewable sources by 2035 in a normal hydrological year, as well as looking at opportunities for the electrification of transport and process heat energy use.

In response to the recommendations of the ICCC's report, the Government launched its renewable energy strategy work programme. The main outcomes of this work programme are:

- An inclusive and consumer focused energy system
- A system that encourages increased investment in low emissions technologies, and
- An innovative and modern energy system that creates new opportunities for business and consumers.

MBIE released a discussion document for consultation at the end of 2019 on *Accelerating renewable energy and energy efficiency*.[16] This covered a range of options for two of the workstreams of the renewable energy strategy:

- Encouraging energy efficiency and the uptake of renewable fuels in industry
- Accelerating renewable electricity generation and infrastructure

15 Available at: www.iccc.mfe.govt.nz/assets/PDF_Library/daed426432/FINAL-ICCC-Electricity-report.pdf
16 Available at: www.mbie.govt.nz/have-your-say/accelerating-renewable-energy-and-energy-efficiency/

Hydro generation

Hydro generation decreased 2.7 per cent, from 26,030 in 2018 to 25,321 GWh in 2019. This was largely a result of relatively less favourable hydrological conditions compared to 2018. Despite this, electricity generation from hydro was at its third highest level for the past ten years.

In December 2019, there was over 5,000 MW of installed hydro capacity over approximately a hundred different sites across New Zealand. This is dominated by major power stations including 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 compared to other countries and can only store around 4,000 GWh when full. This means that regular inflows are required to maintain lake levels. Unfortunately, weather conditions can result in a yearly variation of up to 5,000 GWh. Hence, 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

Wind provided 2,232 GWh of electricity, or 5.1 per cent, of total electricity supply in 2019. This was up 9.1 per cent on the 2018 level. The capacity factor[17] for wind generation was 37 per cent, up from 34 per cent last year. This suggests that wind turbines were generating more frequently in 2019 compared to 2018. The better generation conditions were largely a result of a high wind speed in November and December, and repairs for 11 MW of turbines at the Te Āpiti windfarm.

17 Capacity factor for wind is the amount of electricity generated in relation to the maximum output capable of being generated by installed wind turbines over a period of time assuming no downtime for maintenance.

Geothermal generation

The main use of geothermal energy in New Zealand is for electricity generation. In 2019, the total generation output, 7,586 GWh, was the highest on record, up 0.8 per cent on 2018. This accounted for 17.4 per cent of New Zealand's total electricity supply in 2019, just 0.3 percentage points less than it was at its peak in 2016.

Most of New Zealand's installed geothermal generation is in the Taupō Volcanic Zone. There is also 28 MW installed at Ngāwhā 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.

Other Sources of Renewable Energy

While reliable data is available on the quantity of renewable energy (including electricity) used by large industrial users, information on the direct use of renewable energy and use for distributed generation is more difficult to obtain. The input energy source (e.g. geothermal or solar) does not involve a transaction (e.g. geothermal steam or solar energy is not purchased) so 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.

Solar generation

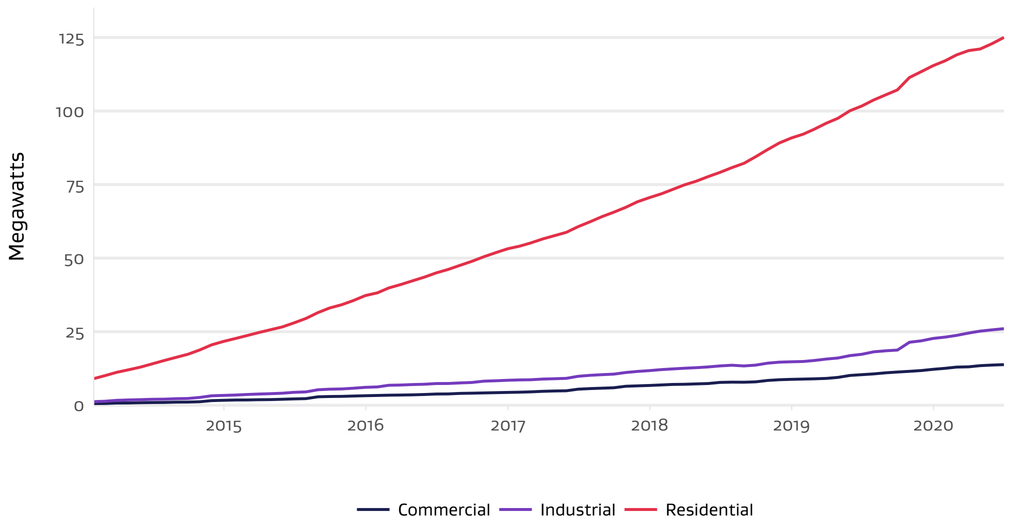
Solar energy sources include solar thermal and solar photovoltaic (PV) systems both of which are predominately installed on the rooftops of households in New Zealand (distributed generation):

› 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.

Solar generation increased by 27 per cent, from 99 GWh in 2018 to 126 GWh in 2019. Solar PV accounted for just over 0.3 per cent of total electricity generation in 2019 at 126 GWh. While accounting for a small share of total generation, solar PV capacity has continued to grow in recent years. As Figure D.2 shows, the capacity has grown since 2014, increasing 36 per cent, from 2,915 to 3,954 MW in 2019. This is largely a result of the uptake of residential systems, as residential connections account for 80 per cent of existing solar PV capacity.

Figure D.2 Solar capacity by sector



Box D.2 Hydrogen Energy

In 2019, a major piece of work for the Government this year was to develop policies that will facilitate a Renewable Energy Strategy for New Zealand. The Renewable Energy Strategy Work Programme plays a key part in meeting our climate change goals and green hydrogen has potential to be part of the work programme.

Unlike brown hydrogen which is produced from fossil fuels and emits GHG, green hydrogen is produced by electrolysis which uses electricity to split water into hydrogen and oxygen. Hydrogen is not a primary energy source carrier. To be green hydrogen, electricity used in generating hydrogen must come from renewable energy sources such as wind and solar.

Hydrogen is a clean fuel. With the use of hydrogen in fuel-cell systems, there is no emission. A fuel cell is a device that uses hydrogen gas and oxygen gas as fuel to generate electricity. Fuel cells will be used in a wide range of products, ranging from portable energy devices to hydrogen-powered aircraft.

As of 2019, there were three hydrogen fuel cell automobiles and limited hydrogen infrastructure in New Zealand but a few hydrogen projects were underway or at the early stage of investigation.

New Zealand Hydrogen Projects

The H2 Taranaki Roadmap was released in early 2019 – the roadmap outlines the potential for Taranaki to leverage its exiting skills and infrastructure to become a leader in hydrogen production and utilisation.

Port of Auckland is on track to open a new hydrogen production in 2020. Initially, hydrogen will be used to power forklifts and cars. Ports of Auckland has been collaborating with Auckland Transport and KiwiRail on the project. KiwiRail has said hydrogen powered trains are an option for the future.

In January 2020 Taranaki-based Hiringa Energy and King Country-based Waitomo Group announced their intention to work together to develop New Zealand's first nationwide hydrogen refuelling station network. The government recently announced $20 million of in principle support for this project, subject to agreement. According to the companies, initial locations have been selected, with plans for a further 20 stations to be developed across both the North and South Island. Development and consenting for the first hydrogen refuelling sites will get under way this year and the two companies will work together to identify and scope further sites for development of the network in 2020.

Hiringa Energy will supply a blend of blue and green hydrogen to a project developed by New Plymouth District Council. Hydrogen will be used to power a gas-fired thermal drying facility, which helps process sewage bio-solids into fertiliser.

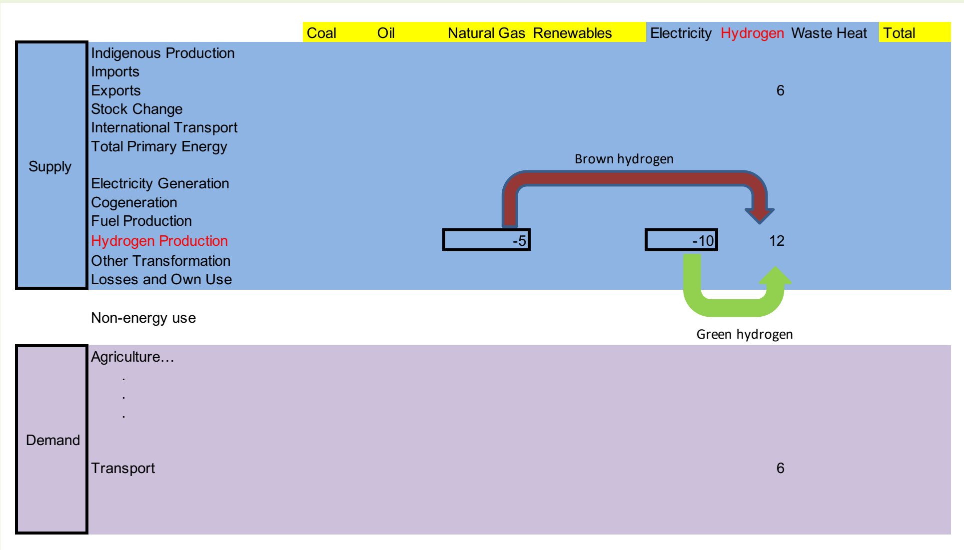
Energy Balance Table

How does hydrogen fit into an energy balance table? The following diagram is a schematic energy balance table which incorporates hydrogen production. The brown and green arrows show fuel inputs for hydrogen production. In this hypothetical table, the hydrogen industry uses 15 PJ of energy to generate 12 PJ of hydrogen, which represent a loss of 3 PJ during the process (this loss is 20 per cent). Further energy losses occur in the logistics chain such as pressurisation, liquefaction and conversion.

Currently, it takes 41.4 kWh to produce 1 kg of hydrogen which contains 33.33 kWh of usable energy. The process of electrolysis represents an electrical efficiency of 80 per cent.

In this hypothetical table, half of the hydrogen production is consumed in New Zealand and the rest is exported.

Box D.2 Figure 1 Energy balance table



Geothermal energy for direct use

Direct use refers to the use of geothermal heat directly, without a heat pump or electricity generation facility. In 2018, an estimated 8 PJ of geothermal energy was used directly. Just under 60 per cent of this was in industrial applications, 32 per cent in commercial, and the remainder in residential and agricultural applications.

Geothermal energy is extracted from heat deep beneath the earth's surface. New Zealand is particularly rich in geothermal energy especially in the Taupō 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 uses such as heating homes or generating electricity. Kawerau, where geothermal steam is a significant source of energy for pulp and paper mills, was until recently the world's largest user of direct geothermal heat concentrated in one location.

Other examples of geothermal direct use in New Zealand include:

› Timber drying – Tenon's wood processing plant near Taupō uses geothermal energy to heat its timber-drying kilns;
› Aquaculture and tourism – The Huka Prawn Park, near Taupō, 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 Taupō -based Gourmet Mōkai has reduced production costs for flowers (PlentyFlora) and tomatoes/capsicums (Gourmet Mōkai);
› Milk drying – The Māori-owned dairy company (Miraka) based near Taupō, 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.

Revisions made to geothermal primary energy supply

For information on this please see the revisions section at the back of this publication.

Woody biomass

The majority of woody biomass is used by pulp and paper mills, and wood processors to provide heat energy and generate electricity (cogeneration). A smaller quantity is used by households for space heating. Reasonable quality data exists for the former (44 PJ), while the latter (7 PJ) is estimated using census data on the proportion of households with wood burners and an estimate for the average firewood consumption per household from the HEEP study.[18]

Woody biomass is also increasingly used for process heat requirements by businesses outside the wood processing industry – this is discussed further towards the end of this chapter.

According to the Bioenergy Association, the number of accredited wood fuel suppliers has doubled over the last six months, and other suppliers are developing their quality assurance systems so that they can also become accredited.

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. 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.

18 The Household Energy End-use Project (HEEP) was a long-term study with the objective to measure and model the way energy is used in New Zealand households.

Biogas

Originating from a variety of non-fossil sources, such as wastewater and sewage; 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. In New Zealand, sludge gas is currently produced by Fonterra at the Tīrau dairy processing facility in Waikato. Cattle effluent is utilised to produce sludge gas that provides heat for the seasonal milk processing facility, 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 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 by and imported from sustainable sources. Bioethanol is produced by fermenting whey, a cheese by-product, and also from the waste produced during 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 to 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, rapeseed oil and used cooking oil, resulting in life-cycle greenhouse gas emissions 40 per cent to 50 per cent lower than those from fossil fuel-derived diesel. 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.

Tallow can be used in food such as shortening and pemmican, therefore using it as a biofuel can be controversial due to the food versus fuel dilemma.[19]

Since used cooking oil is a waste product and rapeseed is grown as a break crop on grain fields to increase soil quality, these biodiesel crops do not compete with food production or compromise biodiversity or soil quality.

Process Heat

Process heat is the energy used as heat mainly by the industrial and commercial sectors for industrial processes, manufacturing and space heating. This is often in the form of steam, hot water or hot gases.

Process heat energy demand is a significant portion of total energy demand in New Zealand. It is estimated that around half of the process heat demand was met by non-renewables sources such as coal and gas in 2016.

Reducing emissions from process heat will be important in achieving our climate targets, as process heat accounts for approximately 28 per cent of all New Zealand’s energy related emissions. It is expected that switching fossil fuel use to electricity or renewables sources, such as woody biomass, will reduce emissions and help New Zealand achieve its goal of being Net Zero by 2050.

19 The food versus fuel dilemma regards the risk of diverting farmland or crops for biofuels production to the detriment of the food supply.

Many existing coal-fired boilers still have decades of life remaining. They can be relatively easily converted to burning biomass instead of coal. However in some regions, such as Canterbury, the supply of woody biomass residues falls short of the energy demand for process heat.

In March 2019, Synlait commissioned New Zealand's first large-scale electrode boiler to replace their coal boiler. This boiler provides process heat and steam in its advanced dairy liquids facility at Synlait in Dunsandel. The replacement boiler has a 12 MW design capacity but is limited to 6 MW operational capacity as per current demand.

Fonterra are currently making changes within their Te Awamutu and Brightwater plants in Nelson. In Te Awamutu there is a 43MW coal-fired boiler which Fonterra is in the process of swapping for wood pellets. They have recently achieved 80 per cent of boiler steam capacity using these wood pellets and expect that by September they should be ready to run entirely on biomass. At the Brightwater plant Fonterra is trialling biomass supplementation in the coal supply for their 7 MW boiler. Coal is still necessary because the older boiler can't deliver the temperatures needed using wood alone. Fonterra has also announced plans to electrify production at its Stirling cheese factory in Otago.

French company Danone has said it would replace an existing 10 MW liquid petroleum gas (LPG) fuelled boiler at its Balclutha milk processing site with a new woody biomass unit. It is expected to be fully operational in 2021.

Golden Bay Cement is investing $26 million in a project to add shredded tyres to its fuel mix. This was expected to be completed in the second half of 2020, but could be delayed due to the COVID-19 pandemic. Golden Bay Cement currently uses a mix of coal and wood waste. By using shredded tyres, they expect to be able to halve their coal consumption to around 35,000 tonnes.

Canterbury District Health Board has committed to replace coal boilers at the Christchurch Hospital with two 7.5 MW wood biomass units.

The Government has announced it would provide up to $4.8 million to help eight schools make the switch from coal to wood biomass this year.

Further developments are expected but may be constrained by regional biofuel availability.

E. Oil and Gas

The 2019 calendar year is noteworthy mostly for being between two major events – the outages of the Pohokura gas field and Marsden Point Refinery in 2018, and the COVID-19 pandemic in 2020.

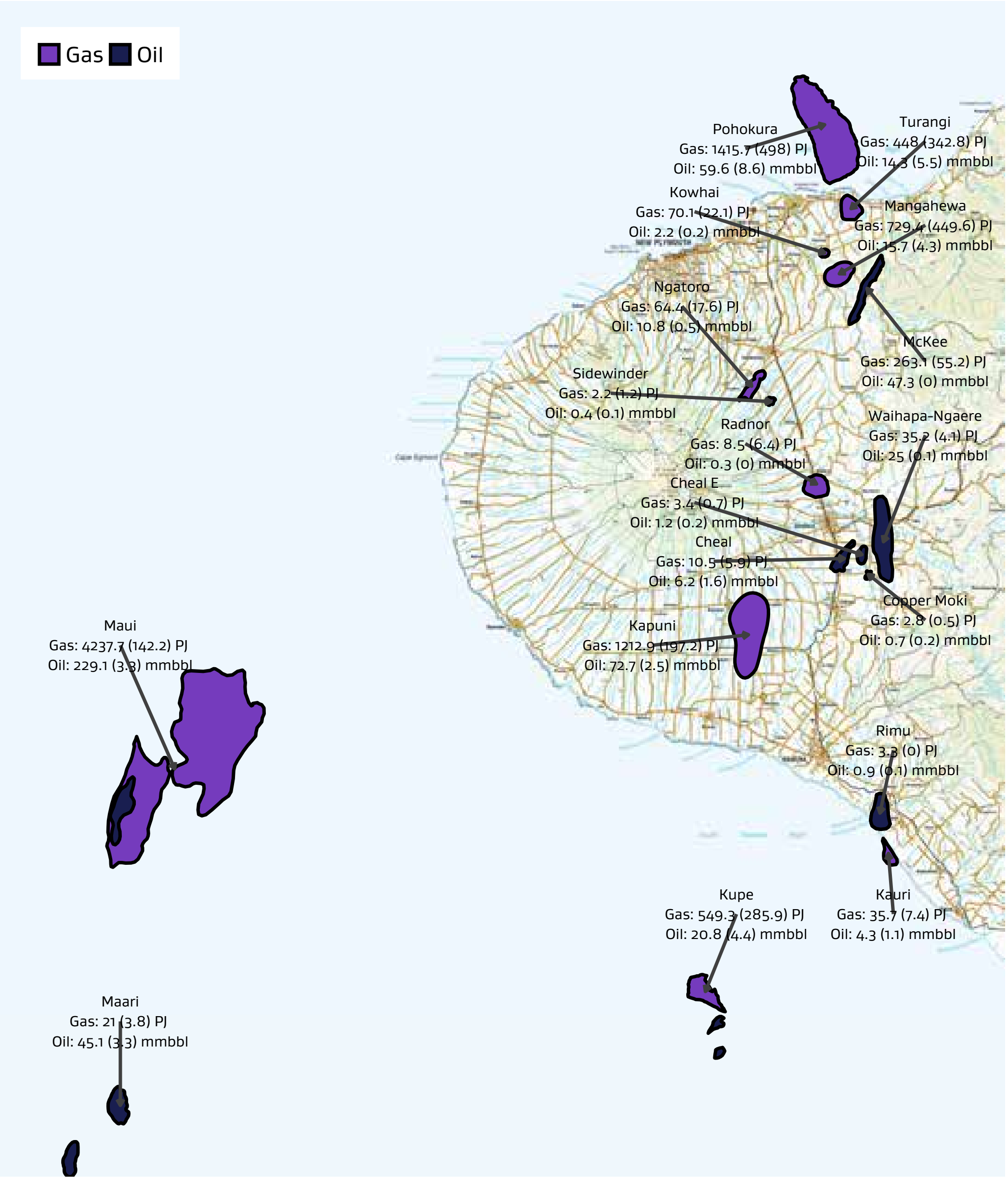
In 2019 gas production and consumption increased as Pohokura returned to operation. However production did not return all the way to 2017 levels (see box E.3 for more details).

At the time of writing, the effects of the COVID-19 pandemic on the energy market are still unclear. As such there is no way to know which of the existing trends in the oil and gas sector may be disrupted in 2020, and if they are, to what extent they will change. The best use of 2019's oil and gas data may be as a baseline to compare future data to, in order to evaluate the effect COIVD-19 had on oil and gas consumption and production in future years.

Reserves

Figure E.1 Map of Taranaki oil

Overview of Taranaki Offshore and Onshore Oil and Gas Fields
P2 Reserves Ultimately Recoverable (Remaining) as at 1 January 2020

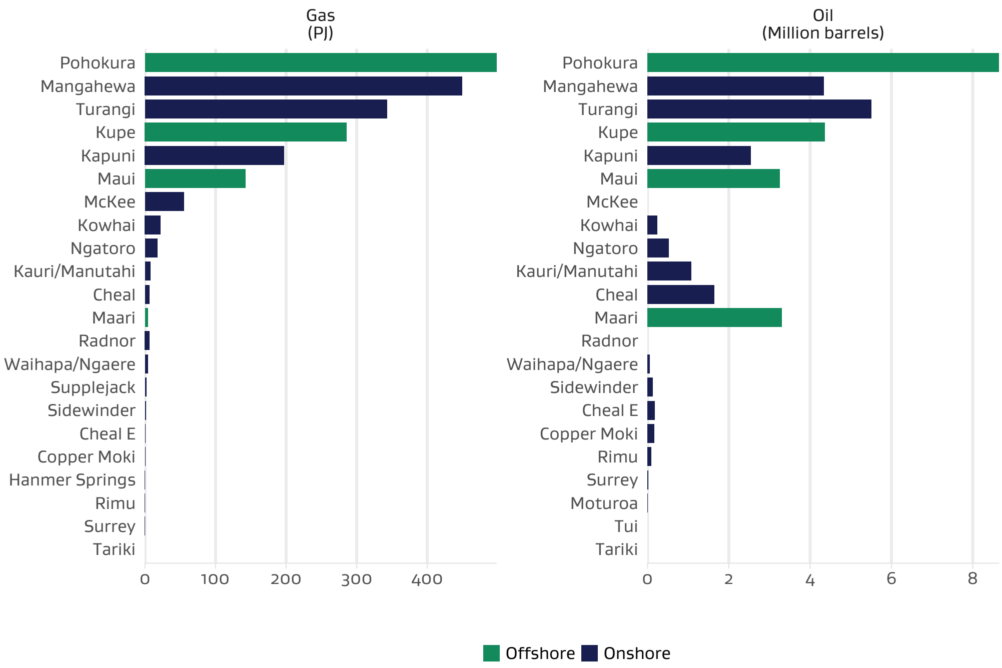


As part of their regulatory obligations, mining permit and license operators are required to submit information on their oil and gas reserves to MBIE. These figures are important because they show how much oil and gas remains in New Zealand. Gas reserves are an important indicator of energy security,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

Development focusing on existing fields

Figure E.2 shows New Zealand's remaining gas and oil reserves (2P) at 1 January 2020. These reserves are estimated volumes of petroleum, from known accumulations that have been demonstrated to be producible under anticipated technological and market conditions.

Figure E.2 2P Reserves as at 1 January 2020

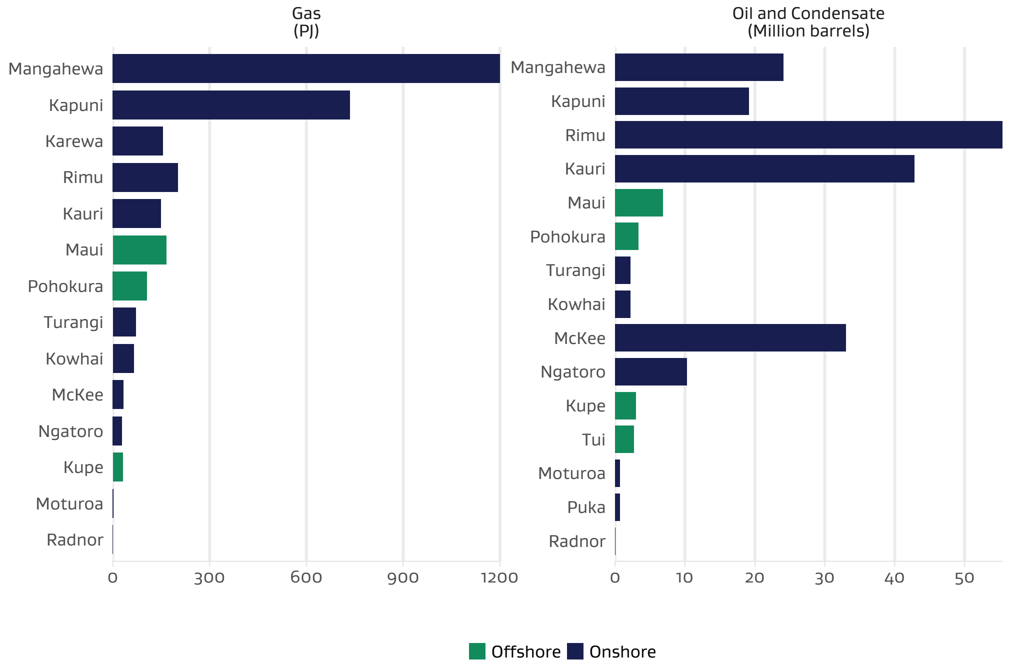


Most of the remaining reserves exist in four key fields – Pohokura, Mangahewa, Kupe, and Turangi.

Despite approaching the end of its productive life, the Maui gas/condensate field remains an important component in New Zealand's gas supply. In 2019, Maui accounted for 13 per cent of New Zealand's net gas supply (22.3PJ of 177.9PJ).

Ongoing investment in existing fields and facilities is important to unlock the value of contingent resources. Contingent resources are defined as quantities of petroleum which are 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 2020



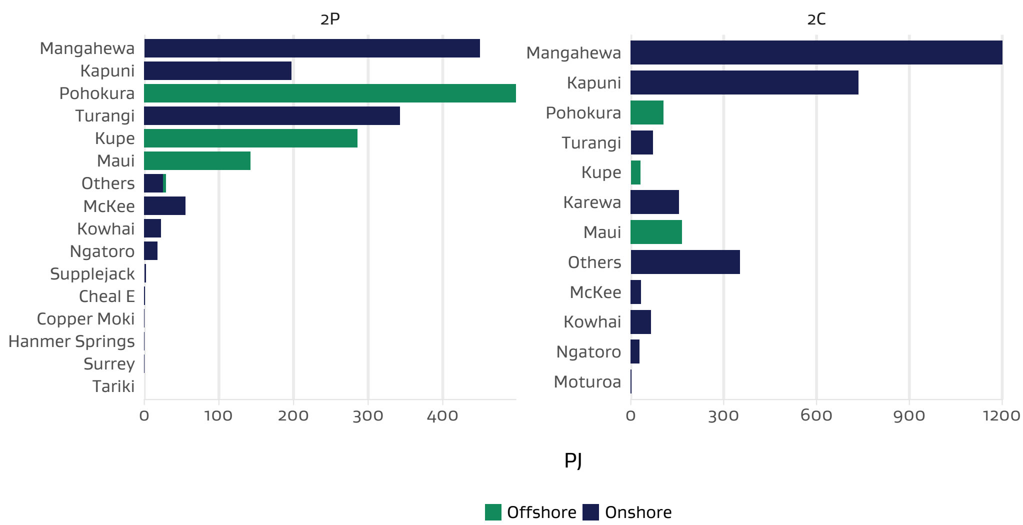
There are some key changes in contingent resources from 2019. Contingent gas resources for the Mangahewa field were revised up 236PJ and gas resources for the Rimu and Kauri fields were also revised up (200 PJ and 149 PJ respectively).

Mangahewa has been the subject of significant development work over the past few years, so this increase in the contingent resources suggests a better understanding of the field now.

While it is important to understand 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 reported the largest volume of remaining gas reserves, it also has very little contingent resources.

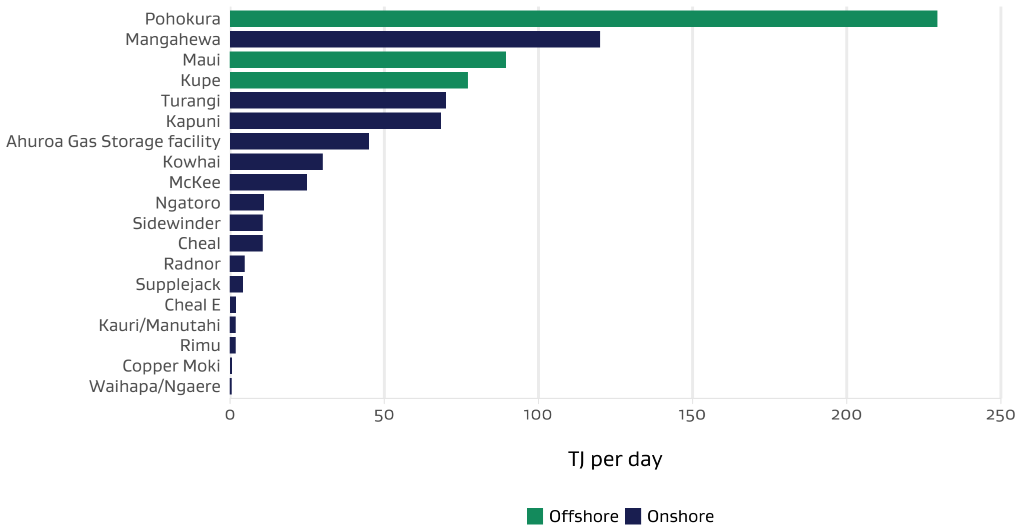
Figure E.4 Comparison of 2C and 2P gas reserves



Maui deliverability drops into third place

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 as at 1 January 2020



Pohokura is currently the most capable field New Zealand has in operation. It is capable of producing up to 229 TJ of gas per day. Any disruption at Pohokura has large impacts on New Zealand's gas supply.

The next biggest producer is Mangahewa, which can produce up to 120 TJ per day, while Maui has fallen into third place at 89.4 TJ per day. Maui is an aging field and its deliverability has been declining since 2014.

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

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 for an available area. These permits are generally non-exclusive and do not guarantee subsequent rights to exploration permits. Once a prospecting permit has been granted a 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.

Exploration

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.

Appraisal

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.

Development

If the appraisal activities show sufficient promise for further development a company may

Exploration and Development

Drilling activity increased in 2019 with a 12 new wells drilled in 2019, compared to 8 in 2018. $235 million was spent on well drilling in 2019, up 114 per cent on 2018. No 3D seismic acquisition took place in 2019.

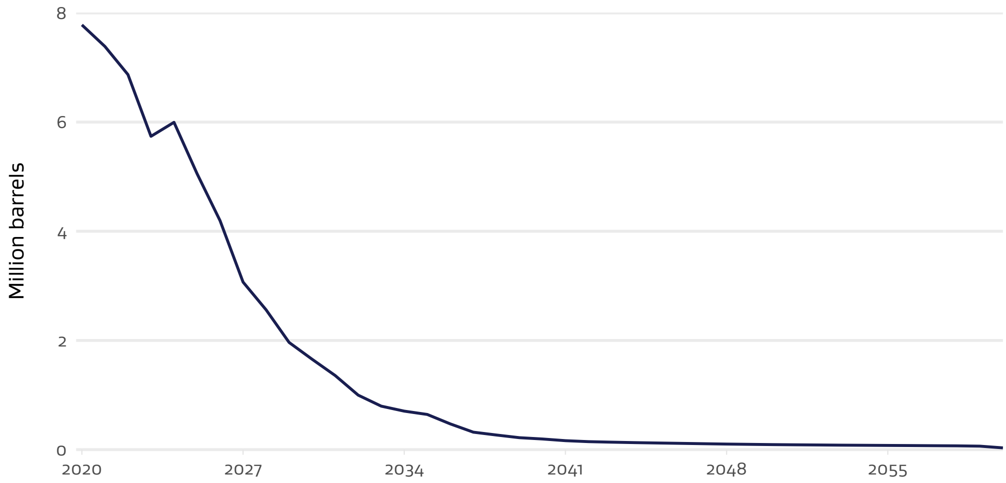
Permits

In 2019, five permits were surrendered and one permit expired. No permits were granted. This saw 50 remaining permits at granted status – 23 of which were exploration permits and 27 mining permits and licenses.

Expected production

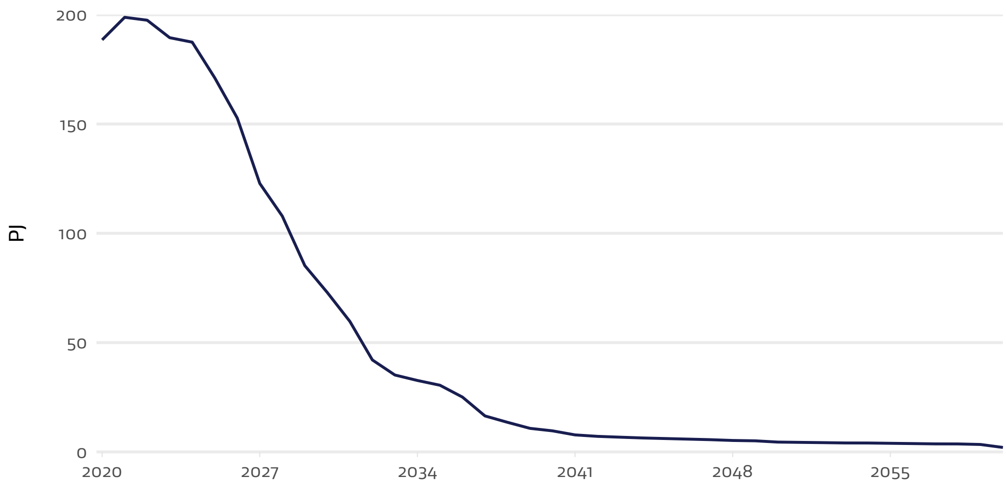
Overall, production of crude oil continues to decline as New Zealand's oil fields age. Development is continuing in several key fields to ensure ongoing supply for as long as possible. Current forecasts show operators are expecting a falloff in production from oil fields in the near future, followed 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

Figure E.7 Forecast gas production profile

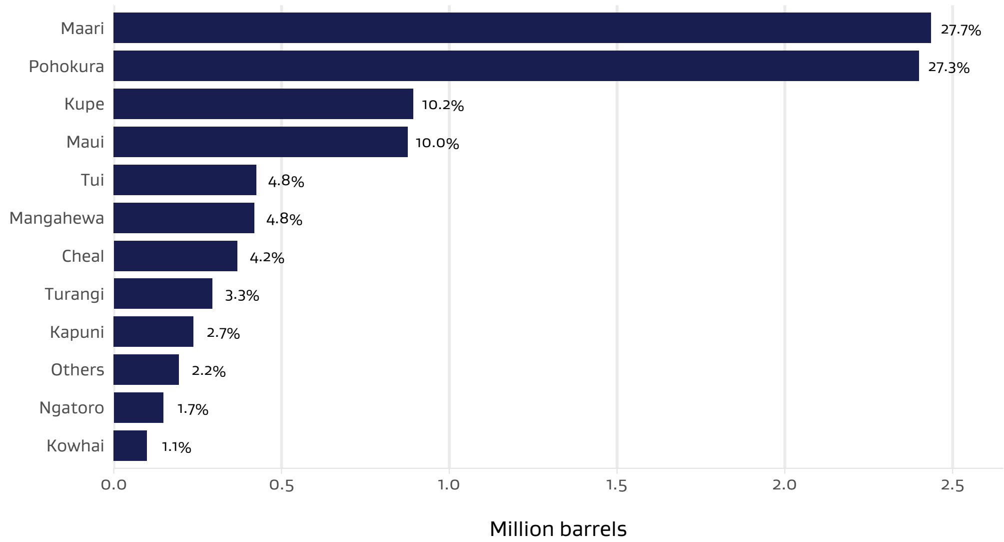


As reported to MBIE by field operators

Oil

Oil production continues to decline

Figure E.8 Indigenous oil production in 2019



New Zealand's oil fields have been largely in decline for the past several years. Almost all 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 10 per cent of New Zealand's oil and condensate.

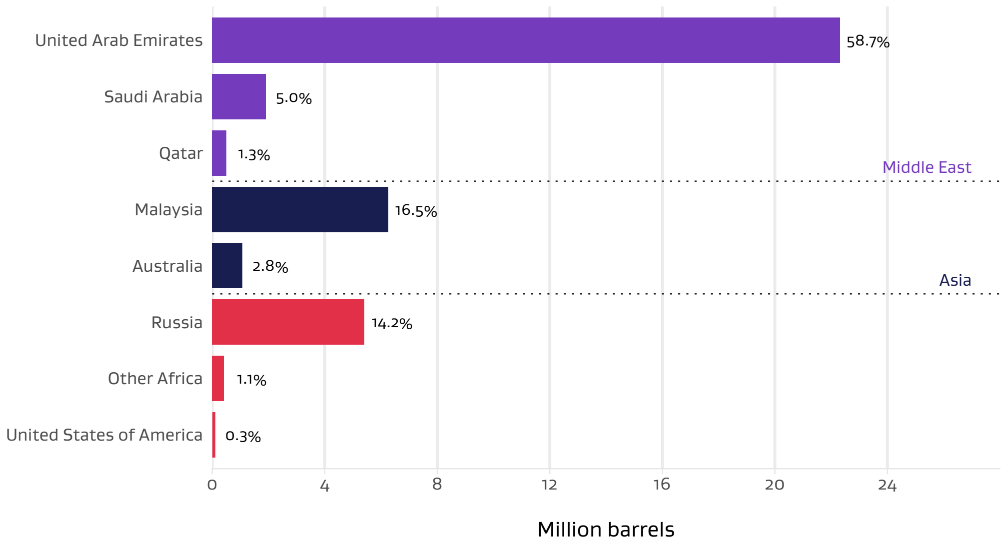
In 2019, production by Pohokura, one of the country's largest oil and gas fields was up 53 per cent from the previous year due to outages that occurred during 2018. For more information on the Pohokura outages and their impact on the New Zealand energy sector, see pop-out box E.4 in the Gas section.

Marsden Point refinery activity rebounded in 2019 after 2018 shutdown

The country's only refinery at Marsden Point shutdown for an extended period in 2018 to undergo a major refurbishment. In 2019, refinery output was up 1.67 million barrels (4.2 per cent) on the previous year. Even accounting for the 2018 outage, this is still an increase in activity, as it is 0.8 million barrels (0.19 per cent) higher than 2017 refinery output. However, as Refining NZ has recently decided to simplify its refinery operations and is considering moving towards an import terminal model, the refinery output may drop in future years.

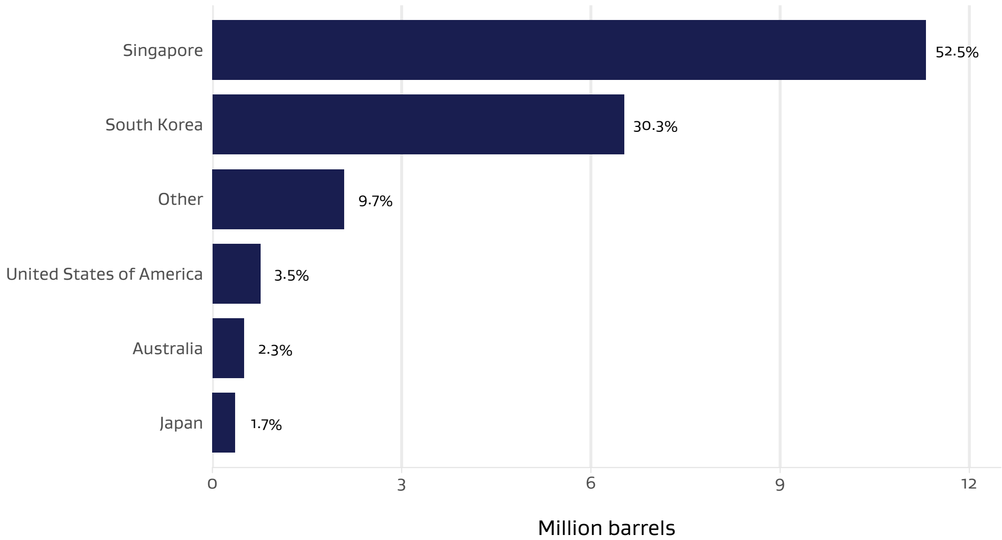
Crude oil intake at the refinery increased from 38.7 million barrels in 2018 to 40.9 million barrels in 2019. The majority of New Zealand's crude oil imports are sourced from the Middle East, with the remainder primarily coming from Malaysia and Russia.

Figure E.9 Crude imports by origin in 2019



Imports of most refined products decreased in 2019, with diesel imports down 2.8 per cent and petrol imports down 11.4 per cent. There were higher than usual imports in 2018, driven by the refinery shutdown. The majority of New Zealand's refined products are loaded in Singapore and South Korea, with 83 per cent of refined product imports in 2019 originating at these two ports.

Figure E.10 Refined products by port of loading in 2019

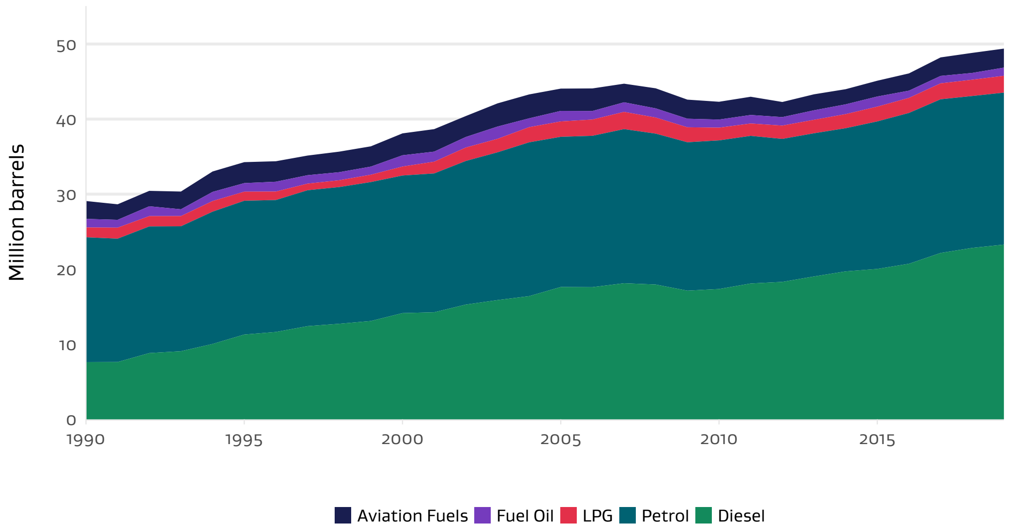


Refinery output of products such as petrol, diesel and aviation fuel rose 4.2 per cent in 2019, even accounting for the shut-down in 2018, refinery output was 2.4 per cent above 2017 levels.

Fuel oil consumption grows, while aviation fuels decline

Domestic oil consumption, covering use of oil products within New Zealand's borders, has been increasing since 2012. Fuel oil consumption increased 0.18 million barrels or 20 per cent over that period. However, in a break from recent years, aviation fuel consumption fell from last year (down 0.14 million barrels or 5 per cent).

Figure E.11 Domestic oil consumption by fuel



Terminal 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 2019.

Figure E.12 Port offtakes by fuel in 2019

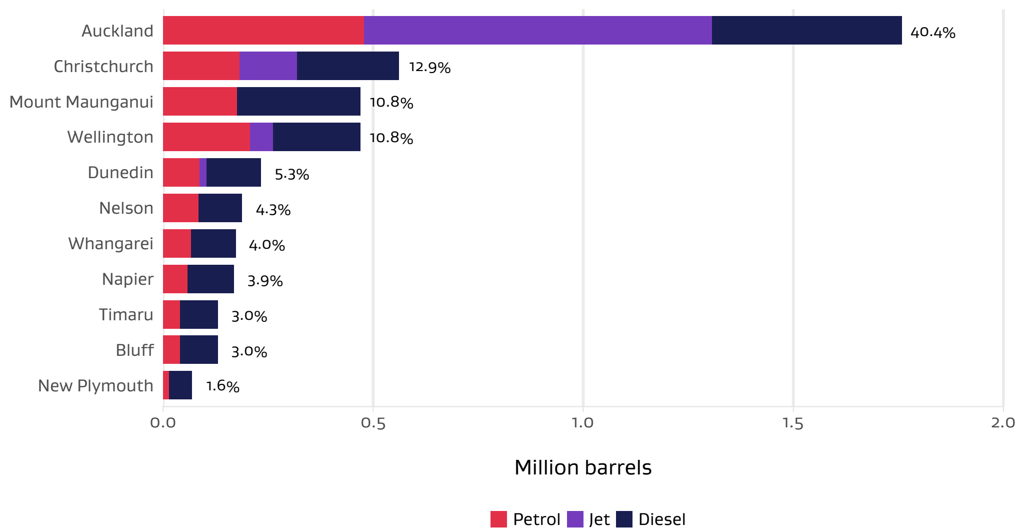
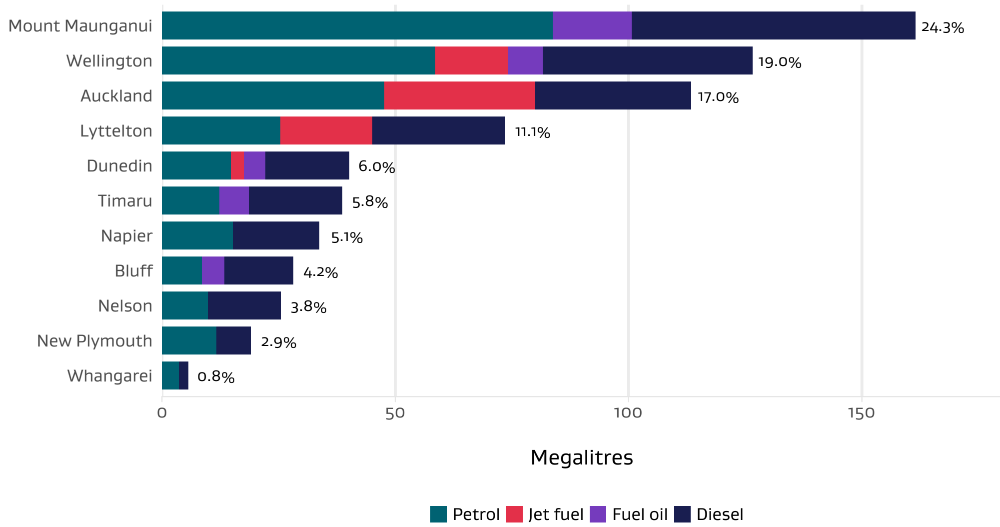


Figure E.16 shows the net fuel capacities by type and terminal. Tank capacities include some volume of fuel at the bottom of a tank that is not generally accessible. Net fuel capacities subtract this volume from the overall volume of the tank. Tank volumes were unchanged in 2019.

Figure E.13 Terminal capacities by fuel



Box E.2 Stock tickets and days of cover

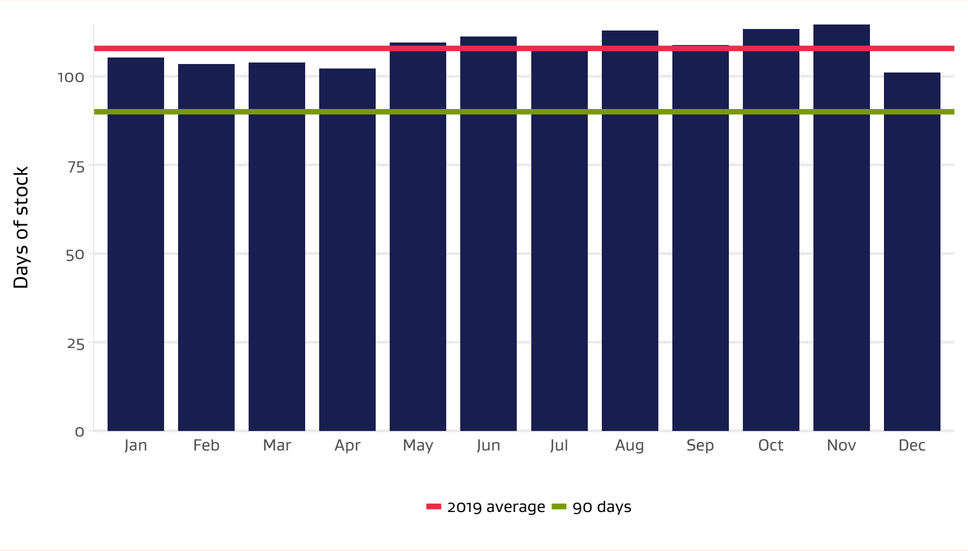
The International Energy Agency (IEA) was established in 1974 with the primary purpose of ensuring energy security around the world. It was formed in response to the oil crisis of 1973, where global oil prices increased significantly.

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 2019, New Zealand held on average 107.9 days of oil stocks. Monthly stock holdings can fluctuate around 90 days, depending on the timing of vessels arriving in New Zealand waters.

Box E.2 Figure 1 Days of stock



International events affected domestic retail prices

Periods of volatility in international oil prices were reflected in New Zealand retail fuel prices, with the highest retail prices in 2019 observed at the end of April.

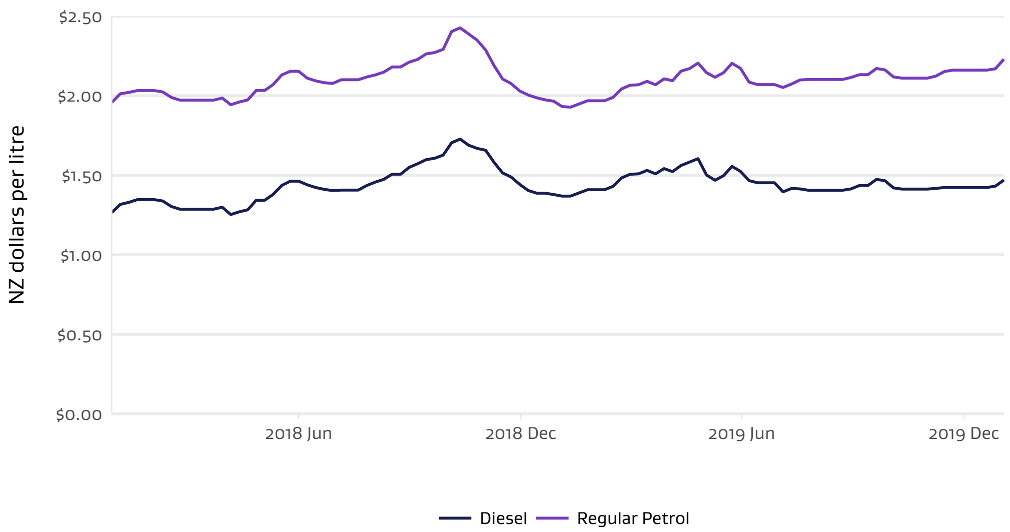
Geopolitical tensions drove uncertainty in the global fuel markets during April and May and fluctuations in the price of Brent crude. Sources of market uncertainty included US sanctions on Iranian oil supply, uncertainty of Venezuelan oil supply, and ongoing tariff discussions between China and the US. The volatility in international prices was reflected in New Zealand retail prices, with the highest prices for both regular petrol and diesel in 2019 observed in April, and a similar price for petrol observed in May.

The September 14th 2019 drone attacks on oil facilities in Saudi Arabia was another significant event to affect the international fuel market. The attack caused the suspension of around half of Saudi Arabia's daily oil production. The reduction of roughly 5.7 million barrels per day accounted for about 5 per cent of global oil production at the time.[20]

Prices for crude oil spiked following the attack. MBIE carries out weekly monitoring of retail price components of regular petrol and automotive diesel. This monitoring shows that in the week following the event, higher prices for Dubai crude oil contributed to higher importer costs for diesel and petrol, with an increase of 5.6 and 8.8 cents per litre (NZD) respectively. This saw the retail price for diesel and petrol both rise 3.9 cents per litre in the week ending Friday September 20th. The impact on the market was not long-term however, and prices in New Zealand were not affected beyond September. Spare capacity in the global fuel market and confidence in Saudi Arabia's ability to restore production saw prices for Dubai crude oil return to pre-attack prices by October.

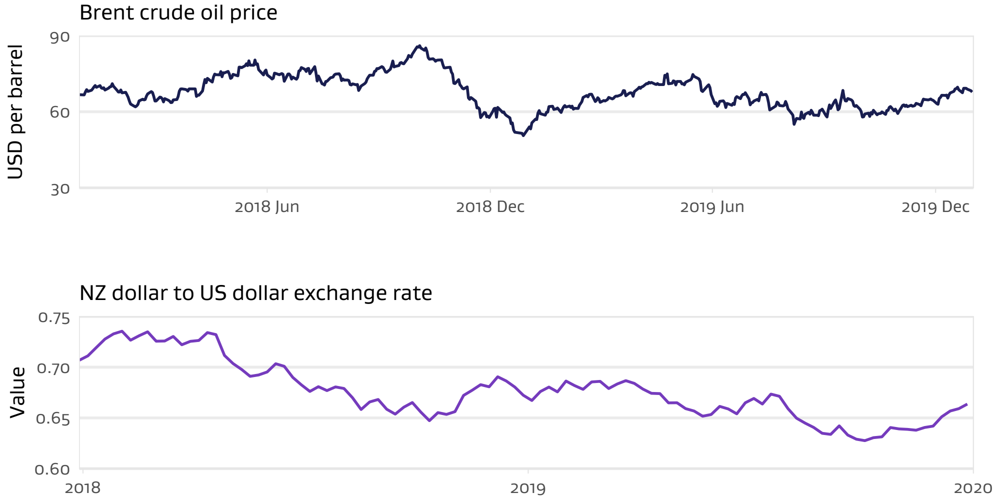
Overall in 2019 New Zealand retail fuel prices increased from the beginning of the year, largely driven by the increased price of crude internationally. Diesel rose 5.3 cents per litre, closing the year at $1.43 per litre. Regular petrol rose 20.4 cents per litre to end the year at $2.17 per litre. While global events caused price spikes in 2019, prices did not reach the peak experienced in October 2018.

Figure E.14: MBIE discounted retail prices of petrol and diesel



20 https://www.bbc.com/news/business-49710820

Figure E.15: Brent crude oil prices and exchange rate



Box E.3

Commission makes recommendations to improve retail fuel market competition

In December 2019 the Commerce Commission published the final report on the Market study into the retail fuel sector. The Commission was required by the Government in December 2018 to carry out a market study into any factors that may affect competition for the supply of retail petrol and diesel used for land transport throughout New Zealand.

Studies into the fuel sector had been undertaken previously, however the 2018-2019 Commission study was commenced after changes to the Commerce Act in November 2018 gave the Commission new powers to undertake market studies.

The Commission found that fuel companies had been making persistently higher profits over the past decade than would be expected in a competitive market, and that higher than expected wholesale prices were flowing through to consumers paying higher prices at the pump.

The core problem identified in the report was the lack of an active wholesale market in New Zealand. The study found that major fuel companies' joint infrastructure network gave them an advantage over other fuel importers, creating cost barriers for potential new entrants into the wholesale market. Additionally, wholesale supply relationships and restrictive contract terms were limiting reseller's ability to switch fuel suppliers, impacting the retail market.

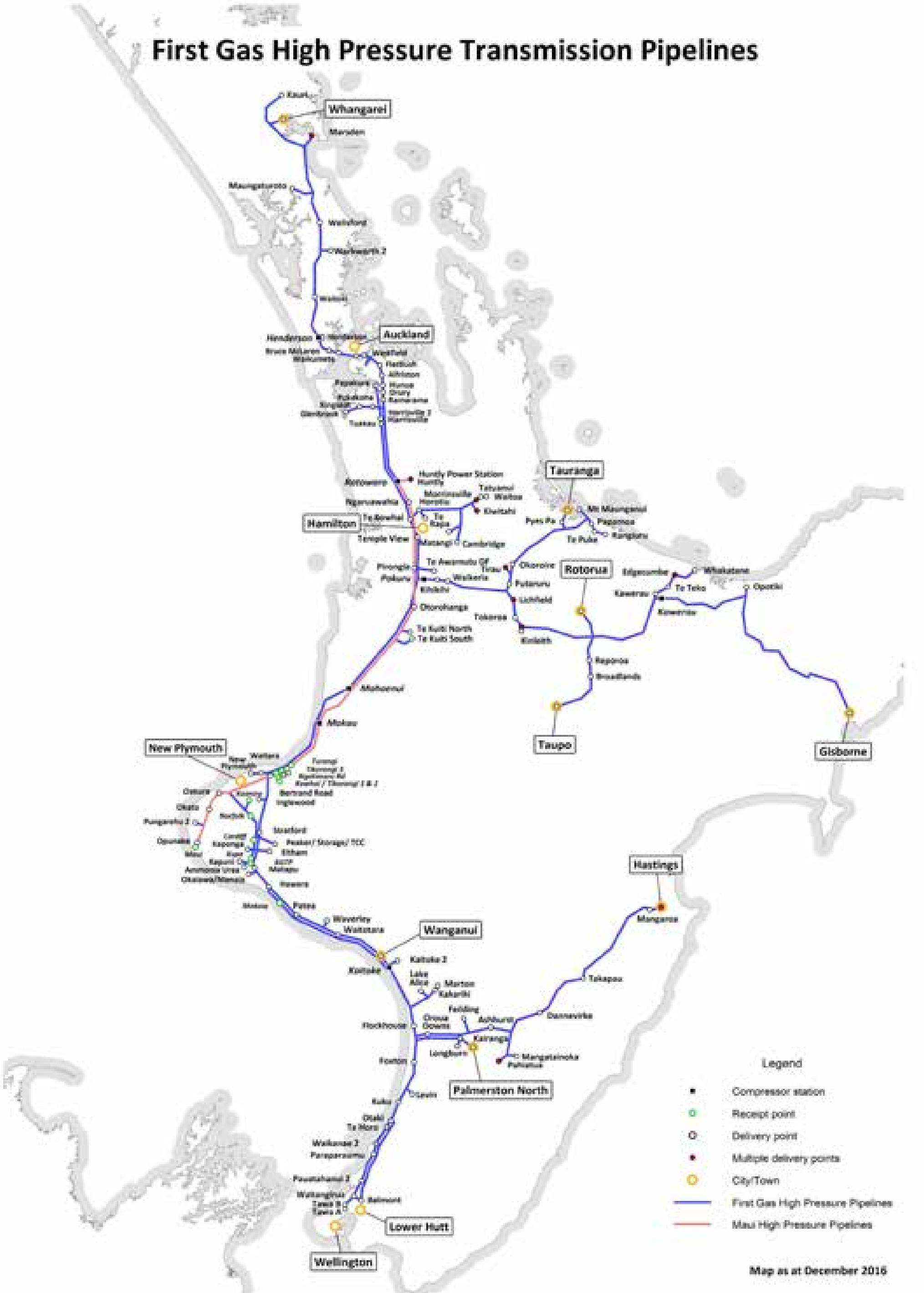
The Commission provided a number of recommendations for improving competition in the retail fuel market. These related primarily to improving wholesale market competition, and better informing consumers. Key recommendations included

- Introducing transparent wholesale pricing at fuel terminals ('terminal gate pricing') to stimulate wholesale competition
- Regulating wholesale supply contracts with resellers to allow resellers greater freedom to compare offers and switch suppliers
- Requiring retailers to display the price of premium fuel on price boards, alongside the price of regular octane.

In response to the Commission's recommendations, the Government has introduced the Fuel Industry Bill. More information on the Bill can be found at www.parliament.nz/en/pb/bills-and-laws/bills-proposed-laws/document/BILL_99315/fuel-industry-bill.

Gas

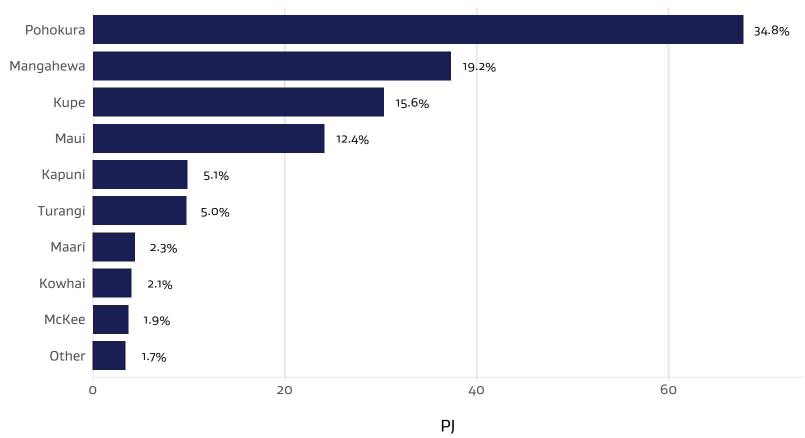
Figure E.16 Gas transmission map



Maui net production falls 25 per cent

While net production at the Pohokura Field increased by 14.9 PJ in 2019 (28 per cent), its annual production was still 4.3PJ (or 6 per cent) below 2017 levels. Combined with a 7.3 PJ (25 per cent) drop in Maui's net production, net production has not rebounded as much as could be expected given the re-opening of the Pohokura field, and is still 6 per cent below 2017 levels.

Figure E.17. Gross gas production by field in 2019

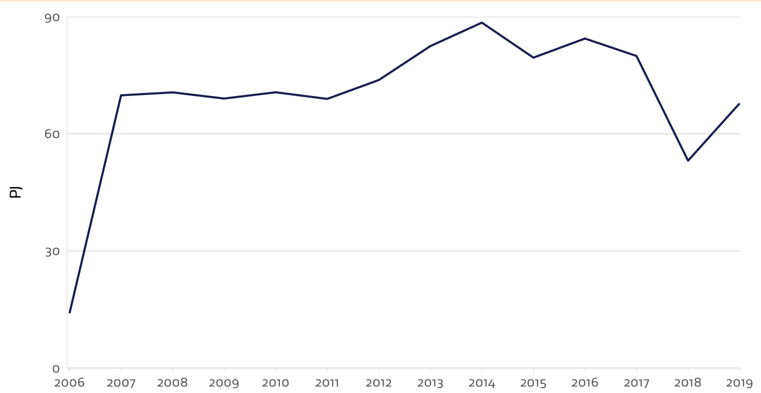


Box E.4 Pohokura outage recovery and impact on energy markets

In March 2018, a regular inspection of the 10.8 kilometre offshore pipeline from the offshore Pohokura wells to the onshore gas production station found bubbling. 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 in 2018. In 2019, production partially recovered to 68 PJ.

Box E.4 Figure 1 Pohokura production

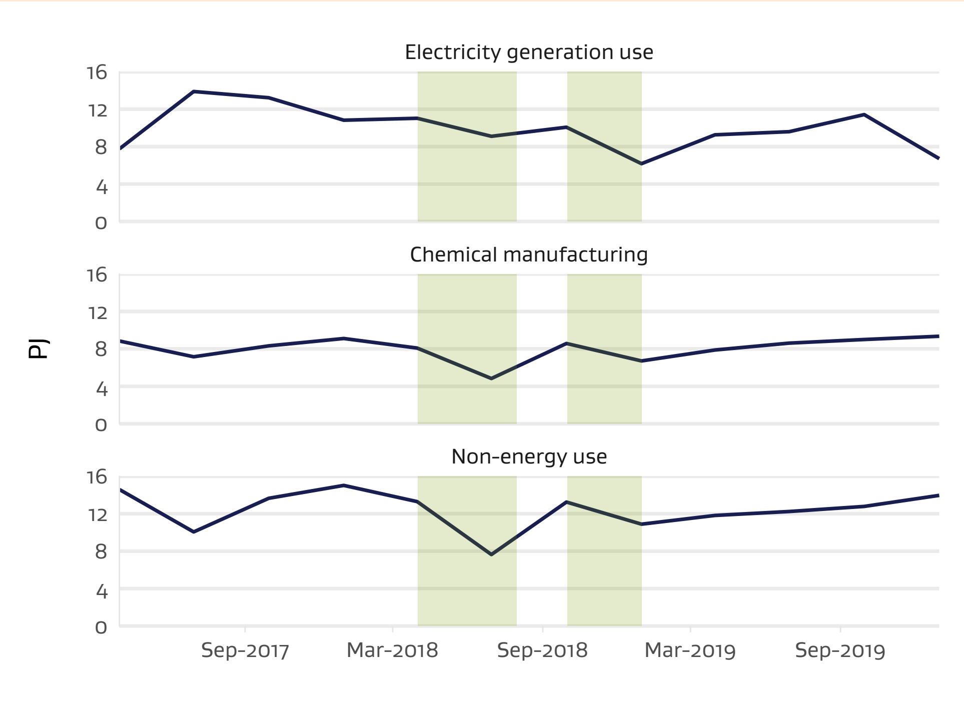


Pohokura experienced two main outages during 2018. These were from March to July, and from September to December. During these periods, the Pohokura field was still operational but at a reduced capacity. As Pohokura usually produces around 40 per cent of all gas used in New Zealand, this reduction in 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.

Non-energy use and chemical manufacturing both started to trend up after the second outage ended, returning to 2017 levels by the end of 2019. Electricity generation was on a similar track, but dropped back again in December 2019.

Box E.4 Figure 2 Gas use during Pohokura outage

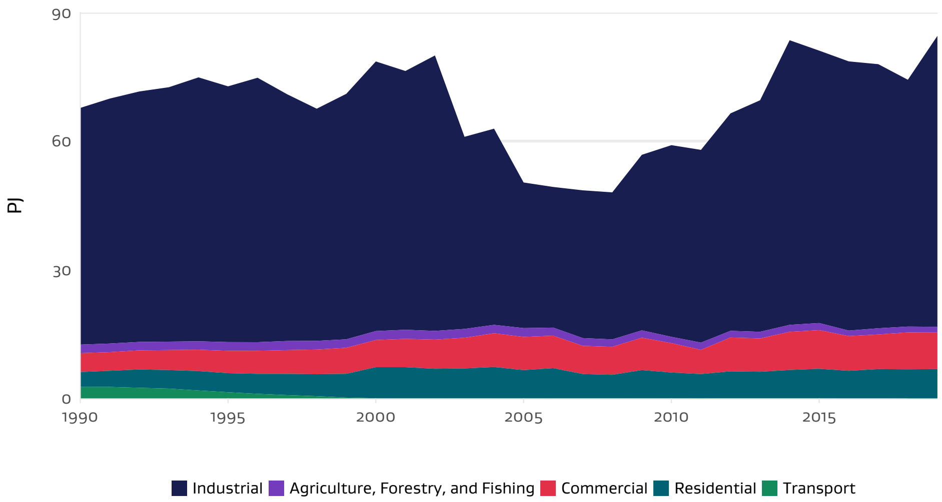


Gas use rose following Pohokura reopening

Non-energy use of gas increased 13 per cent in 2019, driven primarily by Methanex's production. However non-energy use was still 5 per cent below 2017 levels, reflecting the partial recovery of gas production in 2019.

Overall, consumption increased 14 per cent, driven by Industrial gas consumers, especially food processing and chemical production.

Figure E.18 Gas consumption



Record year for natural gas trading on the emsTradepoint platform

2019 saw record highs on emsTradepoint's natural gas trading platform for both volume traded and price, following steadily increasing trading volumes on the platform and a brief unplanned production outage.

emsTradepoint is a subsidiary of Transpower. It was established in 2013 to provide greater flexibility to the gas market where long-term supply agreements dominated. Participants can trade natural gas anonymously on the platform, which also acts as a clearing and settlement service for all trades.

In New Zealand, the majority of natural gas purchases are made under bilateral agreements between producers, wholesalers, gas retailers, and sometimes direct end-users. The terms of these contracts are usually confidential and can be for large volumes over a long time. Trades on emsTradepoint can be as small as 1 GJ, allowing for trades of almost any size between participants. The platform also enables price transparency for spot market and forward trades.

Use of emsTradepoint has increased significantly since it was established. Figure E.19 shows the increase in volume traded on emsTradepoint over time (volume is presented against the month gas was delivered, which is not necessarily the month the trades were agreed upon). Monthly forward trade volumes grew over 2019, with the majority of volumes delivered in the second half of the year being off-market trades conducted via accredited brokers operating on the exchange.

In October 2019 a record high of 1.56 PJ total traded volume[21] was recorded on the platform. Increased forward trading activity also occurred in 2019, with August seeing trades beyond the end of a calendar year for the first time. There were also new types of trades during the year, in the form of "time-swap" trades in October 2019. A time-swap trade is where two participants swap a fixed daily quantity of gas for a specific time period against an equal and opposite quantity for another specific time period. Due to their nature, time-swaps are always conducted as off-market trades, often via brokers.

21 Includes both market and off-market trades

While the volume traded on emsTradepoint has increased, the majority of gas purchased in New Zealand is still via agreements made outside of the platform. Total volume traded on the platform (including off-market trades) accounted for 3.33 PJ of gas delivered in the 2019 December quarter, equivalent to 7 per cent of net gas production over the same period.

A record high spot price of $38.25 dollars per GJ was also observed in May 2019, when a short unplanned outage at the Kupe field occurred at the same time as the planned outage underway at the Pohokura field.

The gas price on emsTradepoint is inclusive of a carbon component. The carbon component takes the closing spot price for carbon on a day and converts it to dollars per GJ using the MBIE published emissions factor. The carbon component of the gas price averaged $1.34 in 2019.

Figure E.19 emsTradepoint

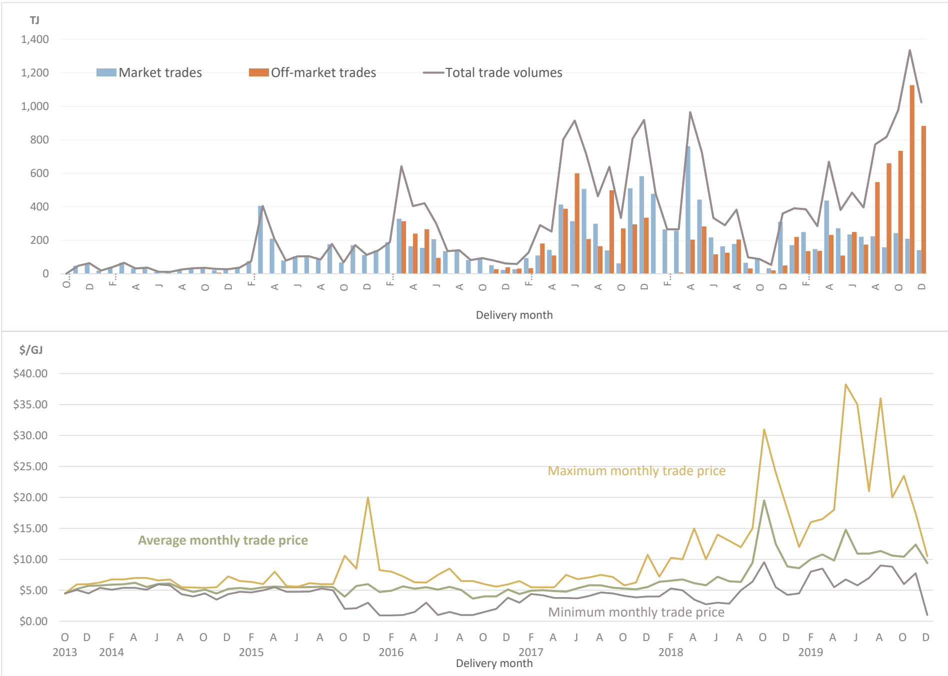


Chart source: Gas Industry Company Limited, Performance Measures Quarterly Report to December 2019. Data from emsTradepoint

F. Coal

Coal production remained largely stable due to the domestic production capacity and high stock built in the previous year for managing the risk of further unscheduled gas outages.

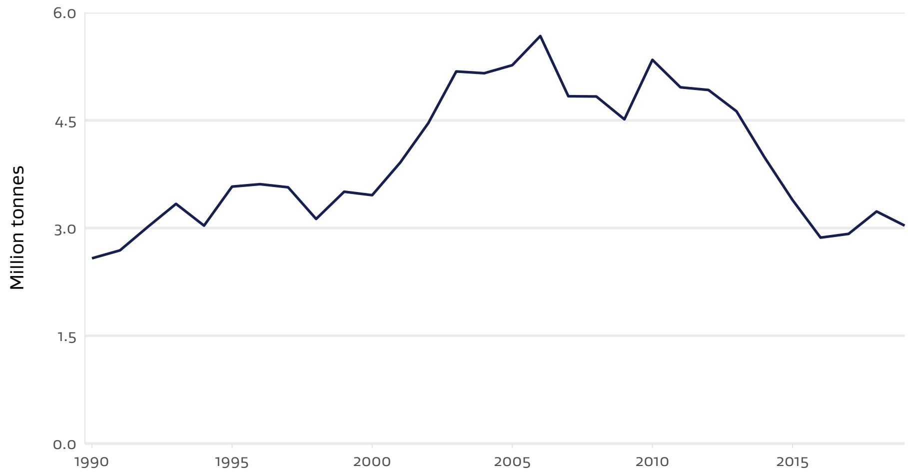
As a result of energy demand and domestic production capacity, coal import increased significantly, primarily for electricity generation. Coal exports also increased on the back of relatively high international coking coal price. Coal consumption was steady overall.

There were 18 operating mines at the end of 2019.

Coal production

Coal production was 3 million tonnes in 2019, a decrease of 6.1 percent on the previous year.

Figure F.1 Coal production



Coal production in New Zealand for the year of 2019 was 3 million tonnes (80 PJ), a decrease of 6.1 percent from 2018. This was due to the domestic production capacity and high stock built in the previous year for managing the risk of further unscheduled gas outages

Other aspects of New Zealand's coal production in 2019 include:

› Sub-bituminous coal production from both islands decreased in 2019 by 9.3 per cent (149 kt) from the high demand in 2018. Production from North Island mines was down by 14.7 per cent (145 kt) on the previous year. Sub-bituminous coal production from South Island also decreased slightly by 0.8 per cent (5 kt).

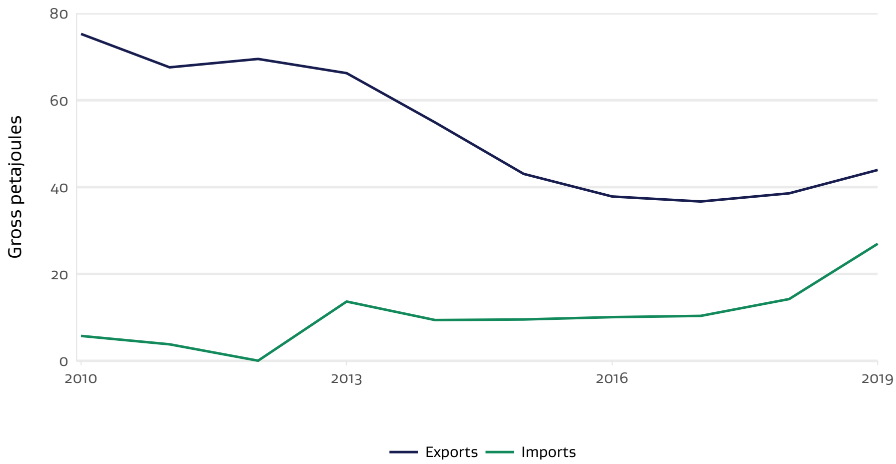
› Bituminous coal production was relatively unchanged, down 2.3 per cent (30 kt) on last year.

› Lignite production was relatively unchanged, down 6.4 per cent (19 kt) on last year.

Trade

Both coal exports and imports increased in 2019.

Figure F.2 Coal exports and imports



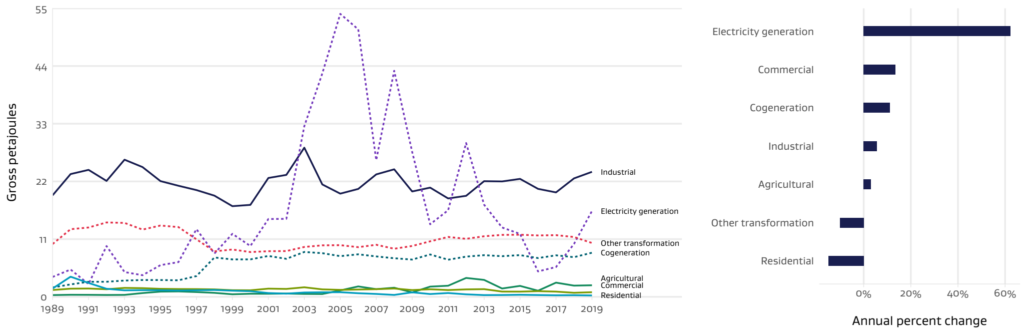
Coal exports increased by 13.9 per cent to 44 PJ in 2019. This was due to relative high and stable international coking coal price throughout the year.

Coal imports increased by 89.4 per cent to 27 PJ. This was due to the increased demand for electricity generation, constraints on domestic production, and the need to supply required amounts at short notice.

Coal use

Coal use for electricity generation increased significantly in 2019 due to increased demand. Other coal use remained relatively stable.

Figure F.3 Coal consumption and annual percent change by Sector



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 2019 was 64 PJ, an increase of 18 per cent on the previous year. Coal accounted for approximately 7.1 per cent of New Zealand's total consumer energy supply.

Consumption

Coal consumption was relatively steady, with an increase in industrial, agricultural, and commercial use more than offsetting a decrease in 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 consumption in aggregate.

Coal consumption in the Industrial sector increased by 5.5 per cent (1.25 PJ) on 2018 levels driven by demand for the dairy sector and the use of lignite being replaced by sub-bituminous coal, which has a higher energy content. Total consumption for 2019 was 27 PJ, an increase of 5.3 per cent (1.37 PJ) on the previous year.

Transformation

Electricity generation from coal increased by 43 per cent in 2019, driven by an increase need for non-renewable generation due to less favourable hydrological conditions and lower gas availability.

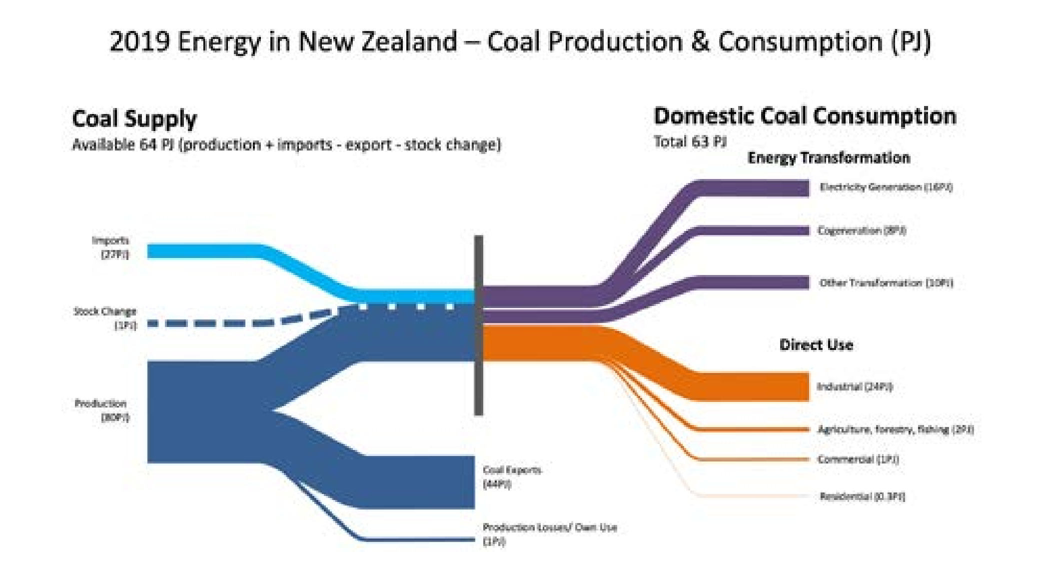
Changes in coal use in the North Island are heavily influenced by Genesis' Huntly power plant. This power plant is the only coal-fired power plant in New Zealand, and is important for New Zealand's security of electricity supply requirements in dry years and amid a gas shortage to meet winter energy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

Coal use for other transformation processes (including iron and steel use) is down approximately 10 per cent on 2018 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



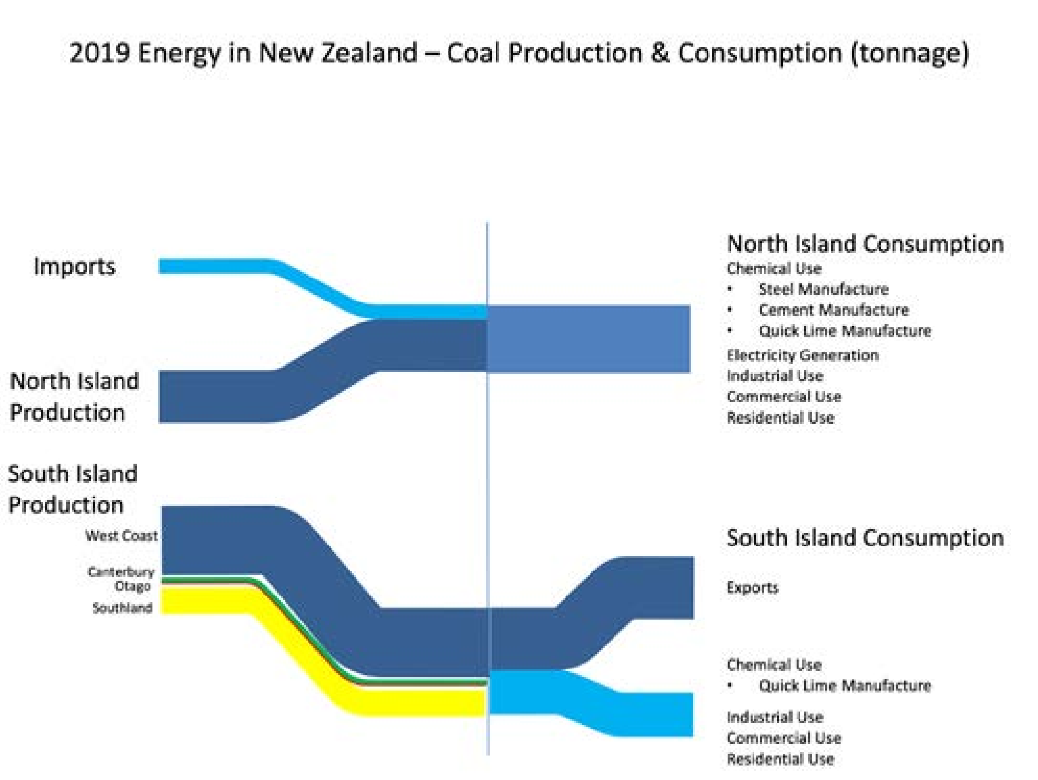


Table F.1 Coal Supply, Transformation and Consumption (Petajoules)

Measure	Coal Use	31/12/2018	31/12/2019	Dec-on-Dec	% Change
Supply	Production	83.78	79.99	-3.79	-4.5%
	Imports	14.23	26.95	12.72	89.4%
	Exports	38.57	43.95	5.38	13.9%
	Stock Change	5.01	-1.25	-6.26	-124.9%
	Production Losses and Own Use	0.84	0.72	-0.12	-14.4%
Transformation	Electricity Generation	10.08	16.36	6.29	62.4%
	Cogeneration	7.56	8.41	0.85	11.2%
	Other Transformation	11.41	10.26	-1.14	-10.0%
Consumption (Observed)	Agriculture, Forestry and Fishing	2.14	2.21	0.07	3.1%
	Commercial	0.77	0.88	0.10	13.5%
	Industrial	22.58	23.83	1.25	5.5%
	Residential	0.31	0.27	-0.05	-14.9%

Coal sector backgroud

New Zealand has extensive coal resources, mainly in the Waikato and Taranaki regions of the North Island, and 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 Maramarua 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: Coal extracted on the West Coast of the South Island comprises both bituminous and sub-bituminous coal, with the majority being bituminous coal. The bituminous coal produced is generally exported for metallurgical applications.
- 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.

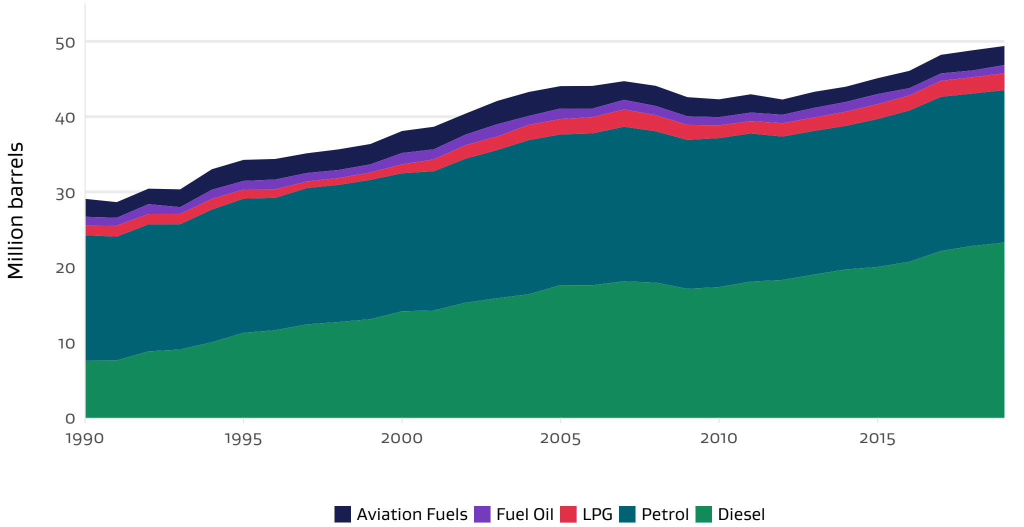
There are also two major non-energy uses for coal in New Zealand:

- At 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".
- At 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".

G. Transport

Transport is a source of significant demand for energy. In New Zealand it currently accounts for around 40 per cent of national energy demand. Nearly all imported oil and petroleum products are used for transport, with the majority used for road transport. The chart opposite shows the growth in domestic consumption of the various petroleum fuels over the last thirty years. Essentially all petrol and diesel is used for road transport and most fuel oil is used by ships and fishing vessels. Only a small amount of LPG is used by vehicles, with most used in stationary heating applications.

Figure G.1 Oil consumption by fuel



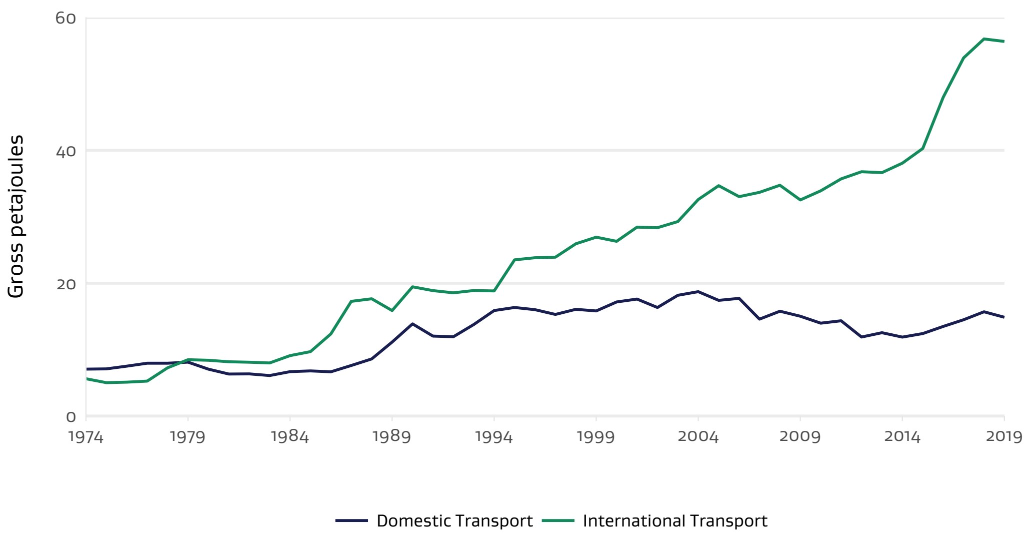
Diesel is used mostly by trucks and buses, while petrol is used mostly by cars. Diesel use is closely associated with GDP, and freight or traffic flows are often cited as real-world, real-time indicators of economic activity.

Changing aviation demand

Demand for aviation fuels, particularly jet fuel for international transport, had a rising trend between mid-1990s and 2018, with a marked jump between 2014 and 2018 mainly due to an increase in international passengers and long-haul flights.

However, in 2019, demand for aviation fuels started to slow down, with a 1 per cent decrease in international transport demand, and a 5 per cent decrease in domestic travel demand. It is expected that demand for aviation fuels will drop even further in 2020 due to the border restrictions that are put in place in response to COVID-19. Fuel sales data collected to date indicates that, subsequent to the introduction of border restrictions in March 2020, jet-A1 volumes have fallen to around 28 per cent of their pre-lockdown levels.

Figure G.2 Aviation fuel use



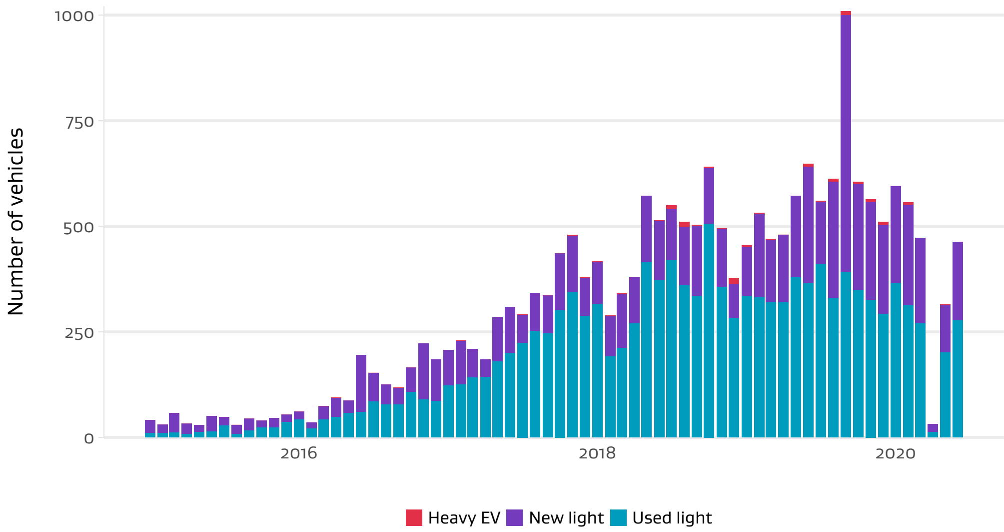
Electric Vehicles

While most energy used for transport comes from petroleum products (over 230 PJ per year), a small but increasing amount has been delivered through electricity. For 2019 this has been estimated as 0.39 PJ.

At the end of 2019 there were over 18,600 registered electric vehicles on the roads in New Zealand. An additional 7,000 where registered in 2019 alone. However, when looking at the monthly EV registrations shown in Figure G.3, the exponential growth in uptake that was observed from 2015 to 2017 has not been maintained, and the trend from 2018 onwards appears more likely to be linear. September 2019 saw a large number of pre-ordered Tesla Model 3s enter the country. The impact of COVID-19 lockdown restrictions can be seen in April 2020.

As for charging stations, by the end of 2019 there were 367 public chargers across the country. This number is expected to grow in the coming years.

Figure G.3 Monthly EV registrations (data source: Ministry of Transport)



Electric rail and buses

The use of electricity for heavy transport in New Zealand dates back many years. Electrification of the Wellington suburban railway started in 1938. Recent developments of note include the introduction of electric trains in Auckland and the retirement of trolley buses in Wellington.

The North Island Main Trunk (NIMT) line and the Auckland suburban rail network both use AC grid electricity. The NIMT runs from Auckland to Wellington, but is only electrified between Palmerston North and Hamilton. The Auckland rail network was fully electrified in 2015. The Wellington suburban electric trains utilise a 1.6 kV DC overhead catenary. The South Korean-built Matangi units were introduced in 2012.

The Wellington trolley buses were taken out of service in October 2017. In June 2020 Metlink announced that Wellington would be taking delivery of an additional 98 electric buses between mid-2021 to early 2023.

Electric boats and ships

The Wellington Electric Boat Building Company, established in late 2018, is in the process of building the first fully electric ferry in the Southern Hemisphere. The company specialises in the construction of ultra-light weight, carbon-fibre composite catamarans with high energy efficiency and a 100 per cent battery electric power train for zero emissions operation. Their first contract is to deliver a 135 passenger public transport ferry for East by West Ferries in Wellington. It will operate on the Queen's Wharf to Days Bay route at speeds up to 20 knots. East by West's current fleet of two ferries uses about 250,000 litres of diesel per year. The cost of electricity used to power the new electric ferry would be up to 60 per cent less than the cost of using diesel. Charging will involve a 15 minute fast charge (~1 MW) between each round trip, as well as a longer 1 hour charge in the middle of the day. Research and development work for the ferry has been supported by Callaghan Innovation, and demonstration work has been supported by EECA.

In 2019 Ports of Auckland announced they were buying an electric tugboat - the world's first full-size, fully electric port tug. The boat is being built in Vietnam, by Dutch shipbuilder Damen Shipyards with delivery expected late 2021. The new e-tug will be able to do three to four shipping moves on a full charge, or around three to four hours work. The 1.5 MW charging station will be able to fully recharge the tug's batteries in about two hours. Those batteries have a capacity of 2,800 kWh – equivalent to 70 Nissan Leafs. While the price tag is approximately double that of a standard diesel tug, the Port expects to recoup that through operational savings over the 25-year lifespan.

Micromobility: The future of urban transportation

Micromobility offers a fast and convenient mode of transport for 'last-mile' mobility in urban areas. Various definitions of micromobility exist including those that cover human-powered transport such as standard bicycles. Here we only consider those lightweight devices capable of moderate speed which utilise commercial forms of energy such as electric scooters, e-bikes, and electric skateboards.

There has been a recent increase in the uptake and prevalence of electric scooters, both through private ownership and public scooter-sharing systems. Such systems utilise mobile phone based applications, along with GPS tracking which allows companies to gather usage statistics and charge customers for the ride. Brands of scooters commonly seen in New Zealand include Lime, Flamingo and Jump. A formal estimate of the energy used by e-scooters in New Zealand has not been made, although the total level is not expected to be significant.

Electric scooters are generally an efficient mode of transport. For example, taking a ten kilometre trip on an e-scooter might require approximately 0.09 to 0.17 kWh (0.3 to 0.6 MJ) of energy. In comparison, the same distance taken on foot would require energy expenditure of between 0.56 and 0.88 kWh (2.0 and3.2 MJ). However, this estimate of the energy directly used by the scooter does not account for the energy cost involved in collecting the discharged scooters and then redeploying the fully charged scooters. Typically, electric scooters need around half a kilowatt-hour of electricity to fully charge the battery. The nightly collection and redistribution by people using cars will almost always use more energy than is actually used by the scooters themselves. In an attempt to increase energy efficiency and reduce costs, some scooter companies are looking at introducing swappable batteries.

Hydrogen: the other electric vehicle

Hydrogen fuel cell vehicles are another sub-type of electric vehicle. Instead of using a battery, energy is stored in the form of hydrogen which is then converted into electricity using a fuel cell. This has several advantages over battery-electric vehicles:

- Stored hydrogen weighs less than an equivalent battery
- Hydrogen can be refuelled in minutes
- Hydrogen vehicles have a longer range
- The hydrogen tank takes up less space than an equivalent battery
- Hydrogen can be produced domestically using renewable resources

Due to these factors, hydrogen has great potential to convert transport, particularly heavy transport, away from fossil fuels and reduce our foreign oil dependence.

In November 2019, Hyundai launched its first hydrogen powered SUV in New Zealand, the Hyundai Nexo. The Nexo has a range of over 660 km on a single tank of hydrogen and refuelling takes just five minutes. Other fuel cell models in production include the Toyota Mirai and the Honda Clarity. The global fuel cell vehicle fleet has grown rapidly in recent years, with an 80 per cent increase in 2018 according to the IEA.

A number of places around the world including Asia, California and Europe are setting ambitious targets to drive the uptake of hydrogen vehicles and refuelling stations. Korea is targeting 81,000 vehicles by 2022, while Japan has a target of 200,000 by 2025.

In addition to the growing fleet of hydrogen cars in the country, a larger cousin will soon join their ranks. New Zealand's first hydrogen fuel cell bus was ordered by Auckland Transport in September 2019. The vehicle is being built in New Zealand by Global Bus Ventures at their Christchurch manufacturing facility. The bus will be used as part of the Ports of Auckland hydrogen fuel production and refuelling plant trial. Due to the limitations of battery-electric buses, and the expense of charging infrastructure, hydrogen fuel cell buses provide an attractive alternative with travel range over 500 km per day and fast refuelling times.

For further information on hydrogen projects, please refer to Box D.2 (Hydrogen Energy).

For further reading on the future of hydrogen see the MBIE green paper A vision for hydrogen in New Zealand.

Biodiesel production

As far back as 2010 Z Energy was investigating the production of biodiesel from beef tallow. Detailed design was underway in 2013 for a plant capable of producing 20 million litres per year. In 2014 Z announced the business case had been critically examined, that they were "in the process of securing a reliable supply of tallow, which will ensure the long-term resilience of the project", and that construction of a plant in South Auckland would proceed with first production of high-quality biodiesel expected by June 2015. After 2015 came and went, Z said the $26 million facility would begin production in June 2016. In 2018, they reported that the plant had been tested, and biodiesel had been successfully produced. In the 2019 financial year the plant produced 0.5 million litres, and the company was focused on ramping up production with full plant capacity expected to reach 20 million litres. By 2020, annual production had hit 1.9 million litres before the decision was made to halt production and hibernate the plant. Closure was being considered before the impact of COVID-19, when rising international tallow prices combined with falling diesel prices resulted in the entire operation becoming uneconomic.

Green Freight project

The Ministry of Transport initiated a project in April 2019 to help inform the Government's strategic approach to reducing greenhouse gas (GHG) emissions from road freight in New Zealand. The project looks specifically at the role alternative fuels, including electricity, hydrogen and biofuels, could play in reducing GHG emissions. This work fits within a wider programme of work across MBIE to reduce GHG emissions from the transport sector.

The project is focused on heavy trucks involved in road freight because they account for nearly one quarter of all road transport GHG emissions. Road freight is vital to New Zealand's economy and is predicted to grow substantially over the next 30 years.

Methodological improvements and revisions

As part of its commitment to statistical quality, the Ministry regularly reviews the methods it uses for producing statistics on energy supply, demand, prices, and emissions. This section gives a summary of significant methodological updates that were implemented for this edition of Energy in New Zealand, as well as notable revisions to previously published data.

For an overview of the data sources and methods currently used by the Ministry to produce national energy statistics, please consult the latest version of the Energy statistics sources and method paper.[22]

22 https://www.mbie.govt.nz/assets/Energy-statistics-sources-and-methods.pdf

Solar photovoltaic panels

The Ministry estimates electricity generated by solar photovoltaic (PV) panels by applying an assumed capacity factor to data published by the Electricity Authority on installed capacity. A capacity factor of 14 per cent is used, which means that solar PV panels are assumed to produce their full output 14 per cent of the time.

Previously this capacity factor was applied to all months of the year. This meant that it did not reflect the seasonality in solar PV generation, with higher output in summer and lower output in winter.

The Ministry has introduced a new method where data on monthly solar hours for the six main centres[23] is sourced from NIWA and used to scale the assumed capacity factor to account for the variation in output from solar PV panels during the year. This is done by calculating the annual average sunshine hours for each year and dividing the average sunshine hours for each month in that year by the annual average, to give a scaling factor. The assumed capacity factor of 14 per cent is then multiplied by this scaling factor to produce a series of monthly capacity factors that account for seasonality.

Once the capacity factor has been scaled, this is multiplied by the total installed capacity in each month and the hours in each month to get the estimated monthly electricity generation by solar PV panels. This is then allocated to sectors using data on installed capacity by market segment which is also published by the Electricity Authority.

This has resulted in revisions to the series of electricity generation from solar PV and electricity consumption in the quarterly data for the September quarter 2013 onwards, and in the annual data for the 2013 calendar year onwards.

Electricity consumption

Estimated sales method

The Ministry uses data on electricity sales by sector as the basis of its electricity consumption statistics. There are two methods employed by the Ministry to prepare the sales data for this:

› One based on actual quarterly sales data as collected under the Quarterly Retail Sales Survey (QRSS). This is available on a quarterly basis for the June quarter 2013 onwards, and an annual basis for the calendar year 2014 onwards.
› One based on estimated quarterly sales data, where March year sales data is allocated to quarters using grid exit point (GXP) demand sourced from the Electricity Authority's website. This is available for the 1990 calendar year onwards.

The estimated sales method requires GXPs to be mapped to sectors (referred to as "scalar sectors") so that they can in turn be mapped to the electricity sales data that the Ministry collects at the Australian and New Zealand Standard Industrial Classification (ANZSIC) code level. Any GXPs that are not mapped to scalar sectors are aggregated in a "General" sector.

The Ministry undertook a review of the scalar sectors and the GXPs mapped to them in order to improve the alignment between the sectoral consumption that is produced by the two methods. This was done by identifying GXPs that either:

› Directly supply sites that are involved in a particular industry or sector, or
› Are ones where the majority of the electricity use is attributable to a particular industry or sector, and the electricity usage follows what would expected in terms of the daily and/or seasonal use for that particular sector

Prior to July 2020 the scalar sectors used were: *Aluminium smelting; Steel manufacturing; Wood, pulp, and paper product manufacturing.*

The following scalar sectors are now used (as at July 2020):

› Industrial activities: Aluminium smelting; Dairy product manufacturing; Petroleum refining; Pulp and paper product manufacturing; Steel manufacturing; Wood product manufacturing
› Other sectors: Agriculture (primarily covering irrigation use); Commercial (covering ANZSIC codes F-G, H, I, J, K-N, O, P, Q, R-S); Residential

23 These are Auckland, Christchurch, Dunedin, Hamilton, Tauranga, and Wellington.

This has resulted in revisions to the entire series of electricity consumption that is based on estimated sales.

Electricity use for transport

Prior to July 2020, the Ministry used an annual estimate of electricity use for transport from a previous modelling exercise. This was assumed to all be used in the commercial sector, and was deducted from the volume sold to the sector to ensure that it was not being double-counted.

However, this estimate did not reflect changes to electricity use for transport that have occurred since the previous modelling exercise was undertaken in 2012. This includes the uptake of electric vehicles (EVs), the removal of Wellington's trolley buses from service in 2017, and the electrification of the Auckland urban rail network in 2014.

The Ministry has estimated electricity use for transport using:

› Data from the Electricity Authority on electricity supplied to GXPs that are connected to the Auckland urban rail network and the electrified section of the North Island Main Trunk
› Estimates of electricity use by EVs from the Ministry of Transport
› Data collected by the Ministry on other electricity use for transport

While most of this electricity use falls under the commercial sector, some of the electricity use by EVs is from households and is therefore captured by the residential sector. This means that unlike previously published data where transport was included in consumption by the commercial sector, total electricity use for transport is now stated as a separate item in the Ministry's sectoral electricity consumption statistics.

Direct use of renewables

Geothermal

The Ministry's statistics on direct geothermal energy use are compiled used a range of sources. While data is collected from major users on an annual basis, the last comprehensive update of information for smaller users was in 2008. For these users, the values for 2008 were carried forward.

GNS Science was commissioned to produce an updated assessment of direct use of geothermal energy for 2019. To incorporate this into the Ministry's statistics, non-linear interpolation was used to fill in the time series between 2008 and 2019. This has resulted in revisions to both geothermal consumption and primary energy supply (which is estimated based on usage data) for 2009 onwards.

The effect of these revisions are mostly to the primary energy supply, which decreased by 7 per cent in 2018.

Solid biofuels

Charcoal introduced

Data on the supply and use of charcoal has been added to the Ministry's renewable statistics. This affects residential solid biofuel use (covering woody biomass and charcoal) for 2000 onwards, with an average of 0.07 petajoules being added for the past five years.

Industrial wood use revisions

As a result of the MPI's revisions of their own data on Quarterly production, stock, and roundwood removals, the Ministry has updated their records of these figures too. This caused decreases in industrial wood use by 3.09 and 3.46 PJ for 2017 and 2018 respectively. Comparatively minor changes were also seen as far back as 2014.

Residential wood use revisions

Following the 2018 Census of Population and Dwellings, the Ministry has updated figures for residential firewood. The Census provides the proportion of households that use firewood. The change affects all years since the 2013 Census. The fraction of houses using firewood decreased from 36.8 to 30.6 per cent between the 2013 and 2018 Census. Generally, this resulted in a decrease in our estimates for residential wood usage by about 1 PJ for the last 6 years.

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