MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

MARKETS – EVIDENCE AND INSIGHTS

ENERGY IN NEW ZEALAND 22

2021 CALENDAR YEAR EDITION

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

Te Kāwanatanga o Aotearoa
New Zealand Government

Energy in New Zealand 2022 provides annual information on and analysis of New Zealand's energy sector. It is part of the suite of publications produced by the Markets team in the Ministry of Business, Innovation & Employment (MBIE).

The 2022 edition includes information up to the end of the 2021 calendar year.

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/

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Authorship

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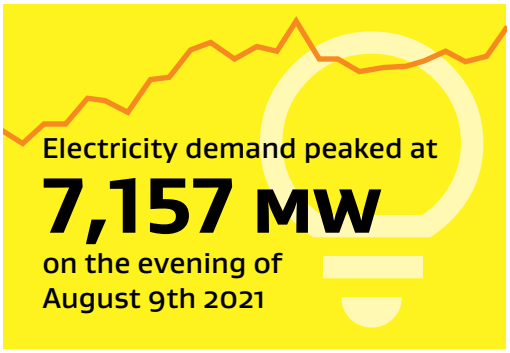
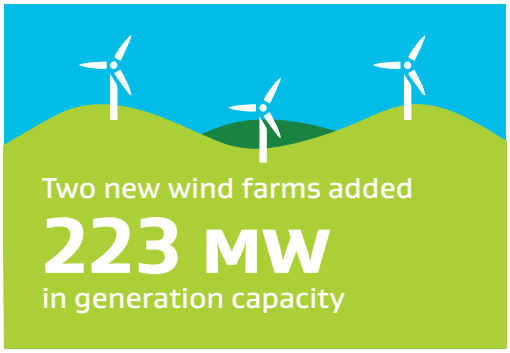
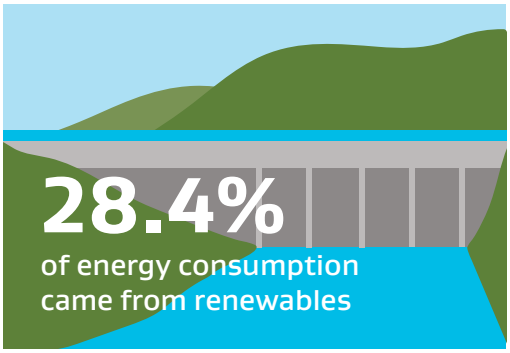
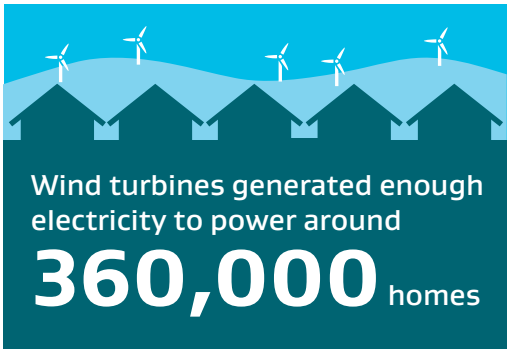
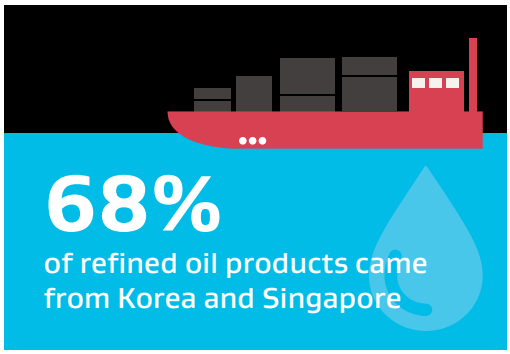
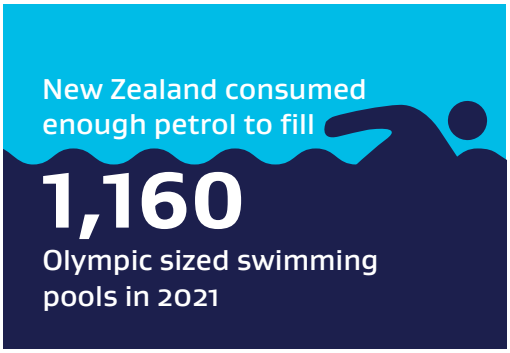


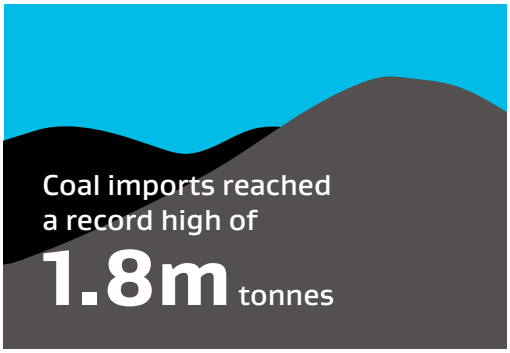












A. Energy Overview

This report presents comprehensive information on and analysis of New Zealand's energy supply and demand for the 2021 calendar year.

The 2021 calendar year saw continued disruptions to economic activity in New Zealand, with the impacts of the coronavirus (COVID-19) pandemic continuing to be felt in the energy sector. National energy consumption increased in 2021 but did not return to levels seen before the beginning of the COVID-19 pandemic. The share of total energy supply from renewables was at its highest level since reporting started in 1990, at 40.8 per cent.

Poor hydro conditions and low natural gas supply led to higher coal use

This year saw both hydro storage and inflows below the 90-year average for the first half of the year. Dry conditions were observed in the South Island, resulting from La Niña events which typically bring reduced rainfall to the South Island and lead to below normal rainfall and river flows.

Natural gas production fell 13 per cent in 2021 as a result of lower output from the Pohokura field. This meant that from July 2021 Pohokura was no longer the highest producing natural gas field on a monthly basis.

The combination of low lake levels and the fall in natural gas production saw coal use for electricity generation increase by 29.5 per cent. This contributed to increased wholesale prices for both electricity and natural gas during the winter months.

Despite high coal use for electricity generation, the renewable share for electricity generation increased to 82.1 per cent for 2021, up from 81.1 per cent in 2020.

Self-sufficiency decreased to its lowest since 1990

During 2021, New Zealand imported more energy products than it exported. This meant that New Zealand was a net importer of energy. Currently all energy needs for natural gas, renewables, and waste heat are met through domestic production. Whereas for other energy types, New Zealand engages in trade through exporting and importing.

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 that all domestic use of oil needs to be met by imports. Each year approximately half our national coal production is exported. Coal produced on the West Coast is mainly exported. Some large users in New Zealand choose to import coal for reasons such as the quality of the coal they require for their processes and for cost competitiveness.

New Zealand imported 69 per cent more coal compared to 2020. This is the highest amount since reporting started in 1990. As a result, New Zealand became a net importer of coal for the first time since reporting started. Imports of oil and oil products decreased by 4 per cent, which is the lowest amount since 2002.

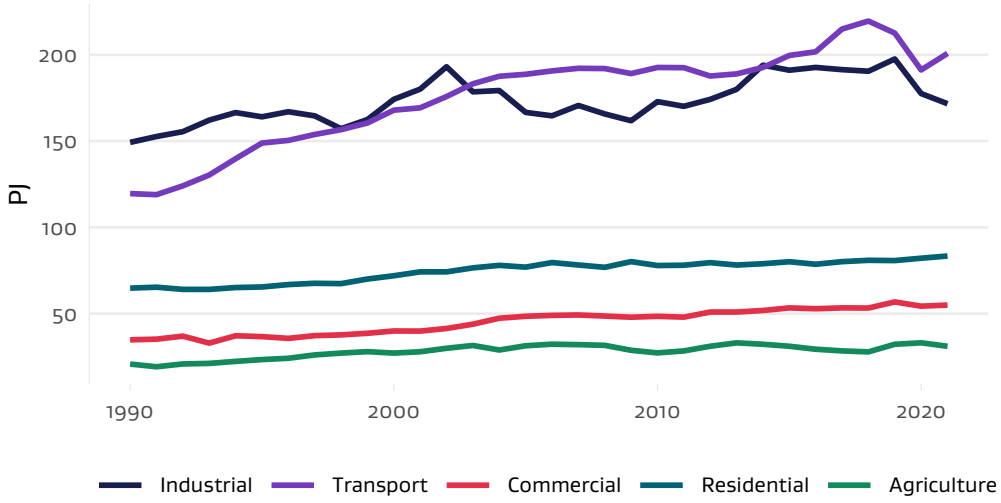
The national average of self-sufficiency was at its lowest level since reporting started in 1990, at 72.4 per cent in 2021[1]. This is a decrease from self-sufficiency of 75.4 per cent seen in 2020. This was driven by decreases in the self-sufficiency of oil and coal. The self-sufficiency of oil decreased due to total domestic crude production falling, mostly due to the decrease in production at the Pohokura field. Product imports also increased contributing to the decrease in self-sufficiency. The self-sufficiency of coal decreased due to coal imports increasing, driven by the demand for coal-fired electricity generation.

1 Self-sufficiency is a measure of a country's ability to meet its own energy supply requirements.

Energy consumption remained below pre-COVID-19 levels

National energy consumption increased by 0.7 per cent compared to 2020, but was still down 6.6 per cent compared to 2019. The greatest increase in 2021 was in the transport sector.

Figure A.1 Energy consumption by sector



The residential sector was the only sector where consumption surpassed 2019 levels

Residential consumption in 2021 increased 1.5 per cent compared to 2020 and 3 per cent since 2019. Use of both electricity and natural gas increased 5 per cent compared to 2019. Electricity and natural gas consumption by households follows a seasonal pattern which peaks in the September quarter – consumption in the September 2021 quarter was the highest it has been since reporting started in 1990. Two factors that contributed to this increase in consumption were New Zealand going into a COVID-19 Level 4 lockdown from 17 August to 31 August and colder weather conditions, causing an increase in electricity consumption.

On 9 August 2021, New Zealand saw its highest ever peak electricity demand. This demand, combined with insufficient available electricity generation, led to supply interruptions that affected more than 34,000 households.

The industrial sector saw consumption decrease by 3.3 per cent compared to 2020

Natural gas saw the biggest decrease in consumption with a 13.4 per cent decrease. Contributing to this was Methanex reducing its natural gas usage from January to July and mothballing its Waitara Valley plant.

The domestic transport sector saw consumption increase 5 per cent compared to 2020

Energy consumption for transport peaked in the June quarter as New Zealand started quarantine-free travel with Australia on 19 April 2021. Quarantine-free travel from all of Australia to New Zealand was suspended on the 23 July 2021. Domestic transport consumption was the lowest in the September quarter as restrictions on activities and movements were put in place to limit the spread of the Delta variant of COVID-19 in mid-August.

The share of modern renewables in final energy consumption increased to 28.4 per cent

This share of modern renewables was the highest it has been since 2016. The Emissions Reduction Plan, which was released in May 2022, includes actions that the government will be undertaking to help New Zealand achieve its emissions budgets. This included the commitment to set a target of 50 per cent of total final energy consumption to come from renewable sources by 2035. For more information on the Emissions Reduction Plan, see Box A.1.

Energy intensity continues to improve

Energy intensity gives 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 1.5 per cent per annum between 1990 and 2019. Energy intensity for all sectors decreased this year, with the biggest decrease in chemicals and metals which decreased by 11.2 per cent compared to 2020. Some of this decrease can be attributed to Methanex reducing its natural gas usage and producing 19 per cent less methanol in 2021. National energy intensity decreased 4.7 per cent in 2021 compared to 2020.

Box A.1

Emissions Reduction Plan

Current trends in the energy sector's emissions

Since 1990, broader energy sector emissions (including transport emissions) have increased by 31.8 per cent[A]. Emissions increased from 1990 to 2005, after which there has been a flat to decreasing trend in energy sector emissions. This growth in emissions has primarily come from road transportation, which increased by around 76 per cent.

The 2020 calendar year saw disruption to economic activity in New Zealand, with the impacts of the COVID-19 pandemic being felt by the energy sector throughout the year. This saw significant changes to the supply and demand of energy in New Zealand.

Emissions budgets set a pathway for the Emissions Reduction Plan

New Zealand is using a system of emissions budgets to set a pathway to meet our 2050 targets of net zero long-lived greenhouse gas emissions and a reduction in biogenic methane emissions. On 16 May 2022, the Government released New Zealand's first Emissions Reduction Plan (ERP), which outlines the strategies, policies, and actions for meeting the country's first emissions budget (covering 2022 to 2025). The ERP also sets a direction to meet future emissions budgets and outlines how New Zealand will contribute to global efforts to limit global temperature rise to 1.5˚C above pre-industrial levels.

The Government's vision for the energy and industry sectors

Chapter 11 of the ERP outlines New Zealand's plans to reduce emissions in the energy and industry sectors. These sectors make up just over a quarter of New Zealand's total gross greenhouse gas emissions. Decarbonising the energy and industry sectors will be vital to New Zealand achieving its emissions budgets.

In the ERP, the Government sets out its long-term vision for the energy sector in 2050 – for New Zealand to have a highly renewable, sustainable, and efficient energy system that supports a low emissions economy.

A For official emissions data, refer to New Zealand's Greenhouse Gas Inventory: https://www.mfe.govt.nz/climate-change/state-of-our-atmosphere-and-climate/new-zealands-greenhouse-gas-inventory

Actions to reduce emissions in the energy and industry sectors

The ERP includes the steps for driving emissions reductions in the energy and industry sectors. Actions to reduce emissions in these sectors fall into 5 interdependent areas:[B]

1. **Use energy efficiently and manage demand for energy.** This includes actions to improve business and household energy efficiency and the state sector's energy efficiency and fuel switching.
2. **Ensure the electricity system is ready to meet future needs.** This includes actions to accelerate the development of new renewable electricity generation to support increased electrification and ensure the electricity system and market can support high levels of renewables. Actions are also included to support the development and efficient use of transmission and distribution infrastructure to further electrify the economy.
3. **Reduce our reliance on fossil fuels and support the switch to low-emissions fuels.** This includes actions to manage the phase-out of fossil fuels, including fossil gas, and to develop low-emissions fuels such as renewable biogas and green hydrogen.
4. **Reduce emissions and energy use in industry.** This includes actions to decarbonise New Zealand industries and to develop an approach for single-firm industries with emissions that are hard to reduce or remove.
5. **Develop strategic approaches and targets to guide us to 2050.** The Government is setting a target for 50 per cent of total final energy consumption to come from renewable sources by 2035. This builds on the Government's aspirational target of 100 per cent renewable electricity generation by 2030. The Government is also developing an energy strategy to be in place by end 2024, and will develop a new New Zealand Energy Efficiency and Conservation Strategy to align with the priorities set out in the ERP and the energy strategy.

B A full list of actions with additional detail is available in the ERP https://environment.govt.nz/publications/aotearoa-new-zealands-first-emissions-reduction-plan/

B. Energy Balances

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

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

Both the energy supply and demand sections of the energy balance tables are calculated from surveys that span different sources. An imbalance exists between consumer energy calculated from reported supply data, and consumer energy observed from reported consumption data.

How to interpret energy balance tables

Supply

Total primary energy supply (TPES) 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 TPES. International transport includes international sea and air transport but excludes coastal shipping, national air transport, and all land transport.

Indigenous natural gas production does not include natural gas that is flared, reinjected, or extracted as LPG. The primary energy figures presented are actual data, except for some that go into electricity generation as detailed under energy transformation.

Energy transformation

Energy transformation includes:

- generation of electricity, including cogeneration
- oil production, including refinery operations and the manufacture of synthetic fuel from natural gas (Methanex stopped the production of methanol to petrol in April 1999)
- 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 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 calculated using the net electricity generated, with the actual input being used where available. The conversion factors shown in Table B.1 are used otherwise. Input to electricity generation from biogas, hydro, wind, and waste heat are fully estimated. Quarterly figures for electricity generation are made up of actual data from major generators and the Electricity Authority. Estimates are made where actual data are unavailable at the time of publishing.

Table B.1: Default Electrical Transformation Factors

Fuel	Default Efficiency
Biogas	30%
Coal	30%
Gas (Combined Cycle)	55%
Gas (Single Cycle)	30%
Geothermal	15%
Hydro	100%
Oil	30%
Waste Heat	15%
Wind	100%
Wood	25%

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

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
- oil industry losses and own use – 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. For example, bitumen used in road construction, and natural gas used as chemical feedstock in the production of methanol and ammonia or urea.

How we treat 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 TPES of solar is the sum of the direct use of solar thermal (for hot water heating), and the amount of solar energy directly converted into electricity using PV panels.

Solar PV electricity generation is estimated using data on the total installed capacity of grid-connected solar PV installations in New Zealand. This is converted to output using an assumed annual capacity factor of 14 per cent – the solar panels produce their full output 14 per cent of the time. The capacity factor is then scaled using data on sunshine hours from the National Institute of Water and Atmospheric Research (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 allocated using data from the Electricity Authority.

Consumer energy 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. It is calculated as TPES less energy transformation less non-energy use.
- **Consumer energy (observed)** forms the bottom half of the energy balance tables. It represents reported demand in the agricultural, industrial, commercial, transport, and residential sectors. With the exception of domestic 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. 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.

Statistical differences

Statistical differences show the difference between ‘consumer energy (calculated)’ and ‘consumer energy (observed)’. This difference is shown at the bottom of the energy balance tables.

Energy Balance Table

2021		Electricity	Renewables								Waste Heat	Natural Gas
Converted into Petajolues using Gross Calorific Values		Total	Hydro	Geothermal	Solar	Wind	Liquid Biofuels	Biogas	Solid Biofuels	Total	Total	Total
SUPPLY	Indigenous Production	-	87.24	203.68	1.09	9.51	0.25	3.65	50.03	355.46	1.11	157.53
	+ Imports	-	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.00
	- Exports	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	- Stock Change	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.09
	- International Transport	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL PRIMARY ENERGY	-	**87.24**	**203.68**	**1.09**	**9.51**	**0.25**	**3.65**	**50.16**	**355.59**	**1.11**	**153.44**
	ENERGY TRANSFORMATION	**144.21**	**-87.24**	**-196.30**	**-0.73**	**-9.51**	**-0.25**	**-3.39**	**-21.22**	**-318.65**	**-1.11**	**-48.31**
	Electricity Generation	**151.63**	-87.24	-195.01	-0.73	-9.51	0.00	-2.59	0.00	**-295.09**	0.00	**-30.48**
	Cogeneration	**8.22**	0.00	-1.28	0.00	0.00	0.00	-0.80	-21.22	**-23.31**	**-1.11**	**-12.43**
	Fuel Production	**0.00**	0.00	0.00	0.00	0.00	-0.25	0.00	0.00	**-0.25**	0.00	**0.00**
	Other Transformation	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	**0.00**
	Losses and Own Use	**-15.64**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	**-5.40**
Non-energy Use		-	-	-	-	-	-	-	-	-	-	**-37.83**
CONSUMER ENERGY (calculated)		**144.21**	**0.00**	**7.39**	**0.36**	**0.00**	**0.00**	**0.26**	**28.93**	**36.94**	**0.00**	**67.30**
DEMAND	**Agriculture, Forestry and Fishing**	**9.58**	**-**	**0.45**	**0.00**	**-**	**-**	**0.00**	**0.00**	**0.45**	**-**	**1.31**
	Agriculture	9.17	-	0.45	0.00	-	-	0.00	0.00	0.45	-	1.31
	Forestry and Logging	0.25	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.00
	Fishing	0.16	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.00
	Industrial	**51.40**	**-**	**4.35**	**0.00**	**-**	**-**	**0.00**	**21.36**	**25.72**	**-**	**52.56**
	Mining	1.55	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.17
	Food Processing	10.30	-	0.00	0.00	-	-	0.00	0.00	0.00	-	19.28
	Textiles	0.37	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.39
	Wood, Pulp, Paper and Printing	5.83	-	0.00	0.00	-	-	0.00	21.36	21.36	-	2.55
	Chemicals	2.66	-	0.00	0.00	-	-	0.00	0.00	0.00	-	25.98
	Non-metallic Minerals	0.98	-	0.00	0.00	-	-	0.00	0.00	0.00	-	2.12
	Basic Metals	22.54	-	0.00	0.00	-	-	0.00	0.00	0.00	-	1.41
	Mechanical/ Electrical Equipment	0.53	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.22
	Building and Construction	1.53	-	0.00	0.00	-	-	0.00	0.00	0.00	-	0.35
	Unallocated	5.10	-	4.35	0.00	-	-	0.00	0.00	4.35	-	0.09
	Commercial	**33.46**	**-**	**2.38**	**0.00**	**-**	**-**	**0.26**	**0.00**	**2.64**	**-**	**7.67**
	Transport	**0.35**	**-**	**0.00**	**0.00**	**-**	**-**	**0.00**	**0.00**	**0.00**	**-**	**0.00**
	Residential	**47.54**	**-**	**0.21**	**0.36**	**-**	**-**	**0.00**	**7.57**	**8.14**	**-**	**7.19**
CONSUMER ENERGY (observed)		**142.34**	**-**	**7.39**	**0.36**	**-**	**-**	**0.26**	**28.93**	**36.94**	**-**	**68.72**
Statistical Differences		**1.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-1.42**

Oil								Coal				TOTAL
Crudes/ Feedstocks/ NGL	LPG	Petrol	Diesel	Fuel Oil	Av. Fuel/ Kero	Others	Total	Bituminous	Sub-bitum.	Lignite	Total	
38.98	7.52	0.00	0.00	0.00	0.00	0.00	**46.50**	37.82	27.46	5.18	**70.46**	**631.05**
163.42	1.39	48.94	61.72	1.63	2.66	13.59	**293.34**	1.17	37.39	0.00	**38.56**	332.03
27.81	0.80	1.94	0.21	4.25	2.04	0.00	**37.04**	35.81	1.13	0.00	**36.95**	73.99
-8.84	0.02	2.21	0.26	-0.83	-1.51	-3.59	**-12.26**	1.05	5.91	-0.03	**6.93**	-1.24
0.00	0.00	0.00	3.25	1.49	13.41	0.00	**18.15**	0.00	0.00	0.00	**0.00**	18.15
183.43	**8.08**	**44.79**	**58.00**	**-3.28**	**-11.29**	**17.18**	296.91	**2.12**	**57.81**	**5.21**	**65.14**	**872.18**
-182.69	**0.00**	**58.67**	**84.95**	**9.03**	**24.54**	**0.32**	**-5.18**	**-0.21**	**-44.29**	**-0.07**	**-44.57**	**-273.60**
0.00	0.00	0.00	-0.31	0.00	0.00	0.00	**-0.31**	0.00	-25.24	0.00	**-25.24**	-199.48
0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	-8.21	-0.05	**-8.26**	-36.89
-182.69	0.00	56.01	83.53	7.82	24.14	2.87	**-8.31**	0.00	0.00	0.00	**0.00**	-8.57
0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	-10.74	0.00	**-10.74**	-10.74
0.00	0.00	2.66	1.72	1.21	0.41	-2.56	**3.44**	-0.21	-0.09	-0.02	**-0.32**	-17.92
-	-	-	-	-	-	**-17.13**	**-17.13**	-	-	-	-	**-54.95**
0.74	**8.08**	**103.45**	**142.95**	**5.75**	**13.26**	**0.37**	274.60	**1.91**	**13.53**	**5.14**	**20.57**	**543.63**
-	**0.12**	**1.35**	**16.18**	**0.57**	**0.00**	**-**	**18.22**	**0.06**	**1.45**	**0.00**	**1.52**	**31.07**
-	0.12	1.30	11.80	0.00	0.00	-	13.22	0.06	1.45	0.00	1.52	25.65
-	0.00	0.01	1.98	0.00	0.00	-	1.99	0.00	0.00	0.00	0.00	2.23
-	0.00	0.05	2.40	0.57	0.00	-	3.02	0.00	0.00	0.00	0.00	3.18
-	**3.72**	**0.09**	**18.69**	**0.14**	**0.00**	**-**	**22.66**	**2.96**	**11.39**	**4.97**	**19.32**	**171.66**
-	0.00	0.00	5.29	0.00	0.00	-	5.29	0.00	0.00	0.00	0.00	7.01
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.43	10.31	4.86	15.60	45.19
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.14	0.05	0.00	0.19	0.95
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.05	0.22	0.00	0.27	30.02
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.01	0.00	0.01	28.65
-	0.00	0.00	0.00	0.00	0.00	-	0.00	1.17	0.81	0.10	2.08	5.17
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	23.96
-	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.75
-	0.00	0.02	7.51	0.00	0.00	-	7.53	0.00	0.00	0.00	0.00	9.40
-	3.72	0.07	5.89	0.14	0.00	-	9.84	1.17	0.00	0.00	1.17	20.56
-	**1.77**	**1.29**	**6.65**	**1.00**	**0.00**	**-**	**10.71**	**0.09**	**0.30**	**0.10**	**0.49**	**54.96**
-	**0.14**	**85.59**	**100.00**	**2.75**	**11.98**	**-**	**200.47**	**0.00**	**0.00**	**0.00**	**0.00**	**200.82**
-	**3.78**	**13.90**	**2.60**	**0.00**	**0.00**	**-**	**20.27**	**0.01**	**0.20**	**0.03**	**0.24**	**83.39**
-	**9.53**	**102.23**	**144.12**	**4.47**	**11.98**	**-**	**272.33**	**3.12**	**13.35**	**5.09**	**21.56**	**541.89**
0.74	**-1.44**	**1.23**	**-1.18**	**1.28**	**1.28**	**0.37**	**2.27**	**-1.21**	**0.18**	**0.04**	**-0.99**	**1.73**

C. Electricity

Electricity generation increased slightly in 2021. Electricity generated from renewable sources this year was 82.1 per cent of total generation, an increase from 81.1 per cent in 2020. The ongoing decrease in supply from Pohokura, one of the country's largest natural gas fields, led to an increase in coal use for electricity generation. This, along with decreased hydro inflows in the first half of 2021 contributed to higher wholesale electricity prices.

Overall national electricity demand decreased by 0.1 per cent in 2021, as a decrease in industrial and agriculture use more than offset the increase in commercial and residential use. The decrease in demand from the industrial sector was largely driven by a fall in demand from wood, pulp, and paper manufacturing, which fell in 2020 and remained low in 2021.

Wholesale electricity prices were higher because of constrained natural gas supply and 2021 being a dry year. The average wholesale electricity price for 2021 was nearly double the previous year's average. Wholesale prices were elevated for most of the year due to La Niña weather conditions causing reduced rainfall in the South Island, and constrained natural gas supply.

Renewable share increased despite La Niña weather conditions thanks to increased hydro generation

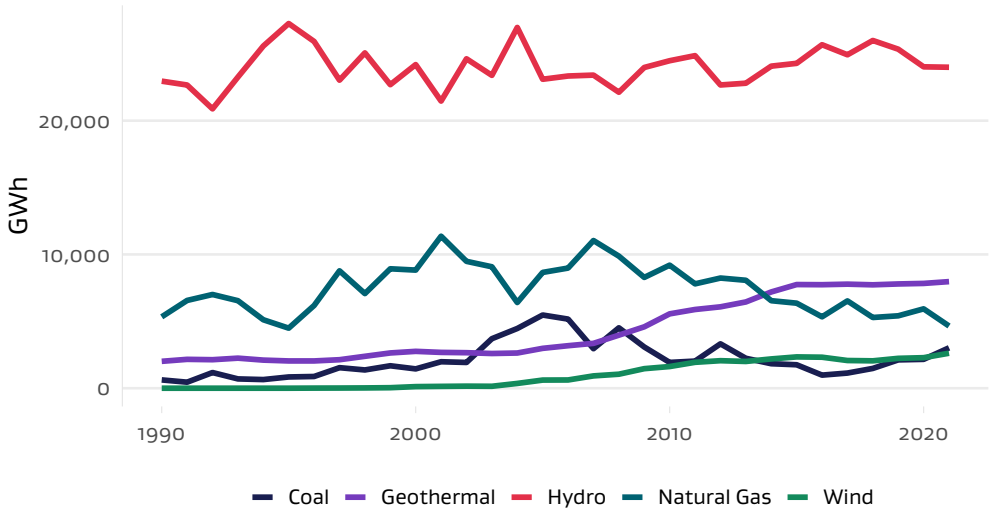
New Zealand generated 43,267GWh in 2021, a 0.2 per cent increase from 2020. In 2020, electricity generation fell as restrictions on activities and movements as part of the country's response to the COVID-19 pandemic led to lower electricity demand.

The share of renewable generation in 2021 rose to 82.1 per cent, despite La Niña weather conditions affecting the country[2]. La Niña events typically bring warmer than normal temperatures to the whole country, along with a surge of rain to the North Island and reduced rainfall to the South Island.

The South Island, where most of New Zealand's hydro storage lakes are located, experienced dry conditions due to the La Niña phenomenon during the first half of 2021. This led to below normal rainfall and river flows, as well as low soil moisture levels. Both hydro storage and inflows were below 90-year average for the first half of the year.

The second half of the year saw above normal levels of rainfall in the South Island, which also experienced a few episodes of heavy rainfall events. This helped hydro lake inflows and snow storage to surpass historical averages. Although annual electricity generation from hydro decreased by 0.1 per cent, hydro generation during the second of half of the year alone was 6.5 per cent higher than the corresponding period in 2020.

Figure C.1 Electricity generation by major source



Constrained natural gas supply led to an increase in the reliance on coal for electricity generation

Constrained natural gas supply as a result of decreased production from the Pohokura field led to a significant decrease in electricity generated from natural gas. This resulted in an increased reliance on coal for thermal generation. Natural gas used for electricity generation dropped by 26 per cent from 2020 levels, while coal used for electricity generation rose by 30 per cent.

2 NIWA El Niño and La Niña impacts on New Zealand https://niwa.co.nz/climate/information-and-resources/elnino/elnino-impacts-on-newzealand

Record amount of electricity generated from wind

Coal was not the only source that increased its contribution to total electricity generation in 2021. With the commissioning of the Waipipi and Turitea wind farms, an additional capacity of 223MW was available to the market. Electricity generated from wind in 2021 was the highest on record, increasing by 15 per cent, while the capacity factor decreased by 5 per cent. This result suggests that the rise in wind generation was due to new plants being commissioned rather than wind conditions being particularly favourable.

Electricity generation from geothermal sources increased

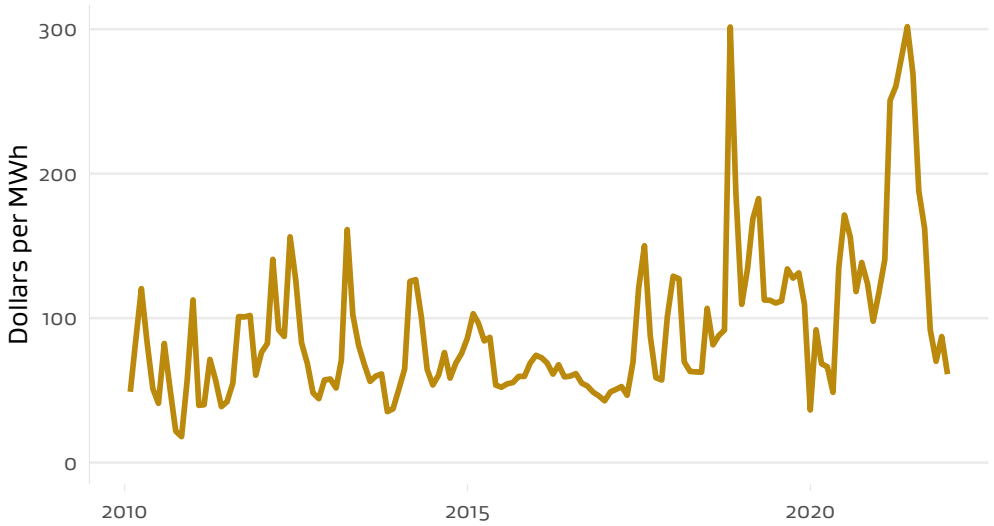
Geothermal plants in New Zealand operate as baseload generation, which means that there is usually little flexibility in intentionally reducing or increasing electricity generation. Electricity generation from geothermal sources in 2021 increased by 1.7 per cent. This was despite a 44-day unplanned outage at Kawerau, one of the country's largest geothermal power stations.

Wholesale prices were volatile due to dry year conditions

The decreased availability of hydro and natural gas as sources for electricity generation also led to a rise in wholesale electricity prices. New Zealand experienced La Niña weather conditions which led to decreased hydro inflows, and subsequently lower hydro generation. Additionally, there was increased uncertainty in the availability of natural gas for electricity generation. These factors contributed to pushing wholesale electricity prices upwards.

The average wholesale electricity price in the first three months of 2021 was nearly three times higher than the prices seen over the same period in 2020. Subsequently, favourable hydro conditions pushed prices down in the second half of the year, with the prices in the final three months of the year decreasing from an average of $113/MWh in 2020 to $73/MWh in 2021. This was a 36 per cent drop.

Figure C.2 Monthly average wholesale electricity prices[3]



3 This graph includes prices for 9 August 2021, which at the time of writing have been directed as interim until further direction from the Electricity Authority.

Additional renewable energy will be entering the market in the future

In addition to the commissioning of Waipipi and Turitea wind farms, Ngāwhā geothermal power station's expansion project (OEC4) was completed in December 2020. This meant that 2021 was the first full year with Ngāwhā generation. This new station brings an additional capacity of 32MW.

Other consented generation includes:

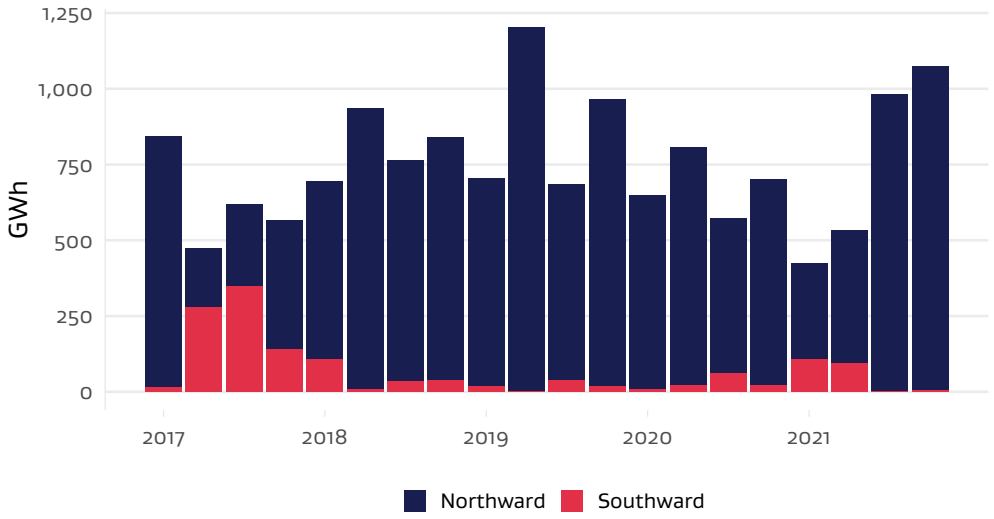
- Mt Cass wind farm – MainPower, 93MW
- Turitea Stage 2 wind farm – Mercury, 103MW
- Mahinerangi Stage 2 wind farm – Mercury, 164MW
- Kaiwera Downs wind farm – Mercury, 240MW
- Kaiwaikawe wind farm – Mercury, 73MW
- Harapaki wind farm – Meridian, 176MW
- Ngāwhā OEC5 geothermal expansion – Top Energy, 32MW
- Tauhara geothermal station – Contact, 168MW

Northward transmission increased in the second half of 2021

Electricity is transferred between the North and South Island via the High Voltage Direct Current (HVDC) inter-island link, connecting Benmore power station in the South Island to Haywards substation in the North Island. With the dominance of hydro in the country's electricity system and most hydro lakes being situated in the South Island, electricity tends to be transferred northwards via the HVDC to the North Island where most electricity demand is located.

During the second half of 2021, transmission northwards increased by 72 per cent compared to the second half of 2020, suggesting an increased reliance on South Island hydro rather than thermal sources in the North Island to meet demand.

Figure C.3 Transfer of electricity by the High Voltage Direct Current (HVDC) inter-island link



Electricity demand from the industrial sector fell, while residential demand rose

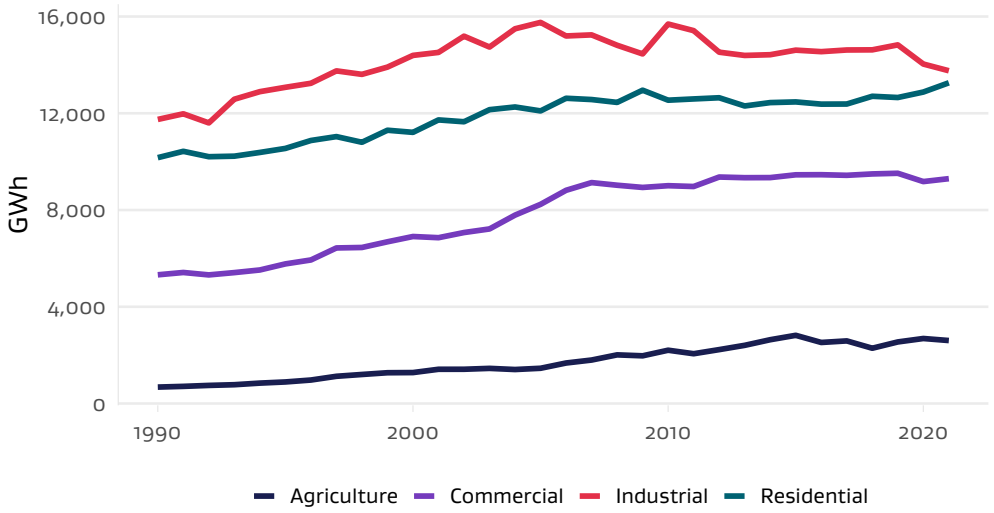
Electricity consumption decreased slightly in 2021, due to decrease in demand from the agricultural and industrial sectors. While the residential and commercial sectors experienced increased demand, they did not completely offset the lower demand from agricultural and the industrial sectors.

Auckland is the most populated region in the country, accounting for just over half of household electricity connections in New Zealand. All of New Zealand moved to Alert Level 4 on 17 August 2021, with the Auckland region remaining under tighter restrictions on activities and movements for the remainder of 2021. This contributed to household electricity demand in the second half of the year being 4.0 per cent higher than the corresponding period in 2020. This was most likely because more people were working and staying at home during the day.

Restrictions on activities and movement as part of the response to the COVID-19 pandemic also affected the commercial and industrial sectors. Industries that were deemed non-essential faced restrictions on their operations. Additionally, there were continued disruptions to global supply chains that affected business activity on our shores. The combination of COVID-19 related restrictions and global supply chain disruptions played a factor in business activity for basic metals and mining sectors. Compared to 2019, electricity demand from basic metals and mining sectors dropped by 4.6 per cent.

Although the first half of the year was dry for most of the country with below normal rainfall, heavy rainfall events in the second half of the year led to above normal soil moisture levels in key irrigation areas in the South Island. This contributed to the decrease in electricity consumption from the agriculture, forestry, and fishing sectors, which fell by 3.7 per cent.

Figure C.4 Electricity consumption by sector



Fall in industrial sector demand was largely driven by wood, pulp, and paper manufacturing

The industrial sector had a 2.6 per cent drop in demand compared to 2020, and a 7.3 per cent drop compared to 2019. The biggest contributor to the drop in electricity consumption by the industrial sector was wood, pulp, and paper manufacturing, which fell by 25 per cent. Demand from wood, pulp, and paper manufacturing fell in 2020, and remained low in 2021. The main contributor to this was Norske Skog's Tasman Mill at Kawerau closing on 30 June 2021 after 66 years of operation in New Zealand.

Box C.1

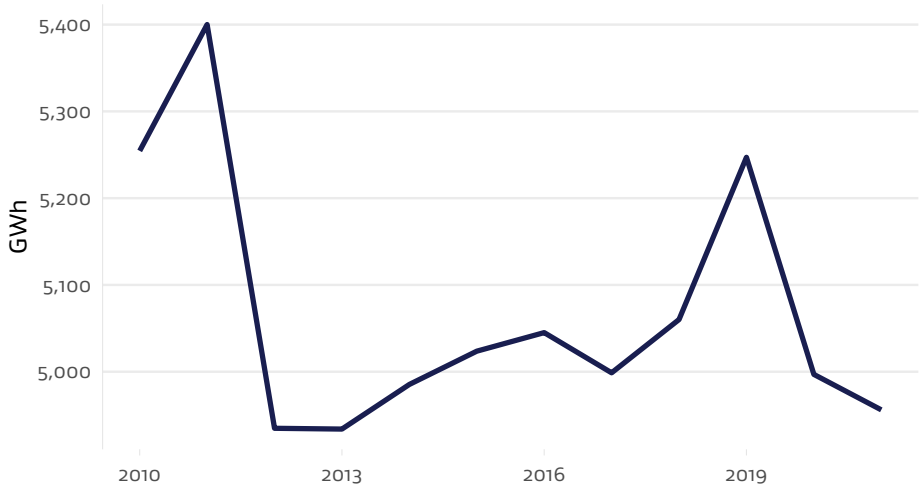
Tiwai point showed flexibility with demand

After discussions of closing as soon as August 2021, New Zealand Aluminium Smelter (NZAS) reached an agreement with Meridian Energy to delay the closure of its smelter at Tiwai Point until December 2024. NZAS is the single largest consumer of electricity in New Zealand, consuming around 13 per cent of electricity generated in the country.

On 31 May 2021, NZAS agreed with Meridian to an electricity swap as part of a demand response to dry hydrology conditions[C]. The electricity swap helped NZAS voluntarily reduce its consumption of electricity and compensated it for any load it decided to reduce. NZAS agreed to reduce its consumption by up to 30.5 MWh an hour.

The potential closure of Tiwai Point has seen an emergence of potential projects such as green hydrogen production.

Figure C.5 Electricity use at Tiwai Point grid exit point



C An electricity swap is an agreement used to manage risks around price volatility for electricity generators and consumers. More details of Meridian and NZAS electricity swap can be found here: https://www.meridianenergy.co.nz/news-and-events/nzas-agree-swap

Peak demand for electricity has been rising in recent years

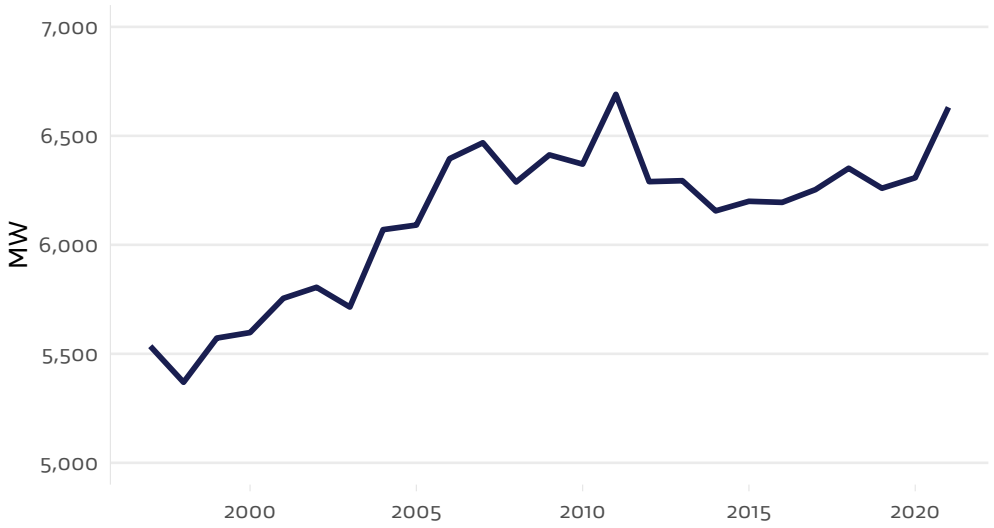
Peak demand has been rising, most notably between 1998 and 2011 as well as over the last 3 years. At the same time, annual electricity consumption has remained just below 40,000GWh.

On 9 August 2021, a power outage left more than 34,000 households without electricity when there was peak electricity demand on one of the coldest nights of the year. The Minister of Energy and Resources launched an investigation to understand the causes of the supply disruption and to provide recommendations for improvements[4]. National electricity demand on Monday 9 August between 6pm and 6.30pm was 16 per cent higher than the average over the previous four years. During this evening, New Zealand saw record high peak demand of 7,157MW.

The electricity system must match generation and demand, with constraints on the amount of electricity that can be transmitted and distributed at any one time. Peak demand usually occurs in the morning and during early evening, and tends to be more pronounced during colder months. It is during this time that the transmission and distribution networks are under most strain.

The rise in peak demand over the last few years is largely driven by the increased demand during winter months. Peak demand during summer has been trending downwards but is expected to grow as warmer temperatures increase the need for cooling.

Figure C.6 Annual peak electricity demand[5]



4 The final report can be found here: https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-consultations-and-reviews/nvestigation-electricity-supply-interruptions-9-august-2021/ Transpower and the Electricity Authority have also carried out independent reviews.

5 Based on grid export data, averaged over half hourly trading periods. Therefore it does not show the peak instantaneous demand on 9 August reaching 7,157 MW

D. Renewables

New Zealand achieved its highest share of primary energy from renewable sources in 2021 at 40.7 per cent produced from renewable sources, significantly higher than the average for the Organisation for Economic Co-operation and Development (OECD) of around 11 per cent.

New Zealand makes use of significant hydro and geothermal resources for energy. The 2021 calendar year saw two large new wind farms constructed at Waipipi and Turitea, and the first full year of the expansion to the Ngāwhā geothermal power plant operating. These contributed to electricity generated from wind and geothermal both being at their highest level on record.

The direct use of renewable energy rose slightly in 2021 to 36.9 PJ, but has yet to recover to pre-COVID levels. While the use of solid biofuels for process heat increased, direct use of geothermal energy fell slightly.

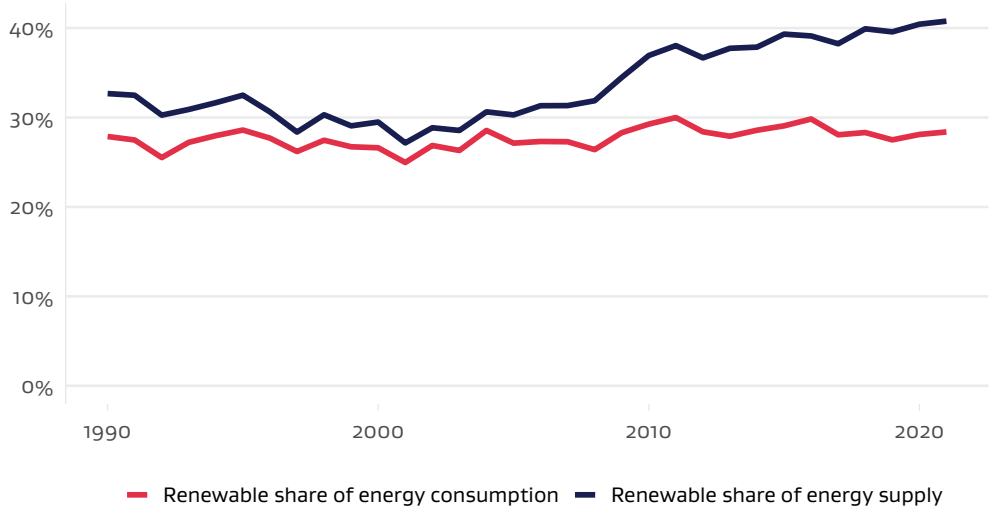
Renewable shares of energy increase

New Zealand's renewable share of total primary energy supply (TPES) increased to 40.8 per cent in 2021, up slightly from 40.4 per cent in 2020. However, the renewable share of supply is not always the best way to measure the level of renewables being used in a country's energy system. For example, geothermal energy has a relatively low efficiency when converting primary energy from steam into electricity. Because of this, primary energy supply can overestimate how much renewable energy is available for use. Conversely, primary energy supply includes the non-energy use of fossil fuels, such as the use of natural gas as a chemical feedstock in the production of methanol or ammonia, which can overestimate the non-renewable share of energy.

Because of this, it can be more useful to consider the renewable share of total final energy consumption (TFEC) when measuring the renewable share of a country's energy use. This method accounts for direct use of renewable energy and the share of electricity generation attributed to renewable sources. From 2005 onwards, the share of electricity produced by geothermal energy has increased, which has raised primary energy supply more than energy consumption due to geothermal energy's relatively low transformation efficiency.

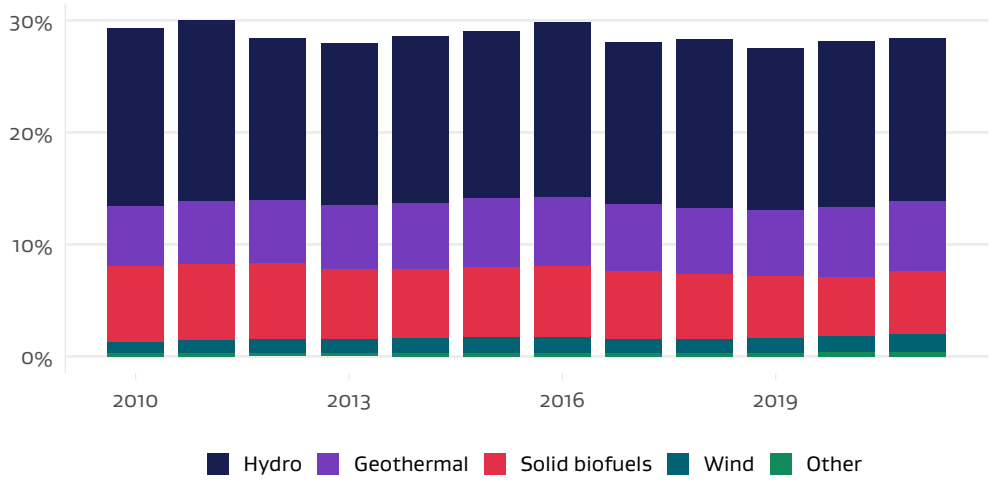
The Government has committed to setting a target of 50 per cent of total energy consumption coming from renewable sources by 2035. New Zealand's renewable share of energy consumption in 2021 was 28.4 per cent, up slightly from 28.1 per cent in 2020.

Figure D.1: Share of renewables in total final energy consumption (TFEC) and total primary energy supply (TPES)



The increase in the renewable share of energy consumption in 2021 was driven by increases in the direct use of solid biofuels and electricity generation from wind turbines. This offset slight declines in electricity generation from hydro.

Figure D.2: Renewable share of total final energy consumption (TFEC) by energy type



'Other' includes Solar and Biogas

Hydro generation fell due to La Niña conditions

Hydro generation fell slightly from 24,024GWh in 2020 to 23,992GWh in 2021 as a result of La Niña conditions. La Niña events typically bring warmer than normal temperatures to the whole country, along with a surge of rain to the North Island and reduced rainfall to the South Island.

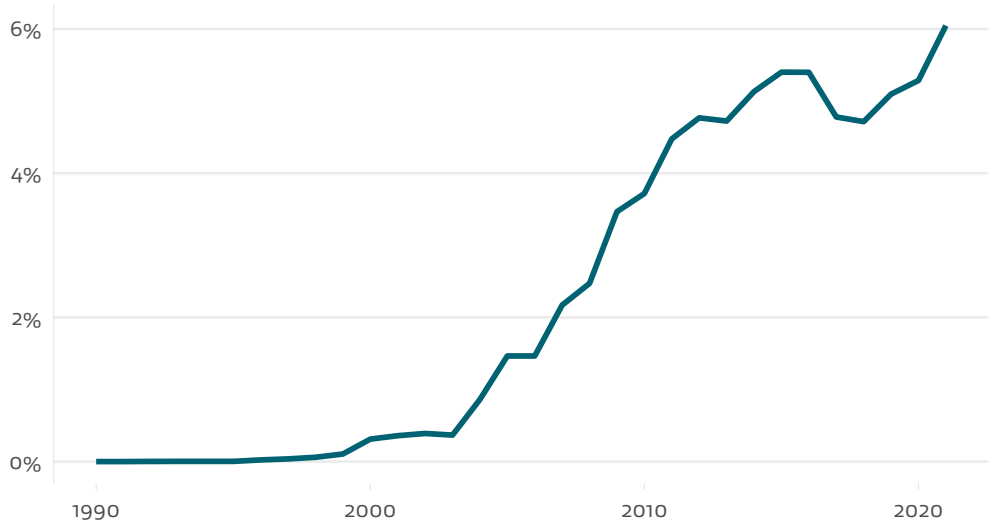
The South Island, where most of New Zealand's hydro storage lakes are located, experienced dry conditions due to the La Niña phenomenon during the first half of 2021. This led to below normal rainfall and river flows. Both hydro storage and inflows were below 90-year average for the first half of the year.

The share of final energy consumption attributed to hydroelectric generation fell slightly to 14.6 per cent, compared to 14.8 per cent in 2020.

Wind generation increased to record levels

Wind turbines generated 2,616GWh in 2021, up from 2,282GWh in 2020. This is the highest wind generation on record, accounting for 6.0 per cent of total electricity generation in 2021. Electricity use attributed to electricity generated from wind now makes up 1.6 per cent per cent of final energy consumption.

Figure D.3: Share of total electricity generation from wind

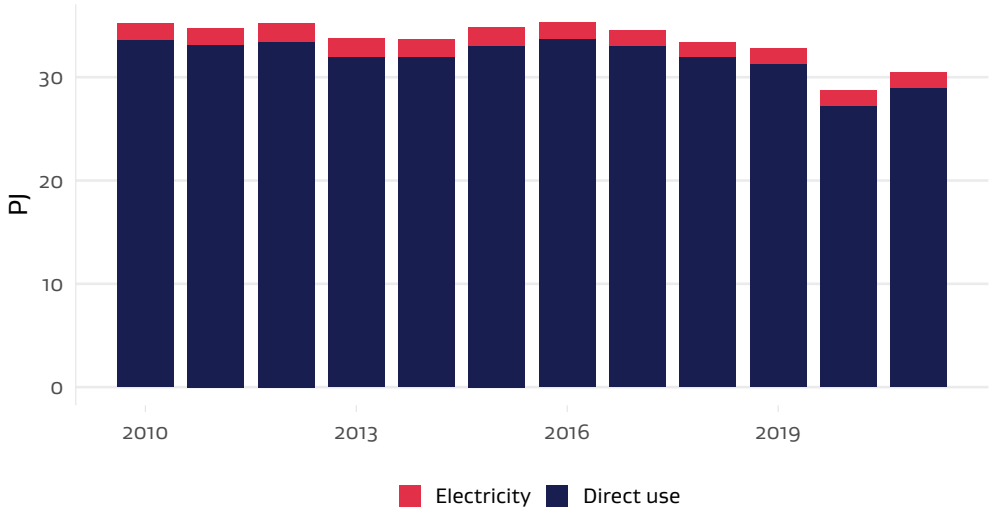


The increase in the share of total electricity generation from wind occurred despite the fact that wind conditions were less favourable in 2021 compared to 2020, leading to a 5 per cent decrease in the capacity factor of wind. Instead, the increase was driven by the completion of new turbine installations at Turitea North and Waipipi. These installations combined added 223MW to New Zealand's wind generation capacity during 2021. The Turitea site is yet to be completed, with the second stage expected to add a further 103MW of capacity when completed in mid-2023.

Solid biofuels use increased

In MBIE's statistics, solid biofuels consist of energy derived from woody biomass, which includes charcoal, residual wood, and black liquor. Many wood processing plants recover costs by burning production by-products (such as wood residuals or black liquor) for electricity and process heat. The use of these fuels rose in 2021 as industrial activity picked up again after the easing of restrictions on activities as part of the response to the COVID-19 pandemic.

Figure D.4: Solid biofuel use



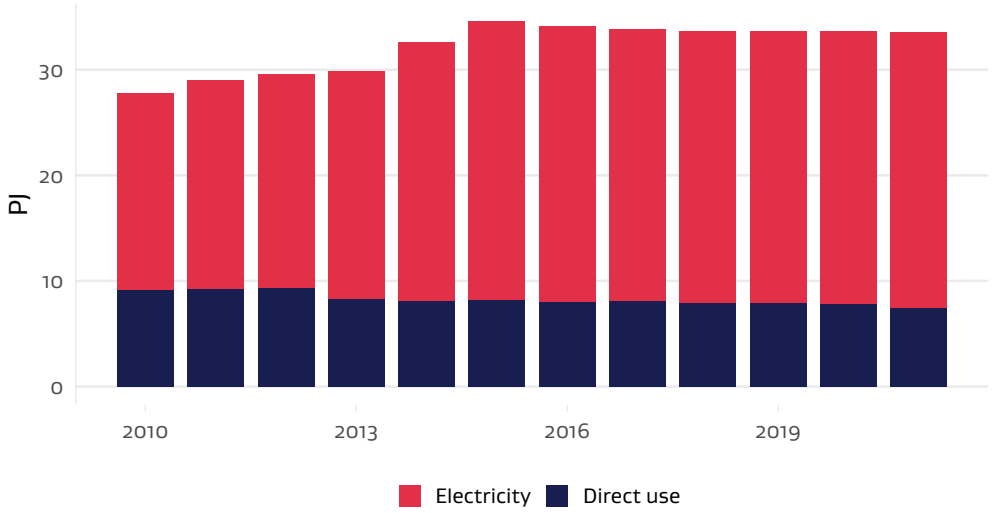
Energy use of solid biofuels rose to 30.5PJ in 2021, relative to 28.7PJ in 2020. However, the use of solid biofuels has still not returned to pre-COVID levels of 32.8 PJ in 2019. Solid biofuels make up 5.6 per cent of total final energy consumption.

Geothermal use remained the same

Geothermal energy use remained relatively static in 2021, at 33.6PJ. This figure includes direct use and electricity generation attributed to geothermal sources, together representing 6.2 per cent of total final energy consumption.

This headline figure does not reflect movements in New Zealand's geothermal energy industry that occurred in 2021. Norske Skog shut down operations at their paper mill in Kawerau at the end of June 2021, as the market for domestically produced newsprint became commercially unviable. This mill had previously been a significant user of geothermal energy for process heat.

Figure D.5: Geothermal use



Direct use of geothermal energy for process heat fell slightly to 7.4PJ in 2021, compared to 7.8PJ in 2020. Further, electricity generated by geothermal plants rose to 7,968GWh in 2021, compared to 7,834GWh in 2020. This was partly driven by new generation from the Ngāwhā geothermal power station's expansion project (OEC4), which was completed in December of 2020.

Electricity generation from solar is expected to increase in future

Solar energy is currently only a small part of New Zealand's energy supply, making up less than 0.5 per cent of electricity generation and 0.2 per cent of final energy consumption. This number is growing as residential installations increase. Several firms are also looking at development opportunities in utility-scale solar.

In May 2021, Lodestone (a privately-owned renewable energy firm) announced plans to roll out 229 megawatts of utility-scale solar capacity throughout New Zealand over the next four years for a total project cost of $300 million. It expects to generate up to 350 gigawatt-hours each year and sell directly into the wholesale market.

In December 2021, Christchurch Airport committed 400 hectares to the construction of the Kōwhai Park energy hub, including 220 hectares set aside for a 150-megawatt solar array. Once completed, this would be the largest single solar farm in the country. Construction will begin in early 2023 and first generation is expected in 2025.

Box D.1

Sustainable aviation fuel

Sustainable aviation fuel (SAF) is a type of jet fuel produced from renewable feedstocks, such as vegetable oil or animal fat. It is very similar to traditional fossil jet fuel in its chemical composition.

To reach net-zero carbon emissions by 2050, New Zealand will need to invest in sustainable aviation fuels. In 2019, aviation accounted for 14 per cent of all New Zealand's emissions. Aviation is a challenging industry to decarbonise – electric or hydrogen-based aviation fuel alternatives are not feasible for long-haul flights in the short to medium term. However, sustainable biofuels are available now that could reduce the industry's emissions and promote low-carbon tourism. Sustainable aviation fuels emit up to 80 per cent less carbon than the fuels they replace, depending on the feedstocks used or production method.

Domestic production could lead to commercial viability

The current cost of sustainable aviation fuel is prohibitive – around ten times that of traditional, fossil-based fuels. The Sustainable Aviation Fuels Alliance of Australia and New Zealand estimates that this would add $A82 to the ticket price of a flight from Sydney to Melbourne, assuming a 50 per cent blend with traditional aviation fuel. However, if the cost of sustainable fuel was only twice that of traditional fuel, the same ticket price would only rise $A9.13. If this price is reached, the Alliance believes that a framework for voluntary passenger purchasing could be viable for the sector[D].

The Ministry of Business, Innovation, and Employment and Air New Zealand signed a memorandum of understanding in September 2021 to explore whether the domestic production of sustainable aviation fuels can be made commercially viable in New Zealand.

International production is increasing

Finnish oil firm Neste, which supplies customers in Sweden and France, currently uses animal and fish fat waste or used cooking oils to produce 100,000 tonnes of sustainable aviation fuels each year. It aims to increase production to 1.5 million tonnes by the end of 2023. International flights departing New Zealand used 1.2 million tonnes of jet fuel in 2019. At a 50 per cent blend ratio, we could use up to 600,000 tonnes of SAFs each year.

Fulcrum BioEnergy began operating its biofuels facility from Nevada in July 2021 and has plans to open several other plants across the United States. It can currently produce about 41.6 million litres of syncrude each year, which can be further refined into sustainable aviation fuel or other fuel products.

D https://cdn.revolutionise.com.au/cups/bioenergy/files/ephcnscv89wbfzjz.pdf

Box D.2

Hydrogen

The Emissions Reduction Plan, which was released in May 2022, includes plans to reduce our reliance on fossil fuels while supporting the switch to low emissions energy sources.

One of the initiatives is to develop a roadmap that assists and guides future investment in hydrogen technologies in New Zealand. This breakout box gives an overview of recent hydrogen developments in New Zealand.

Hydrogen-powered heavy trucks are currently being trialled

The first Hyundai XCIENT hydrogen-powered heavy truck arrived in New Zealand in November 2021. This is the first of 5 trucks that will be part of a working demonstration programme partly funded by the Energy Efficiency and Conservation Authority (EECA).

The XCIENT is powered by a 350kW electric motor with 2237Nm of torque. Electrical power is delivered from a 180kW hydrogen fuel cell system with dual 90kW fuel cell stacks combined with a 72kWh battery. Seven fuel tanks provide a combined storage capacity of about 32kg of hydrogen. The range is about 400 km – the driving distance between Auckland and Palmerston North.

The truck is fuelled by green hydrogen, which is produced in Taupo by a 1.5MW green hydrogen production facility. The plant officially started production in December 2021. The plant uses electricity generated by the nearby Mokai geothermal power station.

Significant investment in renewable electricity generation would be required to support the uptake of a large fleet of hydrogen-powered heavy trucks. The scale of investment would likely be similar to that needed for a large fleet of battery electric vehicle trucks. For example, if half of all the current heavy diesel vehicle fleet is replaced by hydrogen powered trucks, around 1,200MW of additional electricity generation capacity would be needed – equivalent to 9 wind farms the size of Waipipi. Alternatively, closing the Tiwai Point aluminium smelter would free up all the generation from Manapouri power station, which is more than enough to decarbonise half of all diesel heavy trucks with spare electricity generation for other uses.

Apart from investment in renewable generation and hydrogen production plants, we would need to invest in a network of refuelling stations to support a hydrogen-powered truck fleet. Construction of New Zealand's first high-capacity green hydrogen refuelling stations began in May 2022 in Palmerston North. The developers of this refuelling network expect that New Zealand will have 24 high-capacity refuelling stations across the country in the next 4 to 5 years.

Hydrogen aircraft could be viable by mid-2030

In September 2021, Air New Zealand and Airbus signed a memorandum of understanding to analyse the impact that hydrogen aircraft may have on the airline's network, operation, and infrastructure. The International Energy Agency (IEA) suggests that hydrogen aircraft could be commercially viable in the mid-2030s. A report prepared by Castalia for the Ministry of Business, Innovation, and Employment suggests that aviation could be the single largest use of hydrogen in a decade[E].

E This can be accessed at https://www.mbie.govt.nz/dmsdocument/20118-new-zealand-hydrogen-scenarios-pdf

E. Oil and Natural Gas

Indigenous production of crude oil and natural gas both fell in 2021. The fall in natural gas production and reserves were driven mostly by the ongoing decline of the Pohokura field. However, the development of other fields (especially Maui) has partially compensated for Pohokura's decline and the forecasts of long-term production are largely unchanged. Industrial use of natural gas fell in response to the reduction in natural gas supply, most notably seen in the chemical manufacturing sector as Methanex lowered production.

The Marsden Point Refinery had its last full year of operation in 2021, after a strategic review of its operations started in April 2020. The final month of operations for the refinery was March 2022. Marsden Point is now operated as an import terminal by Channel Infrastructure.

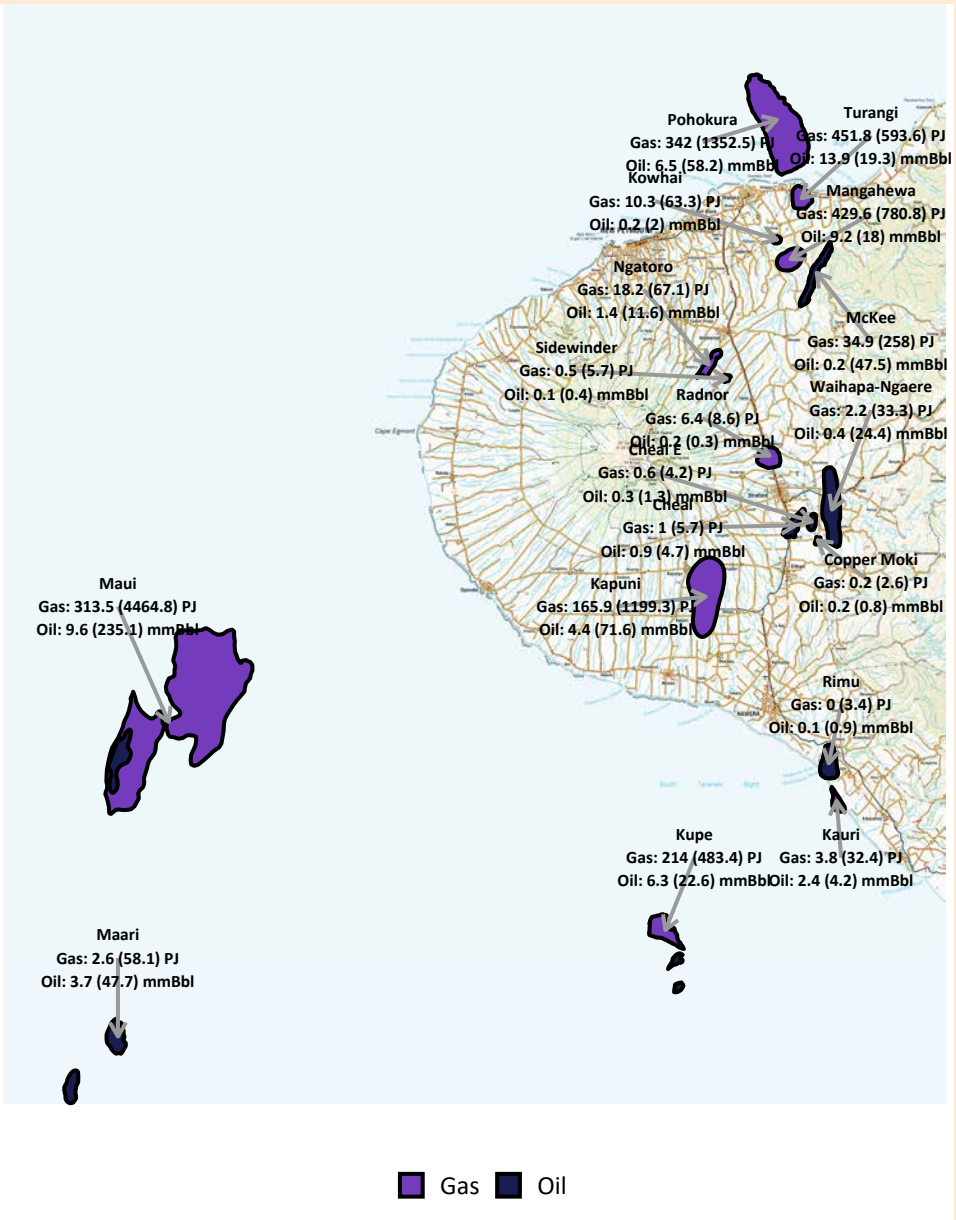
By contrast, liquid fuel consumption increased and partially recovered from the lows seen in 2020. This was led by aviation fuels (due to increased domestic flights) and diesel (due to shipping demand).

Box E.1

Expected Oil and Natural Gas Reserves in Taranaki

Figure E.1 shows the oil and natural gas fields in Taranaki. The first numbers show the expected oil and natural gas that can still be extracted from each field (the 2P reserve). The number in brackets including the total amount of oil and natural gas expected to be recoverable from the field, including the oil or natural gas that has already been recovered.

Figure E.1: P2 reserves of oil and natural gas that are ultimately recoverable as at 1 January 2022



Reserves

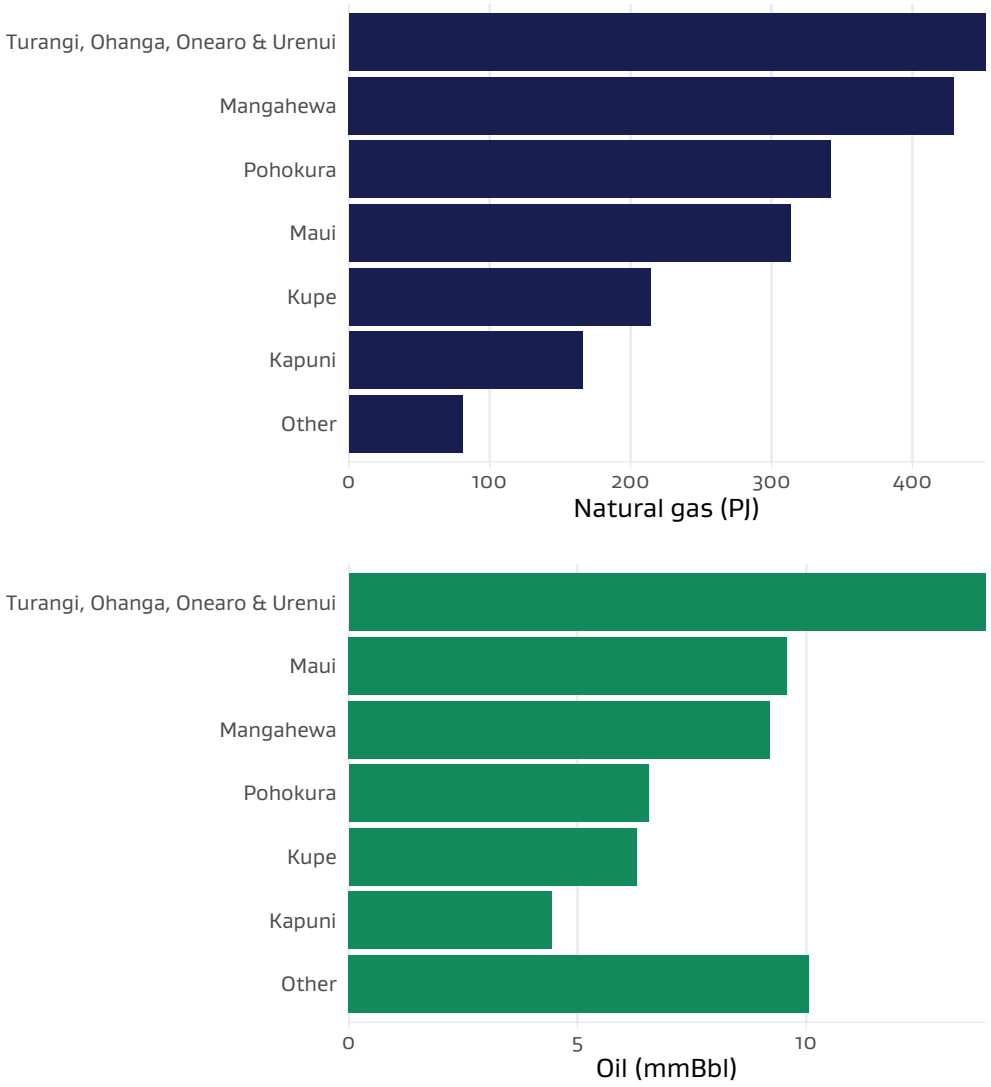
Pohokura is now the third-largest natural gas field in New Zealand

As at 1 January 2022, New Zealand has 59 million barrels of crude oil remaining and 1,967PJ of natural gas remaining (based on 2P reserves). This represents a 5.2 per cent (110PJ) decline in natural gas reserves from 1 January 2021. A full description of 1P, 2P and 3P reserves can be found in the glossary.

The field with the largest change in remaining reserves over 2021 was Pohokura, with reserves falling by 23 per cent (99PJ) since 1 January 2021. The other major fields to see declines were Kapuni (down 17 per cent or 35PJ) and Kupe (down 14 per cent or 35PJ). The main fields to show an increase in reserves were Mangahewa (up 7.1 per cent or 28PJ), Turangi (up 5.5 per cent or 23PJ), and Maui (up 7.1 per cent or 21PJ).

The largest source of uncertainty in remaining natural gas supply is the Mangahewa field, which has a 684PJ difference between its figures for 1P and 2P reserves before considering the additional contingent resources in the field.

Figure E.2: Remaining natural gas and oil reserves by field (2P)

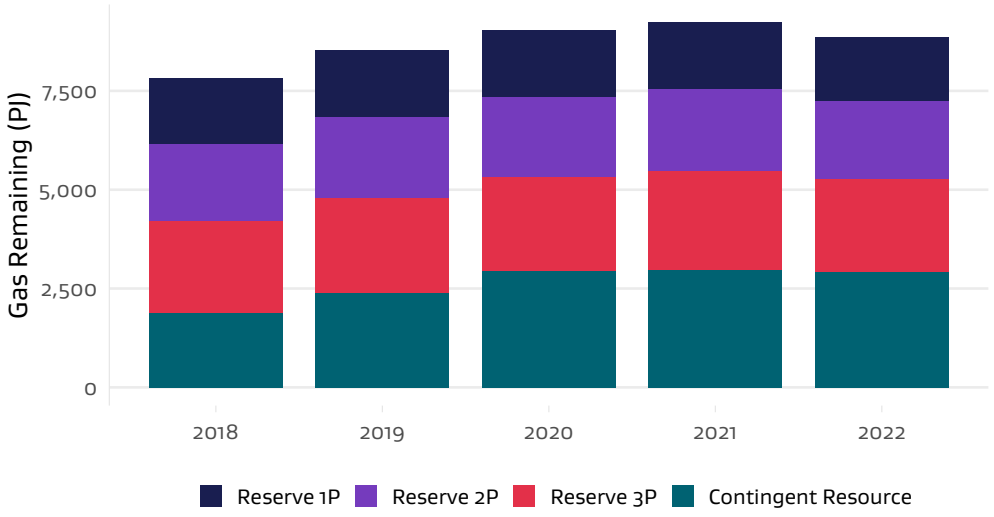


Reserves of natural gas are being sustained by developing contingent resources

Overall, 2P natural gas reserves decreased by 5.1 per cent (1075PJ) in the year ending 1 January 2022. However, since a net 158PJ of natural gas was produced in 2021, 2021's natural gas production was partially offset by new 2P reserves. This represents development work to make natural gas reserves and resources more available for production.

There have also been some revisions in the opposite direction. In particular, Kapuni's production life has been shortened to 2030 to allow 2 years for decommissioning in accordance with the Crown Minerals Act's requirements. This shortening of Kapuni's productive life has resulted in 35PJ of Kapuni's natural gas being reclassified from 2P reserves to contingent resources.

Figure E.3: Remaining natural gas reserves



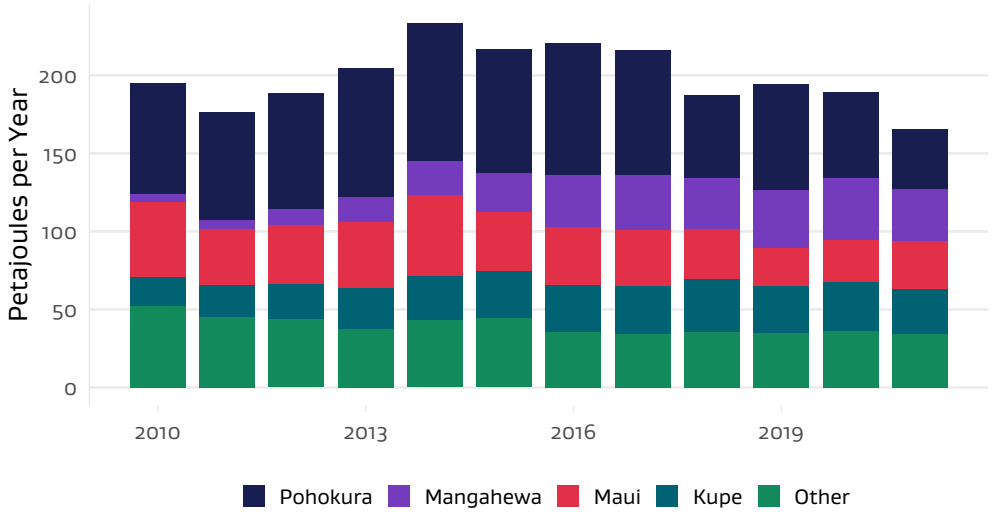
Natural gas

Natural gas production fell to a 15-year low

Natural gas production fell 13 per cent (24PJ) in 2021. The largest contributor to this fall was the Pohokura field, where production fell 31 per cent (17 PJ). Pohokura's production was below the 2018 low due to outages and was at its lowest annual level since 2006, when it first started production.

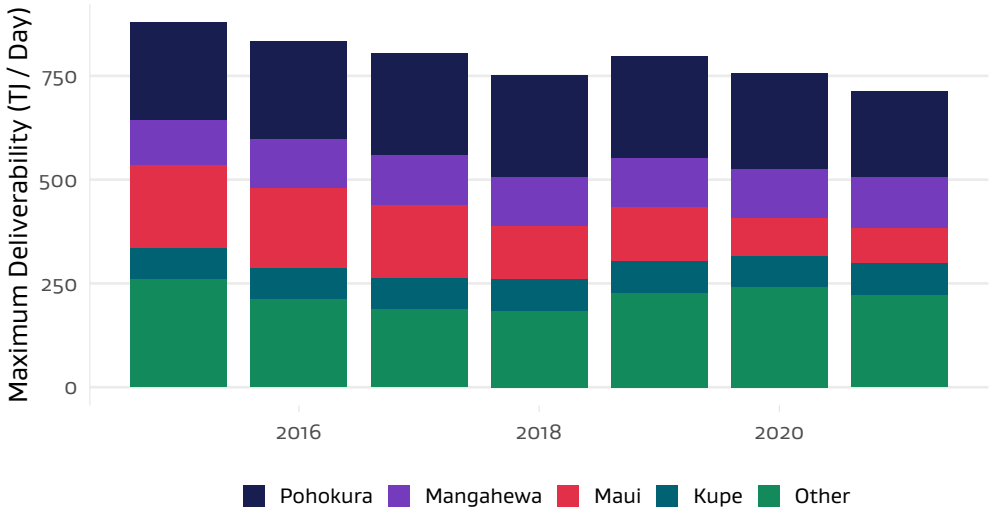
By contrast, Maui's production increased by 15 per cent (3.9PJ). This was driven by development work on the field during 2021, which has continued into 2022. While Pohokura's annual production was higher than Maui's for the whole year of 2021, by July 2021 Pohokura was no longer the highest producing field on a monthly basis. With Maui's higher production starting in September and more development work scheduled in 2022, it is unlikely that Pohokura will be the highest-producing field in the foreseeable future.

Figure E.4 Gross production of natural gas



The maximum deliverability of natural gas continues to decline, falling 7.3 per cent (52TJ a day) over the year ending 1 January 2022. The largest decline came from the Pohokura field, where the maximum deliverability fell 35 per cent (73TJ a day). This is consistent with the trend in previous years. This decline was partially offset by a 30 per cent (25TJ a day) increase in deliverability from the Maui field.

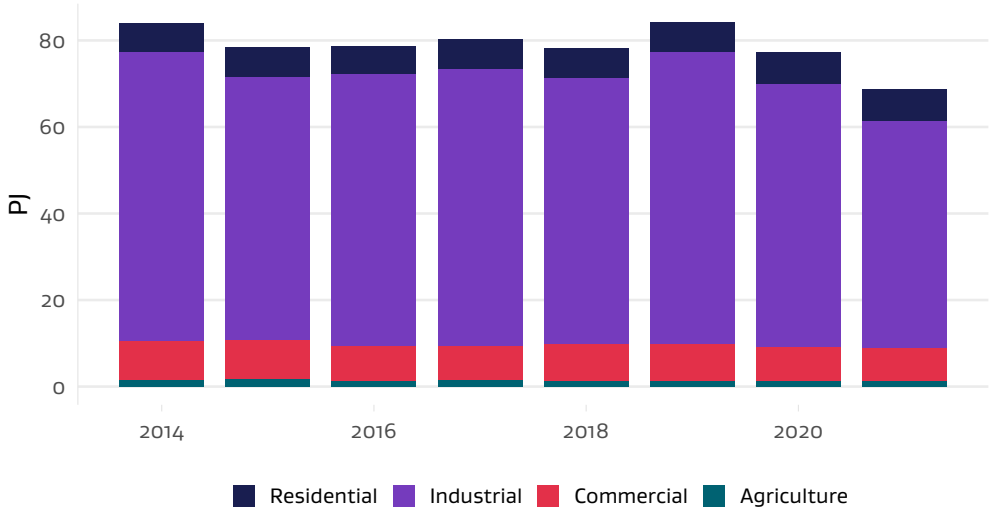
Figure E.5: Maximum natural gas deliverability as at 1st January



Industrial consumption of natural gas fell considerably

Overall natural gas consumption fell by 11 per cent (8.4PJ) in 2021. The largest declines were seen in the chemical manufacturing sector (18 per cent or 5.6 PJ) and wood, pulp, paper, and printing sector (45 per cent or 2.1PJ). No sector experienced an increase in consumption, with little change in residential consumption.

Figure E.6 Annual natural gas consumption by sector



The decline in the consumption of the chemical manufacturing sector was mostly driven by reduced production by Methanex. As Pohokura's production fell in June and July 2021, Methanex – New Zealand's largest single natural gas user – started to cut its natural gas use, reducing its monthly usage January 2021 to July 2021. Methanex also made the decision in 2021 to mothball their Waitara Valley plant. Alongside other cuts to production in mid-2021, this freed up natural gas to be used by other users, mainly in the electricity sector which tends to have the highest demand for natural gas in the winter months. From September 2021, Methanex started increasing its natural gas use following the winter peak and increases in Maui's production.

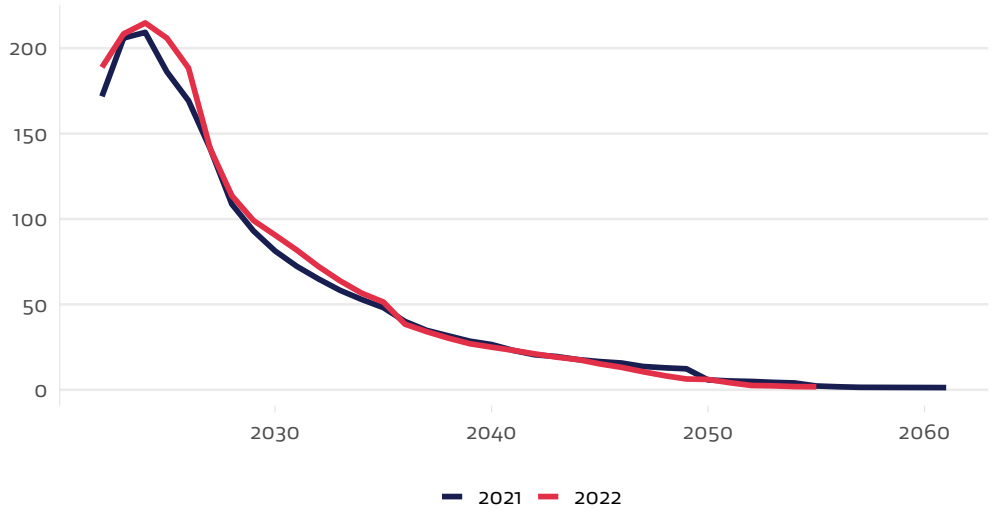
Production forecasts are slightly higher than last year

The future production of natural gas – measured by natural gas reserves production profiles as reported by field operators– is higher than last year. Peak production is still forecast to occur in 2024 but is at a slightly higher level at 215PJ (up 2.6 per cent from last year).

The expected annual production until 2035 is expected to be higher than what was forecast in 2021, with total production over this period projected to be 6.8 per cent (114PJ) higher. After 2035, the forecast is for levels to be lower overall, with total production between 2036 and 2055 projected to be 9.4 per cent (32PJ) lower than the 2021 production profile.

As this is based on 2P reserves figures, there is potential for some contingent resources to be developed to further increase the production forecasts in the medium-term.

Figure E.7 Expected annual natural gas production as reported by field operators



Box E.2

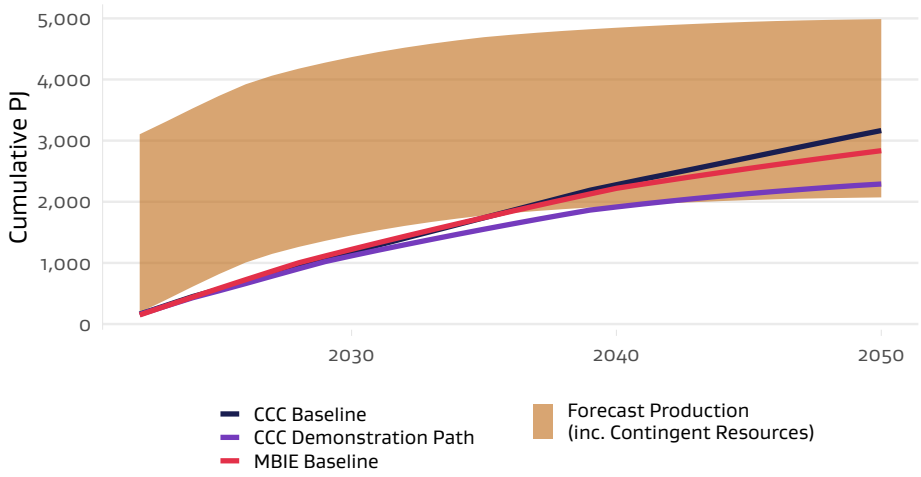
The future of natural gas

Natural gas consumption and production have varied over time and can be expected to change in the future. On the one hand, natural gas production is expected to decline after 2024 as New Zealand natural gas fields enter end-of-life. On the other hand, natural gas use is also expected to decline over time. In the past 5 years, annual natural gas production fell 20 per cent (38PJ), but over this period, transformation use fell 12 per cent (6.7PJ), non-energy use fell 35 per cent (20PJ), and consumption fell by 13 per cent (9.9PJ).

Additionally, New Zealand will need to reduce and eventually eliminate natural gas use to help achieve its emissions budgets and 2050 emissions targets.

Based on forecasts from the Climate Change Commission (CCC) and the Ministry of Business, Innovation and Employment, New Zealand will need to produce between 2,290 and 3,165PJ from 2022 to 2050 in order to meet demand. These scenarios represent an average annual usage of between 79 and 109PJ (as compared to 2021 total usage of 155PJ). While this level of use exceeds New Zealand's 2P natural gas reserves of 1,967PJ, contingent resources of 2,915PJ could provide sufficient gas if partially developed.

Figure E.8: Comparison of cumulative expected annual production of natural gas and forecast natural gas use



There is reason to suggest that natural gas reserves and resources will be sufficient to meet New Zealand's energy demands, while fossil gas remains part of our wider energy system.

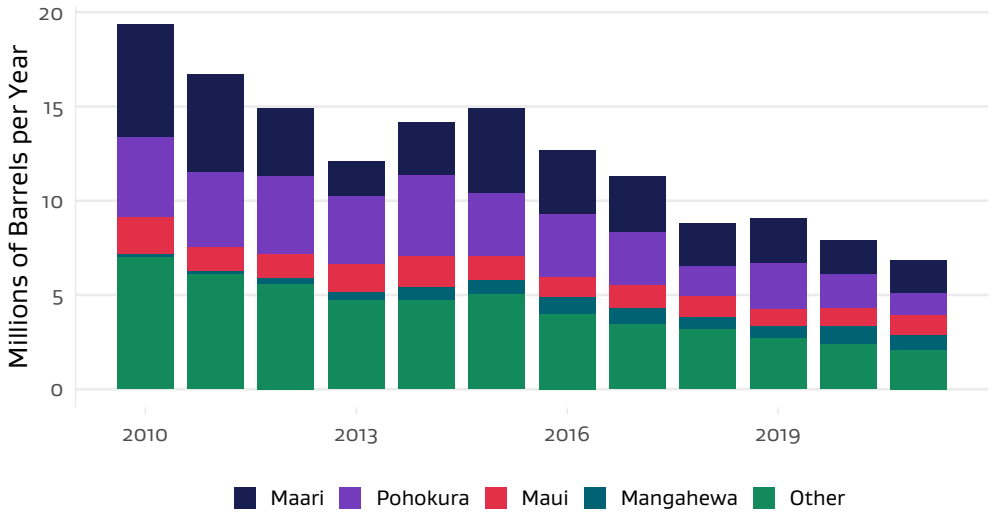
The Government has recently announced that it will be developing a Gas Transition Plan. This will help to guide the fossil gas sector to reduce emissions in line with legislated targets, emissions budgets, and New Zealand's international commitments.

Oil

Indigenous production continued to decline

Total indigenous crude oil production fell by 13 per cent (1.0 million barrels) in 2021. The main driver of this decline was the Pohokura field where production fell by 35 per cent (0.6 million barrels). The only major field to increase its production in 2021 was Maui, which increased by 7.9 per cent (0.1 million barrels). The last time annual indigenous production was this low was in 2006, prior to the opening of the Tui field.

Figure E.9 Indigenous production of oil



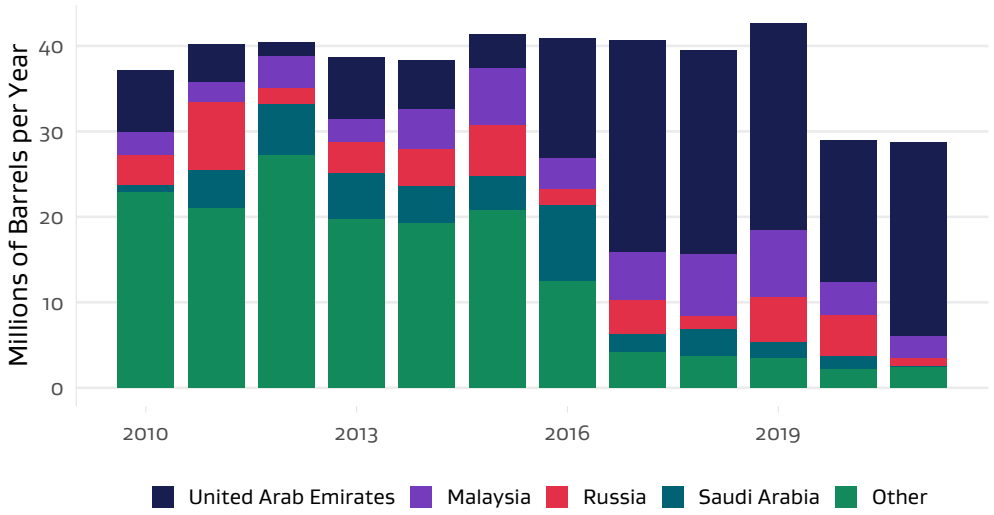
However, it is worth noting that this decline had little to no implications for New Zealand's energy consumption. New Zealand's crude oil is almost exclusively exported because the Marden Point Refinery was designed to run on heavier, foreign crude oil. Only 3.4 per cent of the crude oil used by the refinery in 2021 was indigenously produced.

Nearly all the crude oil used in New Zealand came from overseas

Refinery intake in 2021 was down 0.7 per cent (0.2 million barrels) from 2020. Most of the crude oil used (79 per cent) was sourced from the United Arab Emirates. A small quantity of Russian crude oil (0.9 million barrels) was used in 2021, representing 3.2 per cent of crude oil intake.

Refinery intake is expected to decline sharply in 2022 with the closure of the refinery in April 2022. For more information on the closure of the Marsden Point Refinery, see Box E.3

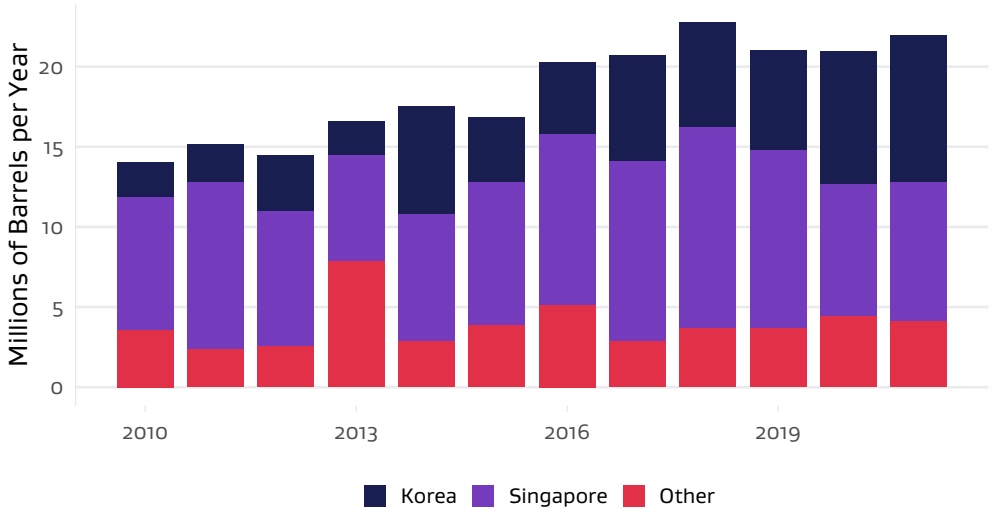
Figure E.10 Crude oil used by Marsden Point Refinery



The main sources of refined oil products were Korea and Singapore

An increase in demand meant that more refined oil imports were required as there was little change in domestic refinery output. Imports of refined oil products rose 4.8 per cent (1.0 million barrels) in 2021. The major sources of our imported products were Korea (39 per cent or 9.1 million barrels) and Singapore (29 per cent or 8.6 million barrels).

Figure E.11 Refined products imported by country

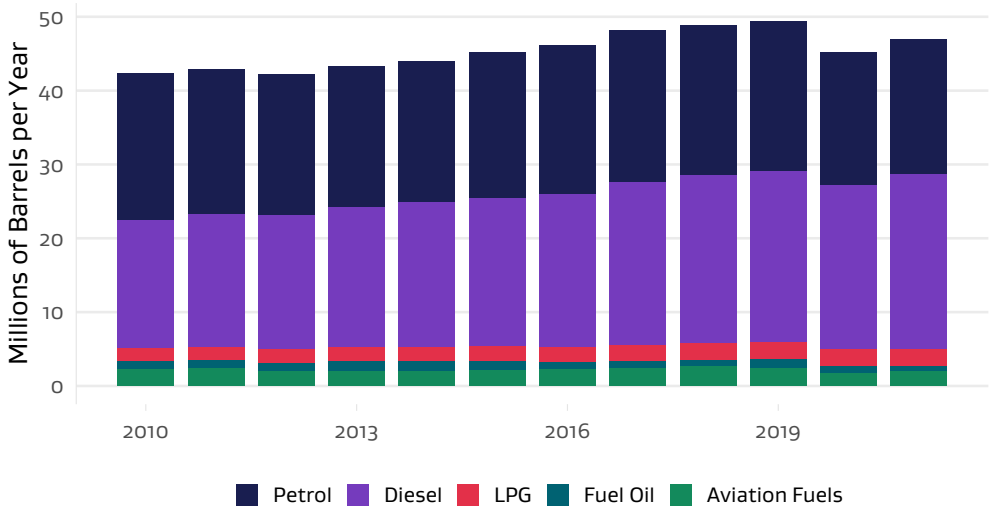


Consumption partially recovered from its low in 2020

Domestic liquid fuel consumption increased by 3.7 per cent (1.7 million barrels) in 2021. The largest gains were in diesel (6.3 per cent or 1.4 million barrels) and aviation fuels (16 per cent or 0.3 million barrels). The increase in the consumption of aviation fuels reflects the increase in domestic travel as a result of the easing of COVID-19 related travel restrictions.

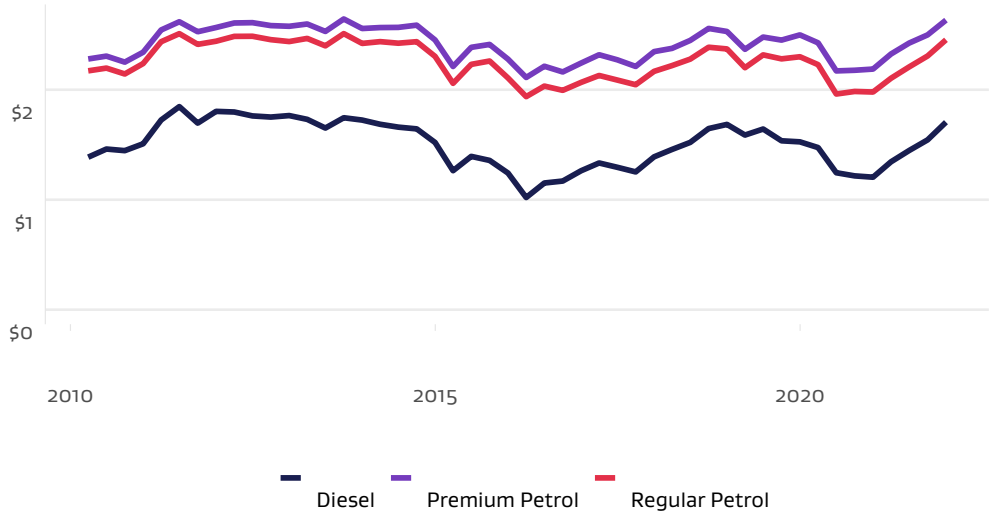
The increase in diesel consumption was driven both the increase in domestic travel and ships switching from diesel to fuel oil. New Zealand fuel oil tends to be high in sulphur, making it unsuitable under MARPOL Annex VI rules for international shipping.

Figure E.12 Consumption of oil products



Fuel prices returned to pre-pandemic levels

Figure E.13 Retail fuel prices (in 2021 $/L)



Over the course of 2021, prices of premium petrol increased by 20 per cent (45 cents per litre), regular petrol increased by 24 per cent (47 cents per litre) and diesel increased 42 per cent (50 cents per litre). International crude oil prices were at historic lows in 2020. The rise in crude oil prices in 2021 increased the cost of imports and therefore fuel prices.

Box E.3

Closure of the Marsden Point Refinery

In November 2021, Refining NZ announced that the Marsden Point Oil Refinery – New Zealand's only oil refinery – would close on 31 March 2022. Shareholders made a decision in August 2021 to stop refining operations. The decision followed a strategic review that started in April 2020. The review's purpose was to determine the future of the refinery in the face of competition from larger refineries in China, Singapore, Korea, and India, as well as the collapse in the demand for jet fuel due to the COVID-19 pandemic.

Starting in April 2022, the Marsden Point facility is being converted into an import terminal and the refinery itself is in the process of being decommissioned. Refining NZ rebranded as Channel Infrastructure Limited on 1 April 2022

Box E.4

Proposed fuel holding regulations

New Zealand's only oil refinery was closed on 31 March 2022, after Refining NZ initiated a strategic review of its operations in 2020. At the time of the review, Refining NZ was facing declining refining margins and increasing competition from bigger, newer refineries overseas. The Marsden Point site where the refinery was based is now a fuel import terminal. It remains a key gateway for fuel supplies to the Auckland and Northland regions.

The Marsden Point Refinery used to supply 65 to 75 per cent of New Zealand's refined fuel products. After the closure of the refinery, all of New Zealand's refined fuel supplies are imported. The refinery's closure improves New Zealand's fuel supply resilience in some respects. For example, more frequent shipments of imported fuel from more diverse sources mean the 'single point of failure' risk associated with an outage of the refinery is no longer as critical.

However, as crude oil stocks and intermediate products are no longer required for the refinery, the overall level of oil and fuel stocks held by fuel companies in New Zealand is lower.

In response to the change in New Zealand's fuel supply chains, the Ministry of Business, Innovation and Employment (MBIE) ran a public consultation on onshore fuel stockholding over January and February 2022. MBIE consulted on options for improving the resilience of onshore fuel supply, including:

- a proposal to introduce a minimum onshore fuel stockholding level equivalent to 28 days' cover for diesel, and 24 days' cover for petrol and jet fuel (based on average daily consumption of these fuels)
- a way to achieve a target level of onshore fuel stocks. This would include requiring fuel wholesalers to hold a minimum amount of fuel onshore, procurement of tickets for onshore fuel stocks, and establishing a stockholding agency to manage the relevant monitoring, compliance, and enforcement activities.

The Government is expected to make final decisions on the design of the onshore fuel stockholding policies in the second half of 2022.

F. Coal

Coal production increased slightly on 2020 levels. This was driven by an increase in bituminous coal for exports which outweighed a decrease in the production of sub-bituminous coal, and there were fewer production constraints due to COVID-19.

The total primary energy supply of coal for 2021 was 65.1PJ, an increase of 12 per cent on the previous year. Coal accounted for approximately 7.5 per cent of New Zealand's primary energy supply.

The domestic demand for coal mainly for electricity generation, combined with the constraints in domestic production, resulted in the highest level of coal imports on record. Coal exports increased as a result of increased production. The calendar year 2021 marks the first time on record that New Zealand became a net coal importer.

Box F.1

Overview of New Zealand's coal industry

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. 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[F].

New Zealand's coal industry 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 – the production of iron and steel. The main consumers of this 'thermal coal' in New Zealand are Genesis' Huntly 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 because of the unique processes used at the facility.
- **West Coast:** Coal extracted on the West Coast of the South Island is made up of 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.

There were 15 mines operating in New Zealand at the end of 2021.

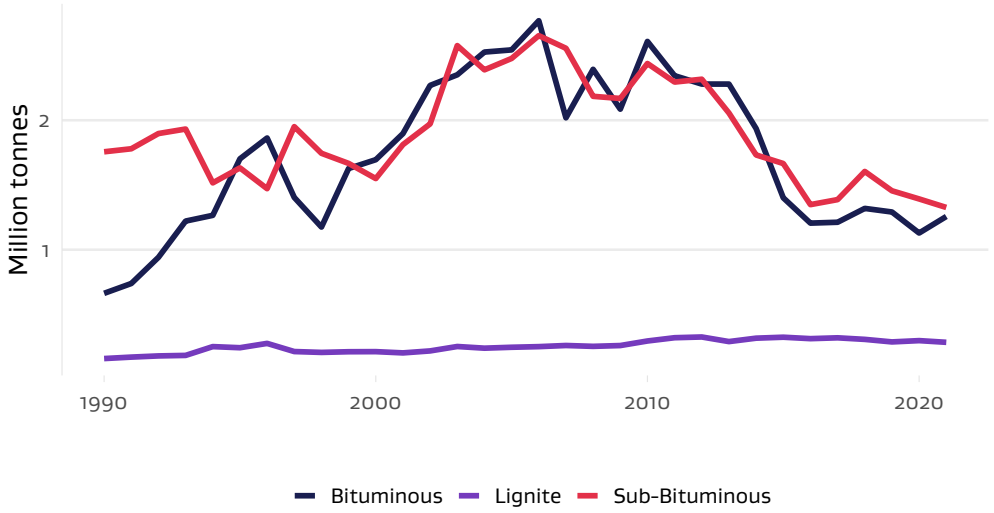
Additional background information on New Zealand's coal industry can be found on the New Zealand Petroleum and Minerals website: https://www.nzpam.govt.nz/our-industry/nz-minerals/minerals-data/coal/.

F For more information on New Zealand's mineral resource potential see https://www.nzpam.govt.nz/nz-industry/nz-minerals/resources-potential/

Coal production increased due to more exports

Coal production was 2.9 million tonnes in 2021, an increase of 1.7 per cent on the previous year.

Figure F.1 Coal production by rank



Coal production in 2021 was 2.9 million tonnes (70.5PJ), an increase of 1.7 per cent from 2020. There was an increase in bituminous coal production for export which outweighed a decrease in sub-bituminous coal production.

Specific changes by rank of coal for 2021 include:

- Sub-bituminous coal production decreased by 4.7 per cent on the previous year. Production from North Island mines was down by 6.5 per cent, while the production from the South Island decreased by 2.4 per cent.
- Bituminous coal production increased by 11 per cent on last year.
- Lignite production increased by 4.4 per cent on last year.

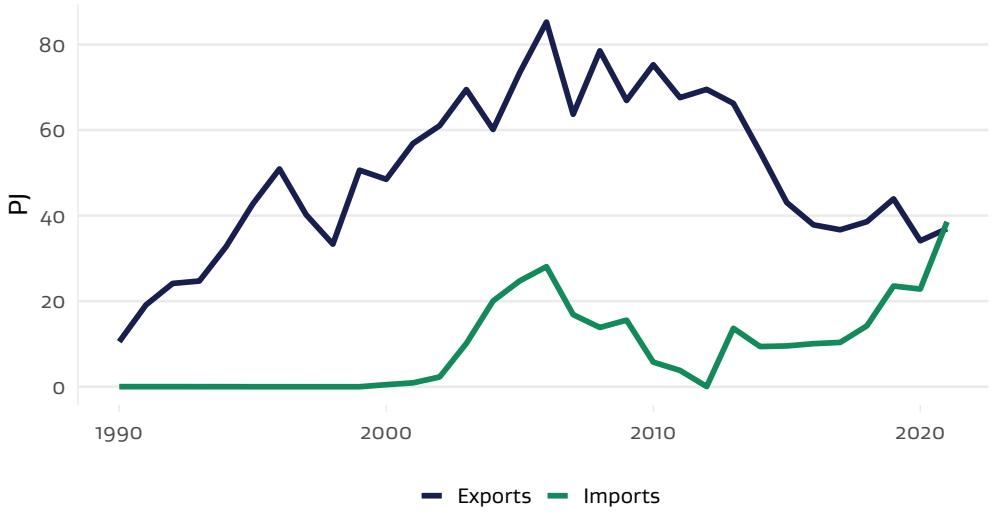
New Zealand was a net importer of coal for the first time

Coal imports exceeded imports for the first time since 1990. This meant that New Zealand was a net importer of coal.

Coal imports increased by 69 per cent to 38.6PJ (1.85 million tonnes), the highest level on record. This was due to higher imports of sub-bituminous coal, which was driven by the demand for electricity generation as well as constraints on the ability of domestic producers to supply the required amounts at short notice.

Coal exports increased by 8.3 per cent to 37PJ (1.24 million tonnes) in 2021. This increase came after the easing of constraints on production in 2020 as a result of restrictions on activities as part of the response to the COVID-19 pandemic.

Figure F.2 Coal exports and imports

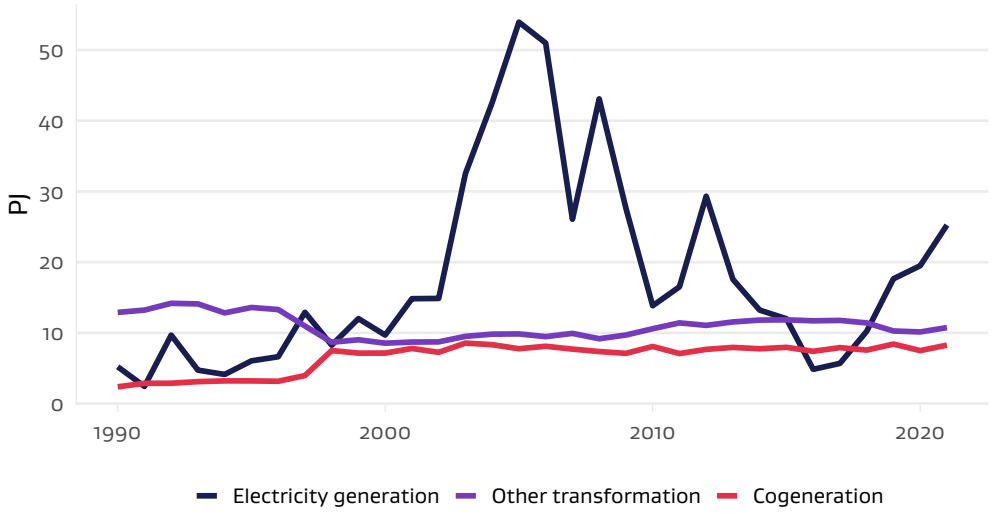


Coal use for electricity generation increased

Coal use for electricity generation increased 29.5 per cent due to a dry hydrological year and lower natural gas production.

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

Figure F.3: Coal transformation use



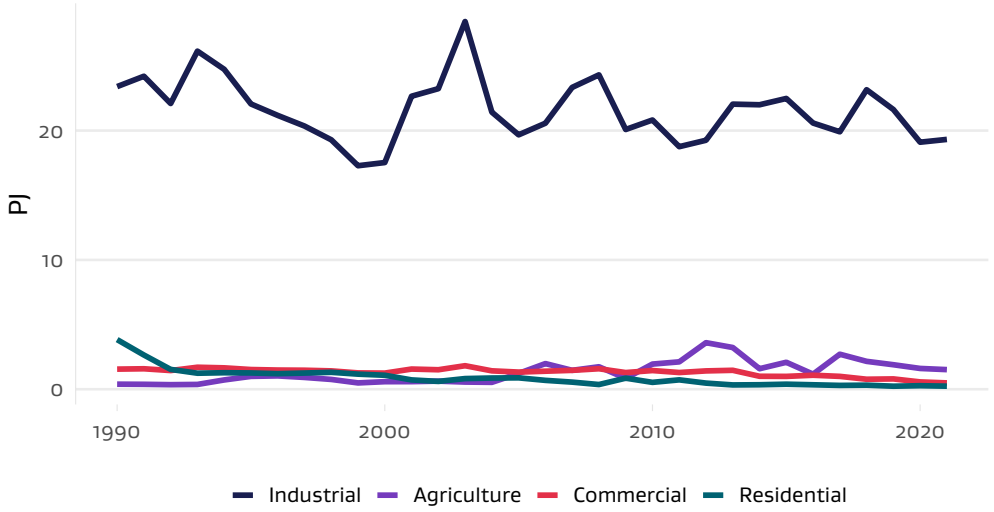
Industrial sector dominates coal consumption

Coal consumption has been declining gradually since 2018. Industrial use on an energy basis increased slightly while residential, agriculture, and commercial use all decreased between 2020 and 2021.

Coal use within New Zealand is currently dominated by the industrial sector. This 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. Consumption from agricultural, commercial, and residential sectors make up approximately 10 per cent of coal use in total.

Coal consumption on a tonnage basis in the industrial sector decreased by 0.1 per cent from 2020, but was up by 1.1 per cent on an energy basis. Total consumption for 2021 was 21.6PJ, an increase of 0.1 per cent on the previous year.

Figure F.4 Coal consumption by sector



G. Glossary

Glossary

Black liquor: A recycled by-product made during the pulping of wood in the paper making industry. It is burned in a boiler to produce heat and electricity and is considered to be a solid biofuel.

Biomass: Organic material from plants or animals which can be used as fuel for producing heat or electricity.

Capacity factor: A measure of how often an electricity generation plant runs in a period of time. It is calculated as the amount of electricity generated by a plant divided by the maximum amount that could have been generated if it operated continuously at full power in that period of time.

Cogeneration: When electricity plants generate electricity and heat at the same time. Otherwise known as combined heat and power, or CHP.

Conversion efficiency: The amount of energy produced in a transformation process divided by the amount of energy that went into the process.

Conversion losses: The energy lost in transforming one type of energy to another. This is calculated as the difference between the amount of energy that has gone into a transformation process and the amount of energy that has been produced.

Contingent resources: Contingent resources are resources estimated at a particular time to be potentially recoverable but are not yet commercially recoverable. This could be a result of technological barriers or economic factors. It is possible for remaining reserves to be reclassified as contingent resources (or vice versa) because of changing economic conditions.

Direct use: The use of energy without it first going through a transformation process (such as electricity generation). For example, the use of geothermal energy to heat greenhouses.

Generation capacity: The maximum amount of electricity that can be produced by an electricity generation plant running at full power at a specific point in time.

Indigenous production: The production of primary energy sources within New Zealand. This includes extracting fossil fuels (such as coal and natural gas) and capturing energy from renewable sources (such as water and the wind).

Modern renewables: A classification for all renewable energy types excluding traditional biomass. 'Traditional biomass' refers to the use of renewable energy types for heating and cooking by households in developing countries.

Non-energy use: The use of energy for purposes other than combustion. This includes the use of bitumen in the construction of roads, and the use of natural gas in ammonia production.

Process heat: The energy used for warming spaces and industrial processes (such as drying milk powder). This is often in the form of steam, hot water, or hot gases.

Reserves (1P, 2P and 3P): The amount of crude oil, LPG, or natural gas that is believed to be available and commercially producible in an oil or natural gas field. These are reported at different levels of confidence or certainty:

- 1P reserves are proven reserves (both developed and undeveloped). These reserves have a 90 per cent certainty of being produced.
- 2P reserves are the sum of proven reserves and probable reserves. These reserves have a 50 per cent certainty of being produced.
- 3P reserves are the sum of proven reserves, probable reserves, and possible reserves. These reserves have a 10 per cent certainty of being produced.

Self-sufficiency: 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 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

Total final energy consumption (TFEC): Energy consumed by end-users such as factories and households.

Total primary energy supply (TPES): The total amount of energy available for use in New Zealand, accounting for domestic production and trade.

Transformation process: The conversion of one energy type to another. For example, the conversion of geothermal energy to electricity.

Utility-scale solar: Large solar photovoltaic (PV) projects that directly supply an electricity grid or network.

Waste heat: Heat that is generated from a by-product chemical reaction and used to generate electricity.

Conversion equivalents between units of energy

	PJ	TJ	GWh
Petajoule	1	1000	0.002778
Terajoule	0.001	1	0.2778
Gigawatt-hour	0.0036	3.6	1

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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