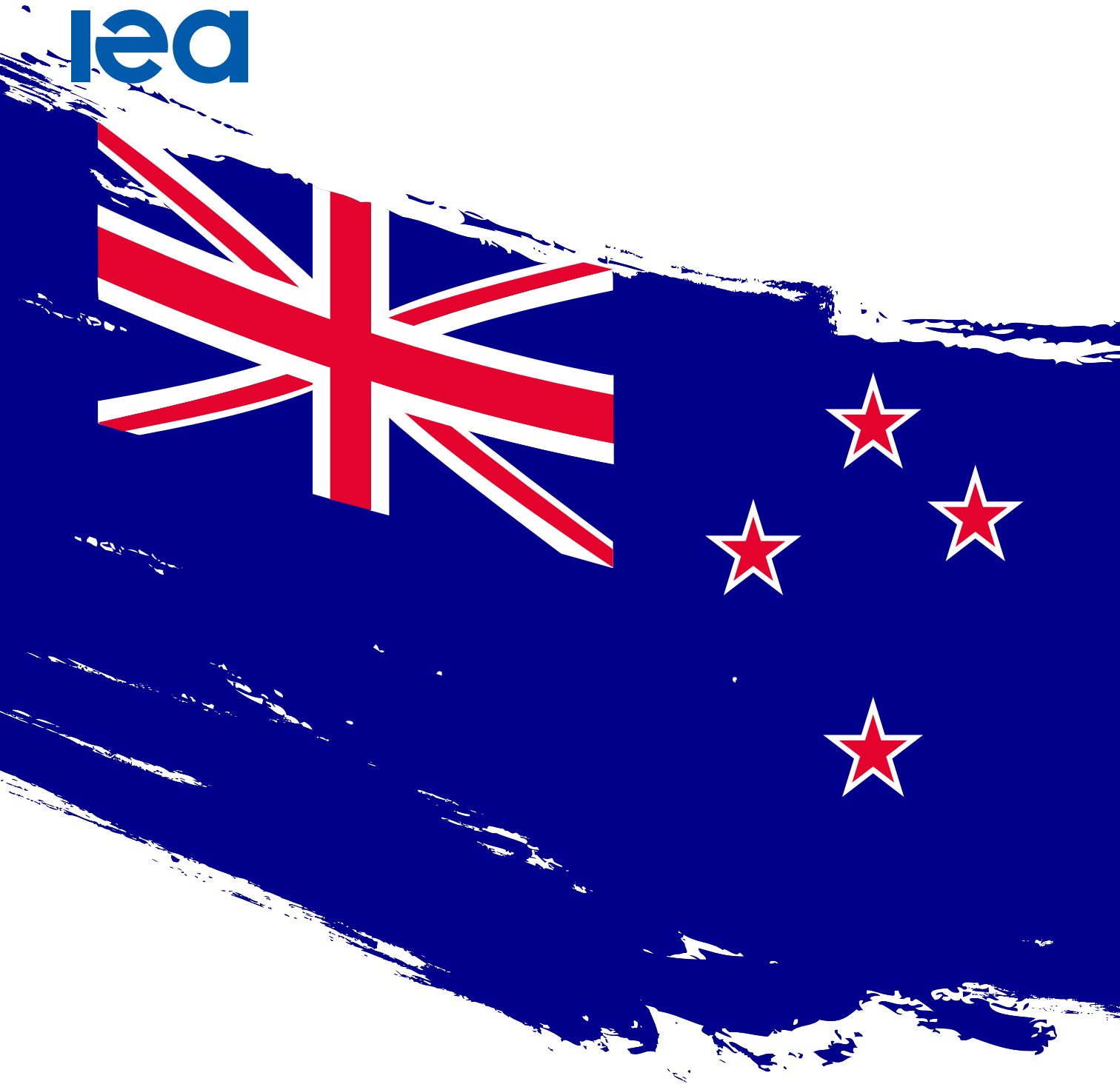

New Zealand 2023

Energy Policy Review

International Energy Agency

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 31 member countries, 11 association countries and beyond.

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Foreword

The mission of the International Energy Agency (IEA) is to shape a secure and sustainable energy future for all. We work with countries around the world on strengthening energy security and reaching net zero emissions. Our in-depth reviews are an essential IEA tool for providing insight and advice to governments on how to best achieve their energy and climate goals.

Under the leadership of Minister of Energy and Resources Dr Megan Woods, New Zealand has made considerable progress in addressing climate change and has increased its support for global efforts on clean energy transitions. I am grateful to Dr Woods for her multilateral engagement through IEA work, including as a member of our Global Commission for Urgent Action on Energy Efficiency.

New Zealand has set ambitious targets for reducing domestic greenhouse gas emissions, including bringing them down to net zero by 2050. New Zealand is starting from a strong position with its low-emissions electricity system in which over 80% of electricity comes from renewable sources. The task for New Zealand now is to leverage its renewables-based electricity system to decarbonise other sectors, notably transport and industry. Not only will this require sizeable investments in technology, but it will also entail a considerable buildout of additional renewable generation capacity, along with new investments in grids and storage. Major energy efficiency upgrades will also be needed to decarbonise the buildings sector.

New Zealand has already made progress to enable this energy system transformation. Its domestic climate legislation requires the government to set emissions budgets underpinned by emissions reduction plans that include comprehensive measures across all economic sectors. Such strategic planning for energy and climate policy will help provide long-term investment signals to the energy sector. The government has also committed to developing a long-term energy strategy by 2024 to establish sectoral pathways for shifting New Zealand's energy system away from fossil fuels toward low-emissions alternatives. Therefore, the most pressing task is to finalise these policy decisions and proceed with implementation.

New Zealand's energy transition offers lessons for other countries facing similar issues. In particular, the NZ Battery Project will provide insight into the viability of a large-scale pumped hydro solution to balance a power grid based heavily on renewables and led by hydropower, which is vulnerable to dry weather challenges. Government-backed efforts to decarbonise heat for industrial processes can also help unlock important decarbonisation solutions for the world.

I hope that the recommendations proposed in this report will help inform key policies in New Zealand, including its aspiration to reach 100% renewables in electricity and the upcoming long-term Energy Strategy.

Dr. Fatih Birol

Executive Director

International Energy Agency

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1. Executive summary

Overview

New Zealand has a diversified energy mix, with significant production of both hydropower and geothermal. As the country embarks on an ambitious energy transition, it has many natural advantages, including an enviable renewable resource base. The key challenge will be to decarbonise end-use sectors through clean power and support investments in new technologies to achieve deeper emissions cuts across all sectors in the most economically efficient way.

New Zealand has set ambitious targets for reducing greenhouse gas (GHG) emissions, including achieving net zero emissions by 2050. New Zealand already has a low-emissions electricity system, with over 80% of electricity coming from renewable sources in 2021. And this share could easily reach over 90% based on existing policies.

Elsewhere, the country has more work to do to decarbonise economic sectors beyond electricity. Notably, the transport sector accounts for the highest share of emissions and is almost entirely dependent on oil as a fuel source. Industry is also a major contributor to New Zealand's GHG emissions and is heavily reliant on fossil fuels.

New Zealand has an attractive opportunity to leverage its clean electricity sector to advance electrification as a decarbonisation strategy in other sectors. This will require not only sizeable technological investments to support electrification in transport and industry but will also necessitate a sizeable buildout of additional renewables generation capacity to meet accelerated load growth, along with additional grid and storage investments. New Zealand should weigh its aspiration to achieve 100% renewable electricity by 2030 against the potentially considerable costs associated with achieving the last 2-5% of the target.

New Zealand does not yet have a long-term energy strategy in place. While work is underway on a strategy, it is not due for release until the end of 2024. A lack of clarity surrounding the pathways to meeting ambitious climate targets (including the roles that various fuels and technologies will play) creates an uncertain policy environment, hampering the significant investment required to meet the government's 2030 targets.

Overall, New Zealand has the potential to reach its emissions reduction and energy targets based on its natural resources and policy levers. But the time frames to meet the targets are very ambitious. If the targets are to be met, the energy sector will need a viable policy road map as soon as possible. Delays in providing policy clarity will likely result in the targets being met much further into the future.

Climate change policies

New Zealand's updated climate target under the Paris Agreement is to reduce net GHG emissions by 50% from gross 2005 levels by 2030. The most recent domestic legislation is the Climate Change Response (Zero Carbon) Amendment Act 2019, which sets a net zero GHG emissions target (exempting biogenic methane, mostly from cattle) by 2050. It also includes a target to reduce biogenic methane emissions by 10% from 2017 levels by 2030 and by 25-47% by 2050.

The Act also established a Climate Change Commission to provide independent, evidence-based advice on the actions the government needs to take to address climate change. In addition, the Act requires emissions budgets and emissions reduction plans (along with national adaptation plans). New Zealand's emissions budgets cover 5-year periods and are set 10-15 years in advance, after considering the recommendations of the Climate Change Commission. The first three emissions budgets were set in May 2022 for the periods 2022-2025, 2026-2030 and 2031-2035.

Each emissions budget must be supported by an emissions reduction plan (ERP) that contains policies and strategies for meeting the emissions budget. New Zealand's first ERP was published in May 2022.

The country's primary emissions pricing tool is the New Zealand Emissions Trading Scheme (NZ ETS). The point of obligation is upstream, so the impact is mainly felt through fuel prices. The government will align the NZ ETS cap with decreasing emissions budgets. The NZ ETS has comprehensive coverage across the entire economy, except for the agricultural sector and a portion of the waste sector. To address carbon leakage, free allocation of allowances is provided to eligible industries that are emissions-intensive and trade-exposed. These allocations are planned to be phased out in the coming decades.

Energy strategy

New Zealand does not have a long-term energy strategy. In its May 2022 ERP, the government committed to developing such a strategy to achieve its vision for the energy and industry sectors. The energy strategy will drive New Zealand's pathways away from fossil fuels and towards greater levels of renewable electricity and other low-emissions alternatives. A scoping of what the new Energy Strategy could look like is underway. The government is working with energy system stakeholders to develop the Energy Strategy by the end of 2024.

Simultaneously, the government is developing several sectoral strategies that will serve as key inputs to the long-term Energy Strategy. These include: a Gas Transition Plan (GTP), expected to be completed by the end of 2023, which will establish the pathway for phasing out natural gas in New Zealand's energy system in line with climate targets; an updated New Zealand Energy Efficiency and Conservation Strategy to replace the existing strategy (that expired in mid-2022) and better align with the government's climate goals; and a renewable energy work programme, which will establish plans for expanding the role of renewables in New Zealand's energy system.

Electricity in the energy transition

New Zealand's electricity system is the cornerstone of the government's strategy for decarbonising the energy sector. The government plans to promote the electrification of end-use sectors such as buildings, transport and industry, leveraging a renewables-based electricity system.

The New Zealand Energy Strategy 2011-2021 set a target for 90% renewable electricity by 2025. Subsequently, the government set an aspirational goal of 100% renewable electricity by 2030. Moreover, the first ERP built on the government's aspirational goal in electricity and set a target of 50% of total final energy consumption from renewables by 2035. Making the electricity system fit-for-purpose is a top priority for the government.

New Zealand is fortunate to already have a high proportion of renewable electricity, which is currently over 80% of electricity production. However, due to the electricity system's heavy reliance on hydropower, its key challenge is coping with a "dry year", when hydro inflows are low. When a "dry year" occurs, and existing hydropower catchments do not receive enough rainfall, backup is currently provided by fossil fuel generation. This issue will become increasingly salient as the country strives to achieve a 100% renewables-based power grid and relies more on electricity to meet its decarbonisation targets.

In response, the government launched the NZ Battery Project in 2020. The project will provide comprehensive advice on the technical, environmental and commercial feasibility of potential energy storage projects, including, but not limited to, the Lake Onslow pumped hydro project. Feasibility studies for the project are expected to be completed early in 2023 and solutions to be in place in the 2030s.

Reaching the aspirational 100% target for renewables in electricity by 2030 and the 50% economy-wide renewables target by 2035 will require a massive buildout of new renewables generation capacity. Given limited options for large new hydro capacity and modest volumes of economically feasible geothermal, a sizeable share of the required new capacity will need to come from wind and solar.

In New Zealand, the Resource Management Act 1991 (RMA) plays a major role in determining the type of electricity generation that gets consented. While the RMA sets national direction on avoiding, remedying and mitigating the adverse effects of activities on the environment, it allows communities to decide how to manage their own environment through regional and district resource management plans. The government plans to repeal the RMA and replace it with three new pieces of legislation. The objectives of this reform are to better meet environmental protections, climate adaptation needs and Māori protections while also improving the efficiency of siting and reducing permitting complexity. Following public consultations, the aim is for the main reforms to be passed into law before the 2023 central government election.

There is considerable potential in other areas of renewables development, like offshore wind electricity generation. There is currently no targeted regulatory framework for offshore wind, and the country does not yet have any offshore wind sites or developments. However, a specific offshore energy regulatory regime is under development and is expected to be in place by 2024. Offshore energy development will be considered as part of the 2022-2024 process of creating a long-term Energy Strategy.

Phasing out fossil fuels

As a step towards addressing climate change and creating a sustainable future for New Zealand, in April 2018, the government announced that no additional offshore oil and gas exploration permits would be granted.

New Zealand's more ambitious climate targets will require lower emissions from fossil fuels driven by substantial declines in consumption. Emissions reductions are likely to occur through both reduced demand (for example, greater energy efficiency and electrification) and lower carbon intensity (for example, blending in renewable gases or biofuels).

A major part of this strategy will be enacted through the Government Investment in Decarbonising Industry (GIDI) Fund, which was established in 2020 as part of the government's Covid Response and Recovery Fund. The aim was to accelerate the decarbonisation of industrial process heat and contribute to the Covid-19 recovery by stimulating the domestic economy and supporting employment. In addition to the previous GIDI Fund targeted at industrial process heat projects, funding will now also include support for replacing inefficient industrial and commercial equipment and help replace fossil fuels in commercial space and water heating with renewable energy.

The government is especially working to reduce the demand for coal for process heat and electricity generation. In addition to GIDI-backed projects, this includes investigating options to manage the dry-year risk through the New Zealand Battery Project (to displace backup fossil generation), a proposed ban on new low- and medium-temperature coal boilers, as well as phasing out all existing coal boilers by 2037.

Currently, natural gas plays an important role in the electricity sector alongside coal-fired generation in firming or backing up hydro and variable renewable generation. The pace for phasing out natural gas and the "end-state" of the electricity sector is currently uncertain. They are dependent on a range of factors, such as emissions pricing, technological adaptation and other economic factors. The GTP will help to establish transition pathways for decarbonising the gas sector in line with the first three emissions budgets defined in the ERP.

To address oil demand, New Zealand also has a number of policies to increase vehicle efficiency and promote the penetration of electric vehicles (EVs) into its transport mix.

Key recommendations

The government of New Zealand should:

- Accelerate the development of the long-term Energy Strategy and related sectoral strategies to clarify the macro level policy settings and encourage necessary investments as soon as possible.
- Assess the relative cost of abatement across energy end-use sectors when developing the long-term Energy Strategy, prioritising overall abatement over the full decarbonisation of any particular sector.

- Move quickly to clarify regulatory regimes for renewables generation, such as the Resource Management Act and an offshore wind framework, to jump-start investments in additional renewables capacity.
- Increase policy focus on the transport sector, especially measures that will deliver structural change to diesel demand.

2. General energy policy

Key data

(2021)

Total energy supply (TES): 829.3 PJ, +11% since 2011

TES by source: oil 34%, geothermal 25%, natural gas 17%, hydro 11%, coal 7.6%, bioenergy and waste 4.9%, solar and wind 1.4%

Energy intensity per capita (TES/capita): 161.8 GJ/capita (IEA average: 166.7 GJ/capita); -5% since 2010

Energy intensity per GDP (TES/GDP): 4.11 MJ per 2015 USD PPP (IEA average: 3.74 MJ per USD); -17% change since 2011

Total final consumption (TFC): 559.8 PJ; +7% since 2011

TFC by sector: industry 42%, transport 36%, buildings 22%

Source: IEA (2022).

Country overview

New Zealand (Aotearoa in Māori) is located in the south-western Pacific Ocean, around 2 000 kilometres (km) east of Australia. Its territory expands over 268 021 km² and is composed of two main islands, the North Island and the South Island, which are separated by the Cook Strait, as well as other small islands. New Zealand is located on the Ring of Fire and is crossed by the Alpine fault, which makes the islands vulnerable to earthquakes and volcanic activity. The country's remoteness explains the high number of endemic fauna and flora species. New Zealand's Exclusive Economic Zone, 15 times its land area, is one of the largest in the world.

New Zealand's population was 5.1 million in 2022, 16% higher than in 2012 (StatsNZ, 2022). Annual population growth has been steady, at around 2% since 2014, but dropped sharply in 2021 to reach 0.6%. With 19 people per square kilometre, New Zealand has a relatively low population density. Eighty-three per cent of the population lives in urban areas. The main cities are Wellington (the capital), Auckland (the most populated) and Hamilton in the North Island, and Christchurch in the South Island. Three-quarters of the population lives in the North Island. English and Māori are the country's official languages. Its currency is the New Zealand dollar (NZD, exchange rate of NZD 1.59 per USD 1 in August 2022).

New Zealand is a constitutional monarchy – Charles III is the King of New Zealand and the head of state. The King is represented by the Governor-General. The government is formed from an elected House of Representatives and advises the Prime Minister, who is the source of all executive legal authority in New Zealand and acts on the advice of the

government. The next parliamentary general election must be held before January 2024. The country is divided into 16 regions: 11 have their own councils and 5 have territorial authorities, both elected.

The Treaty of Waitangi, signed in 1840 between the British Crown and a number of Māori chiefs, is today widely accepted to be a constitutional document laying out the relationship between the government and Māori. It includes a commitment to protect and preserve Māori culture and way of life while giving the Crown the right to govern the country (New Zealand, Ministry of Justice, 2022).

Economy

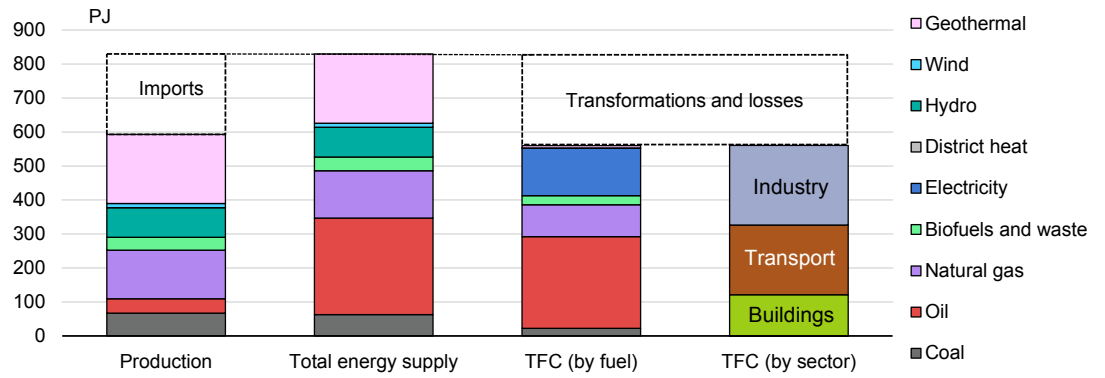
In 2021, New Zealand's gross domestic product (GDP) per capita was USD 46 389, below the OECD average of USD 48 754. The employment rate in the first quarter of 2022 was 79.1%, the fourth-highest among OECD countries (OECD, 2022) after Iceland, the Netherlands and Switzerland. The Covid-19 pandemic caused GDP to fall by 1.3% in 2020, but in 2021 the annual growth rate reached 4.6%, well above pre-pandemic levels (World Bank, 2021).

In 2020, service industries (trade, media, finance, rent, health, education) accounted for 65.6% of GDP, goods-producing (manufacturing, electricity, gas, water and waste, construction) for 19.5%, taxes for 8.4% and the primary sector (agriculture, forestry, fishing and mining) for 6.5% (StatsNZ, 2020).

Energy production, supply and demand

New Zealand's domestic production of energy covers three-quarters of total energy supply. Imported fossil fuels cover the last quarter. Geothermal is the largest single source of energy production (204 petajoules [PJ] in 2021), followed by natural gas (143 PJ), hydro (87 PJ), coal (67 PJ) and oil (43 PJ). Lower amounts of energy are also produced from wind (12 PJ). From 2011 to 2021, oil, coal and natural gas production dropped by 57%, 44% and 2%, respectively, and geothermal increased by 37%. Over the same period, domestic energy production from wind and solar (from a lower base) grew by 35%.

Figure 2.1 Overview of New Zealand's energy production, supply and demand, 2021



Three-quarters of New Zealand's total energy supply is covered by domestic production. The remaining quarter consists of imported oil.

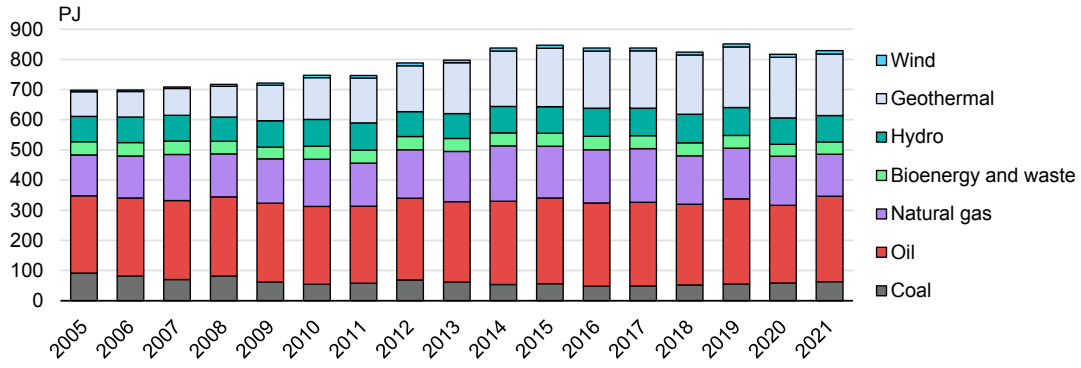
Notes: TFC = total final consumption.

Source: IEA (2022).

Total energy supply

New Zealand's total energy supply (TES) increased by 11%, from 747 PJ in 2011 to 829 PJ in 2021. In 2020, TES dropped to 824 PJ driven by the Covid-19 pandemic, but bounced back in 2021, though to a lower level than in 2019 (Figure 2.2). Fossil fuels accounted for 59% of New Zealand's energy supply in 2021 (compared to an IEA average of 78%), a gradually declining share since the beginning of the 2010s. Oil covers the largest share of TES, and from 2011 to 2021, the share of oil in TES was constant at around 34% (with the exception of a drop in 2020 due to lower consumption in transport amid the pandemic). Over the same period, the share of coal fluctuated at around an average of 7%, while the share of gas decreased from 19% to 17%. From 2011 to 2021, the share of wind in TES slightly grew, from 0.9% to 1.1%, while the share of bioenergy and waste slightly fell from 5.8% to 4.9%. Solar remained nearly flat at 0.1%.

Figure 2.2 Total energy supply by source in New Zealand, 2005-2021



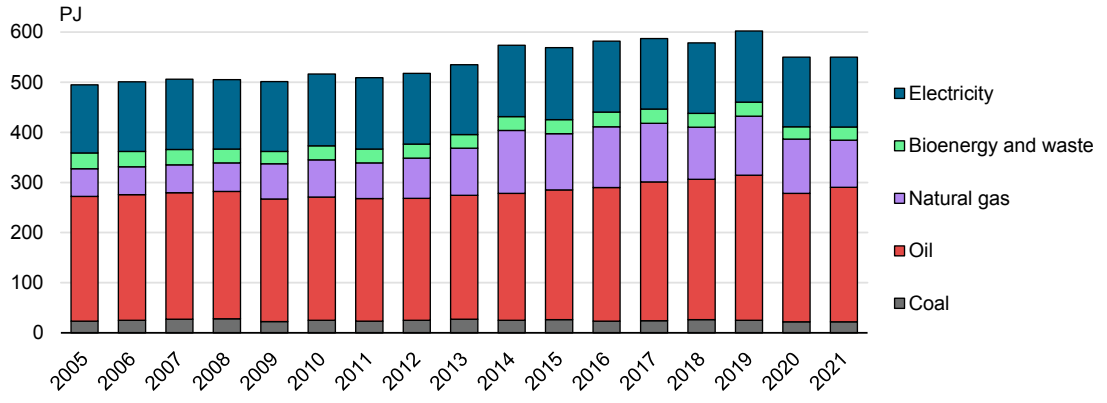
Fossil fuels covered 59% of New Zealand's total energy supply in 2021. After a gradual increase, New Zealand's energy supply has been relatively stable since 2015.

Source: IEA (2022).

Energy demand

Total final consumption (TFC) increased from 505 PJ in 2005 to 611 PJ in 2019 before falling to 561 PJ in 2020 amid the Covid-19 pandemic (Figure 2.3). In 2021, energy consumption did not rebound and remained at a similar level to 2020. New Zealand's energy demand is heavily dependent on fossil fuels, with oil covering almost half (48% in 2021) of the country's TFC, followed by natural gas (17%) and coal (4%). Electricity accounts for one-quarter of the country's TFC.

Figure 2.3 Total final consumption by source in New Zealand, 2005-2021



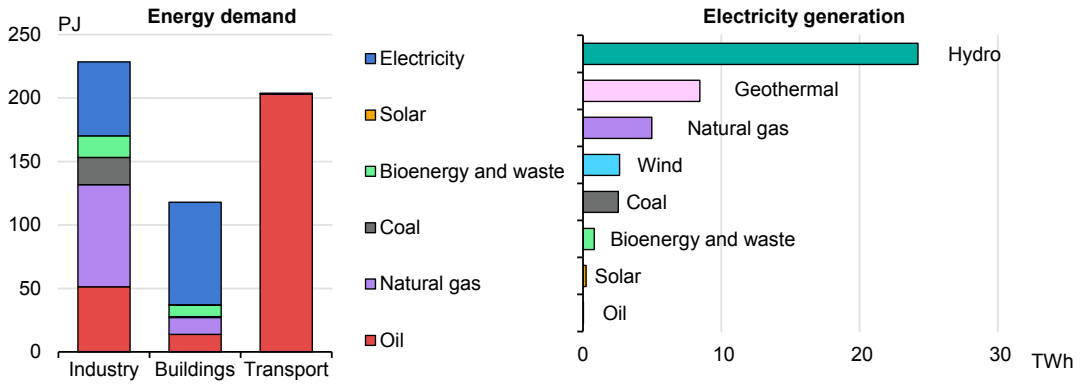
In 2020, fossil fuels represented 69% of New Zealand's total final consumption, which dropped in 2020 amid the Covid-19 pandemic, and did not rebound in 2021.

Source: IEA (2022).

In 2021, New Zealand's electricity was generated mainly using hydro (54%), followed by geothermal (19%), natural gas (14%), wind (5%), coal (4%), and bioenergy and waste (2%). Other sources include very small shares of solar (0.36%) and oil (0.03%).

Industry, accounting for 42% of TFC in New Zealand in 2021 (compared to the IEA average of 36% in 2020), has the highest share of New Zealand's TFC (Figure 2.4), followed by transport (36%) and buildings (22%). Electricity dominates demand in the buildings sector (60%), yet accounts for only 25% in the industry sector. As for most IEA countries, New Zealand's transport sector remains almost completely reliant on oil (99.8% of transport TFC in 2021). Bioenergy is used in industry (7.3% of the sector's demand) and buildings (7.5%). Natural gas is used mainly in the industry sector (35%) and less in buildings (11%). Coal is mostly consumed in the industry sector, where it covers 9.2% of the sector's demand.

Figure 2.4 Energy demand per sector and per fuel, and electricity generation by fuel in New Zealand, 2021



Electrification is high in buildings but much lower in other sectors. Hydro and geothermal were the main sources of electricity generation in 2021.

Note: TWh = terawatt hour.

Source: IEA (2022).

Key institutions and energy players

The **Minister of Energy and Resources** has broad responsibility across energy markets, including electricity, gas, liquid fuels and resources (including minerals and petroleum). The **Ministry of Business, Innovation and Employment (MBIE)** acts as the regulatory steward of resources and energy markets. It has the primary responsibility for advising the minister/government on energy and resources policy.

The **Commerce Commission** is the primary competition regulatory agency. Its responsibilities cover economic controls on natural monopoly infrastructure services, including electricity lines, gas pipelines, telecommunications and airports.

The **Energy Efficiency and Conservation Authority (EECA)** promotes energy efficiency, conservation and renewable energy.

For electricity, **Transpower** owns and operates the national transmission network, while the **Electricity Authority** governs and monitors the electricity market. The Commerce Commission regulates Transpower and grid companies because they operate with little or no competition.

For natural gas, the MBIE's responsibilities include the Crown Minerals Act 1991 (upstream), the Gas Act (primarily downstream) and the role of gas as a thermal fuel. In relation to the Gas Act 1992, the Minister of Energy and Resources has a range of statutory powers around sector regulation. The **Gas Industry Company** is the industry body and co-regulator under the co-regulatory model, in which downstream gas governance arrangements are developed in a partnership between industry and the government. **WorkSafe** is New Zealand's primary workplace health and safety regulator. It is responsible for energy safety, including gas pipelines and gasfitters.

Key energy and climate policies

Climate change targets and policies

New Zealand's updated climate target under the Paris Agreement is to reduce net GHG emissions by 50% from gross 2005 levels by 2030. The most recent domestic legislation is the Climate Change Response (Zero Carbon) Amendment Act 2019, which sets a net zero GHG emissions target (exempting biogenic methane, mostly from cattle) by 2050. It also includes a target to reduce biogenic methane emissions by 10% from 2017 levels by 2030 and by 25-47% by 2050.

The Act also established a Climate Change Commission to provide independent, evidence-based advice on the actions the government needs to take to address climate change.

In addition, the Act requires emissions budgets and emissions reduction plans (along with national adaptation plans). An emissions budget is the quantity of emissions allowed during a particular period. From 2022 onwards, three emissions budgets must be in place at any time, providing a pathway to the 2050 target. After considering the Climate Change Commission's recommendations, New Zealand sets 5-year emissions budgets 10-15 years in advance. The first three emissions budgets were set in May 2022 for the periods 2022-2025, 2026-2030 and 2031-2035.

Each emissions budget must be supported by an emissions reduction plan that contains policies and strategies for meeting the emissions budget. New Zealand's first ERP was published in May 2022 (see Chapter 3 for more details on emissions budgets and the ERP).

The country's primary emissions pricing tool is the New Zealand Emissions Trading Scheme. The point of obligation is upstream, so the impact is mainly felt through fuel prices. Aligning the NZ ETS with decreasing emissions budgets, along with expectations of a rising emissions price, is aimed to flexibly encourage businesses and households to align investment decisions and choices with low-emissions alternatives (see Chapter 3 for more on carbon pricing). The NZ ETS covers the entire economy, except for the agricultural sector and a portion of the waste sector. Some sectors can opt into the NZ ETS, including forestry, for which removal units can be earned. To address carbon leakage, free allocation of New Zealand emissions units is provided to eligible emissions-intensive and trade-exposed industries. These allocations are planned to be phased out in the coming decades.

Energy strategy

New Zealand does not currently have a long-term energy strategy. In the May 2022 Emissions Reduction Plan, the government committed to developing a strategy to achieve its vision for the energy and industry sectors. The vision is that by 2050 New Zealand will have a highly renewable, sustainable and efficient energy system that is accessible and affordable, secure and reliable, and supports New Zealanders' well-being.

The Energy Strategy will help set the pathways to navigate the energy trilemma (security, affordability and sustainability) and provide certainty for investors, industry and consumers. It will set the direction for New Zealand's pathway away from fossil fuels and towards greater levels of renewable electricity and other low-emissions alternatives. A scoping of what the new Energy Strategy could look like is underway.

The MBIE is collaborating and engaging with treaty partners and working with energy system stakeholders to develop the Energy Strategy by the end of 2024. The terms of reference for the strategy were released in October 2022.

Simultaneously, the government is developing several energy strategies that will serve as key inputs into the long-term Energy Strategy (MBIE, 2022a). These include:

- A Gas Transition Plan, expected to be completed by the end of 2023, which will establish the pathway for phasing out natural gas in New Zealand's energy system in line with climate targets.
- An updated New Zealand Energy Efficiency and Conservation Strategy to replace the existing strategy (that expired in mid-2022) and better align it with the government's climate goals and strategies.
- A renewable energy strategy work programme, which will establish plans for expanding the role of renewables in New Zealand's energy system. The renewables work programme has eight workstreams: 1) renewable electricity generation; 2) Green Hydrogen Strategy; 3) Resources Strategy; 4) just transition work; 5) Electricity Price Review; 6) Gas Act changes; 7) process heat; and 8) backing emerging technologies.

Government Investment in Decarbonising Industry Fund

The Government Investment in Decarbonising Industry Fund was first established in 2020 as part of the government's Covid Response and Recovery Fund. The aim was to accelerate the decarbonisation of industrial process heat and contribute to the Covid-19 recovery by stimulating the domestic economy and supporting employment.

An NZD 69 million fund was initially allocated, matched by NZD 117 million of investment by industry, to 53 projects, all contracted for completion by April 2024. The 2022 Budget allocated a further NZD 670 million over four years to business decarbonisation from the Climate Emergency Response Fund.

In addition to the previous GIDI Fund targeted at industrial process heat projects, funding will now also include support for replacing inefficient industrial and commercial equipment, and help replace fossil fuels in commercial space and water heating with renewable energy.

The additional funding will help get projects across the finish line, and more quickly, unlocking larger and earlier emissions reductions. The majority of this funding will be administered by the EECA and allocated to prioritise investment in decarbonisation.

The expanded GIDI Fund is estimated to deliver projects that will make up around 17% of the country's total emissions reductions in emissions budget period 1, and 27% of total emissions reductions in emissions budget period 2.

Electricity sector policies

New Zealand's electricity system is the cornerstone of the government's strategy for decarbonising the energy sector. The government plans to promote electrification of end-use sectors such as buildings, transport and industry, leveraging a renewables-based electricity system. The New Zealand Energy Strategy 2011-2021 set a target for 90% renewable electricity by 2025. Subsequently, the government set an aspirational goal of 100% renewable electricity by 2030. Moreover, the first ERP built on the government's aspirational goal in electricity and set a target of 50% of total final energy consumption (TFEC) from renewables by 2035. Making the electricity system fit-for-purpose is, therefore, a top priority for the government.

NZ Battery Project

New Zealand is fortunate to already have a high proportion of renewable electricity, which is currently over 80% of electricity production. However, due to the electricity system's heavy reliance on hydropower with limited storage, its key challenge is coping with a "dry year" when hydro inflows are low. When a "dry year" occurs, and existing hydropower catchments do not receive enough rainfall, backup is currently provided by fossil fuel generation. This issue will become increasingly salient as the country strives to achieve a 100% renewables-based power grid and relies more on electricity to meet its decarbonisation targets.

In response, the government launched the NZ Battery Project in 2020. The project will provide comprehensive advice on the technical, environmental and commercial feasibility of potential energy storage projects. The name NZ Battery refers to the nature of the intended solution, whether pumped storage or otherwise, to provide stored energy for New Zealand's electricity system in an analogous manner to a battery.

The first phase will evaluate the best method to resolve New Zealand's dry year electricity storage problem in order to achieve 100% renewable electricity and help decarbonise the wider energy system. It will comprise a detailed investigation of possible dry year solutions, including, but not limited to, the Lake Onslow pumped hydro project. It is intended that other smaller pumped storage proposals, as well as alternative technologies, including demand-side solutions, will also be fully investigated.

Tiwai smelter

Due to its size, operations of the Tiwai smelter have a significant effect on the electricity market and questions about its closure affect both investment and price. In July 2020, Rio Tinto announced the conclusion of a strategic review of the smelter and a decision to wind down operations by August 2021 due to high energy and transmission costs. Following negotiations resulting in a new electricity agreement with Meridian, in January 2021, Rio Tinto committed to continue until 2024. With aluminium prices continuing to reach new heights, Rio Tinto has recently stated its intention to potentially continue operating the New Zealand Aluminium Smelter (NZAS) beyond 2024.

The implications of the NZAS operating beyond 2024 are complex and dynamic. In addition to non-energy emissions from the smelter, the NZAS is the single largest consumer of electricity, accounting for, on average, 13% of total electricity consumption. The Climate Change Commission's modelling and government baseline modelling assume that the NZAS will close in 2024, and that this closure will bring forward the end of coal use for electricity generation, thereby lowering annual emissions from electricity generation. The size of the smelter offtake from Manapouri can have a material effect on electricity market investment and prices. Investors have been wary of large commitments to new generation projects as long as there is a risk they would be undermined by the smelter's closure and the release of excess Manapouri generation onto the market at a cheaper rate.

Regulatory reform for renewables projects

In New Zealand, the Resource Management Act 1991 plays a major role in determining the type of electricity generation that gets consented. It was enacted to achieve a more co-ordinated, streamlined and comprehensive approach to environmental management. While the RMA creates overarching provisions on avoiding, remedying and mitigating the adverse effects of activities on the environment, with national direction on significant issues, it allows communities to decide how to manage their own environment through regional and district resource management plans. This framework means that most decisions on resource management are taken by local governments, which also have a wider planning role in transport, infrastructure and economic development.

The government plans to repeal the RMA and replace it with three new pieces of legislation (New Zealand, Ministry for the Environment, 2022). This reform aims to better meet environmental protections, climate adaptation needs and Māori protections while also improving efficiency and reducing permitting complexity. The government plans to introduce three bills to replace the RMA:

- Natural and Built Environments Bill – the main replacement for the RMA, to protect and restore the environment while better enabling development.
- Strategic Planning Bill – requiring the development of long-term regional spatial strategies to help co-ordinate and integrate decisions taken under relevant legislation.
- Climate Adaptation Act – to help New Zealand better deal with climate change, especially complex issues associated with managed retreat (the relocation of communities or infrastructure vulnerable to natural disasters).

Following public consultations, the aim is for the Natural and Built Environments Bill and the Strategic Planning Act to be passed into law before January 2024 (MPDC, 2022).

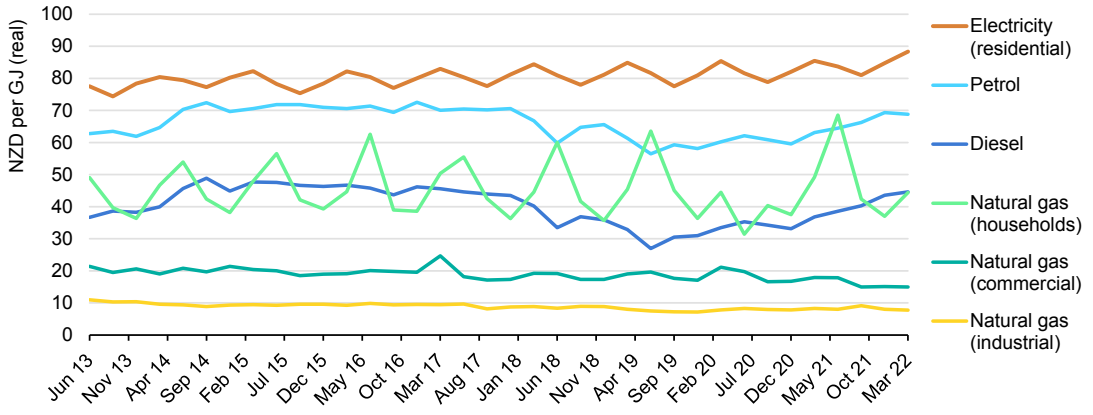
There is considerable potential in other areas for renewables development, like offshore wind electricity generation. The government's ERP commits to developing regulatory settings to enable investment in offshore renewable energy (such as offshore wind farms) and innovation. Regulatory settings are expected to be in place by July 2024. The forthcoming Energy Strategy will indicate further the role envisaged for offshore renewables in New Zealand's future energy mix.

Electricity price reform

In response to the sharp rise in electricity prices for residential consumers, in April 2018, the Minister of Energy and Resources commissioned an independent review of New Zealand's electricity market (MBIE, 2022b). The 2018-2019 Electricity Price Review (EPR) had some unique characteristics compared to previous reviews, as it addressed the need for electricity prices to be fair and affordable, not just efficient or competitive. It was also targeted at the perspective and views of consumers. The MBIE and Electricity Authority are undertaking a number of workstreams to address the EPR's recommendations.

In September 2021, Cabinet decided to phase out the Low Fixed Charge (LFC) regulations over a five-year period. This decision implemented a key recommendation of the EPR, which found the LFC regulations were poorly targeted and had a number of unintended consequences. The first step of the phase-out began on 1 April 2022. The LFC regulations were a well-recognised barrier to distribution pricing reform. By removing the regulations, the electricity industry will more easily be able to manage the increased load on the network through new distribution pricing structures, such as time-of-use pricing. This will allow the industry to avoid costly network upgrades that would otherwise see costs passed on to consumers. A phase-out period of five years has been introduced to help limit the impact on consumers' electricity bills. The government has also secured the industry's commitment to fund an NZD 5 million power credits scheme to support low-income, low-use households that are struggling to pay their power bills through the phase-out, which was launched in June 2022.

Figure 2.5 Quarterly energy prices in New Zealand, June 2013 to March 2022



Energy prices have, on average, been increasing since 2019.

Note: GJ = gigajoule.
Source: MBIE (2022c).

In addition, a new transmission pricing methodology (TPM) is due to take effect in April 2023. The TPM sets out how Transpower, as the transmission grid owner, must recover transmission costs from its customers. The updated TPM addresses three key problems with the previous TPM, which led to inefficient outcomes and created a barrier to transitioning away from non-renewable generation. The new TPM removes effective subsidies on non-renewable generation and taxes in South Island renewable generation. Together with nodal prices, it ensures that the right generation is built in the right location and at the right time.

The EPR also found that while the market is working well overall, it is not delivering for everyone, and many people struggle with the cost of power. The EPR made eight recommendations to address energy hardship. In response to the EPR, the government agreed to a work programme that progresses the majority of the energy hardship recommendations. In August 2020, the government announced an NZD 17 million, four-year package for initiatives to reduce energy hardship and improve advocacy for residential and small business consumers. In September 2021, the Energy Hardship Expert Panel was created to recommend policy priorities and actions to alleviate energy hardship and provide impartial, evidence-based expert advice. The panel is required to report by 30 June 2023.

Policies to reduce fossil fuel demand and improve security

New Zealand's more ambitious climate targets will require lower emissions from fossil fuels driven by substantial declines in consumption. Emissions reductions are likely to occur through both reduced demand (for example, greater energy efficiency, electrification) and lower carbon intensity (for example, blending in renewable gases or biofuels).

Coal

The government is working to reduce the demand for coal for process heat and electricity generation. This includes investigating options to manage dry year risk through the NZ Battery Project (to displace backup fossil generation), a proposed ban on new low- and medium-temperature coal boilers, as well as phasing out existing coal boilers by 2037.

Initiatives that encourage fuel switching will further reduce demand for coal, as will GIDI-supported investments to decarbonise industrial processes.

Internationally, New Zealand is a signatory to the 2017 Power Past Coal Alliance, the 2021 Global Coal to Clean Power Transition Statement, the 2021 No New Coal Power Compact and the 2021 Proposal on Ending Coal Support within the OECD Export Credit Arrangement.

Natural gas

Currently, natural gas plays an important role in the electricity sector, displacing coal-fired generation. The pace for phasing out natural gas and the "end-state" of the sector are currently uncertain and are dependent on a range of factors, such as emissions pricing, technological adaptation and other economic factors.

As noted above, to achieve emissions reductions from natural gas, the Gas Industry Company and the MBIE are developing a Gas Transition Plan. The purpose of the GTP is to establish transition pathways for decarbonising the gas sector in line with the first three emissions budgets defined in the ERP. It is also expected to establish a strategic view on the potential role of renewable gases, including potential measures for accelerating their uptake and for carbon capture and utilisation technology. The plan is expected to be completed by the end of 2023 and will be a key input into the Energy Strategy.

Oil

In April 2018, the government announced that no further offshore oil and gas exploration permits would be granted as a step towards addressing climate change and creating a sustainable future for New Zealand.

To address oil demand, a Sustainable Biofuels Obligation was planned to come into force on 1 April 2024. It would have required liable fuel suppliers to reduce the emissions of the liquid transport fuels they supply in New Zealand by a set percentage each year. However, the government has decided not to move forward with the policy for now.

In addition, New Zealand has a number of policies to increase vehicle efficiency and promote EV penetration into its transport mix. Incentives for EVs include an exemption from road user charges until 2025, a clean car discount, information campaigns, and a fund to encourage and support innovative low-emissions vehicle projects. The Ministry of Transport is leading the development of a long-term National EV Charging Strategy, slated for publication in early 2023. To promote fuel efficiency, the government updated its labelling scheme for vehicles and put in place a fee on high-emissions vehicles.

New Zealand's only oil refinery, which was located at Marsden Point (140 km north of Auckland), shut down permanently on 1 April 2022. Fuels produced from the refinery previously met 65-70% of New Zealand's fuel demand. As crude oil and intermediate products are no longer held and processed at the refinery, the overall level of oil and fuel stocks held onshore by the fuel industry is estimated to be lower than before the refinery's closure.

The refinery's closure has instigated a review of New Zealand's fuel resilience policy. The MBIE has consulted on a proposal to impose a minimum fuel stockholding obligation on fuel wholesale suppliers with bulk storage facilities. The government is expected to take a decision on the high-level design of new fuel resilience policies shortly.

A 2019 Commerce Commission market study into the retail fuel sector identified that there was no real active competition in the wholesale fuel market. The study concluded that the country's downstream fuel industry was essentially a vertically integrated oligopoly, and price competition in the fuel market was not working as well as it could be. The Commerce Commission identified some retail and especially wholesale market measures to promote competition. As a result, the Fuel Industry Act was passed in 2020 to address these issues. The Fuel Industry Act aims to promote competition in engine fuel markets for the long-term benefit of end users.

Critical minerals

In November 2019, the government launched a Resource Strategy (Responsibly Delivering Value – A Minerals and Petroleum Resource Strategy for Aotearoa New Zealand 2019-2029). The strategy set the government's long-term vision for the minerals (and petroleum) sector.

The strategy committed to specific actions to work towards this vision of delivering affordable and secure resources for the benefit of current and future New Zealanders across six areas. Action Area 2 was to secure affordable resources to meet the country's mineral and energy needs. Through activities under this action area, the government aims to:

- understand the stock of strategic resources in New Zealand
- understand New Zealand's potential for clean-tech minerals
- be able to more accurately value the country's resource base
- understand the current and future market for resources, both domestically and internationally
- ensure a secure and affordable supply of resources.

One of the actions is to develop a list of critical minerals for New Zealand. These are minerals that would be considered necessary for the functioning of the economy and the well-being of New Zealanders and whose supply could be at risk.

The MBIE is progressing work to develop this list. While the government is learning from the work carried out by international counterparts on developing lists, it wants the list to be specific to New Zealand.

Just transitions

As New Zealand plans for a transition to a low-carbon economy, some regions and communities will face disruptions to economic activity and livelihoods. The government recognises these impacts and has established a Just Transitions Unit within the MBIE to co-ordinate work on managing the impacts and ensuring an even distribution of opportunities from low-carbon transitions (MBIE, 2021a).

The Just Transition Partnership team supports regional partners to understand, plan and navigate their transition in a fair and equitable way (MBIE, 2021b). It works across government agencies to support regions to plan effectively in response to major economic shocks; promotes partnerships among Māori tribes, regions, sectors and communities toward a common vision for just transition pathways; and works alongside regional government agencies to ensure planning and implementation are aligned with central government objectives and funding streams. The two regions the partnership supports are

the Taranaki (where the government announced a ban on new offshore oil and gas exploration permits in 2018) and Southland (where the Tiwai aluminium smelter is planned for possible closure).

The government is also working on an Equitable Transitions Strategy to ensure that New Zealand's energy transition is fair and inclusive. The strategy will be informed by public engagement, with a draft due in June 2023, followed by a final document in June 2024 (MBIE, 2022d).

Energy taxation

Energy companies domiciled for tax purposes in New Zealand are generally subject to the standard company income tax rate of 28%. However, there are specific rules about when oil and gas expenditures can be deducted.

New Zealand also applies a 15% goods and services tax (GST) to nearly all goods and services supplied in New Zealand, including electricity, gas, petrol and diesel. GST-registered businesses claim input tax deductions to refund the GST component of purchases such as fuel and energy that they use to make taxable supplies (selling their own goods and services).

Firms that supply fuel and energy to the New Zealand market must surrender emissions units to meet their obligations under the New Zealand Emissions Trading Scheme (see Chapter 3 for details). The surrender, sale or other disposal of emissions units are zero-rated supplies for GST purposes. This means GST is charged at 0%, so a GST-registered person who disposes of emissions units can claim input tax deductions on any expenses incurred in the disposal.

Assessment

New Zealand has a diversified energy mix, with significant production of both hydropower and geothermal. The country is also a producer of oil, gas and coal, though it relies heavily on oil imports to meet demand. As New Zealand embarks on an ambitious energy transition, it has many natural advantages, including an enviable renewable resource base. The key challenge will be to decarbonise transport and industry through clean power and support investments in new technologies to achieve deeper emissions cuts across all sectors in the most economically efficient way.

New Zealand's updated climate target under the Paris Agreement is to reduce net GHG emissions by 50% from gross 2005 levels by 2030. In 2019, New Zealand amended its domestic legislation under the Climate Change Response Act 2022 to set a net zero GHG emissions target (exempting biogenic methane) by 2050. It also included a target to reduce biogenic methane emissions by 10% from 2017 levels by 2030 and by 25-47% by 2050.

The Act put in place a number of mechanisms that will support New Zealand in meeting its targets. It created the Climate Change Commission to provide independent, evidence-based advice on the actions the government needs to take to address climate change. It also requires the government to establish domestic emissions budgets, emissions reduction plans and national adaptation plans, all of which will help provide clarity and pathways to achieving the targets.

New Zealand's first set of domestic emissions budget out to 2035 and its first Emissions Reduction Plan were released in May 2022. The ERP sets a number of key actions and targets for the energy sector. It set a target of 50% of total final energy consumption to come from renewable sources by 2035. The target is ambitious, with New Zealand's 2020 renewable energy share being 28%. Achieving the target will not only require a co-ordinated policy response, but also for New Zealand to demonstrate an attractive investment environment. The new final energy consumption target builds on the government's aspirational target of 100% renewable electricity by 2030.

A key policy mechanism for New Zealand to meet its climate targets is the New Zealand Emissions Trading Scheme, which establishes an emissions price signal across the economy to incentivise lowest cost abatement (such as through the adoption of lower emissions technologies, emissions efficiency improvements and forestry sequestration). Entities carrying out defined emitting activities (typically high in the value chain, such as mining coal or importing fossil fuels) buy and trade emissions units via auctions or the secondary market to meet their emissions reduction obligations. Emissions-intensive, trade-exposed industries receive a free allocation of units each year, recognising their risk of emissions leakage. The level of free allocations is being phased down.

To complement the carbon price stemming from the ETS, the New Zealand government has other measures in place to reduce emissions, notably the Government Investment in Decarbonising Industry Fund, established in 2020 as part of the government's Covid Response and Recovery Fund. The fund is designed for decarbonisation projects, especially to accelerate the decarbonisation of industrial process heat, and will help move the country closer to meeting its climate targets.

New Zealand does not currently have a long-term Energy Strategy in place. While work is underway on a strategy, it is not due for release until the end of 2024. The strategy will aim to lay out a plan for New Zealand's 2050 vision to have a highly renewable, sustainable and efficient energy system that is accessible and affordable, secure and reliable. Key elements of the Energy Strategy will include:

- a Gas Transition Plan
- a Hydrogen Roadmap
- an update to the Energy Efficiency and Conservation Strategy.

The strategy is a welcome and necessary development. However, the government should make every attempt to mobilise policies sooner. A lack of clarity surrounding the pathway to meeting ambitious climate targets (including the roles that various fuels and technologies will play) is creating an uncertain policy environment, hampering the significant investment required to meet the government's 2030 targets. The government could already indicate "no-regret" options that can be implemented now, as they will, without a doubt, be part of the strategy, such as a regulatory framework for offshore wind. The ERP commits to establishing regulatory settings for offshore wind by July 2024.

Beyond the energy sector reforms, New Zealand plans to repeal its primary environmental protection legislation, the Resource Management Act 1991, and enact three new pieces of legislation. The new laws will require the development of long-term regional spatial strategies that protect and restore the environment while better enabling economic development, including energy infrastructure, and address complex issues associated with climate adaptation.

For New Zealand to meet its emissions reduction and energy goals, the new legislation will need to find a balance between the need for local environmental protection and New Zealand's ambitions under the Emissions Reduction Plan. Significant delays in the approval process for new renewable energy projects will likely blunt the strong investment signals required to meet the 2030 and 2035 renewable energy targets.

New Zealand has some natural advantages with respect to its energy system. In particular, its electricity sector is already highly decarbonised, with a large contribution from hydropower, which accounts for nearly 60% of electricity generation. Together with other sources such as geothermal and wind, over 80% of the country's power generation already comes from renewables. Though the government has no official policy to phase out coal-fired generation, the share of coal (along with natural gas) has decreased over the past decades. However, recent data show that gas market shortfalls and low hydro availability have resulted in increased coal use since 2017.

New Zealand can leverage its clean electricity sector to advance electrification as a decarbonisation strategy in other fossil fuel-dependent sectors, notably transport and industry. However, there is a significant amount of work ahead to position its electricity system for a future low-carbon world. A central piece to maintaining affordability for consumers will be gaining better long-term clarity on supply and demand outlooks (especially to update forecasts in light of a fast-changing policy and market environment), including the operation of large consumers such as the Tiwai smelter and solving the "dry year problem" for hydro generation.

The "dry year problem" is that New Zealand's existing hydropower catchments are small and sometimes don't receive sufficient inflows to meet generation requirements. When this occurs, some form of backup is needed. This is currently provided by fossil fuel generation. The country is currently assessing the technical, environmental and commercial feasibility of pumped hydro and other potential energy storage projects. Principal among these options is a pumped hydro scheme at Lake Onslow, which appears technically feasible at this stage, although more work is needed to assess its economic feasibility and market compatibility. Until a final investment decision is taken on the project in 2023-2024, the prospect of government intervention in the electricity market is creating short-term investment uncertainty, especially for new generation.

Despite its relatively clean electricity system, New Zealand's energy demand remains heavily dependent on fossil fuels. Oil accounts for nearly half (46%) of the country's total final consumption, followed by natural gas (19%) and coal (4%). Oil is dominant in the transport sector (99.7%), though it also has sizeable shares in industry (20%) and buildings (11%). Natural gas covers more than one-third of energy demand in industry, whereas coal has a share of 9%. Electrification of final energy consumption is higher (25%) than the IEA average (23%), especially in the buildings sector, where it covers more than two-thirds.

The government has several policies in place to reduce the demand for oil, gas and coal in the coming years. For coal, it has proposed a ban on new low- to medium-temperature coal boilers and to phase out existing ones by 2037. For natural gas, the government has support mechanisms for energy efficiency improvements in industry. In addition, the Gas Transition Plan, currently under development, will establish transition pathways for decarbonising the gas sector in line with emissions budgets. For oil, the government has targets and support measures for electric and lower emissions vehicles. While these

measures are likely to reduce emissions from the transport sector, diesel demand continues to increase, and more direct measures are needed to meet the government's targets.

In addition to these major policy developments, New Zealand is progressing with potentially significant reforms to oil emergency stockholding following the closure of the Marsden Point Refinery. These energy security reforms complement those implemented following the Commerce Commission's 2019 market study into the retail fuel sector. The Fuel Industry Act, passed in 2020, promotes competition in engine fuel markets for the long-term benefit of end users.

Overall, New Zealand has the potential to reach its emissions reduction and energy targets. It has the natural resources and policy levers; however, the time frames to meet the targets are very ambitious, and a more pragmatic approach may be required to ease the costs for consumers of such a rapid change to the sector. If the targets are to be met by 2030 for electricity and 2035 for primary energy, the sector will need a viable policy road map as soon as possible. Delays in providing policy clarity will likely result in the targets being met much later in the future.

Key recommendations

The government of New Zealand should:

- Accelerate the development of the National Energy Strategy for release in 2023. Efforts should be made to settle the macro level policy settings as soon as possible to bring on the investment required to decarbonise the energy sector.
- Given the outsized role that electrification will play as a decarbonisation strategy, create an enabling regulatory environment for a flexible electricity system that is fit-for-purpose (such as to support demand response and storage).
- Ensure that reforms to the resource management legislation provide for timely approval of renewable energy projects.
- Increase policy focus on the transport sector; in particular, implement measures that will deliver structural change to diesel demand.

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3. Energy and climate change

Key data

GHG emissions with LULUCF (2020): 55 Mt CO_2-eq; -3% since 2005, +26% since 1990

GHG emissions without LULUCF (2020): 79 Mt CO_2-eq; -5% since 2005, +21% since 1990

Energy-related GHG emissions from fuel combustion (2021): 32 Mt CO_2-eq; -8% since 2005

Energy-related GHG emissions by sector (2021): transport 48%, industry 27%, electricity and heat generation 19%, buildings 5.9%

Energy-related GHG emissions per GDP (2021): 0.152 kg CO_2/USD (IEA average 0.213 kg CO_2/USD)

Energy-related GHG emissions per capita (2021): 6.15 t CO_2/capita (IEA average 8.38 t CO_2/capita)

Overview

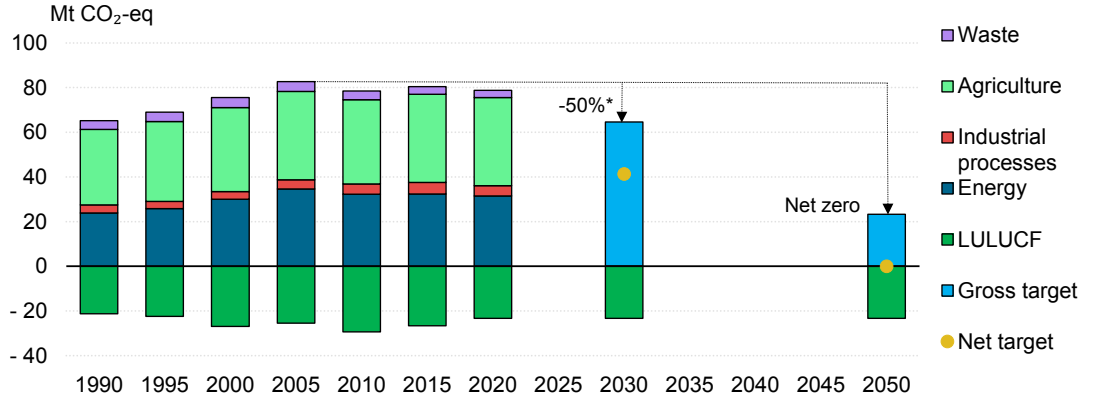
New Zealand's updated target is to cut net GHG emissions by 50% by 2030 compared to gross 2005 levels. New Zealand's Nationally Determined Contribution (NDC) is economy-wide, covering all sectors and all GHGs. New Zealand's next NDC is expected in 2025, covering the period starting in 2031.

GHG emissions in the base year (2005) were 82.7 million tonnes of carbon dioxide equivalent (Mt CO_2-eq), excluding land use, land-use change and forestry (LULUCF), which was the country's highest recorded emissions. In 2020, New Zealand's total GHG emissions stood at 78.8 Mt CO_2-eq, a 4.7% decline since 2005 (Figure 3.1). Additionally, carbon removals from the LULUCF sector accounted for 23.3 Mt CO_2-eq in 2020.

New Zealand's 2020 target was to cut GHG emissions by 5% compared to 1990 levels over the 2013-2020 period. New Zealand's gross GHG emissions increased by 21% in 2020 compared to 1990, mainly due to increased emissions in the energy and agriculture sectors. However, it assesses that it met its 2020 target based on removals and offsets, applying the Kyoto Protocol accounting framework (New Zealand, Ministry for the Environment, 2022a).

In 2020, emissions from agriculture were 39 Mt CO_2-eq and accounted for 50% of total GHG emissions, one of the highest shares in the OECD. Energy sector emissions were 31 Mt CO_2-eq, accounting for 40% of total GHG emissions. Industrial processes accounted for 6% of total emissions, followed by waste with 4%.

Figure 3.1 Greenhouse gas emissions by sector in New Zealand, 1990-2020 and targets



Most of New Zealand's greenhouse gas emissions come from the agriculture and energy sectors.

* The 2030 target is to achieve net emissions of 50% below the 2005 gross level. The figure assumes that LULUCF absorption in 2030 will be similar to that in 2020. The emissions target for 2050 does not include biogenic methane.

Notes: Mt CO_2-eq = million tonnes of carbon dioxide equivalent; LULUCF = land use, land-use change and forestry.

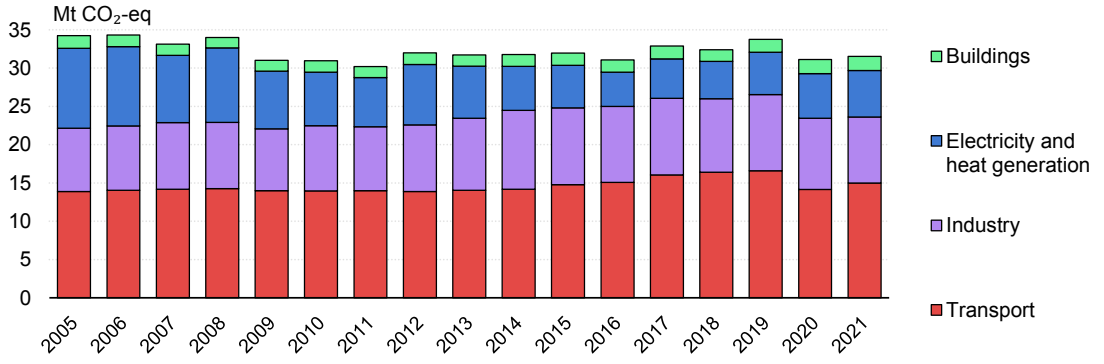
Source: IEA based on data from New Zealand, Ministry for the Environment (2022b).

Energy-related greenhouse gas emissions

In 2021, New Zealand's energy-related GHG emissions were 32 Mt CO_2-eq, 8% less than in 2005 but 32% higher than in 1990. After peaking in 2005-06, emissions have fallen unevenly depending on the year. There was a stronger decline in 2020, mainly due to lower emissions from the transport and industry sectors related to the Covid-19 pandemic. However, provisional data for 2021 show a strong rebound in emissions to above the previous 2006 peak.

The overall slow decline since 2005 is due to sharp reductions in emissions from electricity and heat generation. Emissions in this sector fell by 42% between 2005 and 2021, thanks to the increasing share of renewables and reduced share of coal and natural gas in electricity generation (see Chapter 7). On the other hand, other sectors increased their emissions from 2005 to 2021: 13% for buildings, 8% for transport and 4% for industry.

Figure 3.2 Energy-related greenhouse gas emissions by sector in New Zealand, 2005-2021



Transport accounted for 45% of greenhouse gas emissions in 2020. After dropping in 2020 amid the Covid-19 pandemic, GHG emissions rebounded strongly in 2021.

Note: Mt CO_2-eq = million tonnes of carbon dioxide equivalent.
Source: IEA (2022a).

Domestic oil consumption (mainly in the transport and industry sectors) was responsible for the largest share of energy-related GHG emissions in New Zealand, accounting for 61% of the total in 2021, followed by natural gas at 19% and coal at 20% (Figure 3.3).

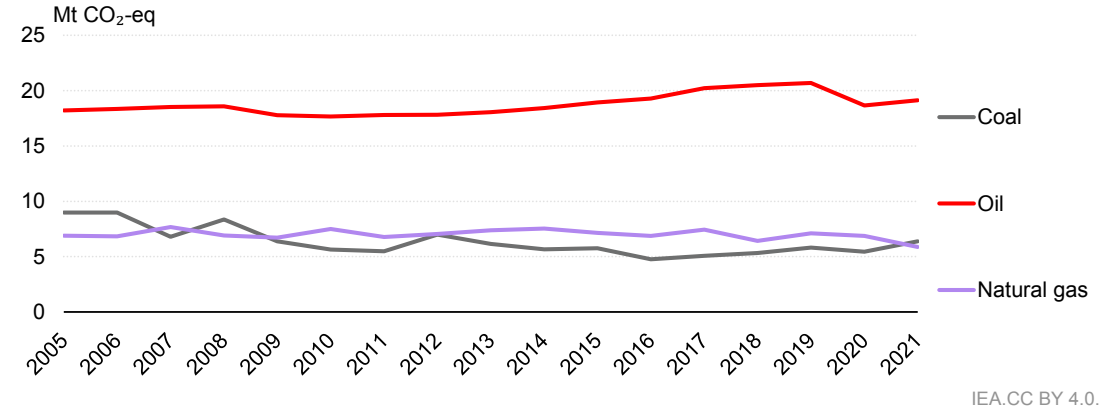
Since 2005, emissions from coal have fallen by 29%, while emissions from oil have increased by 5%. Natural gas emissions have dropped by 15%.

Emission drivers and carbon intensity

Over the period 2005-2021, New Zealand's GDP increased by 45% while GHG emissions decreased by 8%. Overall, the GHG intensity of New Zealand's energy supply (GHG/TES), GDP (GHG/GDP) and electricity production have been declining compared to 2005 levels.

In 2021, GHG emissions per unit of GDP in New Zealand were 0.152 kilogrammes of carbon dioxide per USD (kg CO_2 per USD), below the IEA average of 0.213 kg CO_2/USD.

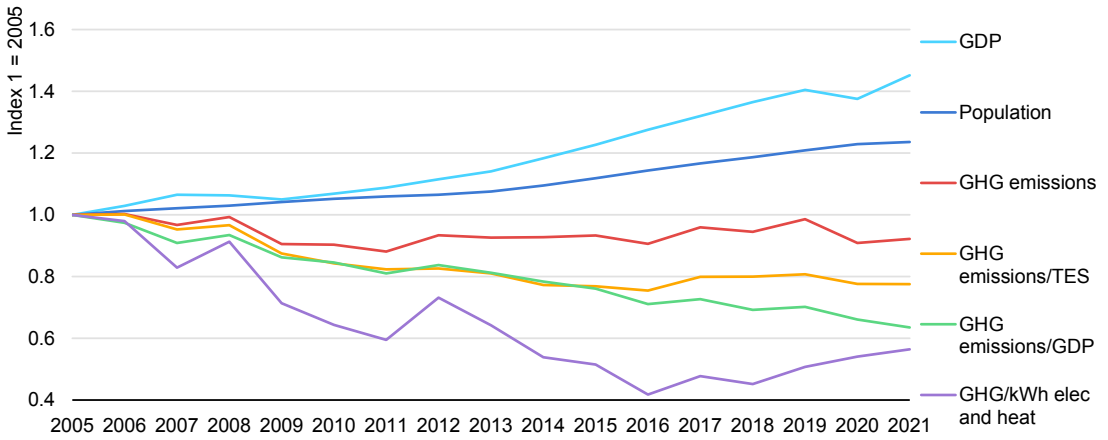
Figure 3.3 Energy-related greenhouse gas emissions by energy source in New Zealand, 2005-2021



Natural gas greenhouse gas emissions have declined since 2005, whereas oil and coal emissions rebounded slightly in 2021.

Note: Mt CO_2-eq = million tonnes of carbon dioxide equivalent.
Source: IEA (2022a).

Figure 3.4 Energy-related greenhouse gas emissions and main drivers in New Zealand, 2005-2021



Since 2005, there has been a progressive but limited decoupling between greenhouse gas emissions and economic and population growth.

Notes: GDP = gross domestic production; GHG = greenhouse gas; TES = total energy supply; kWh = kilowatt hour.
Source: IEA (2022a).

Emissions targets and policies

Under the Paris Agreement, New Zealand set an NDC of reducing net emissions by 50% below gross 2005 levels by 2030. The target is expressed as an emissions budget for the period 2021-2030.

The Climate Change Response Act 2002 provides a legal framework for New Zealand to meet its international obligations under the United Nations Framework Convention on Climate Change (UNFCCC), including the Kyoto Protocol and the Paris Agreement.

The Climate Change Response (Zero Carbon) Amendment Act 2019 updates the framework and includes domestic emissions reduction targets to 2050 such that:

net GHG emissions, with the exception of biogenic methane, will reach zero by 2050

biogenic methane emissions will be 10% lower than 2017 emissions by 2030 and 24-47% lower than 2017 levels by 2050.

The 2019 Act also required the government to:

- establish a system of emissions budgets toward the long-term target
- develop and implement policies for climate change adaptation and mitigation
- establish a new, independent Climate Change Commission to provide expert advice and monitoring to help keep successive governments on track to meeting long-term goals.

Carbon pricing

The country's primary carbon pricing tool is the New Zealand Emissions Trading Scheme. The NZ ETS creates a price signal by setting a "cap" on net emissions and letting covered

entities purchase, receive and trade allowances for the right to emit New Zealand emissions units (NZUs). Over time, the cap will decrease in line with national emissions budgets, reducing the number of NZUs available and consequently increasing the incentive for cost-effective emissions abatement. Tightening the scheme's cap in line with decreasing emissions budgets can drive expectations of a rising allowance price and allows it to shape future economic development by flexibly encouraging businesses and households to align investment decisions and choices with low-emissions alternatives.

The NZ ETS has comprehensive coverage across GHGs and all sectors of the economy, except for the agricultural sector and a portion of the waste sector. The agricultural sector, which has reporting requirements but no surrender obligations, can opt into the NZ ETS (post-1989), for which removal units can be earned. Work is ongoing to price emissions in the agricultural sector, but decisions are yet to be taken, and the pricing system could be within the NZ ETS or outside. The NZ ETS is a domestic scheme; as such, it does not account for emissions that occur outside New Zealand's boundaries, such as international aviation or maritime shipping.

Following its introduction in 2008, the NZ ETS underwent a major reform in 2021 following a public consultation. The resulting Climate Change Response (Emissions Trading Reform) Amendment Act 2020 included a number of key changes, such as:

- penalties for failing to meet emissions return deadlines
- phasing out industrial allocations from 2021
- publishing participants' emissions and removal data
- increasing the fixed price option for 2020 emissions obligations from NZD 25 to NZD 35 per unit, and removing the fixed price option on the introduction of NZU auctions from 2021
- cancelling legacy units from the first commitment period (Environmental Protection Authority, 2022).

Free allocation of NZUs is provided to eligible emissions-intensive and trade-exposed industries. These free units reduce the impact of the emissions price on these industries, which in turn reduces the risk of emissions leakage. There are 26 activities eligible for free allocation in the NZ ETS. The total number of units allocated freely in 2020 was approximately 7.7 million (roughly equivalent to 10% of total emissions). There are two classes of eligibility: moderately emissions-intensive and highly emissions-intensive industries. These activity classes received, respectively, 58% and 88% of their emissions allowances for free in 2022, though these are being phased out over 2021-2050. NZ ETS allocation settings are currently being updated to address overallocation, reassess the eligibility of industries, update data and undertake technical changes to improve allocation (New Zealand, Ministry for the Environment, 2022c).

The NZ ETS also has price controls to serve as safety valves. These settings were updated in December 2022 to align with emissions budgets and adjust for inflation. The updated NZ ETS price controls include an auction reserve price of NZD 33.06 in 2023 (which serves as a floor) and a trigger price for activating a cost containment reserve of NZD 80.64 in 2022 (which acts as a "soft" ceiling price) (New Zealand, Ministry for the Environment, 2022d). The current price on the secondary market for NZUs is around NZD 88 (November 2022). The government also has a confidential reserve price, which prevents NZUs from being sold at auction at a price significantly below the secondary

market price. If the auction clearing price is less than the confidential reserve price, no NZUs are sold at the auction. Unsold NZUs are rolled forward to be sold at the next auction if it is in the same calendar year (New Zealand, Ministry for the Environment, 2022e).

NZ ETS participants can "bank" NZUs, or hold them in an account for future use. This feature was established to mitigate against price volatility and help participating entities manage their future obligations. As a result, a sizeable volume of banked units is now present in private accounts. The Climate Change Commission estimated the surplus (the number of stockpiled units not needed for future obligations) to be around 49 million NZUs and recommended reducing auction volumes to draw down surplus units in line with emissions budgets (New Zealand, Ministry for the Environment, 2022f).

The NZ ETS earned NZD 2.38 billion in unit auction revenues in 2021, which have historically been directed to the general budget. Based on the first Emissions Reduction Plan, from 2022, revenues will be earmarked for emissions reduction measures, including through the Climate Emergency Response Fund (see below) (ICAP, 2022).

The NDC requires more reductions than the domestic 2021-2030 emissions budgets are expected to achieve. New Zealand, therefore, expects to access offshore mitigation using international co-operation under Article 6 of the Paris Agreement as an additional contribution to meeting its NDC.

New Zealand may use the NZ ETS to access international carbon markets in the future. While the NZ ETS was open to Kyoto markets in the past, it has been closed to these since 2015 and is currently a domestic-only scheme. Legislative reforms to the NZ ETS, passed in 2020, included provision for possible future use of offshore emission units, subject to quantitative and qualitative limits.

Climate Emergency Response Fund

While emissions pricing plays a central role in reducing emissions, New Zealand also has complementary measures to support low-cost emissions reduction opportunities. In addition to targeted and sector-specific policies outlined in the ERP, the Climate Emergency Response Fund (CERF) was established in 2021 at a size proportional to forecasted cash proceeds from the auctioning of units under the New Zealand ETS over a four-year period. This multi-year fund is intended to support climate-related spending under each budget and can also be drawn from outside the budget cycle.

Budget 2022 was the inaugural year for the CERF, with an expected NZD 4.5 billion allocation, which was revised upward by NZD 800 million in the Budget Economic and Fiscal Update (New Zealand Government, 2022a). Spending in Budget 2022 focused on mitigation policies, in particular those contained within New Zealand's first ERP. This included policies within the energy sector, such as the GIDI Fund, and measures to transition the electricity system. In the future, there is flexibility for the CERF's eligibility criteria to be amended to reflect the government's approach to New Zealand's climate response. To this end, in May 2022, the government announced expanded funding of around NZD 650 million over four years for the GIDI, coming from the CERF.

Beyond the CERF, a number of other funding mechanisms are available for climate mitigation measures, including the National Land Transport Fund and institutions like New Zealand Green Investment Finance (New Zealand Treasury, 2022).

Climate Change Commission

The Climate Change Commission was established under the Climate Change Response (Zero Carbon) Amendment Act 2019 to provide independent, evidence-based advice on the government's actions to address climate change.

To undertake its work, the commission held extensive consultations with the public, meeting with over 4 000 stakeholders and receiving over 15 000 submissions (Climate Change Commission, 2021). The Climate Change Commission found that New Zealand is not on track to meet its GHG reduction targets, noting that past policy has focused on forestry measures to generate offsets through carbon removals, resulting in growth in gross GHG emissions since 1990 of 26%.

In May 2021, the Commission provided its advice to the government, which covered:

1. the levels of the first three emissions budgets, which step down the total amount of GHG emissions allowed in New Zealand over five-year periods to 2035, charting a course toward meeting the 2050 emissions reduction targets
2. direction on the policies and strategies needed in the government's ERP, which will detail actions for meeting the first emissions budget
3. advice on the NDC and eventual reduction in biogenic methane, as requested by the Minister of Climate Change.

Based on extensive modelling and sensitivity analysis, in addition to issuing proposals for emissions budgets, the Commission also issued a set of recommendations that includes developing a long-term Energy Strategy, scaling up energy efficiency investments, a massive expansion of the electricity system to underpin decarbonisation in other sectors, large-scale EV roll-out, a phase-out of coal in electricity generation, planning for a phase-out of natural gas in buildings, and adapting regulatory frameworks to technology advances, among many others.

While it is the Commission's role to provide advice on climate action, it is the government's responsibility to determine the specific policies and set the first three emissions budgets to 2035.

Emissions budgets

An emissions budget is the quantity of emissions allowed during a particular period. From 2022 onwards, there must be three emissions budgets in place at any time, providing a pathway to the 2050 target. New Zealand's emissions budgets cover five-year periods and are set 10-15 years in advance, after considering the recommendations of the Climate Change Commission.

In May 2022, the government published the first three emissions budgets. The total of the emissions budgets for the first three budget periods is 20 Mt CO_2-eq (2.3%) lower than the Climate Change Commission's proposed budgets.

Table 3.1 New Zealand's emissions budgets

Budget period	2022-2025	2026-2030	2031-2035
All gases, net	290 Mt CO_2-eq	305 Mt CO_2-eq	240 Mt CO_2-eq
Annual average	72.5 Mt CO_2-eq	61 Mt CO_2-eq	48 Mt CO_2-eq

Note: Mt CO2-eq = million tonnes of carbon dioxide equivalent.

Emissions reduction plan

Each emissions budget will be supported by an emissions reduction plan that contains policies and strategies for meeting the emissions budget. The Climate Change Response Act 2019 requires that the ERP include sector-specific policies to reduce emissions and increase removals, multi-sector strategies to meet emissions budgets, and a strategy to mitigate the negative impacts of emissions reduction measures on local populations.

New Zealand's Emissions Reduction Plan from May 2022 sets out the pathway for how New Zealand will meet its first emissions budget (2022-2035) and achieve long-term climate targets. Actions outlined in the plan include: increasing EV access, supporting business to improve energy efficiency, banning new coal boilers and phasing out existing ones, introducing emissions pricing in agriculture, accelerating agricultural emissions reduction technologies, reducing waste, establishing native forests to develop long-term carbon sinks, accelerating the supply of woody biomass, and driving mission-led innovation in hard-to-abate sectors (New Zealand, Ministry for the Environment, 2022g).

To oversee the implementation of the ERP, the government set up a dedicated governance structure. The Climate Change Commission and central government agencies are responsible for monitoring and regularly reporting on progress toward the sub-sector targets and emissions budgets, as well as the success and implementation of the ERP. The government established the Climate Change Chief Executive Board to support the implementation and co-ordination of the ERP. The board will provide strategic advice on how New Zealand is progressing and where adjustments on the approach are needed. The Climate Response Ministerial Group was established in 2020. Chaired by the Prime Minister, this group of ministers meets regularly to advance the climate change work programme, including the emissions budgets and sector sub-targets.

A new ERP will be published before the start of each emissions budget period. The next one is scheduled to be issued by 31 December 2024.

Sectoral emissions reductions

Within the energy sector, New Zealand's emissions vary across sectors. While buildings and electricity have relatively lower shares of emissions, the bulk of the country's emissions come from the transport and industry sectors. Under the ERP, a critical component of New Zealand's decarbonisation strategy is to increase the role of renewables-based electricity in other sectors. This will require not only an expansion of renewables generation capacity to meet load growth but also policy support to incentivise the switch to electricity across sectors.

Electricity

Given the high proportion of renewables in New Zealand's electricity mix, electrification represents an overarching strategy for New Zealand to increase the penetration of renewables and reduce GHG emissions across all sectors of the economy. In 2021, 85% of the country's electricity generation came from renewable energy sources: 55% from hydro and 23% from geothermal.

A renewable electricity target was defined in the New Zealand Energy Strategy 2011-2021 at 90% renewable electricity by 2025. Subsequently, the government has set an aspirational goal of 100% renewable electricity by 2030.

More recently, the Emissions Reduction Plan defined targets to build on the government's aspirational goal of 100% renewable electricity by 2030. These targets include setting a target of 50% of TFEC from renewables by 2035, monitoring progress toward the aspirational target of 100% renewable electricity by 2030 and reviewing this target in 2024 before developing the second emissions plan (see Chapter 5).

Transport

New Zealand has a number of measures in place to promote the uptake of EVs, including an exemption from road user charges (RUC) for EVs until 2025. In May 2016, the government announced a package of measures to increase the uptake of EVs, which included: a goal of reaching 64 000 EVs by 2021; extending the RUC exemption on light EVs until they account for 2% of the fleet; a RUC for heavy EVs until they make up 2% of the fleet; investigate the bulk purchase of EVs across government and the private sector; and NZD 1 million annually for EV information campaigns over five years. More recently, the ERP set a target to increase zero-emissions vehicles to 30% of the light-duty fleet by 2035. The Ministry of Transport is leading the development of a long-term National EV Charging Strategy. A draft of this strategy is due to be released for public consultation in February 2023, with the final strategy to be published by 30 June 2023.

To encourage the purchase of lower emissions light vehicles, in 2022, the government legislated a Clean Car Standard that sets ambitious targets and financial penalties on vehicle distributors to reduce average emissions to 63 grammes of CO_2 per kilometre for passenger cars and 87 grammes for commercial vehicles entering New Zealand by 2027, which is approximately a two-thirds reduction on emissions levels recorded in 2021. This is supported by a Vehicle Emissions and Energy Economy Label scheme and a Clean Car Discount (that offers rebates to zero- and low-emissions vehicles and places a higher fee on high-emissions vehicles).

The ERP also includes targets to reduce emissions from freight transport by 35% and to reduce the emissions intensity of transport fuels by 10% by 2035.

The government also plans to promote alternative modes of transportation, such as public transit, walking and bicycling in urban areas through urban development plans and incentives for consumers. The ERP sets a target to reduce kilometres travelled by the light-duty fleet by 20% by 2035 through urban modal shifts (see Chapter 4).

New Zealand has endorsed the global transition to zero-emission vehicles by signing a non-binding global declaration at COP26 in 2021. This strives for all new light vehicle sales to be zero emissions by 2035-2040 and for heavy vehicles by 2040.

Industry

The New Zealand Energy Efficiency and Conservation Strategy 2017-2022 included a target to decrease industrial emissions intensity (kg CO_2-eq/NZD real GDP) by at least 1% per annum on average between 2017 and 2022. The 1% rate is relatively low compared to the approximately 2% gains seen in economy-wide energy efficiency globally over the 2010-2020 decade and well below the 4% required under the IEA's net zero emissions scenario (IEA, 2022b).

In July 2020, the government announced an NZD 70 million investment to decarbonise industrial and process heat, including support for energy efficiency, fuel switching and transmission line upgrades (where electrification is the appropriate solution). This GIDI

Fund is administered by the EECA and aims to accelerate the decarbonisation of industrial process heat by assisting private sector businesses with the upfront capital costs of switching from fossil fuels to renewables. Through Budget 2022, the EECA received a significant increase to expand the GIDI Fund. Approximately NZD 1 billion over seven years is currently undergoing programme design.

The EECA also provides co-investment, advice and technical assistance to businesses to encourage the adoption of energy-saving technologies and process improvements, and the prioritisation of energy management and lower emissions. In addition, the EECA administers a fund for technology demonstration projects in New Zealand, contributing to the cost of demonstrating proven technology or an innovative process improvement opportunity that has yet to be widely adopted in New Zealand (see Chapter 4).

Methane emissions

Compared to other countries, New Zealand has a relatively high contribution of methane emissions to its total GHG emissions, at 43.5%. However, unlike many other countries with sizeable methane emissions, the bulk of New Zealand's methane emissions come from the agriculture rather than the energy sector.

In an effort to tackle methane emissions from agriculture, as noted above, the Climate Change Response (Zero Carbon) Amendment Act 2019 established a target for reducing biogenic methane by 10% from 2017 levels by 2030 and by 24-47% from 2017 levels by 2050.

The country's latest GHG inventory found that from 2017 to 2020, both total gross methane emissions (not including LULUCF) and biogenic methane emissions were roughly the same. Nearly all methane emissions are biogenic methane (98%). Out of total biogenic methane emissions of 33.5 Mt CO_2-eq in 2020, 91% came from the agriculture sector and 9% from waste.

Furthermore, at the COP26 summit in Glasgow, New Zealand joined over 100 countries in signing the Global Methane Pledge, which commits countries to voluntarily reduce methane emissions by at least 30% from 2020 levels by 2030 (New Zealand Government, 2021). The government plans to meet its commitment both through the biogenic methane targets established in the Zero Carbon Act as well as by reducing methane emissions from fossil fuel production and transport. The government's Methane Emissions Reduction Action Plan includes a planned price on agricultural emissions from 1 January 2025, a new Centre for Climate Action on Agricultural Emissions to support the development of mitigation technology and efforts to promote waste management (New Zealand, Ministry of Foreign Affairs and Trade, 2022).

The ERP from May 2022 also called for establishing an emissions pricing system to be put in place for the agriculture sector by 1 January 2025 (New Zealand, Ministry for the Environment, 2022g). In October 2022, the government released for public consultation its proposal for an emissions pricing system in the sector, taking into account input from the Climate Change Commission and agricultural groups (New Zealand Government, 2022b).

Hydrogen

The government released its Hydrogen Vision in 2019. The vision described the potential role of hydrogen in the New Zealand economy.

It was followed by modelling work released in 2022 that outlined a potential business-as-usual development path for hydrogen in New Zealand.

This modelling work is intended as a precursor or base case for the hydrogen road map that is currently being developed and due to be finalised by the end of 2024 (MBIE, 2022). A key issue to be resolved is how this hydrogen road map development will be integrated into work on a wider Energy Strategy and the transition of the electricity market, given the material effects large-scale electrolyser demand would have on the generation and transmission system if New Zealand adopts a large-scale hydrogen development pathway.

A component of the hydrogen road map is ensuring regulations are fit-for-purpose. The consultancy firm PWC was engaged to undertake a review of New Zealand's regulations and standards as they affect hydrogen. This work aimed to prioritise a subsequent legislative programme to support hydrogen use in New Zealand. The PWC paper is still being finalised.

The government has no specific hydrogen-supporting funds. However, several pilot hydrogen projects have received government funding as part of funds focused on economic development, Covid recovery or decarbonisation. Several private sector initiatives are underway concerning hydrogen, and some have received government funding.

Climate adaptation and resilience

In August 2020, the government published New Zealand's first National Climate Change Risk Assessment. The assessment painted a national picture of the risks New Zealand faces from climate change and helped identify where the government needs to prioritise action. It identified the most significant risks and opportunities from climate change and highlighted gaps in the information and data needed to properly assess and manage them.

The risk assessment identified 43 priority risks across five value domains (natural environment, human, economy, built environment and governance) and highlighted the 10 risks considered to be the most significant. The most significant risks in the built environment are the risk to potable water supplies due to changes in rainfall, temperature, drought, extreme weather events and ongoing sea-level rise, and the risk to buildings due to extreme weather events, drought, increased fire weather and ongoing sea-level rise. Another of the 43 risks identified in the National Climate Change Risk Assessment is the risk to electricity infrastructure due to changes in temperature, rainfall, snow, extreme weather events, wind and increased fire weather.

For this risk, the assessment notes that New Zealand's heavy reliance on renewable electricity sources (particularly hydroelectricity and wind) exposes the country to climate variability. Climate change could also affect electricity demand due to higher cooling demand in summer and lower heating demand in winter. Transmission and distribution infrastructure is at increasing risk of disruption and damage from climate hazards, which could undermine energy security if it is not managed appropriately.

New Zealand published its first National Adaptation Plan in August 2022 (to be updated every six years based on national climate change risk assessment updates, as mandated by the 2019 Climate Change Response Act). The plan includes a long-term adaptation strategy underpinned by three goals (reducing vulnerability, enhancing adaptive capacity and strengthening resilience) and emphasises the need to work in partnership to meet those goals.

The plan also sets out four main priorities:

- enabling better risk-informed decisions
- ensuring planning and infrastructure investment decisions drive climate-resilient development in the right places
- adaptation options, including managed retreat
- embedding climate resilience in all government strategies and policies.

The actions in the plan aim to help achieve these priorities and to address the 43 risks identified in the risk assessment. Some of the actions included in the National Adaptation Plan will help to address the estimated climate impacts on the energy system, including: the NZ Battery Project that aims to overcome the "dry year risk" (when hydro inflows are low), developing the government's planned Aotearoa New Zealand Energy Strategy by 2024, the electricity transmission system operator Transpower's commitment to developing a climate adaptation plan by 2026, and a review by the Commerce Commission of the electricity and gas networks' management of climate risk and resilience.

Assessment

New Zealand's updated target under the Paris Agreement is to cut net GHG emissions by 50% by 2030 compared to gross 2005 levels. New Zealand's Nationally Determined Contribution is economy-wide, covering all sectors and all GHGs. New Zealand has a release schedule planned for its next four NDCs, through 2050, which will facilitate long-term planning toward meeting climate targets.

GHG emissions in the NDC base year (2005) were 82.7 Mt CO_2-eq, excluding LULUCF. In 2020, New Zealand's total GHG emissions stood at 78.8 Mt CO_2-eq, a 4.7% decline since 2005. Carbon removals from the LULUCF sector accounted for 23.3 Mt CO_2-eq in 2020.

New Zealand's previous target under the UNFCCC was to cut GHG emissions to 5% below 1990 levels over the period 2013-2020. Gross GHG emissions increased by 21% in 2020 compared to 1990, with an increase in energy and agriculture sector emissions, but the country assesses that it met its target with the help of removals and offsets. In 2020, emissions from agriculture were 39 Mt CO_2-eq and accounted for 50% of total GHG emissions, one of the highest shares in the OECD. Energy sector emissions were 31 Mt CO_2-eq, accounting for 40% of total GHG emissions. Energy-related emissions in 2021 were 8% lower than in 2005; they decreased in 2020 due to the Covid-19 pandemic, and did not rebound strongly in 2021. Energy-related emissions come mainly from transport (48% in 2021), followed by industry (27%), electricity generation (19%) and buildings (5.9%).

New Zealand is one of a growing number of countries to have a net zero emissions by 2050 target enshrined in law. The Climate Change Commission determined that national policies were insufficient to meet that target. New Zealand must act with greater urgency to issue and implement policies, such as its first long-term Energy Strategy.

The Climate Change Response (Zero Carbon) Amendment Act 2019 includes domestic emissions reduction targets to 2050 such that: 1) net GHG emissions, with the exception

of biogenic methane, reach zero by 2050; and 2) biogenic methane emissions are 10% lower than 2017 emissions by 2030 and 24-47% lower than 2017 levels by 2050.

In 2021, New Zealand signed the Global Methane Pledge, which established a collective target to reduce global methane emissions by at least 30% from 2020 levels by 2030. New Zealand's biogenic methane emissions were reportedly the same in 2017 and 2020 (New Zealand, Ministry for the Environment, 2022h). Although the global pledge is not an individual target, New Zealand should not fall behind the ambition of its partners.

The Zero Carbon Act called for establishing a system of emissions budgets toward the long-term target; required the government to develop and implement policies for climate change adaptation and mitigation; and established a new, independent Climate Change Commission to provide expert advice and monitoring to help keep successive governments on track in meeting long-term goals. Each emissions budget will be supported by an emissions reduction plan that contains policies and strategies for meeting the emissions budget. The Zero Carbon Act requires that the ERP include sector-specific policies to reduce emissions and increase carbon removals.

In May 2021, the Climate Change Commission provided the government with advice for the first time, which covered: 1) the levels of the first three emissions budgets over five-year periods to 2035; 2) direction on the policies and strategies needed in the government's ERP; and 3) advice on New Zealand's NDC and eventual reduction in biogenic methane. The final advice reflects extensive research and analysis and a consultation that encompassed submissions from more than 15 000 people. The Climate Change Commission's report was timely to precede and inform the government's development of the first ERP. The Commission's monitoring of government progress, combined with its annual reports that will begin in 2024, will contribute to transparency and accountability around government policy making and achieving its targets.

In May 2022, the government published the first three emissions budgets, covering the periods of 2022-2025, 2026-2030 and 2031-2035. The ERP then outlined how New Zealand will meet this first set of emissions budgets (2022-2035) and achieve its long-term climate targets. Actions identified in the ERP include: increasing EV uptake; supporting business to improve energy efficiency; banning new coal boilers and phasing out existing ones; introducing emissions pricing in agriculture; accelerating agricultural emissions reduction technologies; reducing waste; establishing native forests to develop long-term carbon sinks; accelerating the supply of woody biomass; and driving mission-led innovation in hard-to-abate sectors.

New Zealand's primary emissions reduction tool is the New Zealand Emissions Trading Scheme. The NZ ETS covers the entire economy except for the agricultural sector and a portion of the waste sector. A unique characteristic of the NZ ETS is that the point of obligation is almost always upstream rather than the point of emissions, so the carbon price impact comes through the prices of fuels and waste disposal. Some sectors can opt into the NZ ETS, including forestry, for which allowances can be earned. The agricultural sector has reporting requirements under the NZ ETS but no surrender obligations. NZ ETS price controls include an auction reserve price of NZD 30 in 2022 (which serves as a floor) and a cost containment reserve price of NZD 70 in 2022 (which acts as a "soft" ceiling price). In November 2022, the price on the secondary market was around NZD 88.

While the market-based system will help motivate emissions reductions by increasing prices for emissions-intensive fuels in favour of greener options, some legacy design

elements will likely impact the efficacy of the programme. To start, the system has a sizeable volume of "banked" units that can enter the market at any time, thereby lowering prices. In addition, a theoretically unlimited supply of forestry units can be generated, adding to supply in the system and placing downward pressure on prices. As such, afforestation measures can dominate the ETS over mitigation measures in the energy sector. Together, the banked credits and forestry units mean that the ETS emissions cap is effectively a soft cap.

The NZ ETS also allows the free allocation of emissions allowances to 26 eligible industrial activities that are emissions-intensive and trade-exposed. One of the concerns from stakeholders is that if they face a price of carbon while their international competitors do not, their international competitiveness will be eroded; the opposition argues the free allocation has led to overallocation and weakened incentives to mitigate emissions. New Zealand is currently reviewing this policy.

Additionally, New Zealand's ETS system is not open to international markets. Legislative reforms in 2020 did include a provision for possible future use of offshore emission units subject to quantitative and qualitative limits. Though the ERP says offshore mitigation will be necessary for New Zealand to reach its NDC, the New Zealand government has not yet published plans to develop an offshore mitigation system. New Zealand should reconsider the option to meet its targets based on future theoretical advancements in the international offset market against possible domestic value creation in the energy sector through domestic emissions reductions (such as in the transport sector).

While emissions pricing plays a central role in reducing emissions, New Zealand also has complementary measures to support low-cost emissions reduction opportunities. Given limitations to the current NZ ETS scheme to meet the scale of emissions cuts required by targets, it is positive that New Zealand is not solely relying on the scheme to meet its climate targets. In addition to targeted and sector-specific policies outlined in the ERP, the Climate Emergency Response Fund was established in 2021 to support climate-related spending from NZU auction proceeds over a four-year period.

On a sectoral basis, New Zealand already has a low-emissions electricity system, with over 80% of electricity coming from renewable sources in 2020. Given New Zealand's natural enabling environment, this percentage is predicted to reach 90-95% even without additional government intervention beyond the NZ ETS. As such, New Zealand can leverage its clean electricity system to decarbonise other sectors through electrification, which will require an additional buildout of renewables generation to support accelerated load growth. However, New Zealand should weigh its aspiration to achieve 100% renewable electricity by 2030 against the potentially considerable costs associated with achieving the last 2-5% of the target. This notion was supported by the Climate Change Commission's Recommendation 20, which suggests the 100% target be replaced with a 95-98% target.

Elsewhere, New Zealand has more work to do to decarbonise economic sectors beyond electricity. Notably, the transport sector accounts for the highest share of emissions and is almost entirely dependent on oil as a fuel source. New Zealand has policies to encourage consumers to buy lower emissions and electric vehicles, but the government should closely monitor progress to ensure that the measures produce sufficient market shifts to support consumer uptake to the extent needed to meet climate targets. The

ERP's emphasis on public transport is positive, as New Zealand's car ownership per capita is among the highest in the world.

Industry is also a major contributor to New Zealand's GHG emissions. One of the main focus areas for the recently established GIDI Fund, as well as programmes administered by the Energy Efficiency and Conservation Authority, is to accelerate the decarbonisation of industrial process heat. Initiatives like the GIDI Fund are a positive step for New Zealand, whose total final energy consumption is dominated by industry at 45%. Given that a sizeable share of coal demand comes from the industry sector, the IEA welcomes measures that support a shift away from fossil fuels.

In 2019, the government released its Hydrogen Vision, which describes hydrogen's potential role in New Zealand's economy. The government then released modelling in 2022 that outlined a potential business-as-usual development path for hydrogen in New Zealand. This modelling work is intended as a precursor or base case for the hydrogen road map that the government is currently developing. Given the material effects large-scale electrolyser demand would have on the generation and transmission system if New Zealand adopts a large-scale hydrogen development pathway, the hydrogen road map must be developed in an integrated way with the broader Energy Strategy. There is a range of opportunities for hydrogen in New Zealand, but it cannot yet be relied on as a core element of New Zealand's emissions reduction strategy, given the industry's nascency. Moreover, New Zealand will likely be dependent on imported technology to advance its hydrogen sector, so technological advancements abroad may inform progress domestically.

New Zealand is also taking steps to adapt its energy system to the impacts of climate change. In August 2020, the government published New Zealand's first National Climate Change Risk Assessment, which identified 43 risks that New Zealand faces from climate change and highlighted data and information gaps needed to properly assess and manage climate risks and opportunities. In August 2022, the government released the first National Adaptation Plan, which responds to the risks identified in the risk assessment. The 2019 Climate Change Response Act requires the preparation of a climate change risk assessment at least every six years, followed by a National Adaptation Plan in the following two years. Future national climate change risk assessments will be carried out by the Climate Change Commission. They will help ensure New Zealand's response to the impacts of climate change tracks with updated risk assessments. The Climate Change Commission will also report to the Minister of Climate Change on the implementation and effectiveness of the National Adaptation Plan every two years.

New Zealand published its first National Adaptation Plan in August 2022. Some of the areas include: the NZ Battery Project that aims to overcome the "dry year risk"; developing the National Energy Strategy by 2024; Transpower's commitment to developing an adaptation plan by 2026; and the Commerce Commission's review of electricity and gas networks' management of climate risk and resilience. The National Adaptation Plan and the pending Transpower plan will help provide clarity to the energy sector and inform investments into energy sector resilience.

Recommendations

The government of New Zealand should:

- Assess the relative abatement cost across energy end-use sectors when developing the Energy Strategy. Prioritise overall abatement over full decarbonisation of any particular sector.
- Accelerate measures to reduce emissions in both the light- and heavy-duty segments of the transport sector.
- Address surplus supply in the New Zealand Emissions Trading Scheme to provide a stronger carbon price signal to motivate energy sector decarbonisation.
- Consider the value creation for the domestic energy sector of offshore carbon credit purchases in meeting New Zealand's Nationally Determined Contribution.
- Quickly put in place a regulatory framework to enable investment in supporting infrastructure for future hydrogen developments.

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4. Energy efficiency

Key data

(2021)

TFC: 560 PJ, +7% from 2011 to 2021

TFC by source: oil 48%, electricity 25%, natural gas 17%, bioenergy and waste 4.7%, coal 4.0%, geothermal 1.3%

TFC by sector: industry 42%, transport 36%, buildings 22%

TFC per capita: 109 GJ/capita (IEA average in 2020: 113 GJ/capita), -8% since 2011

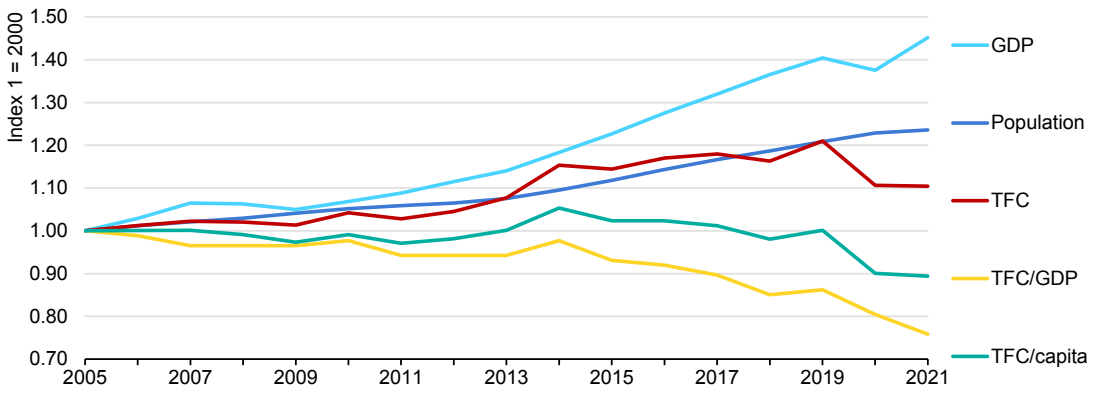
TFC per GDP: 2.77 MJ/USD (IEA average in 2020: 2.66 MJ/USD), -19% since 2010

Source: IEA (2022a).

Overview

Both economic growth and energy consumption have increased in New Zealand since 2005. Between 2011 and 2021, New Zealand's GDP grew by 33% while TFC increased by 7% (Figure 4.1). Given that GDP growth was stronger than TFC, energy intensity saw a notable decrease, both in terms of TFC per GDP (-19% from 2011 to 2021) and TFC per capita (-8% from 2011 to 2021). Electricity consumption per capita also fell by 14% between 2011 and 2021.

Figure 4.1 Energy demand and drivers in New Zealand, 2005-2021



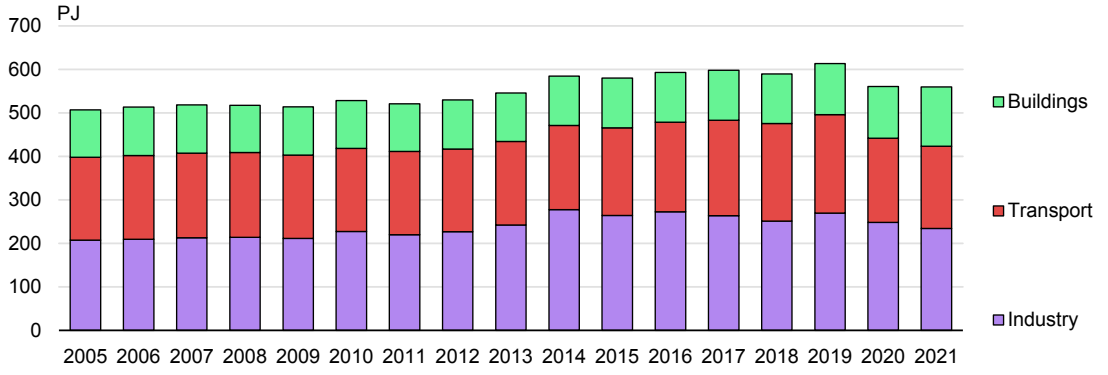
Total final consumption and GDP have increased since 2005 while TFC/GDP and electricity consumption per capita are slowly declining.

Notes: GDP = gross domestic product; TFC = total final consumption.

Source: IEA (2022a).

TFC in New Zealand was 560 PJ in 2021 and had been growing over the previous decade, with a peak in 2019 before the drop in 2020 due to the Covid-19 pandemic. In 2021, TFC remained stable at a similar level to 2021. Industry was the largest energy-consuming sector in 2021 (42%), followed by transport (36%) and buildings (22%). From 2005 to 2019, energy demand increased in all sectors: by 30% in industry, 19% in transport and 8% in buildings. In 2020, energy demand dropped year-on-year because of the Covid-19 pandemic in all sectors except buildings, where it remained stable. From 2020 to 2021, transport energy demand rebounded by 6%, while TFC in buildings increased only slightly by 2% and that of industry fell by 6%.

Figure 4.2 Total final consumption by sector in New Zealand, 2005-2021



Industry accounts for the largest share of total final consumption in New Zealand.

Note: PJ = petajoule.
Source: IEA (2022a).

Energy efficiency strategies

The EECA was established as a Crown entity under the Energy Efficiency and Conservation Act 2000 to encourage, promote and support energy efficiency, energy conservation and the use of renewable sources of energy. The EECA runs a number of programmes to achieve these goals. This work is delivered through partnerships with the private sector, community groups, industry associations, and central and local governments.

The current New Zealand Energy Efficiency and Conservation Strategy 2017-2022 (NZEECS) sets the overarching policy direction for government support and intervention for promoting energy efficiency, energy conservation and the use of renewable sources of energy.

The current NZEECS outlines government policies, objectives and targets for 2017-2022; guides the EECA's work programme; and encourages businesses, individuals, households, community institutions and public sector agencies to take actions to help unlock the country's renewable energy and energy efficiency potential. Its priority areas are renewable and efficient use of process heat, efficient and low-emissions transport, and innovative and efficient uses of electricity. Its targets are to reduce industrial emissions intensity by at least 1% per year over 2017-2022, for EVs to make up 2% of the fleet by the end of 2021, and for 90% of electricity to come from renewable sources by 2025 (MBIE, 2017).

The current NZEECS expired in 2022. Rather than rolling it over for another five years, a new five-year NZEECS will be developed to replace the existing strategy. The new strategy will better align with the government's climate change and energy system priorities.

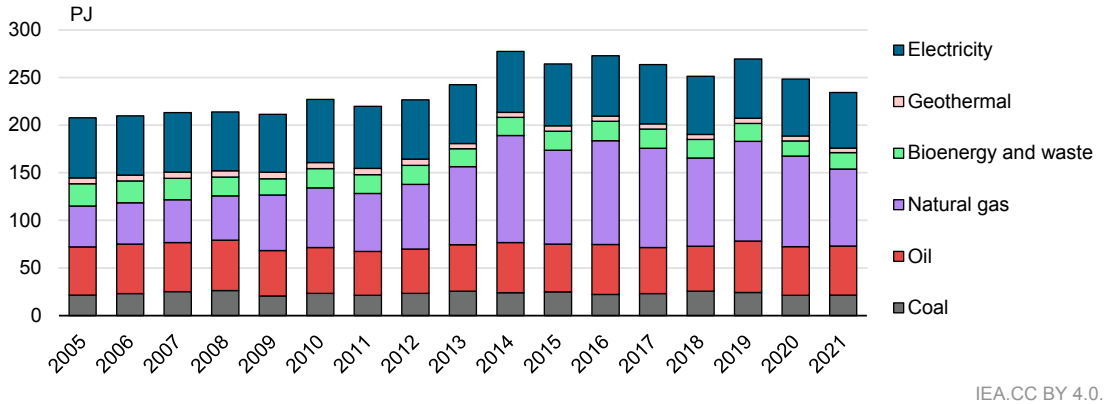
Since 2012, the EECA has published an Energy End Use Database (EEUD) to track energy use in various sectors of the energy system (i.e. the residential, commercial, transport and industrial sectors). The database not only collates data on energy efficiency, but national-level data on energy use by technology, and end uses and fuel types in the aforementioned sectors as well. It provides baseline data on how energy is being consumed in New Zealand to meet the demand for energy services. Following a review of the EEUD in 2018, the EECA put its publication on hold and invested in improving the database system, data quality and stakeholder engagement. In August 2020, the EECA published the much-improved EEUD on its website for the 2017, 2018 and 2019 calendar years. In 2021, the EECA published an online visualisation tool with its EEUD data to allow for easy, user-friendly access to the data and insights. In 2022, the EECA remodelled and published an improved data set for the transport data component of the EEUD.

The New Zealand government helps promote energy efficiency measures in part through public information and behaviour change campaigns. In particular, in September 2019, the EECA launched a flagship information campaign called "Gen Less" to help overcome awareness barriers and to get New Zealanders mobilised to replace their energy-related emissions (Gen Less, 2022). The campaign aims to make a climate-friendly lifestyle appealing and desirable and to articulate the role of energy use and energy efficiency in achieving that lifestyle. The programme includes recommendations for both businesses and individuals.

Industry

Industry is the sector with the highest TFC: in 2021, its share of energy consumption was 42% (234 PJ), 13% lower than in 2019 and 7% higher than in 2010. In 2021, the main energy source in industry was natural gas, accounting for 35% of consumption (Figure 4.3). However, the sector also depends on other fossil fuels, such as oil (22%) and coal (9%), as well as on electricity, which meets 25% of energy demand. Bioenergy (7.3%) and geothermal (2.0%) account for smaller shares.

Figure 4.3 Total final consumption in industry by source in New Zealand, 2005-2021



In 2021, industry relied on fossil fuels for 66% of its total final consumption.

Note: PJ = petajoule.
Source: IEA (2022a).

Policies and measures in the industry sector

The NZEECS includes a target to reduce industrial emissions intensity (kg CO_2-eq/NZD real GDP) by at least 1% per annum on average between 2017 and 2022. This target (which was based on historical trends and not on new, additional policies) is not being specifically tracked, but indications are that New Zealand will meet the 2022 goal.

In July 2020, the government announced an NZD 70 million investment to decarbonise industrial and process heat, including support for energy efficiency, fuel switching and transmission line upgrades (in cases where electrification is the appropriate solution). The GIDI Fund is administered by the EECA and aims to accelerate the decarbonisation of industrial process heat by assisting private sector businesses with the upfront capital costs of switching from fossil fuels to renewables.

Through Budget 2022, the EECA received a significant increase in the GIDI Fund to expand it. Approximately NZD 1 billion over seven years is currently undergoing programme design. Around NZD 600 million is expected to go toward an expanded process heat fund, which has the potential to include: nationally available contestable funding; a streamlined process for smaller projects; partnerships with the biggest emitters; enabling infrastructure and supply of low-emissions fuels to support decarbonisation, such as network upgrades; regionally targeted decarbonisation based on plans through the Regional Energy Transition Accelerator; and technology diffusion. An additional NZD 40 million will be allocated to commercial space and water heating decarbonisation, switching fossil fuel space and water heating to renewable energy, and increased energy efficiency in the commercial sector. Lastly, NZD 330 million will go toward assisting businesses, including small and medium-sized ones, to upgrade to more energy-efficient equipment.

The government estimates that the first three rounds of GIDI funding contributed NZD 69 million in EECA investment, along with NZD 117 million in private investment, to fund 53 projects that will result in 7.46 Mt CO_2 in lifetime emissions abatement (EECA, 2022a). For example, GIDI funds supported the Whakatane Mill to invest in equipment that allowed for an increase in process temperature without using additional energy, thereby saving the paper mill from impending closure (EECA, 2022b). Elsewhere, Auckland Meat Processors Limited will decommission two gas-fired water boilers and install high-temperature heat pumps, whereby heat from refrigeration can be recovered and used, improving energy efficiency (New Zealand Government, 2022).

The EECA also provides co-investment, advice and technical assistance to businesses to encourage the adoption of energy-saving technologies, process improvements, and the prioritisation of energy management and lower emissions. It engages directly with the largest energy-using businesses and partners with accredited service providers and industry associations to assist the wider sector. Under the Large Energy Users Programme, the EECA provides large energy-using businesses with access to technical assistance to help them improve their energy productivity and reduce emissions. The EECA currently partners with around 83 businesses, which together account for around 22% of New Zealand's energy use.

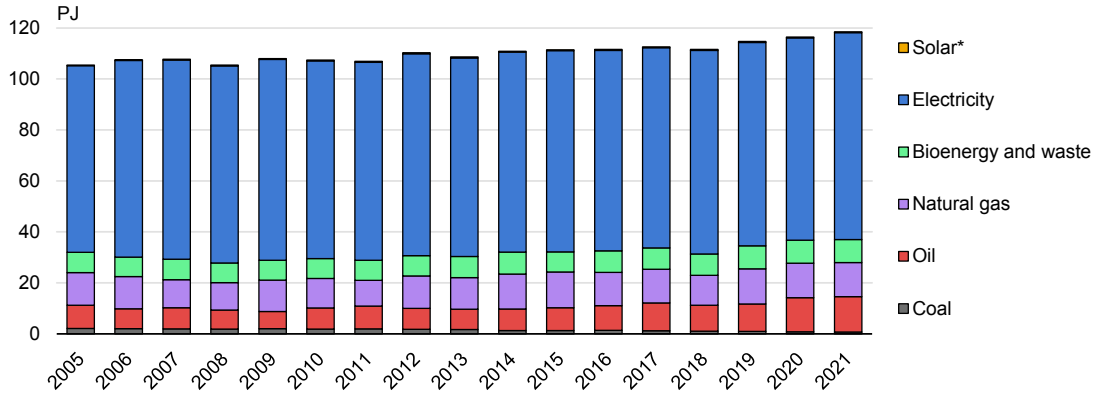
In addition, the EECA administers a fund for technology demonstration projects in New Zealand to promote demonstrations of proven technologies or innovative processes that have yet to be widely adopted in New Zealand. The projects must improve energy efficiency and/or reduce carbon emissions, and the EECA pays up to 40% of the project

costs, generally limited to NZD 100 000 per project. For projects that result in energy and carbon savings through process heat technology, funding can be up to NZD 250 000.

Buildings

In 2021, the buildings sector accounted for 22% of TFC. This sector includes residential buildings (56% of buildings TFC in 2021) and service sector buildings (44%). The largest part of energy consumption in buildings is covered by electricity (67% in 2021), which accounts for most of the demand in both residential buildings (71%) and service sector buildings (62%) (Figure 4.4). The next-largest sources of energy for buildings are natural gas and oil, each representing 11% in 2021. Bioenergy satisfies 7.5% of TFC in buildings, almost entirely in the residential sector.

Figure 4.4 Total final consumption in the buildings sector by source in New Zealand, 2005-2021



Electricity covers most of the energy consumption in buildings.

* Solar is poorly visible on this scale.

Note : PJ = petajoule.

Source : IEA (2022a).

Policies and measures in the buildings sector

Statistics New Zealand maintains some data and estimates of New Zealand's building stock. As of 31 March 2022, there were just under 2 million dwellings in New Zealand, of which around 1.9 million were privately occupied (Statistics New Zealand, 2022). Around 1 million homes were estimated to be built before the 1978 minimum insulation requirements for new residential buildings were implemented, while around 1.4 million were built before the next major upgrade to insulation requirements in 2000.

New Zealand does not currently have a comprehensive, compulsory building certification system. However, in December 2022, the government announced plans to introduce legislation that would require energy performance ratings for government, commercial and large residential buildings. This is a long-term piece of work, so new requirements are not expected to be in force until 2025 at the earliest. New Zealand's May 2022 ERP stipulates that the government will explore expanding energy performance ratings to other residential buildings in the future.

Additionally, several voluntary rating or certification schemes operate in New Zealand:

- Homestar: an independent rating tool that holistically rates a home's performance and environmental impact. A 10 Homestar rating recognises world-leading standards for design, construction and efficiency in operation. A 6 Homestar rating recognises a home built above the current standards set by the New Zealand Building Code.
- Green Star: a sustainability rating system for commercial buildings across key categories. Each category includes a benchmark for a lower carbon, healthy project. Points are awarded for successfully meeting these criteria, and the total number of points awarded decides the final Green Star rating.
- NABERSNZ: based on the successful Australian Built Environment Rating System (NABERS) and adapted for New Zealand conditions. NABERSNZ is a voluntary scheme that aims to assist owners and tenants in reducing energy use and costs and GHG emissions. Under NABERSNZ, qualified assessors measure and score the energy performance of office buildings, giving tenants and owners a star rating out of six that clearly shows a building's energy performance compared to others. The rating is valid for one year.
- Passive House: designed and built according to a set of quantifiable, science-based minimum performance requirements according to the Passive House Standard. The third-party certification offers two options: "Certified Passive House Building" for new construction and "EnerPHit Retrofits" for buildings refurbished to the Passive House Institute retrofit standard.

The government applies several voluntary schemes to improve the performance of its own buildings, including the Carbon Neutral Government Programme, NABERSNZ and Green Star. The Kāinga Ora – Homes and Communities, which delivers public housing and urban development projects, committed that all new homes it builds would be to a Homestar 6 standard.

All new buildings in New Zealand must comply with the New Zealand Building Code. The New Zealand Building Code is performance-based. It sets minimum performance requirements that new building work must meet, but does not prescribe how a building and its components must be designed or constructed. The New Zealand Building Code was not introduced until 1992. However, in 1978, the first nationwide minimum insulation requirements for new residential buildings were introduced. These were then updated in 2000, in 2007-2008 and most recently in 2021 (which will come into full effect in May 2023).

During the transition period for the MBIE's latest minimum requirements for insulation in new homes and buildings, designers and builders can choose to use either the new documents or the previous versions to show compliance. In response to concerns in the building and construction sector, the MBIE extended the transition period so that the previous lower insulation requirements could be used until 1 May 2023. During the consultation period for the new requirements, the government undertook a comparison with other locations with comparable climates (such as Australia, California and the United Kingdom), which found that the updated New Zealand standards were a little more than half of what these other countries have. The standards were set based on what the MBIE deemed quickly achievable by the domestic housing industry and were presented as a first step in the Building for Climate Change programme. Further changes are expected in the coming years.

Since 2009, successive New Zealand governments have delivered insulation programmes. The programmes have combined government and third-party funding (and, in some phases, homeowner contributions) to provide insulation retrofits, and sometimes heating, in older houses.

The current programme, Warmer Kiwi Homes (WKH), is the principal energy efficiency programme for the residential sector and is a successor to the Warm Up New Zealand programme. WKH was announced in 2018 as a four-year programme making NZD 142.5 million in grant funding available for insulation and efficient heating. The programme provides grants to low-income households for up to 67% of the costs of insulation and heating retrofits and is administered by the EECA. To be eligible for an insulation grant under this programme, a person needs to own the home they live in, the home must have been built before 2008, and the person needs to have either a Community Services Card or live in an area identified as low income. The original aim was to insulate or install a heater (or both) in 52 000 houses over the four years of the programme.

In 2020, the programme was supplemented with an additional NZD 56 million in funding to retrofit an additional 9 000 homes. In addition, the grants cover 90% of the costs of insulation or installing a heater. In May 2021, the government announced a further NZD 120 million for the programme to extend it another year to 30 June 2023, to cover an additional 47 000 insulation and heating retrofits. The grant percentage also decreased from 90% to 80%. In May 2022, the government announced another year of funding for the programme from July 2023 to June 2024, with additional funding of NZD 73 million to install insulation and heating retrofits in 26 500 more homes. WKH has now completed more than 100 000 installations of insulation and efficient heaters. An independent evaluation of the programme has concluded that households report a 16% average reduction in their winter electricity bills.

In 2016, New Zealand introduced mandatory insulation requirements for rental homes. These were expanded in 2019 to the “Healthy Homes Standards” for rental homes, which set minimum requirements for ceiling and floor insulation, living room heaters, draught stopping, moisture ingress and ventilation. Compliance is triggered by the commencement or renewal of tenancy agreements, with all rental homes needing to comply by mid-2025.

The Building for Climate Change programme (BfCC) was set up to reduce emissions from the building and construction sector and to prepare buildings for the ongoing effects of climate change. The BfCC programme will also deliver the building and construction sector’s contribution to the ERP. In December 2022, plans were announced to introduce mandatory energy performance ratings for certain building types, which could require new and existing buildings to hold and display a current energy performance rating. The BfCC programme also includes a workstream focused on using a behavioural lens to support the building and construction sector’s contribution to emissions reductions and adaptation. The BfCC is exploring the use of a range of interventions to encourage action and reduce barriers, including behaviour change communications, awareness raising, support, education, incentives, training, restrictions, modelling, tools, guidance and service provision, to make it easy for people to contribute to achieving New Zealand’s climate change goals. Initial regulatory measures from the programme are expected to be issued for public consultation in early 2023. The government anticipates that energy and emissions reporting requirements for buildings could be introduced in 2025.

Appliances, equipment, lighting

New Zealand develops energy efficiency regulation through its participation in the Trans-Tasman Equipment Energy Efficiency programme. By working with Australia and basing regulation on international standards, New Zealand minimises costs to government and industry while raising the energy efficiency of products supplied to the New Zealand market. Measures used include Minimum Energy Performance Standards (MEPS), which prevent the least energy-efficient products from entering the market, and mandatory energy performance labelling requirements, which enable consumers to compare the energy performance of products as part of their purchase decisions.

The programme develops MEPS and mandatory energy performance labelling requirements for a range of commonly used electrical, residential, commercial and industrial products. The programme allows both Australia and New Zealand to set consistent standards and measures for energy efficiency and enables consumers to assess and compare the energy efficiency of a product at the point of purchase. Compliance with the programme requirements is monitored and actions are taken to remove non-compliant products.

The Energy Efficiency (Energy Using Products) Regulations 2002 govern New Zealand's MEPS for energy-using products. The regulations are updated periodically as technology changes, new test methods are developed or when new products are added to the programme. The last update was in 2021.

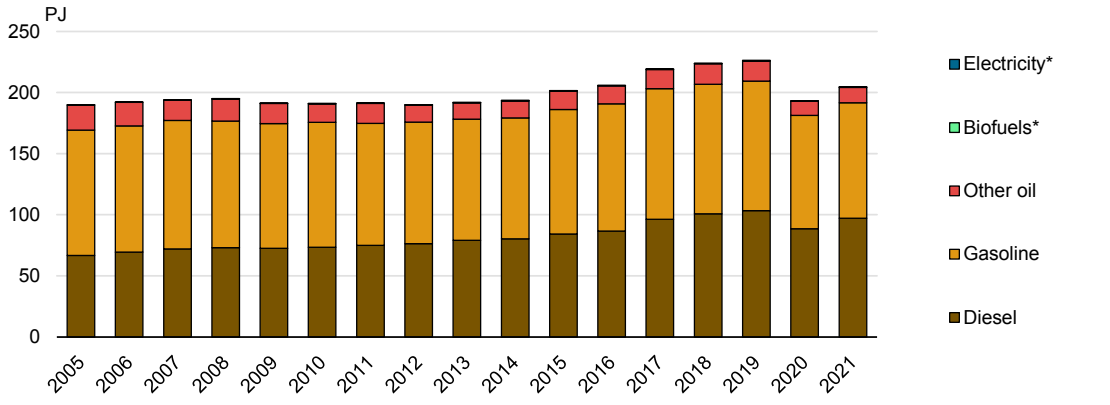
Product labelling regulations require retailers to provide energy efficiency information to consumers at the point of sale. The labels assess how much electricity the appliance is likely to use in a year (on average) and provide a star rating that compares the appliance's efficiency to other appliances of its kind.

MEPS and/or energy rating labels are currently in place for 20 product classes and 7 are under development. Suppliers of regulated products are required to provide the EECA with annual sales data, which allows measuring changes in product efficiency over time and calculating the energy savings from improvements in energy efficiency (EECA, 2021).

Transport

In 2021, energy demand in the transport sector accounted for 36% of TFC (205 PJ). Energy consumption in the sector increased by 18% from 2010 to 2019 and dropped by 15% in 2020 due to the Covid-19 pandemic, before slightly rebounding by 6% from 2020 to 2021 (Figure 4.5). Oil products almost entirely cover transport energy demand, with diesel and gasoline accounting, respectively, for 47% and 46% of transport's TFC in 2021. The same year, biofuels and electricity together represented less than 1% of New Zealand's TFC in transport.

Figure 4.5 Total final consumption in transport by energy source in New Zealand, 2005-2021



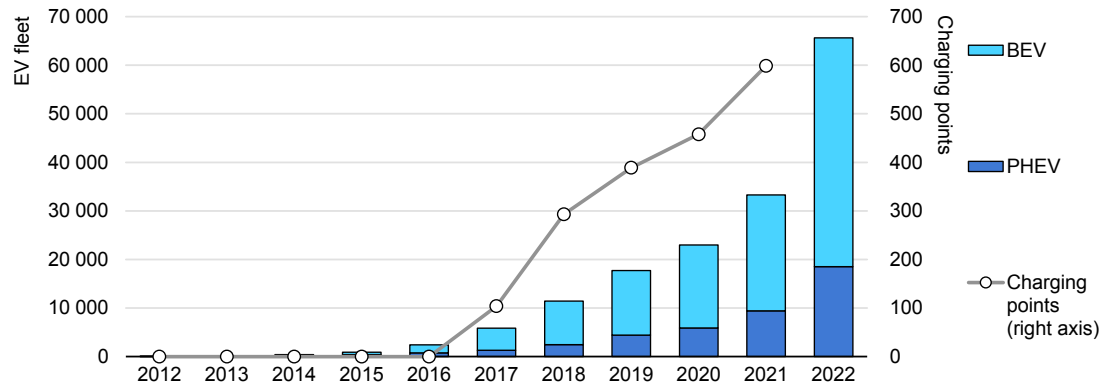
Gasoline and diesel cover nearly all the energy demand from transport.

* Electricity and biofuels are poorly visible on this scale.

Notes: PJ = petajoule. Transport sector demand excludes international aviation and navigation.

Source: IEA (2022a).

Figure 4.6 Registered electric vehicles and public charging points in New Zealand, 2012-2022



New Zealand has seen strong growth in electric vehicle sales in recent years from a small baseline.

Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. 2022 data on charging points was not available at the time of writing.

Sources: IEA (2022b); New Zealand, Ministry of Transport (2023).

EVs have experienced rapid growth in New Zealand, from 2 407 vehicles on the road in 2016 to around 65 500 in 2022. Of these, around 47 000 were battery electric vehicles and 18 500 were plug-in hybrid electric vehicles. In 2021, EVs accounted for just 0.9% of the total light-duty vehicle fleet (versus 1.6% in the European Union and 0.4% in Australia). However, in 2022, the share of EVs in New Zealand's fleet increased to 1.5%, with a growing share in new passenger cars that reached 26% in December 2022. In 2021, available data indicated 599 publicly available charging points, most of which are DC fast chargers.

Policies and measures in the transport sector

The NZ ETS encourages efficiency improvements in the transport sector by adding the carbon price to the cost of fuel. This incentivises commercial operations in particular to reduce the amount of fuel they use.

The NZEECS included a target for EVs to make up 2% of the fleet by the end of 2021. As of December 2021, this target was missed by a large margin, as the government reported 36 876 registered electric and plug-in hybrid electric light vehicles out of a fleet of nearly 4 million, representing 0.9% of the fleet.

New Zealand has a number of measures in place to promote EV uptake, including an exemption from RUC for EVs until 2025. RUC is paid on a per kilometre basis for non-petrol powered vehicles driving on New Zealand roads (for example, diesel-powered vehicles). The exemption applies to light EVs as well as heavy EVs, though light EVs mainly compete with petrol cars, which are also not subject to the charge (petrol faces an excise tax, however).

In May 2016, the government announced a package of measures to increase EV uptake in New Zealand by removing barriers that have prevented households and businesses from choosing EVs. The Electric Vehicles Programme included: a goal of reaching 64 000 EVs by 2021; extending the RUC exemption on light EVs until they account for 2% of the fleet; a RUC for heavy EVs until they make up 2% of the fleet; investigating the bulk purchase of EVs across government and the private sector; and NZD 1 million annually for EV information campaigns over five years.

The Low Emission Vehicles Contestable Fund was launched in 2016 and made funding of up to NZD 6.5 million a year available to encourage and support innovative low-emissions vehicle projects. In Budget 2021, the government announced it would expand the scope of the fund and increase funding to an eventual NZD 25 million per year by 2023-2024.

The Ministry of Transport is leading the development of a long-term National EV Charging Strategy, targeted to be published by 30 June 2023. The strategy will set out the government's long-term vision for EV charging infrastructure over time toward the goal of a 30% zero-emissions light-duty fleet by 2035. The EECA is also developing a road map to inform the public and industry about how the government is planning to approach investment in public EV fast-charging infrastructure in the short term as well as improving cross-sectoral collaboration to optimise the roll-out. The EECA's approach to developing New Zealand's public fast-charging network is to support the installation of fast-charging clusters at priority locations with multiple charging heads and services (similar to a petrol station). A preliminary map of potential locations for fast-charging clusters has been developed, and a pilot of two clusters will take place in 2022-2023.

Notably in the New Zealand context, the supply of EVs heavily depends on the stock of imported cars. The Climate Change Commission estimated that around 50% of vehicles imported into New Zealand were already used and that 90% came from Japan (Climate Change Commission, 2022). Therefore, New Zealand's progress in turning over its vehicle fleet toward EV models in line with climate targets is very dependent on Japan's EV production and fleet turnover. However, the majority of EVs entering New Zealand in 2022 were new and came from non-Japanese sources.

In terms of fuel efficiency, the Vehicle Fuel Economy Labelling scheme came into effect in April 2008, making it compulsory for vehicle traders and online vendors to display information about the fuel economy of their vehicles. In April 2022, the label was updated to the Vehicle Emissions and Energy Economy Label, which includes CO_2 emissions data and easier-to-understand data on cost savings and rebates.

The Clean Car Discount encourages the purchase of zero- and low-emissions light vehicles by reducing the cost of eligible new and used vehicles coming into New Zealand (through rebates) and putting a fee on high-emissions vehicles from 1 April 2022. The Clean Car Standard focuses on the supply of vehicles coming into New Zealand. Since 1 January 2023, vehicles with a high CO_2 emissions rating incur a fee; the higher the CO_2 rating, the higher the fee. In 2022, the government legislated a Clean Car Standard that sets ambitious targets and financial penalties on vehicle distributors to reduce average emissions to 63 g CO_2/km for passenger cars and 87 g CO_2/km for commercial vehicles entering New Zealand by 2027, which is approximately a two-thirds reduction on emission levels recorded in 2021.

In the heavy-duty segment (which accounts for around a quarter of road transport emissions in New Zealand), the ERP has several actions designed to improve the efficiency of heavy transport, including: providing funding to support the freight sector to purchase zero- and low-emissions trucks, requiring only zero-emissions public transport buses by 2025, and supporting the uptake of low-carbon liquid fuels by implementing a sustainable aviation fuel mandate and a Sustainable Biofuels Obligation. Furthermore, the EECA administers a contestable low-emissions transport fund to help businesses demonstrate new low-emissions technologies.

The government is also developing a national freight and supply chain strategy ("Green Freight Project") in collaboration with industry, which will present a long-term and system-wide view of the freight system, looking across industries, sectors and modes to identify challenges and opportunities in the long term. The project, which commenced in 2019, will specifically look at the role of green fuels such as electricity, hydrogen and biofuels in decarbonising heavy-duty transport (New Zealand, Ministry of Transport2020).

In other transport segments, New Zealand has two main initiatives to enhance aviation efficiency: 1) New Southern Sky is an initiative led by the New Zealand Civil Aviation Authority which anticipates annual savings of 6 000-9 000 t CO_2 at two of New Zealand's busiest airports – Auckland and Wellington; 2) performance-based navigation, under which New Zealand's ground-based navigation aids are being replaced with more accurate satellite-based technologies.

The New Zealand Rail Plan, released in April 2021, outlines the government's long-term vision for New Zealand's rail network to provide modern transit systems in its largest cities and enable increasing volumes of freight to be moved by rail. Supporting increased use of rail is an important element of the country's ERP. Furthermore, state-owned KiwiRail's new locomotive fleet, which was replaced with funding through Budgets 2018-22, is expected to emit up to 25% less nitrous oxide (NO_x) and be 20-25% more fuel efficient than the nearly 50-year-old locomotives they are replacing. This is in addition to the estimated 70% fewer carbon emissions per tonne of freight carried by rail over heavy road transport. KiwiRail estimates that every 1% increase in the availability of locomotives and wagons provides the additional capacity for reducing 11 000 truck trips per annum.

In shipping, within Asia-Pacific Economic Cooperation (APEC), New Zealand is promoting a maritime initiative to assist in decarbonising domestic and international shipping. KiwiRail is also investing in more fuel-efficient ferries for inter-island travel (36% estimated fuel savings compared to the current fleet).

The ERP's Transport Chapter includes a focus area on reducing reliance on cars and supporting people to walk, cycle and use public transport. It sets out the proposed policies to achieve the ERP Target 1: reduce vehicle kilometres travelled by cars and light vehicles by 20% by 2035 by providing better travel options, particularly in the largest cities. Toward this end, the government also plans to promote alternative modes of transport, such as public transit, walking and bicycling, in urban areas through urban development plans and incentives for consumers.

Assessment

In the past decade, New Zealand has made progress decoupling economic and population growth from energy consumption. Between 2011 and 2021, New Zealand's energy intensity saw a notable decrease, both in terms of TFC per GDP and TFC per capita. Electricity consumption per capita also fell by 14% between 2011 and 2021.

Energy demand grew over the previous decade, with a peak in 2019 before the drop in 2020 due to the Covid-19 pandemic. From 2020 to 2021, TFC was roughly steady, with an increase in energy demand from transport but a decrease from industry; buildings remained mostly stable. Industry was the largest energy-consuming sector in 2021 (42%), followed by transport (36%) and buildings (22%).

The Energy Efficiency and Conservation Authority was established in 2000 to encourage, promote and support energy efficiency, energy conservation and the use of renewable sources of energy.

The current New Zealand Energy Efficiency and Conservation Strategy 2017-2022 sets the overarching policy direction for government support and intervention for promoting energy efficiency, energy conservation and the use of renewable sources of energy. Its priority areas are renewable and efficient use of process heat, efficient and low-emissions transport, and innovative and efficient uses of electricity. The current NZEECS expired in 2022, and a new five-year strategy will be developed to replace the existing one, which will better align with the government's climate change and energy system priorities. The government should conduct early consultation with industry, including energy efficiency practitioners, with sufficient lead times on the development of such strategies to ensure policies are best aligned with market needs and capabilities.

Overall, New Zealand has made considerable progress in advancing energy efficiency programmes across economic sectors in recent years. The government's application of the "energy efficiency first" principle in funding is commendable and should be maintained. Post-Covid recovery efforts and Budget 2022, in particular, greatly increased spending on programmes to advance energy efficiency. The government should ensure a sustained focus and continued funding for successful programmes in future budget cycles.

Moreover, New Zealand has often employed a behavioural lens to promote energy efficiency actions, which can yield considerable results toward meeting decarbonisation targets and lowering household energy bills. The availability of information is key to such

programmes. To this end, the government should expand rating and labelling programmes, especially in the buildings sector, to drive better behavioural change outcomes.

To advance energy efficiency strategies, the government should ensure sufficient capacity and skills to deliver on projects. As in other countries, the scale of upcoming energy efficiency upgrades to meet decarbonisation plans will require a significant expansion of skilled workers across the sector. As the government pursues a new NZEECS and decides on budgetary outlays, specialty skills training in the energy efficiency space should be given due consideration.

Industry

The main energy source in the industry sector is natural gas, accounting for 35% of consumption in 2021, followed by oil and coal (together 31%), electricity (25%), bioenergy (7.3%), and geothermal (2.0%).

The NZEECS includes a target to reduce industrial emissions intensity by at least 1% per annum on average between 2017 and 2022. The target was based on historical trends and is modest in terms of ambition. As the government issues a new NZEECS, it should reassess targets (and consider an energy consumption or efficiency-based target) to increase ambition based on technological evolution and global best practice. Moreover, the 1% target is not specifically tracked, though the government expects that New Zealand is on track to meet the 2022 goal. Dedicated tracking of the targets can not only raise their profile, but also inform policies and measures to support their achievement, including for course correction where progress lags.

In recent years, the government has bolstered financial support for energy efficiency improvements in the industry sector. In July 2020, it announced an NZD 70 million investment as part of the GIDI Fund to decarbonise industrial and process heat, including support for energy efficiency, fuel switching and transmission line upgrades. The funding will be administered by the EECA and aims to accelerate the decarbonisation of industrial process heat by assisting private sector businesses with the upfront capital costs of switching from fossil fuels to renewables. Through Budget 2022, the EECA received a significant increase to expand the GIDI Fund. The IEA welcomes the additional budgetary outlays in this area and encourages a strong, dedicated focus on projects that lower energy consumption in industry.

The EECA also provides co-investment, advice and technical assistance to businesses to encourage the adoption of energy-saving technologies, process improvements, and the prioritisation of energy management and lower emissions. In addition, the EECA administers a fund for technology demonstration projects in New Zealand, contributing to the cost of demonstrating proven technology or innovative process improvement opportunities that have yet to be widely adopted in New Zealand.

Transport

Energy consumption in the transport sector increased by 18% from 2010 to 2019 but dropped by 15% in 2020 due to the Covid-19 pandemic and rebounded by 6% from 2020 to 2021. Oil products almost entirely cover transport energy demand, with diesel and gasoline accounting, respectively, for 50% and 43% of transport's TFC in 2021. The same year, biofuels and electricity represented less than 1% of New Zealand's TFC.

EVs have experienced rapid growth in New Zealand since 2016 (nearly 13-fold), but they still accounted for just 1.5% of the total car fleet at the end of 2022, lower than the 2% target. In 2022, there were around 47 000 battery electric vehicles and 18 500 plug-in hybrid electric vehicles along with 599 public charging points.

The NZ ETS encourages efficiency improvements in the transport sector by adding the carbon price to the cost of fuel. This incentivises commercial operations in particular to reduce the amount of fuel they use.

Additional efforts to encourage fuel efficiency on the part of consumers include the Vehicle Fuel Economy Labelling scheme, which took effect in April 2008. It requires vehicle traders and online vendors to display information about the fuel economy of their vehicles. In April 2022, the label was updated to include CO_2 emissions data and easier-to-understand data on cost savings and rebates.

The Clean Car Discount encourages the purchase of zero- and low-emissions light vehicles by offering rebates on zero- or low-emissions vehicles and placing a fee on high-emissions vehicles from 1 April 2022. Meanwhile, the Clean Car Standard focuses on the supply of vehicles from distributors in New Zealand, with higher fees for higher CO_2 ratings for fleets. The combination of schemes is likely to show results in the coming years and shift the car fleet toward lower emissions models. However, the programmes warrant close monitoring to ensure that they are yielding results in line with New Zealand's more ambitious climate targets. In particular, the government should ensure that the fees and incentives narrow the cost gap between more emitting vehicles and low-emissions options quickly enough to accelerate the uptake of the low-emissions options (especially considering the heavy dependence on imported models from Japan).

In the heavy-duty segment, the ERP has several actions designed to ensure that the efficiency of heavy transport is improved, including: providing funding to support the freight sector to purchase zero- and low-emissions trucks, requiring only zero-emissions public transport buses by 2025, and supporting the uptake of low-carbon liquid fuels by implementing a sustainable aviation fuel mandate and a Sustainable Biofuels Obligation. The government is also developing the Green Freight Project, which will present a long-term and system-wide view of the freight system to identify long-term challenges and opportunities. The initiatives are all oriented in the right direction and should be backed by sufficient resources to ensure successful and timely implementation.

New Zealand has two main initiatives to enhance aviation efficiency in other transport segments: the New Southern Sky initiative and performance-based navigation. The New Zealand Rail Plan, released in April 2021, outlines the government's long-term vision for New Zealand's rail network to provide modern transit systems in its largest cities and to enable increasing volumes of freight to be moved by rail. In shipping, within APEC, New Zealand is promoting a maritime initiative to assist in decarbonising domestic and international shipping.

As part of the ERP, the government also plans to promote alternative modes of transport, such as public transit, walking and bicycling, in urban areas through urban development plans and incentives for consumers. Given that New Zealand has among the highest shares of vehicle ownership in the world, these initiatives are welcome moves and should be backed by sufficient support for related infrastructure to motivate consumer shifts.

Buildings

The largest part of energy consumption in buildings is covered by electricity (67%), while other sources have lower shares: natural gas and oil (11% each), bioenergy (7.5%), and coal (0.6%).

New Zealand does not have a comprehensive, compulsory building certification system, though one is being explored. In December 2022, the government announced plans to introduce legislation that will require energy performance certificates for government, commercial and large residential buildings. However, this is a long-term piece of work, so new requirements are not expected for several years. The May 2022 ERP further identifies that the government will explore expanding energy performance ratings to other residential buildings in the future. Nonetheless, several voluntary rating or certification schemes operate in New Zealand, including Homestar, Green Star and NABERS NZ.

All new buildings in New Zealand must comply with the New Zealand Building Code. The New Zealand Building Code sets minimum performance requirements for new building work but does not prescribe how a building and its components must be designed or constructed. In 2021, the MBIE issued changes to increase the minimum requirements for insulation in new homes and buildings, though extended the transition period for compliance so that the previous, lower insulation requirements can still be used until 1 May 2023. The consultation process for the changes included a comparison of standards in countries with comparable climates, which found that New Zealand's updated standards are only slightly more than half that of other countries. The comparatively low levels of the new requirements were established to align with industry capabilities for near-term implementation. This is seen as a first step in the MBIE's Building for Climate Change programme, which intends to further increase building requirements to support New Zealand's 2050 zero-carbon goal.

New Zealand has demonstrated success in the past decade in delivering home insulation programmes. The programmes have combined government and third-party funding (and, in some phases, homeowner contributions) to provide insulation retrofits, and sometimes heating, in older houses. The current programme, Warmer Kiwi Homes, is the principal energy efficiency programme for the residential sector. The programme was announced in 2018 as a four-year programme making NZD 142.5 million in grant funding available for insulation and efficient heating. The programme provides grants to low-income households for up to 67% of the costs of insulation and heating retrofits, and is administered by the EECA. In subsequent years, the programme's funding has expanded, with an additional NZD 56 million in 2020, NZD 120 million in 2021 and NZD 73 million in 2022. The programme is now funded up to June 2024. The revised focus on low-income homes is a welcome development.

However, given the age of New Zealand's building stock, more widespread energy efficiency upgrades will be needed to support climate targets, including for the rental market, which lags behind the rest of the market. While information campaigns can help, they need to be supplemented by more targeted efforts to stimulate greater uptake of upgrades and retrofits. There are currently no funding programmes or regulatory levers to encourage broader retrofits, and performance ratings schemes are still voluntary and in their nascency. Expanding the scope of the NABERS rating programme for commercial buildings, as well as government programmes for public buildings and social housing, could be a good place to start.

The Building for Climate Change programme was set up to reduce emissions from the building and construction sector and prepare buildings for the ongoing effects of climate change. The programme has announced plans to introduce legislation that would require energy performance ratings for certain building types, which could require new and existing buildings to hold and display a current energy performance rating. The BfCC programme also includes a workstream focused on using a behavioural lens to support the building and construction sector's contribution to emissions reduction and adaptation. Initial regulatory measures from the programme are expected to be issued for public consultation in early 2023. The effort to undertake a more transformational change in the buildings sector is a good one, and the IEA encourages rapid finalisation of ensuing implementing measures to avoid locking in more buildings with less advanced standards.

New Zealand develops energy efficiency regulation for electrical, residential, commercial and industrial products through its participation in the Trans-Tasman Equipment Energy Efficiency Programme. Measures used include Minimum Energy Performance Standards, which prevent the least energy-efficient products from entering the market, and mandatory energy performance labelling, which enable consumers to compare the energy performance of products as part of their purchase decisions. MEPS and/or energy rating labels are currently in place for 20 product classes, and 7 are under development.

Recommendations

The government of New Zealand should:

- ☐ Ensure that the Energy Efficiency and Conservation Authority-backed and Government Investment in Decarbonising Industry-funded projects consider energy efficiency ahead of other decarbonisation or fuel-switching options.
- ☐ Monitor turnover of the light-duty fleet toward low-emissions models and expand incentives as needed to keep progress on track with climate targets.
- ☐ Building off the success of the Warmer Kiwi Homes programme, expand energy efficiency programmes to benefit the wider stock of existing buildings, especially to promote deep retrofits that yield greater energy savings.
- ☐ Consider a mandatory energy ratings programme for residential buildings.
- ☐ In co-ordination with the buildings sector, quickly advance updates to building codes to align with international best practices.

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5. Renewable energy

Key data

(2021)

Renewables in TFEC*: 148 PJ/28.9% of TFEC (hydro 76 PJ, geothermal 34 PJ, bioenergy** 29 PJ, wind 8.3 PJ, solar 1.0 PJ)

Renewables in electricity generation: 36 TWh or 81% of electricity generation (hydro 24 TWh, geothermal 8.4 TWh, wind 2.6 TWh, bioenergy** 0.8 TWh, solar 0.2 TWh)

Renewables by sector: 60% in buildings, 36% in industry, 0.2% in transport

* Total final energy consumption (TFEC) excludes non-energy use, which is counted in total final consumption.

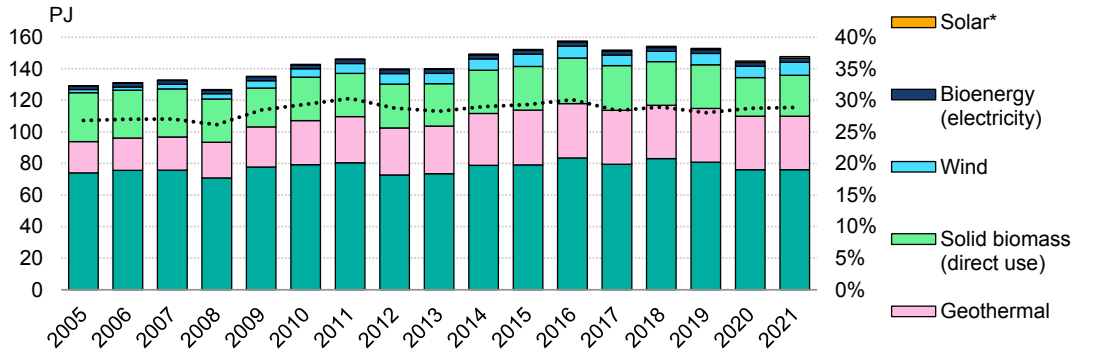
** *Bioenergy* includes solid biomass, liquid biofuels, bioenergy (electricity) and biogas.

Source: IEA (2022).

Overview

New Zealand has the tenth-highest share of renewable energy in TFEC[1] among IEA countries. In 2021, 29% of TFEC came from renewables, while the IEA average in 2020 was 13%. The main renewable energy source in New Zealand is hydropower, which covers 55% of electricity generation, the fifth-highest share among IEA member countries.

Figure 5.1 Renewable energy in total final energy consumption in New Zealand, 2005-2021



Hydro accounts for the largest share of renewable energy in TFC.

* Solar is not visible at this scale and was 1.0 PJ in 2021.

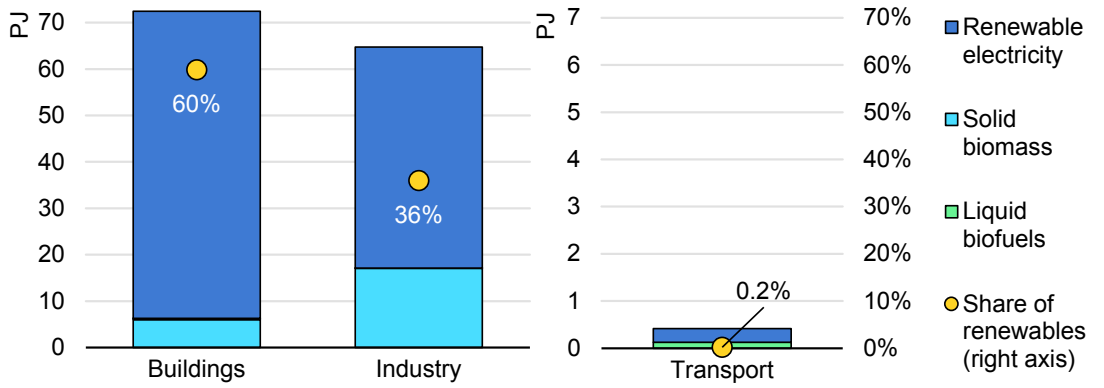
Source: IEA (2022).

[1] TFEC excludes non-energy use, which is counted in TFC. TFEC provides a more accurate assessment of the share of energy demand covered by renewable energy.

In 2021, New Zealand had the largest share of geothermal (25%) in total energy supply and electricity generation (19%) among IEA countries.

In 2021, renewables provided 60% of energy demand (TFEC) in buildings, 36% in industry and 0.2% in transport. Renewable electricity covered 55% of buildings TFEC, 26% of industry and 0.14% of transport. Solid biomass provided 5% of energy in buildings and 9% in industry, and liquid biofuels had a share of 0.06% of transport energy demand (Figure 5.2).

Figure 5.2 Renewable energy by sector in New Zealand, 2021



In 2021, renewable energy covered most of the energy demand in buildings and one-third in industry, but just 0.2% in transport.

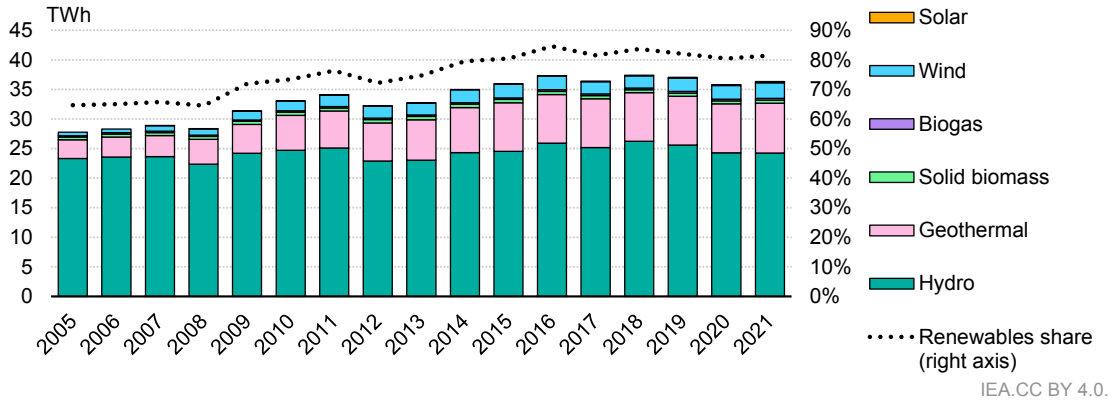
Note : PJ = petajoule.
Source : IEA (2022).

Renewable electricity generation

Out of 45 TWh of total electricity generation in New Zealand in 2021, 36 TWh (81%) came from renewable energy sources. Hydro accounted for 54% of total generation, while geothermal accounted for 19%. The share of renewables in electricity generation has been increasing since 2005.

The use of geothermal for electricity generation has increased by 165% from 2005 to 2021. Wind experienced a fourfold increase over the 2005-21 period, reaching 2.6 TWh in 2021. Solar power has increased since 2011 (from a very low base), going from 3 gigawatt hours (GWh) to 200 GWh in the span of 10 years, but still accounted for just 0.5% in 2021.

Figure 5.3 Renewable energy in electricity generation in New Zealand, 2005-2021



Hydro and geothermal are the main sources of renewable electricity.

Notes: TWh = terawatt hour. Solar generated 0.2 TWh in 2021 and is not visible at this scale.
Source: IEA (2022).

Renewable energy policies

Renewables in electricity

New Zealand already has a high proportion of renewable electricity. But due to the electricity system's heavy reliance on hydropower (over 50%), its key challenge is coping with a "dry year" when hydro inflows are low. New Zealand's mostly run-of-river hydro projects together have around three months of storage capacity (Science Media Centre, 2020). Currently, backup is provided by fossil fuel generation.

Given the high proportion of renewables in New Zealand's electricity mix, electrification represents an overarching strategy to increase the penetration of renewables and reduce GHG emissions across all sectors of the economy.

In April 2019, the Interim Climate Change Commission published *Accelerated Electrification*, which explores the impacts of electrifying up to half of New Zealand's vehicle fleet by 2035 (3 TWh of additional electricity demand) and increasing the amount of process heat provided by electricity instead of coal or gas (by around 5 TWh). The report finds that compared to a business-as-usual scenario that would require 3.4 gigawatts (GW) of additional total installed electricity capacity by 2035, a 100% renewables scenario would require 5.1 GW of additional capacity and an accelerated electrification scenario 5.5 GW (ICCC, 2019). Other government estimates note the need for higher levels of capacity growth, doubling or even tripling today's levels (9.9 GW in 2021).

The New Zealand Energy Strategy 2011-2021, released in 2011, defined a renewable electricity target of 90% renewable electricity by 2025 (in an average hydrological year). Subsequently, the government set an aspirational goal of 100% renewable electricity by 2030.

More recently, targets were defined in the Emissions Reduction Plan to build on the government's aspirational goal of 100% renewable electricity by 2030. These targets include setting a target of 50% of TFEC from renewables by 2035, monitoring progress toward the aspirational target of 100% renewable electricity by 2030 and reviewing this target in 2024 before developing the second ERP.

The Interim Climate Change Commission's *Accelerated Electrification* report found that New Zealand will achieve 93% renewables in electricity by 2035 without any additional interventions (ICCC, 2019). The report also found that a 100% renewables target would require considerable "overbuilding" of capacity (to cover dry years and variability) and come at a high cost that serves as a disincentive to achieve accelerated electrification. Moreover, it notes that avoided emissions to achieve the last few percentage points are minimal.

Over 2022-2024, the government aims to develop an Energy Strategy across sectors to address strategic challenges in the energy sector, including signalling a pathway away from fossil fuels and toward greater levels of renewable electricity and other low-emissions fuels.

The use of hydropower to produce electricity has a long history in New Zealand, and it remains the principal source of electricity capacity. Large-scale hydropower development in New Zealand was prolific between 1950 and 1980 but has decreased markedly since. In fact, no new large-scale schemes have been constructed since the Clyde Power Station (commissioned in 1992). This is largely due to water conservation orders and the higher value and competition for fresh water compared to the past (MBIE, 2020). Refurbishments of existing plants, however, occur as needed to keep older facilities in service for longer.

In 2020, the MBIE and Transpower commissioned an updated assessment of potential small-scale embedded hydroelectricity generation in New Zealand (either connected to a distribution network or operated independently of a network). The report found that the combined capacity and annual generation potential of identified small-scale hydropower opportunities is not at a level that could play a significant part in meeting New Zealand's future demand growth. The report did find that in some areas, small-scale hydropower could help meet electricity demand at a local level and also provide network stability.

Geothermal energy is currently the second-largest source of renewable electricity generation. The country has an abundant supply of geothermal resources, with an estimated geothermal potential of 1 000 megawatts (MW) that could be used for generating electricity in the North Island, though not all of it may be economically or environmentally viable or socially acceptable. While there has been consideration of geothermal potential in the South Island following drilling discoveries of hot water below the South Island Alpine Fault, the Institute of Geological and Nuclear Science (GNS) has indicated that work to date indicates it is likely a minor resource only suitable for small-scale direct use applications.

With its narrow islands and geographic location, New Zealand has good exposure to coastal winds, and its ranges and areas of elevated terrain give localised wind speed accelerations. New Zealand has one of the most consistent wind energy resources in the world. Onshore wind energy is already a developed and growing resource in New Zealand. Wind speeds are the highest at coastal locations (such as Wellington, New Plymouth and Invercargill) and lowest in inland and covered areas (NIWA, 2018). Wind speeds also vary considerably throughout the year and are the highest from around October to January and the lowest from April to August; the latter period coincides with when electricity demand is at its highest due to heating demand.

New Zealand does not have any offshore wind generation. Despite considerable potential, there are at present no offshore wind sites or developments. The country's offshore wind potential is concentrated in the Taranaki Region, off the west coast of Auckland and

Waikato. New Zealand's offshore wind sector is at its very earliest stage as there is no regulatory framework for the sector's development. The government has committed to developing a regulatory framework for offshore renewable energy as part of the 2022-2024 process of creating a long-term Energy Strategy.

The use of bioenergy has been growing in New Zealand over the past 20 years (129% growth in electricity over 2011-2021). Bioenergy in New Zealand predominantly comes from woody biomass consumed at a number of co-generation plants located at wood processing factories and also from biogas produced from digesting waste at wastewater treatment plants and landfills. There is little biogas production from the abundant agriculture sector (cows and sheep).

Resource Management Act

In New Zealand, the Resource Management Act 1991 plays a major role in determining the type of electricity generation that gets consented. It was enacted to achieve a more co-ordinated, streamlined and comprehensive approach to environmental management. While the RMA creates overarching provisions on avoiding, remedying and mitigating the adverse effects of activities on the environment, with national direction on significant issues, it allows communities to decide how their own environment is managed through regional and district resource management plans.

However, as noted by the Interim Climate Change Commission, a number of renewable generation projects, especially hydropower, wind and geothermal, face challenges due to RMA requirements, which have slowed down the pace of renewable energy development in New Zealand. The Infrastructure Commission estimated the cost of consent for medium-sized infrastructure to have grown by 150% in the past ten years, and timelines for project approval have also increased by 150% in the past decade. It also found that infrastructure project developers spend an average of NZD 1.29 billion annually to get projects approved, representing 5.5% of total project costs, well above global comparisons (New Zealand Government, 2022).

To address the shortcomings, the government plans to repeal the RMA and replace it with three new pieces of legislation (Ministry for the Environment, 2022). This reform aims to better meet environmental protections, climate adaptation needs and Māori protections while also improving efficiency and reducing permitting complexity. The three bills to replace the RMA are:

- Natural and Built Environments Bill – the main replacement for the RMA, to protect and restore the environment while better enabling development.
- Strategic Planning Bill – requiring the development of long-term regional spatial strategies to help co-ordinate and integrate decisions taken under relevant legislation.
- Climate Adaptation Act – to help New Zealand better deal with climate change, especially complex issues associated with managed retreat (the relocation of communities or infrastructure vulnerable to natural disasters).

The Natural and Built Environments Bill will include a National Planning Framework under which the national government will provide consistent direction and help resolve potentially conflicting development outcomes at the national level. Meanwhile, the regional spatial strategies will identify areas suitable for development as well as those requiring additional actions for development and those that are more constrained (New Zealand Government, 2022). To undertake this zonal mapping, the government is working with local jurisdictions

and in collaboration with industry to help identify locations suitable for renewables development. The mapping will also include consideration of grid availability.

Following public consultations, the aim is for the Natural and Built Environments Bill and Strategic Planning Act to be passed into law before the 2024 central government election (MPDC, 2022).

NZ Battery

Due to the electricity system's heavy reliance on hydropower, New Zealand's key challenge is coping with a "dry year" when hydro inflows are low. When a "dry year" occurs and existing hydropower catchments do not receive enough rainfall, the backup needed is currently provided by fossil fuel generation. It is estimated that New Zealand would need around 3-5 TWh of total renewable energy storage to offset the use of thermal generation to solve the dry year problem (MBIE, 2022a). This issue will become increasingly salient as the country strives to achieve a 100% renewables-based power grid and relies more on electricity to meet its decarbonisation targets.

In response, the government launched the NZ Battery Project in 2020. The project will provide comprehensive advice on the technical, environmental and commercial feasibility of potential energy storage projects. The name NZ Battery refers to the manner in which the intended solution, whether pumped storage or otherwise, will provide stored energy for the New Zealand electricity system in an analogous manner to a battery.

The first phase will evaluate the best method to resolve New Zealand's dry year electricity storage problem in order to achieve 100% renewable electricity and help to decarbonise the wider energy system. It will comprise a detailed investigation of possible dry year solutions, including, but not limited to, the Lake Onslow pumped hydro project (which was preliminarily found to be technically feasible based on earlier studies). It is intended that combined smaller pumped storage proposals as well as alternative technologies, including demand-side solutions, will also be fully investigated. The results from the first phase will determine whether or not the government will move forward with a second phase, which would entail engineering design and preliminary works on a chosen solution. If approved by Cabinet, the final stage would involve construction.

Feasibility studies for the project are expected to be completed in 2023, and solutions to be in place in the 2030s.

Renewable energy zones

The transmission system operator Transpower is exploring a renewable energy zone (REZ) pilot in the Northland region to enable new renewable generation investment. The REZ would facilitate the connection of new renewable electricity generation and major electricity users to the electricity network, thereby increasing renewable energy production and consumption. A REZ can expand electricity network capacity in regions where network capacity constraints may be a barrier to clusters of new renewable generation or industry demand for electrification.

Transpower estimates that approximately 11 GW of wind and solar investments could be built in the next 30 years, but that around 5 GW of capacity is located in regions where connection costs or first-mover disadvantages currently deter investments (Transpower, 2022). In the Northland region, this potential is considered to be around 2 GW, which is

currently impeded by infrastructure constraints. Following a call for expressions of interest and a tender in 2023, Transpower plans for construction to start in 2024.

Lessons from the pilot could be used to expand the model to other regions in the country. The Electricity Authority will also set a new transmission pricing methodology to address potential disadvantages for early investors, and the REZ would align with these new regulatory requirements.

Tiwai smelter

Rio Tinto announced its intent to close the Tiwai aluminium smelter in August 2021. This will mean a reduction of 5 TWh/annum, or 13%, of New Zealand's (renewable) electricity demand. However, early in 2021, Rio Tinto reached an agreement on a new electricity agreement with Meridian Energy that will allow the smelter to continue operating through the end of 2024. There is a possibility that the smelter will remain open beyond 2024. The potential closure of Tiwai Point's aluminium smelter could provide an opportunity to use some of that clean (hydro) electricity for switching out coal boilers in the region to low-emissions options. The size of the smelter offtake from the Manapouri power station can also have a material effect on investors in new renewables generation capacity if there is a risk they would be undermined by the smelter's closure and the release of excess Manapouri generation onto the market at a cheaper rate.

Market design and operation

In New Zealand, all electricity is bought and sold via a wholesale half-hourly spot market. All large-scale generators connected to the transmission or distribution network offer power into the pool while retailers and large off-take customers submit half-hourly bids. The market is cleared on an *ex post* basis using generation offers and actual consumption. The market is an energy-only market, with no capacity markets or capacity payments.

Since market liberalisation, the capacity growth of renewables in New Zealand has been largely driven by the market under a cost minimisation principle, without fiscal or regulatory interventions such as feed-in tariffs, contracts for difference or renewable portfolio standards.

The Electricity Authority's Market Development Advisory Group is currently investigating how the wholesale electricity market might operate (including how prices would be discovered) under a 100% renewables scenario. The study will address a number of topics, including how the wholesale market will enable efficient investment in a context where low marginal cost generation dominates supply and how efficient pricing can be guaranteed during extended periods of supply scarcity (i.e. dry years) (Electricity Authority, 2022).

In addition, a new transmission pricing methodology is due to take effect in April 2023. The TPM sets out how Transpower, as the transmission grid owner, must recover transmission costs from its customers. The TPM addresses several key problems with the previous TPM, which led to inefficient outcomes and created a barrier to transitioning away from non-renewable generation. First, the so-called usage-based network charges will be replaced by fixed-based charges in order to reduce inefficient and costly charge avoidance behaviour. The new TPM also removes effective subsidies on non-renewable generation and taxes in South Island renewable generation and, together with nodal prices, helps ensure that the right generation is built in the right location and at the right time. Finally,

the new TPM introduces benefit-based charges whereby customers will pay for interconnection costs in proportion to their expected benefits, as determined by Transpower (see Chapter 7).

The New Zealand electricity market is open to power purchase agreements, though they have not been commonly used to date. In 2020, the Major Electricity Users Group initiated the Renewable Electricity Generation Project to explore the option of jointly procuring a portion of their electricity needs (around 2 TWh annually) from renewables projects through a corporate power purchase agreement (Vorrath, 2020). Two agreements, supporting one geothermal project, were signed in 2021.

Renewable heating and cooling

New Zealand already has a relatively high share of renewables in the buildings sector, mainly from renewable electricity. The New Zealand Emissions Trading Scheme will also provide further impetus to switch from fossil fuels to renewable electricity in buildings. Therefore, the greater emissions reduction gains from switching to renewables, especially renewable electricity, are seen to come from the industry sector, where targeted measures are needed to supplement the NZ ETS.

Toward that end, the GIDI Fund offers grants for businesses to implement projects to decarbonise the use of industrial process heat through fuel switching and energy efficiency improvements, including: high-impact process heat decarbonisation projects, with adapted criteria to fund larger projects with longer time horizons; using regional energy transition plans to inform investment and optimise options for fuel switching at a regional level; additional electricity network connections and distribution network upgrades to unlock and/or accelerate fuel-switching for multiple process heat users; and technology diffusion projects. The GIDI Fund was first created in 2020 with NZD 70 million in investments and was expanded under Budget 2022 to NZD 1 billion over seven years. Thirty-eight projects received co-funding in the first and second rounds of the GIDI Fund to help transition away from fossil fuels.

In 2022, the government completed a *Regional Heat Demand Database*, an interactive data visualisation tool that allows users to view fuel demand for process heat by region, site count, heat demand and energy demand.

The government also plans over 2022-2026 to offer grants or rebates for commercial buildings to replace fossil fuel boilers for space or water heating with low-emissions alternatives (primarily electric heat pumps). It is also working with businesses to support decarbonisation efforts through the EECA's business programmes, including the energy transition accelerator, large energy user partnerships and sector decarbonisation plans.

Lastly, New Zealand released the terms of reference for a Gas Transition Plan in May 2022. It aims to establish a strategic view on the potential role for renewable gases and potential measures for accelerating their uptake in applications that include both industrial process heat and space and water heating in commercial buildings and households (MBIE, 2022b). Supported technologies may include biogas, biomethane, renewable liquefied petroleum gas (LPG) and green hydrogen. Pillar 2 of the GTP focuses on establishing a strategic view on the potential role for renewable gases and potential measures for accelerating their uptake. This includes the role of biogas/biomethane in the energy system and measures to accelerate its uptake. The GTP is expected to be completed by the end of 2023, as input for the overall Energy Strategy due by the end of 2024.

There is one major biogas project in New Zealand – Ecogas's Reporoa Biogas/Biomethane facility that opened in October 2022. The NZD 50 million Reporoa facility will turn 75 000 tonnes of organic food waste, from businesses and kerbside food scrap collections throughout the North Island, into biogas, the equivalent of the natural gas consumption of 9 000 homes and businesses.

Renewables in transport

As in other sectors, electrification is a core strategy to achieve emissions reductions in the transport sector through renewable electricity. To date, though EVs have experienced rapid growth in New Zealand since 2016, from 2 407 vehicles on the road in 2016 to 33 306 in 2021, they still cover just 0.9% of the total car fleet.

The May 2022 Emissions Reduction Plan sets four targets in the transport sector: 1) reducing total light-duty kilometres travelled by 20% by 2035; 2) increasing zero-emissions vehicles to 30% of the light-duty fleet by 2035; 3) reducing emissions from freight transport by 2035; and 4) reducing the emissions intensity of transport fuel by 10% by 2035. Of these, the second, third and fourth targets will also increase the role of renewables in the transport mix, depending on the technologies used to meet them (EVs, biofuels, hydrogen, etc.).

New Zealand has a number of measures to promote EV uptake (see Chapter 4), including an exemption from road user charges for EVs until 2025, applied to both light and heavy EVs. In May 2016, the government announced a package of measures to increase EV uptake and remove barriers that have prevented households and businesses from choosing EVs. The Electric Vehicles Programme included: a goal of reaching 64 000 EVs by 2021; extending the RUC exemption on light EVs until they account for 2% of the fleet; a RUC for heavy EVs until they make up 2% of the fleet; investigating the bulk purchase of EVs across government and the private sector; and NZD 1 million annually for EV information campaigns over five years. The Low Emission Vehicles Contestable Fund was also launched in 2016 and made funding of up to NZD 6.5 million a year available to encourage and support innovative low-emissions vehicle projects. In Budget 2021, the government announced it would expand the scope of the fund and increase funding to an eventual NZD 25 million per year by 2023-2024. Furthermore, the Ministry of Transport is leading the development of a long-term National EV Charging Strategy in 2023.

On biofuels, the Sustainable Biofuels Obligation was supposed to come into force on 1 April 2024, but has recently been shelved. The obligation would have required liable fuel suppliers to reduce the emissions of the liquid transport fuels they supply in New Zealand by a set percentage each year. Initially, this would have been through the supply of biofuels, though there is an opportunity to expand the obligation to include other low-emissions fuels over time. The obligation would apply to all liquid transport fuels, excluding aviation fuels, meaning it could impact the road, rail and shipping transport sectors.

The proposed targets issued for public consultation in June 2022 start at 1.2% for 2023 and increase to 3.5% in 2025. Provisional targets for later years start at 3.8% in 2026 and rise to 9.0% in 2035 (MBIE, 2022c). The targets are consistent with emissions reductions needed from the transport sector to meet emissions budgets. The proposed regulations also include sustainability criteria to meet the standard, including as it relates to biodiversity, the impact on carbon sinks, food and feed security, water quality and availability, the use of waste, and the risk of indirect land-use change (MBIE, 2022c).

The government also has plans to implement a sustainable aviation fuel (SAF) mandate, though no implementation date has been set. The SAF Mandate came about based on the consultation feedback for the Sustainable Biofuels Mandate. If implemented, it is expected that an obligation would increase the uptake of SAFs across the domestic aviation industry and help foster the market environment necessary to stimulate domestic SAF production. Feedstocks for SAF would include cooking oils, landfill waste, or forestry and agricultural residues (Air New Zealand, 2021). In October 2021, Cabinet invited the Minister of Energy and Resources and the Minister of Transport to report back on the proposed settings of a SAF-specific mandate by December 2022, once the findings of the MBIE-Air New Zealand SAF feasibility study become available. This feasibility study looks at the potential for domestic SAF production. They indicate that there is potential for producing SAF in New Zealand, but further feasibility studies, with a higher degree of cost certainty, are required to facilitate any investment decisions. Funding for these further feasibility studies is being investigated.

Assessment

New Zealand is very well-positioned in terms of the penetration of renewables in its energy system, notably in electricity. New Zealand has the tenth-highest share of renewable energy in total final energy consumption among IEA countries. In 2021, 29% of TFEC came from renewables, while the IEA average in 2020 was 13%. New Zealand has set an ambitious economy-wide target of 50% of TFEC from renewables by 2035 as part of its commitment to reducing emissions. The target highlights the need for transformation across New Zealand's energy system, particularly the transport and industry sectors.

Hydro is the main renewable energy source in New Zealand, covering 55% of electricity generation, the fifth-highest share among IEA countries. In 2021, New Zealand had the largest share of geothermal (25%) in total energy supply and electricity generation (19%) among IEA countries. In 2021, renewables provided 60% of energy demand in buildings, 36% in industry and 0.2% in transport.

Thanks to the sizeable share of renewables in its electricity system, New Zealand has managed to achieve relatively strong shares of renewables in the buildings sector, though less so in industry and transport. Looking ahead, New Zealand has a significant opportunity to leverage its highly renewable-based electricity system to decarbonise and increase the penetration of renewables in other economic sectors through electrification.

An important development since the IEA's last in-depth review in 2017 has been the establishment of renewable energy targets, notably an aspirational target of 100% renewable electricity by 2030 and a target for 50% of TFEC from renewables by 2035. These targets are supported by a number of policies and measures at varying stages of implementation. The main task for the country now is to accelerate the pace of renewables penetration in sectors that use coal and natural gas for heating, especially through electrification, which will require a strong expansion of its renewables generation capacity.

Renewables in electricity

Out of 45 TWh of total electricity generation in New Zealand in 2021, 36 TWh (81 %) came from renewable energy sources, 54% from hydro, 19% from geothermal, 5.9% from wind

and 1.8% from bioenergy. Since 2005, the share of renewables in electricity generation has been increasing, though progress has stalled in the past five years.

The government is monitoring progress toward the aspirational target of 100% renewable electricity by 2030 and will review this target in 2024 before developing its second emissions plan. Due to electrification, consumption is expected to grow by 70% in 2050, which requires large-capacity additions of renewables.

The use of hydropower to produce electricity has a long history in New Zealand, and it remains the principal source of electricity capacity. However, large-scale hydropower development in New Zealand has slowed markedly since the 1980s, and there have not been any new large-scale projects since 1992. Though small-scale hydropower could help, New Zealand will need to meet future load growth primarily with non-hydro options.

The potential closure of Rio Tinto's Tiwai smelter could free up sizeable volumes of (renewable) electricity that could underpin efforts to switch out coal boilers to lower emissions options. However, uncertainty on closure plans due to current high aluminium prices is impeding new generation investments, including in renewables.

New Zealand has considerable potential for non-hydro renewables. Geothermal energy is currently the second-largest source of renewable electricity generation. The country has an abundant supply of geothermal resources that could be used for generating electricity in the North Island, though not all of it may be economically or environmentally viable or socially acceptable. New Zealand also has good exposure to high-speed and consistent wind resources, though it does not currently have any offshore wind generation. The government is designing a regulatory framework for offshore wind which is due by 2023. The use of bioenergy has been growing in New Zealand over the past 20 years, mainly from woody biomass consumed at co-generation plants in wood processing factories and from biogas produced at wastewater treatment plants and landfills. There is little biogas production from the abundant agriculture sector (cows and sheep).

100% renewable electricity target

Reaching the aspirational 100% target for renewables in electricity by 2030 as well as the 50% economy-wide renewables target by 2035 will require a massive buildout of new renewables generation capacity. By some government and industry estimates, New Zealand will need to double or even triple its current generation capacity by 2050. Given limited options for large new hydro capacity and modest volumes of economically feasible geothermal, a sizeable share of the required new capacity will need to come from wind and solar.

Investor interest in wind and solar appears to be strong but faces some constraints. Notably, the Resource Management Act applies strict environmental and ecological restrictions that have posed challenges for the advancement of renewables projects, especially wind facilities. In light of the country's climate change mitigation imperative, the government will need to facilitate greater and faster expansion of new renewables generation capacity. To this end, the government is currently undertaking a review of the RMA to balance biodiversity and local environmental considerations with the need to enable more renewables generation facilities. As part of this, the government is exploring a zoning process under which local jurisdictions could help identify locations suitable for renewables development, in collaboration with the industry. While ensuring careful

ecological and biodiversity preservation, the government should provide greater clarity to the industry on the RMA review to jump-start the pipeline of planned wind and solar investments.

Transpower is exploring a renewable energy zone pilot in one region to facilitate new renewable generation investment. A REZ can facilitate the connection of new renewable generation and major consumers to the electricity network, thereby accelerating renewable energy supply and consumption. A REZ can expand electricity network capacity in regions where network capacity constraints may be a barrier to clusters of new renewable generation or industry demand for electrification. It can also help address social licence issues through support for local communities.

Due to the high share of hydropower in the electricity system, New Zealand's key challenge is coping with a "dry year" when hydro inflows and subsequent generation is low; the backup needed is currently provided by fossil fuel generation. Such a system will not be viable in a 100% renewables world. To address this challenge, the government commissioned the NZ Battery Project to provide comprehensive advice on the technical, environmental and commercial feasibility of potential energy storage projects. While NZ Battery can provide greater clarity on the direction of the future market, interim uncertainty leading up to a planned investment decision in 2023-2024 might further cloud investment decisions in generation over the next few years.

Given New Zealand's enviable wind resources and current challenges siting onshore wind facilities, offshore wind could present an important growth opportunity. Though the government is considering an offshore wind regulatory regime as part of its long-term Energy Strategy to be released in 2024, long lead times associated with the development of the industry mean that actions taken sooner to spur the industry's development should be considered and prioritised.

Historically, the capacity growth of renewables in New Zealand has been largely driven by the market under a cost minimisation principle. This is in contrast to many other countries, where sizeable fiscal or regulatory interventions have been employed, such as feed-in-tariffs, contracts for difference and renewable portfolio standards. Such a market-oriented policy has worked well to achieve a highly renewable electricity system to date. However, in light of growing uncertainties in the market – including those related to the Tiwai smelter, NZ Battery and demand from EVs – delivery of the large-capacity additions to meet the 100% target could face challenges. Absent fiscal incentives, the government should place further emphasis on the timely implementation and clarification of regulatory frameworks, such as the Transmission Pricing Methodology, grid connection rules and a regulatory framework for offshore wind. Based on the Market Development Advisory Group's ongoing work, the government should also more thoroughly assess its market design to determine whether an energy-only market is compatible with a 100% renewables system, with a focus on the risks of underinvestment, reliability challenges and high/volatile electricity prices. The government should also explore ways to create a more enabling environment for growth in power purchase agreements.

In addition, the degree of uncertainty in the investment environment could be reduced by improved communication on supply and demand forecasts. Though the MBIE and Transpower issue periodic market forecasts, more frequent updates (and scenario analysis) to reflect the fast-changing policy environment would benefit the industry and provide greater investor clarity. The government should also be mindful of the constraints

to a massive expansion of renewables generation that will come from a skills shortage, and consider training programmes accordingly.

More broadly, New Zealand should more thoroughly assess the potentially steep costs that come from a 100% renewables-based electricity system (including as they relate to balancing and stability issues) compared to one that is 90-95% based on renewables, especially in comparison to other decarbonisation options or cross-sectoral emissions targets.

Renewables in heating and cooling

New Zealand has minimal direct use of renewables for heating and cooling, with the main renewables source for buildings coming from electricity. Solid biomass provided 5% of energy in buildings in 2021.

Renewables in heating and cooling in New Zealand is predominantly based on the relatively high use of renewable electricity in buildings. This stands in contrast to the industry sector, where industrial process heat is still heavily reliant on fossil fuels. More progress is needed in the industry sector to meet the 50% economy-wide target for renewables by 2035. In conjunction with energy efficiency measures, electrification of process heat will play an important role in decarbonisation and increasing renewables penetration.

As part of its decarbonisation efforts, the government has a number of programmes in place to increase the use of renewables for heating and cooling, notably in industry. The GIDI Fund offers grants for businesses to implement projects to decarbonise the use of industrial process heat through fuel switching and energy efficiency improvements. The government also plans over 2022-2026 to offer grants or rebates for commercial buildings to replace fossil fuel boilers for space or water heating with low-emissions alternatives (primarily electric heat pumps). It is also working with businesses to support decarbonisation efforts through EECA business programmes, including the energy transition accelerator, large energy user partnerships and sector decarbonisation plans. The GIDI and other EECA-led programmes are a good step in the right direction. Notably, strong funding levels and selection criteria for the GIDI programme position the sector well for favourable results.

In addition, New Zealand released the terms of reference for a Gas Transition Plan in May 2022. It aims to establish a strategic view of the potential role for renewable gases and potential measures for accelerating their uptake in applications that include heating. Supported technologies may include biogas, biomethane, renewable LPG and green hydrogen. The Gas Transition Plan is expected to be completed by the end of 2023 as input for the overall Energy Strategy due by the end of 2024. Renewable gases could notably play a role in transitioning away from natural gas. New Zealand has natural advantages for biomethane production, given its vast agricultural waste sector, but the ETS price alone may not be sufficient to motivate investments in the sector, indicating that the government should consider additional measures to encourage its uptake.

In cases where electrification is not feasible, the government should also explore options to support the conversion of heating and cooling through the direct use of renewables such as bioenergy, green hydrogen and other alternatives.

Renewables in transport

With biofuels covering just 0.07% of energy demand in the transport sector and renewable electricity only 0.15%, New Zealand has the second-lowest share of renewables in transport among IEA countries, after Mexico.

The Sustainable Biofuels Obligation was planned come into force on 1 April 2024 (delayed by one year). It would have required liable fuel suppliers to reduce the emissions of the liquid transport fuels they supply in New Zealand by a set percentage each year. Initially, this would be through the supply of biofuels, though other low-emissions fuels may be included over time. The government should reassess its decision to abandon the policy and consider more ambitious biofuels blending options as well as rapid implementation under the programme to help decarbonise the light-duty transport segment while EV penetration ramps up.

The government also has plans to implement a sustainable aviation fuel mandate, though no implementation date has been set. If implemented, it is expected that an obligation would increase the uptake of sustainable aviation fuels across the domestic aviation industry and help foster the market environment necessary to stimulate domestic SAF production.

Beyond biofuels, the main policy to increase renewables in transport will be through electrification. In addition to an exemption from the road use tax, the government has support mechanisms in place for EVs through the 2016 Electric Vehicles Programme and the Low Emissions Vehicle Contestable Fund. The Ministry of Transport is leading the development of a long-term National EV Charging Strategy, slated for publication in 2023.

To date, New Zealand has made little progress on increasing the penetration of renewables in its transport mix – both direct and through electrification – signalling that significant acceleration will be needed in the coming years. Government policy is heavily focused on increasing the level of electrification in transport, notably through an ambitious EV policy that uses incentives to address the range of requirements for EV penetration in the light-duty segment, from car availability to consumer uptake and charging infrastructure. Given that the level of EV penetration is still very low and policies are still in their early stages of implementation, the government should carefully monitor EV uptake to ensure that existing measures are achieving results. Supplemental measures may be needed to keep track of the ambitious 50% economy-wide renewables target, as it will require a much faster turnover of the vehicle fleet.

Where electrification may be more challenging – such as in the heavy-duty, shipping and aviation segments – biofuels will play a larger role, especially before hydrogen becomes an economically viable option. While the government has a number of policies at various stages of consideration on biofuels, none are as yet in effect. Rapid finalisation of biofuels measures will go a long way toward spurring increased biofuels blending into transport fuels and supporting an expansion of related infrastructure. Over time, New Zealand might also find a new opportunity in sustainable biofuels production, though the initial years of the mandates will mostly be met by imports. The SAF Mandate will help toward this end, as it will provide the necessary signals to guide investments in production and related infrastructure.

Recommendations

The government of New Zealand should:

- Move quickly to clarify regulatory regimes for renewables generation, especially the Resource Management Act, to spur investments in additional renewables capacity.
- Expedite the enactment of an offshore wind regulatory framework in collaboration with industry to help advance projects.
- Provide more frequent supply and demand forecasts to the market to support new generation investments in light of considerable uncertainties in the outlook at the moment.
- Ensure sustained funding through future budgetary cycles for Government Investment in Decarbonising Industry-supported programmes to decarbonise process heat.
- To supplement electric vehicle policy, encourage accelerated biofuels penetration in road transport through rapid implementation of a Sustainable Biofuels Obligation with ambitious greenhouse gas intensity targets.
- Based on results from the feasibility study, accelerate the implementation of the sustainable aviation fuels mandate to jump-start a domestic sustainable biofuels industry.

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6. Energy research, development and innovation

Key data

(2020)

Government energy research, development and innovation (RD&I) budget: EUR 21.4 million (nominal)

Energy RD&I budget as a share of GDP: 0.009% of GDP (IEA average* 0.032%)

Energy RD&I budget per capita: 4.1 EUR/capita (IEA average: 18.8 EUR/capita)

* Average of 28 IEA countries for which 2020 data were available.

Overview

The New Zealand government supports innovation through a number of mechanisms, including: contestable investment funds that support scientific research and research, development and innovation (RD&I); a dedicated innovation agency called Callaghan Innovation, which provides innovation advice, services and grants to businesses to support their RD&I activities; a 15% R&D tax incentive for businesses investing in RD&I in New Zealand; and a Pre-Seed Accelerator that supports publicly funded research to reach commercialisation (MBIE, 2022a).

Given New Zealand's relatively small market size and the unique characteristics of its economy and energy sector, energy-specific RD&I has not been a dedicated focus area for the government. However, in 2021, New Zealand's Climate Change Commission identified innovation as one of three pillars to reduce emissions and accelerate the country's economic transformation toward net zero emissions. The government is currently undertaking a review of the country's research and innovation system to provide clearer guidance and better align research outcomes with overarching strategies, including for a low-emissions society.

In the past decade, New Zealand's public spending on energy-related RD&I has fallen, accounting for around 0.009% of the country's GDP, one of the lowest shares among IEA countries. Energy efficiency and renewables tied for the largest shares (34% each) of the public budget on energy-related RD&I in 2020.

Key actors in the energy innovation ecosystem

The MBIE manages the government's energy research, science and innovation portfolio.

The MBIE invests in energy research via the Endeavour Fund (annual rounds); the Strategic Science Investment Fund platform investments, including the one-off Advanced Energy Technology Platform; and through the Catalyst Fund.

Ara Ake is the National New Energy Development Centre funded by the government and established by Venture Taranaki (the regional development agency for the Taranaki Region) in 2020. Ara Ake's purpose is to support energy innovators on their journey to decarbonising New Zealand. It does so by connecting innovators with opportunities to test and trial their technology, and with funding opportunities, professional services or insightful information. Ara Ake is tasked with bridging the innovation "valley of death" by reducing the time, cost and risk associated with developing energy innovation.

Callaghan Innovation is New Zealand's innovation agency, working closely with government partners, Crown research institutes, and other organisations that help increase business investment in RD&I. Callaghan Innovation leads a New Zealand CleanTech Mission, which seeks to bring together organisations that work with New Zealand cleantech innovators, providing a joined-up approach to support and develop a collective plan for clean technology in the country. Callaghan Innovation also supports human resource and student development in the research and innovation space.

Energy innovation priorities and guiding documents

In 2021, New Zealand's Climate Change Commission identified innovation as one of three pillars to reduce emissions and accelerate the country's economic transformation toward net zero emissions.

Based on the commission's recommendations, the government's first Emissions Reduction Plan (May 2022) sets out policies and strategies for meeting the first emissions budget period as well as a direction for emissions reductions in the second and third budget periods. The ERP sets out a vision for the energy system to be highly renewable, sustainable and efficient and to support a low-emissions and high-wage economy (see Chapter 3).

Chapter 8 of the first ERP is about research, science, innovation and technology. As such, it represents the first guiding document for energy and climate innovation. It includes actions that are not sector-specific and some that are or could be. Key actions are to provide tools to support knowledge development, help sectors to transition and unlock new opportunities. These include:

- working towards mission-focused climate innovation platforms to co-ordinate action on the greatest climate challenges facing New Zealand
- reorientating the science system to improve its ability to service a low-emissions future
- scaling up and further targeting research funding and innovation support programmes
- developing strategic partnerships domestically and internationally to ensure research and innovation have a greater impact

- supporting Māori to use the power of *mātauranga* (traditional knowledge) in the transition
- attracting leading innovators to build a sustained research and development presence in New Zealand
- partnering internationally on low-emissions initiatives with leading researchers and frontier firms.

As part of ERP actions, the government will create climate innovation platforms to co-ordinate actions toward a low-emissions future that are aimed to enhance competitiveness. The climate innovation platforms will be mission-oriented, internationally facing and flexible, and will include a mandate across government agencies and sectors to support innovation (New Zealand, Ministry of Environment, 2022). The whole-of-government approach will employ a variety of strategies and tools, including policy and regulatory settings. The government will use a portfolio approach across sectors of the economy to pursue several options at once.

Presently, there is no clear alignment between innovation and energy policy areas in New Zealand. However, a major review of the country's research and innovation system is underway, with various funds and research institutes under review.

The review, the Te Ara Paerangi – Future Pathways Programme, aims to create a modern, future-focused research system for New Zealand that is adaptable to a rapidly changing future; resilient to changes; and connected to itself, industry and the public sector. It is led by the MBIE and will establish research priorities and identify challenges and opportunities and how to navigate them. The government consulted on a green paper under the initiative in 2021-22, which informed a white paper that was published in December 2022. Key themes explored under the research paper include: 1) better identifying research priorities; 2) understanding how the science system can best support Māori; 3) reviewing the funding system for research; 4) exploring how to increase collaboration across research institutions; 5) assessing how the research and innovation workforce is developed and funded; and 6) supporting national research infrastructure (MBIE, 2021).

New Zealand also has an Innovative Partnerships programme to help RD&I businesses connect, collaborate and invest in New Zealand. Through the programme, a group of experts works with companies undertaking innovative technology development to help identify business opportunities in New Zealand (MBIE, 2022a).

The climate innovation platforms and innovative partnerships, along with the Te Ara Paerangi – Future Pathways Programme, are intended to help create clearer guidelines and synergies as they are developed and finalised over the next one to three years.

The 2019 Hydrogen Vision touched on the role of research in creating a viable hydrogen economy, but not in any detail. This issue will be considered as part of the development of the hydrogen road map over 2022-2024 (see Chapter 3).

Resource push[2]

The New Zealand government has committed to raising economy-wide RD&I spending to 2% of GDP by 2027 and is supporting businesses in growing their R&D activity to achieve this ambitious goal (MBIE, 2022a).

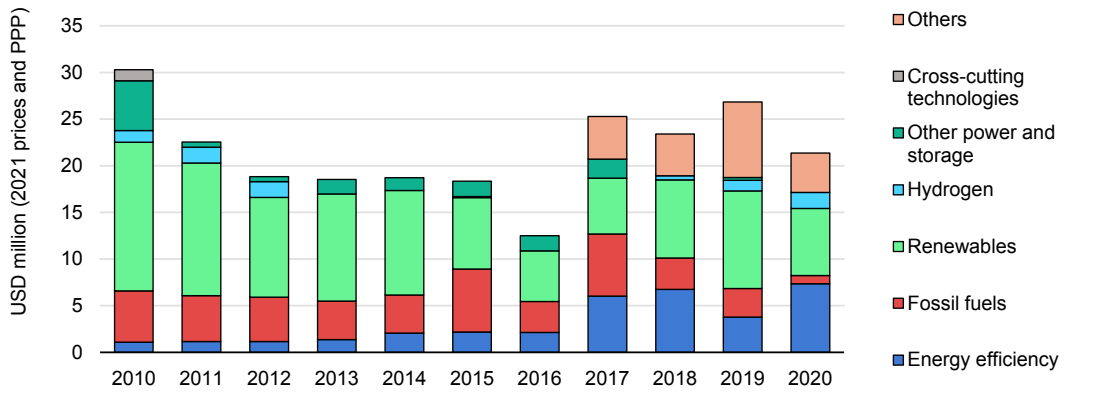
Public spending on energy RD&I

In 2020, New Zealand's public budget for energy-related RD&I was USD 21 million, 30% lower than in 2010, when it peaked at USD 30 million (Figure 6.1). In the last decade, it fluctuated around an average of USD 22 million, which corresponds to 0.009% of the country's GDP, one of the lowest shares among IEA countries (Figure 6.2).

Energy efficiency and renewables tied for the largest share (34% each) of the public budget on energy-related RD&I in 2020. Spending on energy efficiency has increased significantly in the past decade, yet saw a significant decrease in 2019, to rebound again in 2020.

The renewables budget peaked in 2010, when it reached USD 16 million, and has decreased over the last decade, except for a budget increase in 2019. In 2020, the budget for renewables RD&I was USD 7 million. The third-largest sector for RD&I spending was hydrogen (8%), while 20% of the 2020 budget was not specified ("others" in Figure 6.1).

Figure 6.1 Energy-related public RD&I budget by sector in New Zealand, 2010-2020



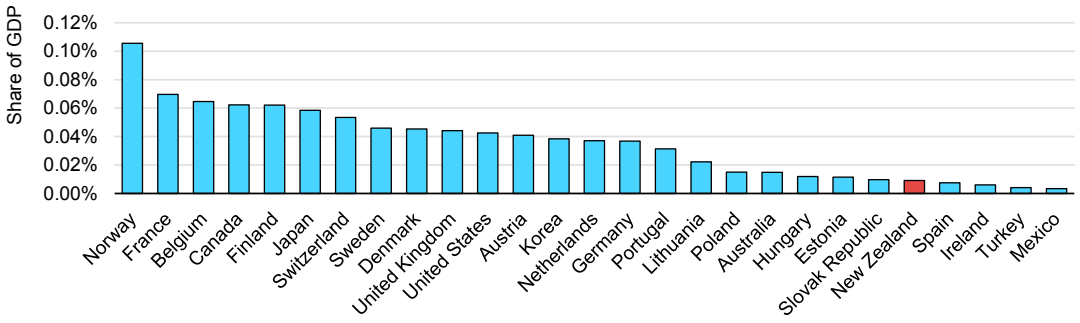
In 2020, most public RD&I spending was dedicated to energy efficiency and renewables.

Note: PPP = purchasing power parities.

Source: IEA (2022).

[2] This and the following sections are structured according to the IEA framework for energy innovation policies. Technology innovation processes are complex and decision makers must pay attention to a variety of elements. The IEA groups these elements into four core functions: A) resource push; B) knowledge management; C) market pull; and D) socio-political support. Successful energy innovation ecosystems have effective policies in each of the four areas. In some cases, the policies might operate at different levels, such as local, national or municipal. See: https://www.iea.org/reports/tracking-clean-energy-innovation.

Figure 6.2 Energy-related public RD&I spending per GDP in IEA countries, 2020



In 2020, New Zealand lagged behind most IEA countries on RD&I spending as a share of GDP.

Notes: GDP = gross domestic product. Data for Greece, Italy and Luxembourg are not available for 2020.
Source: IEA (2022).

Funding mechanisms

The government's key broad-based instrument to support RD&I is the Research and Development Tax Incentive (RDTI) (not exclusive to the energy sector). The RDTI provides businesses with a tax credit equal to 15% of eligible research, development and demonstration expenditure.

The RDTI was introduced in April 2019 and replaced the Growth Grants delivered by Callaghan Innovation. It is expected that the RDTI will reach more firms and fund more RD&I compared to the previous measure. To date, the RDTI has doubled the number of businesses accessing funding for RD&I. The government paid NZD 94 million in RDTI tax credits for the 2019/20 income tax year to 473 businesses.

In 2019, tax incentives in New Zealand accounted for 13% of total government support for business enterprise expenditure on R&D, while the rest came from direct funding (OECD, 2021).

The Endeavour Fund generates new knowledge that supports sectors to transition to a low-emissions and climate-resilient economy, including through the development of new energy opportunities and new materials. This includes the GNS Science-led Geothermal: The Next Generation project, which explores new ways to extract geothermal energy at greater depths. The knowledge developed is intended to deliver new options to significantly reduce emissions in the energy sector and will help provide opportunities for Māori and regional development (New Zealand, Ministry of Environment, 2022).

The Endeavour Fund is an open, contestable process focusing on research excellence and a broad range of impacts. Funding is via two mechanisms: 1) Smart Ideas (to rapidly test promising, innovative research ideas and enable fresh ideas and diversity in the science portfolio) worth between NZD 0.4 million and NZD 1 million over a two- to three-year term; and 2) research programmes (to support ambitious, well-defined research ideas that have credible potential for benefits) worth more than NZD 0.5 million per annum for a term of three, four or five years. Currently, active contracts in energy research total NZD 77.95 million in government contributions.

As an example, the Endeavour Fund awarded an NZD 6.5 million research grant to the Robinson Research Institute, in collaboration with Wellington UniVentures and New Zealand Steel, toward the development of a pilot-scale reactor at New Zealand Steel's Glenbrook site that uses hydrogen instead of coal to produce iron and steel (New Zealand, Ministry of Environment, 2022).

The Strategic Science Investment Fund (SSIF) funds strategic investment in research programmes and scientific infrastructure that have long-term beneficial impacts on New Zealand's health, economy, environment and society. Its programmes are structured around science platforms that combine people, facilities, information and knowledge (MBIE, 2022b) and include a number of energy-focused research programmes. The SSIF Advanced Energy Technology platform intends to raise New Zealand's research capacity and capability in energy science through early-stage research and to respond to domestic and international opportunities that could contribute to New Zealand's and a global zero-carbon future. It was supported in the government's 2019 Budget with an investment of NZD 50 million over seven years.

The Catalyst Fund supports activities that initiate, develop and foster collaborations that take advantage of international science and innovation for New Zealand's benefit (see below under "International co-operation"). For a country of New Zealand's size, international science and innovation connectivity is a key contributor to achieving national objectives (MBIE, 2022c).

The government launched new incentives in 2022, namely the Ārohia Innovation Trailblazer Grant and New to R&D Grant, to strengthen support for businesses doing RD&I. The grants are delivered by Callaghan Innovation.

The EECA also provides a range of co-funding and support for businesses and individuals looking to decarbonise their energy use, including for technology demonstration. Specifically, the EECA fund offers up to 40% of project costs for the early adoption of proven technology or an innovative process improvement opportunity that has yet to be widely deployed in New Zealand (EECA, 2022).

The "Accelerating renewable energy and energy efficiency" discussion paper released by the MBIE in 2019 noted that while the government already supports early-stage science and technology research and development through research and innovation funds, there is currently no government support for diffusion – i.e. the gap between pre-commercialisation and full commercialisation/market transformation (MBIE, 2019).

Private spending on energy research, development and demonstration

In New Zealand, the private sector accounts for more than half of RD&I investment, though there are no breakdowns of private spending on energy-specific RD&I. Partnerships between the private sector and government are an important element in New Zealand's innovation ecosystem, especially given the country's relatively small size.

By way of example, Air New Zealand and the MBIE are inviting innovation leaders to demonstrate the feasibility of operating a commercial-scale sustainable aviation fuel plant in New Zealand (Air New Zealand, 2021). The study will include assessments of feedstocks, costs and development pathways and underpin efforts to decarbonise the aviation sector's hard-to-abate emissions.

Human capability and support for start-ups

Callaghan Innovation provides a range of funding and programmes that build human capability. Some are not energy-specific and include student grants, R&D "experience grants" and a series of courses on innovation skills. It also funds local governments to run incubator and accelerator programmes for start-up businesses to build general skills and capabilities of founders.

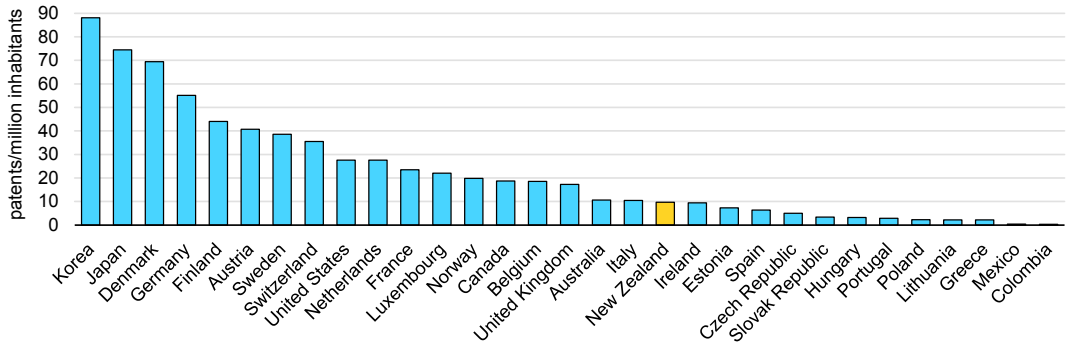
Various local council/government economic development agencies have delivered on programmes to support energy- or climate-oriented innovators through, for example, climate or energy accelerator programmes. These include: Orion Energy Accelerator, Creative HQ in Wellington and the Auckland Unlimited Climate Innovation Hub.

Tātaki Auckland Unlimited's Climate Innovation and Sustainability team is establishing a national centre of excellence for climate innovation. Launched in Auckland in 2022, the Climate Innovation Hub will connect climate change challenges to solutions, showcase climate innovation, be the national climate innovation collaboration space and establish a climate innovation ecosystem.

Intellectual property

OECD data show that the number of patents per capita issued in environment-related technology in New Zealand was on the lower end among IEA countries, with an average of 9.7 patents per million people over the 2010-2019 period, versus an IEA average of 22.5.

Figure 6.3 Average number of patents in environment-related technology per capita in IEA countries, 2010-2019



On average over the 2010-2019 period, New Zealand was below the IEA average for the per capita number of environmental patents.

Source: OECD (2022).

Monitoring, evaluation and tracking of results

There is currently no mechanism to evaluate the performance of New Zealand's energy technology innovation policies against their high-level objectives (competitiveness, investment, costs, sustainability, etc.).

Recipients of MBIE science-led funding are required to submit an annual report on the outputs and outcomes of activities undertaken/produced during the preceding 12 months. Annual reporting supports the evaluation of contract performance and allows the government to stay informed about research progress. The MBIE also uses data obtained via annual reporting for policy and strategy development, marketing, and corporate accountability documents (MBIE, 2022d).

A performance framework outlines the monitoring and review process for the SSIF. The framework allows the MBIE to understand how research organisations are progressing towards achieving the strategy set out for each SSIF platform, how they are responding to any changes in SSIF investment signals and how well SSIF investments align with the signals in the SSIF Investment Plan (MBIE, 2018).

Knowledge management

International collaboration

GNS Science is New Zealand's leading provider of Earth, geoscience and isotope research and consultancy services. International collaborations are an important component of the energy research undertaken at GNS Science. These collaborations range from project-based to institutional collaborations.

The SSIF Advanced Energy Technology Platform investment process includes investment goals of fostering and growing international and national collaborations among energy technology researchers and end users, and creating new opportunities for New Zealand to contribute to global efforts. The criteria include a 20% weighting on domestic and international collaboration.

Under the MBIE's Catalyst Fund, with co-funding from the German Ministry of Education and Research, four grants focused on German-NZ Green Hydrogen partnerships have been awarded. First, they co-funded an APRA programme project (NZD 613 000 on the New Zealand side) that supports New Zealand's and Germany's transformation into a green hydrogen economy by establishing a German-NZ Green Hydrogen Centre for research, networking and outreach. Alongside that, three research grants (NZD 2 million each on the New Zealand side) are being jointly supported that: target the development of cost-effective, safe hydrogen storage technology using New Zealand's resources, which will enable widespread uptake of new hydrogen technologies by various sectors, including electricity, transport and industry; investigate ways of producing low-cost green hydrogen; and create a New Zealand-German platform for green hydrogen integration.

New Zealand currently participates in nine IEA technology collaboration programmes. It does not participate in Mission Innovation. New Zealand became a member of the Clean Energy Ministerial in 2020. Over the last few years, New Zealand has actively participated in Clean Energy Ministerial workstreams focused on clean technologies such as EVs and hydrogen.

Assessment

Given New Zealand's relatively small market size and the unique characteristics that mark its energy sector and economic structure, energy-specific RD&I has previously not been a dedicated focus area for the government. However, as the energy sector embarks on a transformation in line with ambitious climate targets, RD&I could play a more significant role in shaping the energy sector's trajectory and competitiveness, including through more strategic prioritisation and targeted funding.

The government's key broad-based instrument to support RD&I is a tax incentive (not exclusive to the energy sector). The Research and Development Tax Incentive provides businesses with a tax credit equal to 15% of eligible R&D expenditure. Therefore, New Zealand has so far relied heavily on indirect financial support that lets companies choose their focus areas. In light of a strategic focus on the energy transition, a more structured direction to companies would be helpful, as would devoted data collection on RD&I spending by the private sector.

A business-friendly regulatory regime has supported the development of an agile RD&I culture in New Zealand, enabling trial and error across the energy sector. Nevertheless, there are currently no dedicated RD&I plans for energy to support the high-level energy policy and targets, nor a strategic prioritisation of technology areas. A lack of concrete energy RD&I plans without milestones has caused fragmented investment, leading to low performance (such as low levels of patents). Notably, a better aligned and better targeted framework for energy RD&I could direct investments towards areas that are uniquely advantageous in New Zealand's energy system, such as offshore wind, geothermal, grid flexibility, green hydrogen and biomethane, to name a few. Importantly, there is an opportunity to include more strategic prioritisation in the upcoming review processes that are currently underway.

The chapter on research, science and innovation as part of the first Emissions Reduction Plan means that for the first time, New Zealand has an overarching strategy that highlights the role of energy technology RD&I in the energy transition. It includes actions to develop a more mission-focused innovation system, reorient the science system toward achieving a low-emissions future, scale up and further target research and innovation funding, and step up both domestic and international partnerships. The IEA welcomes a more focused direction for energy RD&I, including defining key technologies of focus, which can better direct innovation investments towards priority areas. The move toward a mission-oriented approach will likely also help improve co-ordination on programmes across the government. The government's commitment to reducing carbon emissions should also be matched by energy RD&I budget increases in the near term. Moreover, while the list of actions is a major step in the right direction, the ERP does not include a set of objectives against which success can be measured.

The NZ Energy Strategy, climate innovation platforms and innovative partnerships in clean energy workstreams stemming from the ERP, along with the Te Ara Paerangi – Future Pathways Programme, will, if implemented successfully, create some clear guidelines and synergies for the energy innovation ecosystem as they are developed and finalised over the next one to three years.

General metrics not specific to the energy sector have been employed to evaluate the performance of energy RD&I projects so far. Better aligning energy policy goals and

energy RD&I spending will provide clearer energy RD&I metrics, which will help bridge the gap between the ERP targets and RD&I results. Metrics to track the effectiveness of New Zealand's energy RD&I policies would be most helpful if calibrated to the stated policy objectives and if they cover input (e.g. amount of funding), output (e.g. patents) and energy-specific outcomes (e.g. efficiency improvement, electricity generation capacity, capacity factors).

A high share of renewable energy and a relatively small/isolated ecosystem are distinctive characteristics of RD&I in New Zealand. New Zealand is thus heavily dependent on the adoption and adaptation of verified imported energy technologies to achieve its decarbonisation targets. The transition to higher levels of renewables (including in transport) will require rapid deployment of technology solutions that are new to New Zealand. This means the country will have to be an informed buyer in new areas (based on its current approach). There is an opportunity for New Zealand to strategically participate more actively in new value chains through innovation (e.g. hydrogen or critical minerals) and to co-operate internationally to steer technology development towards its needs and be more educated about the opportunities in advance.

New Zealand already engages in several international collaborative efforts with respect to energy innovation. International collaborations are an important component of the energy research undertaken at GNS Science. The SSIF Advanced Energy Technology Platform investment process includes goals for fostering and growing international and national collaborations among energy technology researchers and end users, creating new opportunities for New Zealand to contribute to global efforts. The Catalyst Fund supports activities that initiate, develop and foster collaborations that take advantage of international science and innovation to the benefit of New Zealand. A current international programme focuses on New Zealand-Germany Green Hydrogen research partnerships. New Zealand also participates in nine IEA technology collaboration programmes and is an active member of the Clean Energy Ministerial.

Although New Zealand has a relatively small research ecosystem, a limited energy RD&I budget has led to a competitive environment for funding among researchers, which might hamper collaborative research toward mission-focused innovation. Furthermore, there is currently no government support for diffusion, i.e. the gap between pre-commercialisation and full commercialisation/market transformation. Given the circumstances, Ara Ake is exploring an energy RD&I ecosystem based on technology readiness levels to strengthen collaboration and basic-applied-commercialisation RD&I links. National RD&I programmes based on the technology development stage would effectively prevent this investment gap and should be addressed in a future energy RD&I plan.

Recommendations

The government of New Zealand should:

- Build a specific plan for energy research, development and innovation in line with the Emissions Reduction Plan, including key technologies that require investment as part of a long-term technology innovation road map, with concrete milestones and funding.
- Clarify research, development and innovation metrics to evaluate technological development performance in the energy sector, encompassing input, output and energy-specific outcomes.

- Focus on "tailored research, development and innovation", which refers to the modification of technologies oriented to New Zealand's environment.
- Launch a national collaborative research, development and innovation programme that creates partnerships among domestic research groups to maximise performance and share knowledge.

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7. Electricity

Key data

(2021)

Electricity generation: 45 TWh, -0.05% since 2011

Electricity generation mix: hydro 54%, geothermal 19%, natural gas 11%, coal 7.2%, bioenergy and waste 1.8%, wind 5.9%, solar 0.5%, oil 0.1%

Electricity consumption: 40 TWh (industry 44%, residential buildings 33%, service sector buildings 23%, transport 0.2%), +0.2% since 2010

Installed capacity* (2022): 9.8 GW (10% variable renewables, 76% renewables)

*Source: Transpower (2022a).

Overview

Electricity production in New Zealand is traditionally dominated by hydro, which covered, on average, 55% of total electricity generation from 2005 to 2021. In recent years, the country has seen increased electricity generated from wind and geothermal. Meanwhile, generation from coal reached a low in 2016 but later increased until 2021 due to tight natural gas supply. Electricity generation from natural gas has almost halved since 2011.

Electrification of New Zealand's energy consumption is slightly higher than the IEA average, thanks to a high share of electricity in the energy consumption of buildings. Looking forward, the electrification of additional economic sectors is a critical component of New Zealand's decarbonisation strategy, which will result in the need for increased generation capacity. A large share of new capacity is expected to come from variable renewable sources such as wind and solar.

The New Zealand Energy Strategy 2011-2021 set a target for 90% renewable electricity by 2025. Subsequently, the government set an aspirational goal of 100% renewable electricity by 2030. More recently, the first Emissions Reduction Plan set a target of 50% of TFEC from renewables by 2035, based largely on electrification.

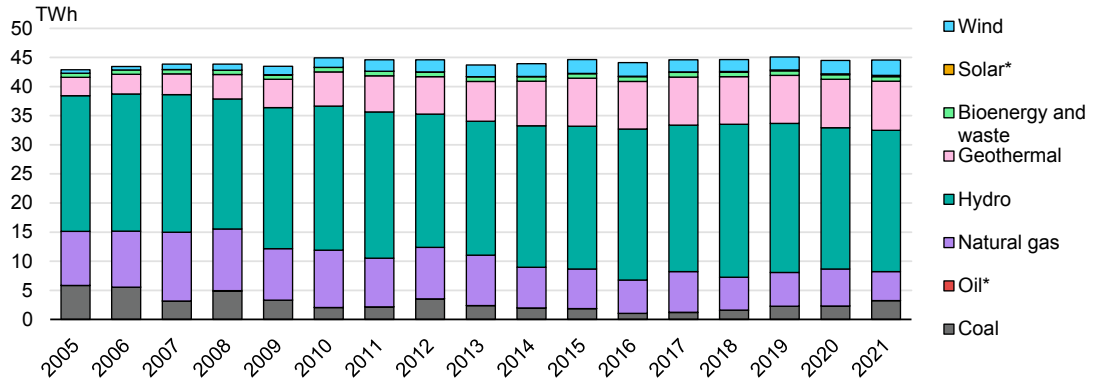
Though New Zealand is fortunate to already have a high proportion of renewable electricity due to its electricity system's heavy reliance on hydropower, its key challenge is coping with a "dry year" (or years) when hydro inflows are low. During these periods, the backup needed is currently provided by fossil fuel generation, so the government is looking for low-carbon solutions.

A well-functioning electricity market that provides the right price signals for new investments in renewable energy as well as the development of sufficient flexibility in the energy system will be crucial to meeting New Zealand's climate targets.

Electricity generation

New Zealand's annual electricity production stood at 445 TWh in 2021. Hydropower has historically been the main source of electricity generation, accounting on average for 55% of generation over the last 15 years (and 54%, or 24 TWh, in 2021). The share of natural gas in power generation has fallen by 46% since 2005. Coal had also been declining until 2016, but its share has increased over the past five years. Geothermal reached 8.4 TWh in 2021, compared to 2.9 TWh in 2005, gradually replacing natural gas. Electricity generation from wind has also increased, reaching 2.6 TWh in 2021, and bioenergy slightly increased from 2020 to 0.8 TWh in 2021.

Figure 7.1 Electricity generation by source in New Zealand, 2005-2021



Renewables account for most of New Zealand's electricity generation. Natural gas consumption has been steadily declining.

* The share of oil and solar are barely visible on this scale and represented less than 0.06% and 0.47% of electricity generation in 2021, respectively.

Note: TWh = terawatt hour.

Source: IEA (2023).

Electricity generation capacity

In 2022, the total installed capacity of New Zealand's power system, excluding distributed generation, was 9.8 GW (Transpower, 2022a). Hydropower accounted for 55% (5.4 GW) and geothermal for 10% (1.03 GW) of installed capacity. Natural gas made up 13% of the total (1.28 GW), while wind contributed 11%, at 1.04 MW. Installed coal capacity has decreased since 2005, from 1 GW to 750 MW, accounting for 8% of total installed capacity in 2022.

Thermal cover during dry years is very important for security of supply, given the relatively limited storage in New Zealand. Genesis Energy's Huntly Power Station is the only coal-fired power station in New Zealand. It has two 250 MW Rankine generation units that can be fuelled by coal or natural gas (or a mixture of both). In 2018, Genesis Energy

announced that it plans to stop using coal for electricity generation, except in an emergency, from 2025 and totally from 2030 (Genesis, 2018).

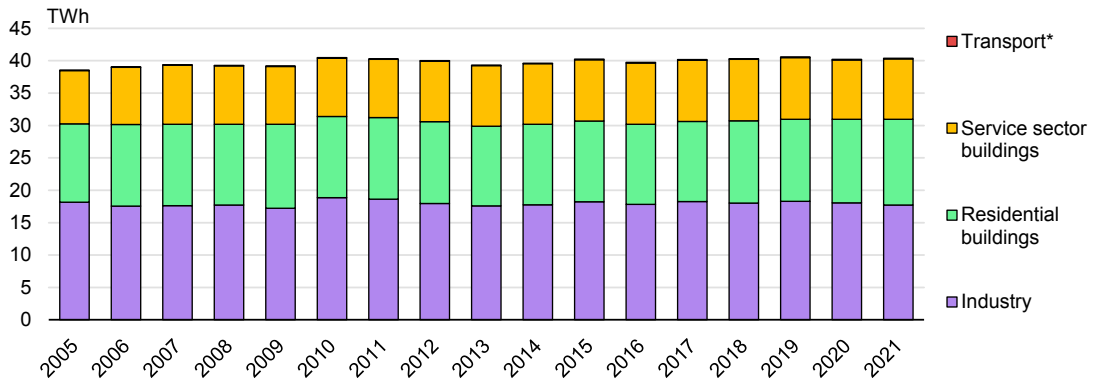
Electricity trade

Given its location, New Zealand does not trade electricity with any other countries and is self-sufficient in electricity production to cover the country's demand.

Electricity demand

Electricity demand in New Zealand was 40 TWh in 2021 (Figure 7.2). In 2021, the industry sector accounted for 44% of electricity consumption, followed by residential buildings at 32% and service sector buildings at 23%. The shares of electricity consumption per sector have remained relatively stable over the years.

Figure 7.2 Electricity demand by sector in New Zealand, 2005-2021



In 2021, industry accounted for the largest share (44%) of electricity demand.

* *Transport* demand for electricity is barely visible at this scale. It accounted for 0.1 TWh in 2021.

Note: TWh = terawatt hour.

Source: IEA (2023).

Electricity consumption has increased slightly since the IEA's last in-depth review in 2017. Demand from the agriculture sector, which is mainly for irrigation purposes, increased during the dry years of 2020 and 2021. Industrial demand decreased by 7.3% between 2019 and 2021. This drop is largely driven by the drop in demand from the wood, pulp, paper and printing sector. One of New Zealand's biggest electricity users, Norske Skog, decided to close its Tasman newsprint mill in June 2021. However, prior to the closure of the Tasman mill, demand from the wood, pulp, paper and printing sector had already dropped in 2020. The food processing sector's consumption increased between 2020 and 2021, during Covid-related movement restrictions, as the food processing sector was deemed an essential business and allowed to operate. The residential sector's demand growth between 2020 and 2021 is likely due to more people working from home.

Peak demand has been rising in the past three years (driven by increased winter demand), reaching a peak load of 7.157 GW on the evening of 9 August 2021, 16% higher than the average over the previous four years (MBIE, 2022b).

Operations of the New Zealand Aluminium Smelter at Tiwai Point significantly affect the electricity market due to its size, and questions about its closure affect both investment decisions and prices. In July 2020, NZAS, which is 79% owned by Rio Tinto and 21% owned by the Japanese Sumitomo Chemical Company, announced the conclusion of a strategic review of the smelter and a decision to wind down operations by August 2021 due to high energy and transmission costs. Following negotiations resulting in a new electricity agreement with Meridian, in January 2021, NZAS committed to continue operations until 2024. With aluminium prices continuing to reach new heights, NZAS has recently stated its intention to continue operating beyond 2024. The smelter consumes approximately 13% of New Zealand's electricity generation. The smelter's future will likely influence Genesis Energy's decision on when to decommission the Rankin units at the Huntly Power Station.

Electricity market structure and operation

Key institutions

The Ministry of Business Innovation and Employment monitors the activities of several electricity regulatory bodies. Independent regulators, the Electricity Authority and the Commerce Commission oversee the regulation of the sector, while the Crown agent, the Energy Efficiency and Conservation Agency, promotes and manages electricity efficiency programmes.

The Electricity Authority was established in 2010 under the Electricity Industry Act of 2010. Its main statutory objective is to promote competition, reliable supply and the efficient operation of the electricity industry for the long-term benefit of consumers. The Electricity Authority also has an additional objective to protect the interests of domestic and small business consumers in relation to their electricity supply. To ensure the electricity industry is efficient, the Electricity Authority administers and enforces the Electricity Industry Participation Code 2010, a set of rules governing the electricity industry covering generation, transmission, system operation, security of supply, market arrangements, metering, distribution and retail.

The Commerce Commission is New Zealand's primary competition and economic regulatory agency. It strives to achieve the best possible outcomes in competitive and regulated markets for the long-term benefit of the country. The Commerce Commission regulates the revenues of the electricity transmission network and the majority of electricity distribution networks.

Both the Electricity Authority and the Commerce Commission are independent Crown entities, not subject to direct instruction either from their reporting minister or ministry. The minister may, however, issue policy statements that the agencies must regard. In addition, the minister issues an annual letter of expectations that conveys the portfolio's priorities, along with strategic priorities and performance expectations for the agencies for the upcoming financial year. The letter of expectations helps guide, but does not direct, the agencies' work programmes. Both agencies, while levy-funded, require their respective budgets to be approved through the normal government budget cycle process, which (to the extent funding is granted) may further influence the agencies' work programme.

Wholesale market

All electricity in New Zealand is bought and sold via a gross half-hourly spot market. All generators (including distributed generators, except solar) offer power into the pool while retailers and large off-take customers submit half-hourly bids. The market is an energy-only market and there are no capacity markets or capacity payments. A half-hourly instantaneous reserve market is also operated alongside the energy market to ensure enough backup generation (or load reduction if needed) is available should the largest generator (or transmission link) unexpectedly fail. Since 1 November 2022, energy and instantaneous reserve prices are published every time the system operator issues a dispatch instruction, which occurs at least once per half-hour trading period but usually more frequently based on grid conditions. These dispatch prices are averaged on a time-weighted basis at the end of each trading period to determine the final settlement price for that trading period at all grid injection and exit points (approximately 250 nodes) based on security-constrained dispatch. Interim spot prices are available to participants immediately at the end of each half-hour trading period. Prior to 1 November 2022, indicative spot prices for energy and instantaneous reserves were not finalised until at least two days after the trading period.

A notable feature of the wholesale market is its "full nodal pricing" regime, whereby the marginal cost of meeting a change in load or generation at each grid injection and exit point (node) on the country's electricity network is calculated separately for each node. The differences in prices across the nodes reflect the costs of half-hourly transmission losses and constraints (congestion). The nodal spot prices signal the marginal cost of delivered energy at each node, which can lead to significant local price fluctuations.

The Electricity Authority initiated a review of competition in the wholesale market in 2021 in response to persistent high wholesale electricity prices since 2018. That review is ongoing. The first initiative to be developed from its findings is an urgent amendment to the Electricity Industry Participation Code 2010 to prohibit generation from giving effect to contracts of net 150 MW or more unless certain conditions are met.

A new trading conduct rule in the Electricity Industry Participation Code 2010 sets out the appropriate trading conduct behaviour required of generators and ancillary service agents and defines when market power becomes significant. The Electricity Authority monitors this rule by identifying possible breaches by comparing prices with estimated costs, past prices during similar conditions and forecasted prices. This rule came into force on 30 June 2021 (Electricity Authority, 2021a).

To further deter industry participants from breaching the code, the maximum penalty that the Rulings Panel may impose on industry is NZD 2 million. The Rulings Panel can also impose an additional NZD 10 000 penalty for every day (or part-day) that a breach continues to incentivise parties to remedy breaches in a timely fashion. Following a review led by the MBIE, these penalties were increased through the Electricity Industry Amendment Act 2021.

A series of reforms over the past several years has aimed to facilitate and enhance trust, confidence and competition in wholesale markets. A notable change is a revised trading conduct rule, which requires all generators to offer in the market as if they were constantly subject to competitive pressure. The Electricity Authority conducted a formal review of the changes to trading conduct rules in 2022 and noted positive changes in sector behaviours

as a result of this reform. Ongoing reforms will depend on the outcomes of the Electricity Authority's review of wholesale market competition (see below).

The Electricity Authority's Market Advisory Group also released an options paper on how price discovery would work in a 100% renewables system for New Zealand's wholesale electricity market. The paper, released in December 2022, includes several options for changes that might be needed to transition to a 100% renewables electricity system (Electricity Authority, 2023).

Retail market

Most end consumers (by number and volume) buy electricity on contract from retailers, who, in turn, purchase electricity on the wholesale market. Electricity retailers and a small number of customers (generally large industrial users) buy electricity directly from the spot market. As electricity spot prices can vary significantly across nodes, on a half-hourly, weekly and seasonal basis, these parties will typically also enter into financial hedges or futures contracts that allow them to manage the volatility associated with locational marginal pricing.

There are many market participants, and the number of retailers that are independent of the gentailers (businesses that are both generators and retailers) has increased in recent years, though it still represents a small share of the total market. The Electricity Authority continues to monitor whether the terms on which independent retailers have access to the wholesale market are a barrier to their entry into, or growth within, the sector. These concerns arise because independent retailers must compete with the gentailers – who may offer preferential rates to their own retail arms.

Efforts have been made to increase competition in the retail market, ensure efficient price signals, reduce barriers for new retailers to enter and expand in the market, and reduce information barriers for consumer participation and provider switching.

Supplier switching

Most of the retail market is served by the retail arms of four large gentailers. However, a growing number of new retailers entering the market is increasing competition and consumer choice. At year-end 2003, five retailers supplied 95% of all registered installation control points. By year-end 2021, 43 retailers were active in the market, with the top 5 retailers serving 74% of installation control points.

To encourage strong retail market competition, the Electricity Authority provides a levy-funded contribution (NZD 1.2 million per year) to fund Powerswitch, an online tool (created by a consumer advocacy group, Consumer NZ). This contribution represents approximately 75% of Powerswitch funding, the remaining 25% coming largely from electricity retailers from a "success" fee of NZD 50 per switch.

Powerswitch helps domestic consumers get the best deal on their energy bills. On the site, consumers can compare electricity and gas prices and plans in their location and begin the process of switching retail providers. The switching process is easy, takes an average of three to four days and is not confirmed until consumers have entered into a new agreement with their new retailer.

Consumer care

In 2021, the Electricity Authority published and implemented the Consumer Care Guidelines, which focus on retailers providing a consistent and supportive standard of service to domestic consumers. These guidelines replaced historical guidelines created in 2009 that were no longer fit-for-purpose.

The guidelines describe a level of care for all consumers through minimum recommended actions. They are not prescriptive or codified but designed for retailers to use as a guide as they proactively monitor consumer behaviour. The Electricity Authority monitors retailer alignment and the intended outcomes of the guidelines through annual alignment statements and quarterly monitoring information provided by retailers.

Retailer of last resort

There is no universal supply obligation in the New Zealand electricity market, and there is no statutory obligation for any retailer to supply any customer to ensure continuous supply to customers. There are no mandatory standards for customer contracts (the Electricity Authority publishes voluntary contracting best principles and minimum terms and conditions for domestic contracts), but there are also no guarantees in place for consumers who choose spot price contracts and want to return to a basic contract with a last-resort supplier to avoid high financial exposure due to rising prices.

However, the Electricity Authority has arrangements to deal with a retailer default event: this includes an initial phase where the defaulting trader can resolve its default or assign its customers to another retailer; a second phase (if required) in which affected customers are given notice of the situation and have seven days to find an alternative retailer of their choice; and a final phase where the Electricity Authority intervenes to allocate any remaining customers to other retailers.

Generation

There are more than 220 electricity generation stations in New Zealand. The five largest generation companies produce the majority of electricity (Contact Energy, Genesis Energy, Manawa Energy, Meridian Energy and Mercury NZ). The government has a majority 51% shareholding in three of the biggest generators – Genesis Energy, Meridian Energy and Mercury NZ.

New Zealand produces the vast majority (85% in 2021) of its electricity from zero- or low-emissions sources.

Hydroelectric generation has been a part of New Zealand's energy system for over 100 years, with the majority of generation located in the South Island. Looking forward, the government expects that the amount of electricity generation from hydro sources will be largely unchanged, as the economic and environmental capacity for new large-scale schemes has mostly been exhausted.

Geothermal generation has also, for a long time, been an integral part of New Zealand's electricity landscape. It began over 60 years ago with the opening of the Wairakei Power

Station in November 1958. Most of New Zealand's installed capacity is situated in the Taupō Volcanic Zone. Generation from geothermal sources is projected to reach around 10.3 TWh by 2030.

Wind generation has grown quickly as a source of electricity. The first wind farm, Hau Nui, was commissioned in 1997. Most of New Zealand's wind farms are located in the North Island. This includes the country's two largest farms, Tararua Wind Farm and West Wind Makara, in the lower North Island.

Government generation development scenarios indicate that annual wind generation is expected to reach around 4 700 GWh by 2030, while annual generation from solar is expected to reach around 620 GWh.

Electricity generation from the combustion of coal, oil and gas provides baseload, backup and peak electricity supply. Most of New Zealand's thermal plants are found in the North Island, close to domestic coal, oil and gas resources. Genesis Energy's Huntly Power Station plays an important role in New Zealand's thermal generation. Huntly has three Rankine units that can run on either natural gas or coal, which currently play an important role in helping New Zealand meet winter electricity demand peaks. Coal is used if the gas supply to the plant is restricted. Generation from both coal and gas is expected to decline over time in line with emissions targets and a rising carbon price.

New Zealand currently has slightly over 1 GW of distributed generation (small-scale generation, connected directly to the distribution grid), of which 36% is hydro, 31% wind, 20% solar and 13% liquid fuels. In the last eight years, almost all distributed generation growth has been solar photovoltaics, which will become the predominant distributed generation type in the coming years. The average size of residential solar is now slightly over 5 kilowatts (kW) and non-residential solar 37 kW. Both have been increasing in size over time, with non-residential increasing at a much faster rate than residential. Approximately 96% of solar installations are less than 10 kW.

There is a large pipeline of solar photovoltaics (and solar/battery) applications seeking connection to distribution networks, far in excess of what has been installed to date. This includes commercial solar farms, which are now economical. The top 100 of these applications (out of around 2 000) make up over 90% of the total capacity of all applications, with 58% of these approved for installation (and the remaining awaiting approval).

The Electricity Authority is investigating regulatory changes to streamline the installation of distributed energy resources, improve their overall energy performance (e.g. by requiring them to be smart) and promote system flexibility (e.g. flexibility traders).

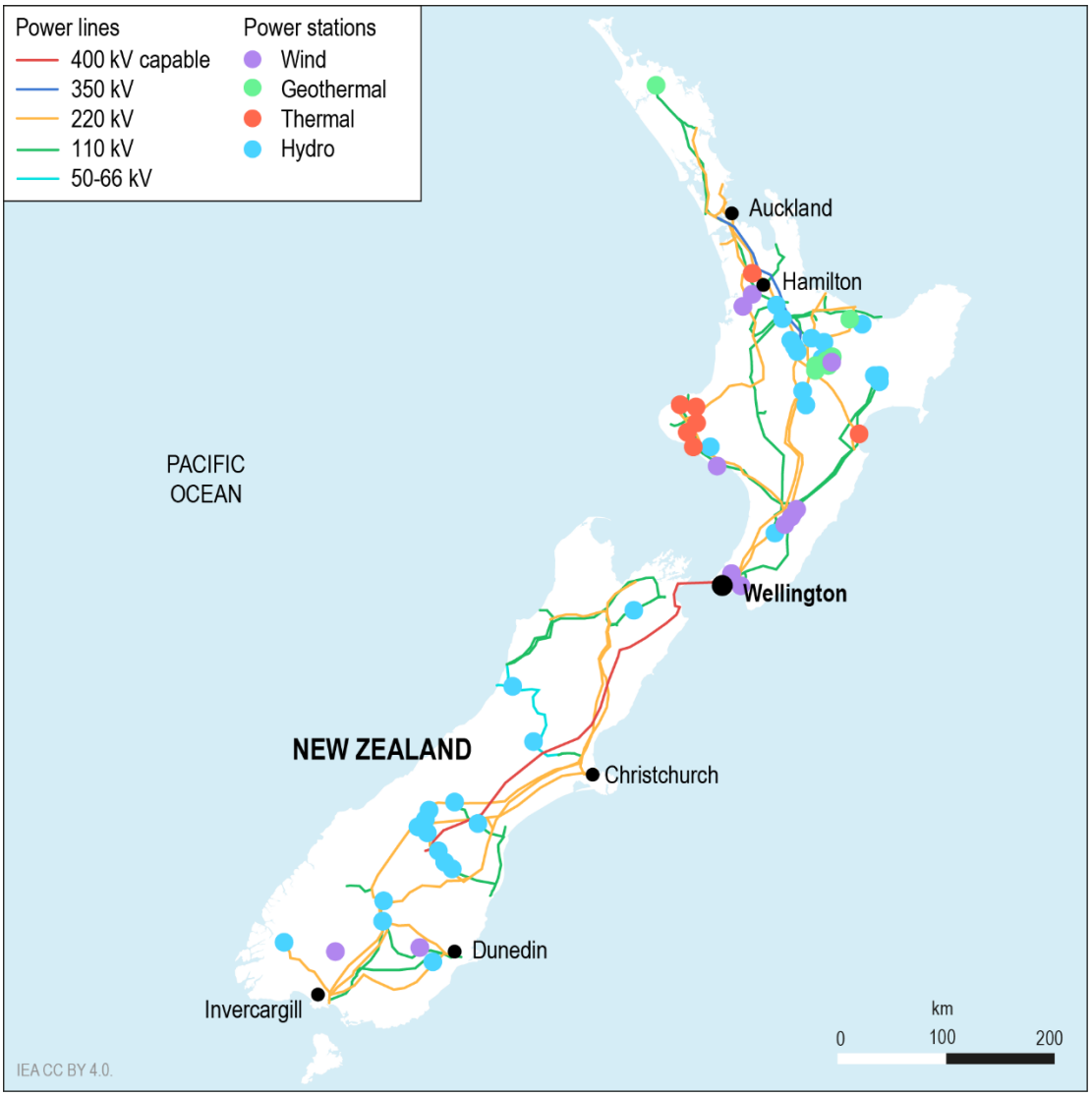
Transmission

New Zealand's electricity transmission network is owned and operated by the state-owned enterprise Transpower. Under the Electricity Industry Act (2010), Transpower is also the designated transmission system operator (TSO), tasked with ensuring the real-time co-ordination of the electricity system, providing information and short- to medium-term forecasting on all aspects of supply security, and managing supply emergencies.

There is a relationship charter and agreement in place between Transpower and the Electricity Authority in relation to the provision of the system operator service by Transpower. That charter and agreement acknowledge the Electricity Authority's

objectives and functions, and Transpower's designated role as the contracted system operator service provider for the Electricity Authority is stipulated in legislation. The charter and agreement help ensure that Transpower and the Electricity Authority effectively deliver on the Authority's objectives across market design and compliance work.

Figure 7.3 Electricity infrastructure in New Zealand



Note: kV = kilovolt.

A new transmission pricing methodology is due to take effect in April 2023. It sets out how Transpower, as the transmission grid owner, must recover transmission costs from its customers – grid-connected generation and load, as well as electricity distribution businesses. Charges for the high-voltage direct current link connecting the North Island and South Island alternating current grids were allocated solely to South Island generators under the previous TPM, creating a disadvantage for South Island generators. Under the new TPM, the grids are allocated according to benefit-based charges, meaning other customers who also benefit – in particular, North Island loads – pay a portion of the charge. Removing this effective tax on generation from the South Island (where there are abundant renewable fuel sources such as hydro and wind) will help ensure efficient South Island

generation is built and may contribute toward the earlier decommissioning of large, non-renewable thermal plants in the North Island.

In Transpower's Net Zero Grid Pathways project, the company submitted a proposal to the Commerce Commission for approval of NZD 400 million for upgrades to the existing grid under a first phase over 2023-2035, while a second post-2030 phase would focus on new grid lines to accommodate load growth (at a still to-be-determined cost) (Transpower, 2022b).

Distribution

New Zealand has 29 electricity distribution businesses (EDBs). By international comparison, New Zealand has a large number of companies relative to its size, and the vast majority of them are very small (21 of the 29 have fewer than 50 000 connections).

Smaller distributors are predominately rural with lower customer density and geographically diverse areas to service. Efficiency gains could be made through mergers. Interest in this issue has increased recently with concerns over the ability of small network owners to respond adequately to new technologies and the needs of smart grids, and from investment behaviour by some small distributors regarding non-core business activities such as vineyards.

The 29 EDBs have varied ownership and operate in geographically defined local areas. Four companies are fully or partially privately owned (Vector, Horizon, Wellington Electricity and Powerco), while the majority are consumer-owned (trusts) or owned by local authorities/municipalities. There are 13 smaller EDBs exempt from price-quality regulation from the Commerce Commission. They are still, however, subject to information disclosure regulation.

All distributors may set their own terms of access to the electricity network. They may set standards and tariffs as they wish as long as they comply with the relevant price-quality regulation (if applicable) and take account of the distribution pricing principles set by the Electricity Authority. Rules administered by the Electricity Authority require distributors to charge incremental costs for distributed generation. Charging for new load is currently only subject to guidance that charges be cost-reflective. Pricing principles encourage a similar charging approach for new load connections. Sometimes applicants can connect to the network for an incremental cost until the capacity of that section of the network is reached. Once capacity is reached, the next applicant seeking to connect may face substantial costs as a network upgrade is required. This is commonly known as the "first-mover disadvantage" and is being reviewed by the Electricity Authority to determine whether it is suitable going forward, as part of its work on distribution pricing reform.

There are over 150 000 km of distribution lines in New Zealand and almost all consumers are connected to a distribution network along with a number of embedded small-scale generators. The majority of customers are connected to a distributor. Generally, the 29 distribution companies sell their services to retailers, who manage the electricity supply agreements with end consumers.

Electricity policy

The New Zealand Energy Strategy 2011-2021 set a target for 90% renewable electricity by 2025. Subsequently, the government set an aspirational goal of 100% renewable electricity by 2030. Moreover, the first Emissions Reduction Plan (May 2022) built on the government's aspirational goal in electricity to set a target of 50% of TFEC from renewables by 2035, based largely on increased electrification across sectors of the economy.

New Zealand does not subsidise or directly incentivise renewable power investment, but market access is facilitated through simplified market arrangements, including: streamlined connection processes for small-scale distributed generation and special rules for dispatch.

Policy reforms of New Zealand's electricity market focus on delivering the government's aspiration of achieving 100% renewable-based electricity by 2030 (see Chapter 5 for more detail), including through five-yearly assessments to ensure that security of supply and affordability of electricity are well-managed.

In April 2018, the government established the Interim Climate Change Committee to consider how New Zealand could transition to 100% renewable electricity and a low-emissions energy future. It delivered its evidence, analysis and recommendations on this in its April 2019 report *Accelerated Electrification*, and recommended that the government focus on electrifying transport and process heat to achieve emissions reductions. The modelling behind the report included scenarios with ambitious levels of EV uptake and electrification of process heat to 2035.

In November 2020, the government announced the NZD 70 million GIDI Fund that will allow business and industries to access financial support to switch from coal and gas boilers to cleaner electricity and biomass options. The GIDI Fund will target New Zealand's largest energy users to accelerate their uptake of electrification and other technologies that will dramatically lower emissions. Though the measures will likely lead to improved energy efficiency outcomes, on balance, they will also increase electricity demand, requiring additional investment in generation, transmission and distribution infrastructure.

Budget 2022 announced that the government would invest around NZD 650 million over four years to increase funding for the GIDI programme. There will also be targeted investment at a regional level for projects that optimise low-emissions fuel use, funding for electricity transmission and distribution infrastructure upgrades to support fuel switching, and the early adoption of high decarbonisation energy technologies.

In addition, approximately NZD 5 million over two years will provide funding to develop measures that support a reliable and affordable electricity supply while accelerating the move to a highly renewable electricity system, and to explore the potential for public sector procurement of renewable electricity via long-term power purchase agreements.

Electricity Price Review

In April 2018, the Minister of Energy and Resources commissioned an independent review of New Zealand's electricity market. This was because electricity prices, especially for residential consumers, increased faster than inflation for many years, putting pressure on household budgets. In comparison, prices faced by commercial and industrial customers remained relatively flat (MBIE, 2022c).

While such reviews are not new in New Zealand, the EPR was unique, as it addressed the need for electricity prices to be fair and affordable, not just efficient or competitive. Another novel element was the review's focus on the consumers' point of view and their say in the direction of the sector. The review also considered how to future-proof the sector and its governance structures to help ensure the electricity sector functions well during New Zealand's transition away from carbon-based fuels – a consideration that will become increasingly important as electricity meets more of New Zealand's energy needs, and as new technologies are adopted.

The final report was delivered in May 2019, containing 32 recommendations related to consumers, industry, regulation and technology (MBIE, 2022c). The government announced its response to the EPR in October 2019. It includes measures such as improving the availability of wholesale electricity and gas market information, ensuring distributors have access to smart meter data, and giving the Electricity Authority an explicit consumer protection function.

Wholesale market competition review

In March 2021, the Electricity Authority announced it would conduct a review of competition in the wholesale electricity market. The review covers the start of 2019 to June 2021, during a period of sustained elevated electricity prices due to an unplanned outage at the Pohokura gas facility in the spring of 2018 and the announcement in January 2021 of the arrangements to extend the operation of the New Zealand Aluminium Smelter at Tiwai by four more years (Electricity Authority, 2021b).

The review was carried out in stages. The first stage consisted of two consultation papers on market monitoring review and inefficient price discrimination. The market monitoring review concluded that elevated prices over the review period did not always match underlying supply and demand conditions, and there was some evidence that generators may have exercised market power. It also found that the pipeline of new renewable generation was thin but improving. The inefficient price discrimination paper found that very large electricity contracts that have the ability to shift market prices, such as the Tiwai contract, could have adverse impacts on consumers (Electricity Authority, 2022).

The Electricity Authority has followed its initial review with a forward-looking assessment of what changes to market settings are required to promote competition for the long-term benefit of consumers in the transition toward 100% renewable electricity generation. The final report focused on activities to support ongoing investment in net new generation, both to improve prices for consumers, improve security and reliability, and support competition. Among the findings are that:

- More and faster investment in generation and focus on monitoring and enforcement is currently the best strategy to promote competition in the wholesale electricity market.

- There is now a substantial pipeline of intended investment in new renewable generation, which will help to promote competition.
- Uncertainty around the 100% renewable electricity aspiration, Gas Transition Plan, NZ Battery Project and Energy Strategy is causing delays in investment.
- Fundamental structural change is not currently justified by the available evidence and may risk unintended consequences.

NZ Battery project

With a high share of hydro generation, New Zealand's electricity system is susceptible to dry hydrological years when less water is available for electricity generation. These tend to occur, on average, around once every ten years. In those years, the country has traditionally relied on thermal generation to top up the hydro shortfall during the winter. Water inflows to hydro resources are generally lower in winter, which coincides with both lower availability of wind and solar resources and the highest demand for electricity. For that reason, several studies have indicated that thermal generation will still have a role in the generation mix, to manage the seasonal mismatch of demand and variable renewable generation sources. In the very long term, climate change-induced variations in local rainfall and wind may also affect the seasonal mismatch.

Based on a recommendation from the Interim Climate Change Committee, in July 2020, the government announced that options to address New Zealand's dry year risk, including the use of pumped hydro storage, would be explored to manage peak demand, dry hydrological years and the variability of renewable energy sources such as wind. The project is known as NZ Battery, referring to the manner in which the intended solution, whether it is pumped storage or otherwise, will provide stored energy for the New Zealand electricity system in an analogous manner to a battery.

The first stage of the project was the announcement of NZD 30 million in funding to pay for the detailed development of a business case for a solution to address New Zealand's dry year storage problem. This analysis will consider a pumped hydro storage project at Lake Onslow in Central Otago and will also include an assessment of smaller potential pumped storage options in the North Island, as well as other alternative technologies.

Activities as part of Phase 1 of the NZ Battery Project include (MBIE, 2022d):

- analysis into the nature of New Zealand's dry year problem – and how it could change in the future
- technical investigations into different technological options to address the dry year problem (such as pumped hydro) and their applicability in New Zealand
- investigations into the environmental impacts and other impacts of different options, with a focus on pumped hydro at Lake Onslow
- research into the electricity market impacts of long-term, large-scale storage
- exploration on consenting pathways, with a detailed focus on pumped hydro at Lake Onslow
- early engagement with Māori groups and other key stakeholders
- securing land access for environmental, cultural and geotechnical investigations for the Lake Onslow option.

The results of the Phase 1 feasibility study will inform a decision on whether to proceed to the next phase. This would involve detailed engineering design and preliminary works of the chosen solution to provide more solid knowledge of the costs and capabilities and to inform a Cabinet decision on whether to proceed to construction (estimated cost of NZD 70 million). If approved, the final phase of the project would involve the construction of the selected option, or options (at a still undetermined cost). Feasibility studies for the project are expected to be completed early in 2023 and solutions to be in place in the 2030s.

System flexibility

Work is underway across government agencies to support increased electricity system flexibility. This includes work on market mechanisms led by the Electricity Authority and a recent consultation on regulatory settings for distribution networks and distribution pricing.

New Zealand's hydro generation with storage provides a balancing resource for the other variable renewable sources of generation. At the current and forecasted levels of large-scale run-of-river hydro, wind and solar generation, the government estimates that hydro can provide a sufficient balancing resource, except in dry hydrological years and in the middle of winter.

As New Zealand transitions to a higher proportion of renewable and variable sources of generation (wind and solar), demand-side flexibility – which involves modifying generation and/or consumption patterns in reaction to a price change – will become increasingly important to ensure that supply can continuously meet demand in real time.

Real-Time Pricing Project

The Electricity Authority has been working with Transpower as the system operator and New Zealand's Exchange to progress the system's design work for the Real-Time Pricing Project. The project will deliver more accurate and reliable spot prices to be published during each trading period. Final settlement prices will then be calculated immediately at the end of the trading period.

The Real-Time Pricing Project largely took effect on 1 November 2022, with the remaining components (dispatch notification) due to come into effect in April 2023. A software release for the project will enhance the current dispatchable demand regime for large industrial consumers and introduce dispatch notification participation for aggregated demand response and renewables in the wholesale market. This final software release will go live at the end of April 2023.

Previously, indicative spot prices for energy and instantaneous reserve were determined in the wholesale electricity market and not finalised until at least two days after the trading period. This meant industry participants took decisions regarding spot prices two days before knowing the final prices. They relied instead on a series of indicative prices (i.e. forecasts of final prices) to estimate the financial consequence of their decisions.

Demand response and distributed resource aggregators will be able to register as dispatch notification participants. This will allow them to provide wholesale market offers of their resources on a much lower cost basis than full market participation. Dispatch notification receipt and acknowledgement will be through web services. Participants will be able to "opt out" of dispatch to reflect business or resource constraints. Dispatch compliance will be measured on a monthly basis.

Roles of market players in supporting system flexibility

Throughout the sector, EDBs, generators, retailers and new market entrants are working to build new business models to make the most of new distributed energy resource technologies in New Zealand.

Since November 2022, New Zealand has had its first distributed solar and battery system provider offering its resources into the wholesale instantaneous reserves market. And from April 2023, the New Zealand wholesale electricity market will include participation mechanisms to allow dispatchable demand and distributed energy resource aggregators to participate directly in the price discovery process.

In February 2022, a cross-industry group (the FlexForum) was established to identify the practical, scalable and least-regrets steps for unlocking the value of distributed energy resources and flexibility for households and businesses. The FlexForum is working to deliver and implement a Flexibility Action Plan to achieve the following objectives:

- identify the minimum specifications of the services that distributed resources can provide, to whom, when, where, how and for how much
- identify the practical, scalable and no regrets steps to use the services that distributed resources can provide
- support ongoing learning and collaboration across the electricity sector on real-world deployment of solutions to realise the benefits of distributed energy sources, including identifying and resolving barriers.

Whenever major regional capital project grid investments are investigated, Transpower must consider non-transmission solutions. In January 2021, such a scheme using solar photovoltaics and batteries was commissioned by the distribution company Aurora Energy and adopted in the Upper Clutha (Wānaka) district. The initiative is expected to lower customers' power bills as well as allow Aurora Energy to defer up to NZD 25 million in spending on upgrading power lines.

Smart meters

New Zealand has relied on a market-based roll-out of smart meters by retailers with no regulated cost recovery or incentives. In 2022, retailers had close to 2 million smart meters installed (out of 2.26 million customers of all types) and, in general, they measure consumption at least every 30 minutes; some have more or less functionality.

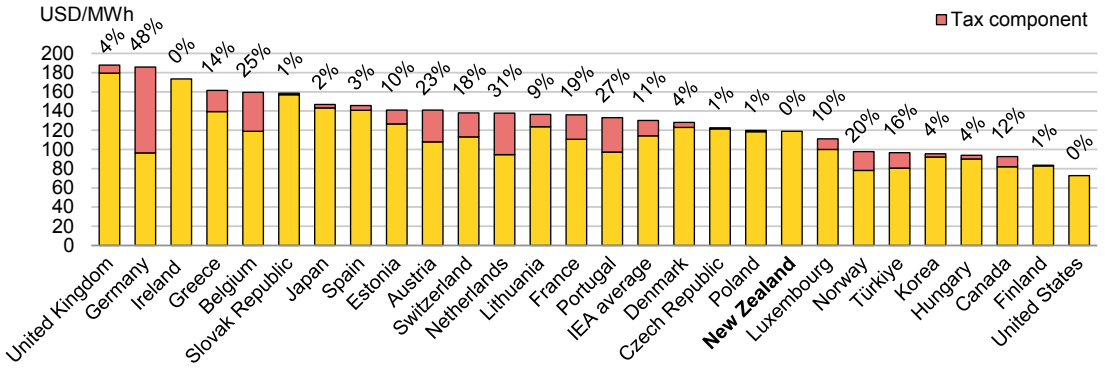
Energy data from smart meters are gathered via a communications layer (cellular or mesh networks) to a centralised database managed within a data centre. Access to energy data is managed by on-premise identity and access management protocols. In addition, all access attempts are logged and monitored by a 24/7 security operations centre. From the centralised database, versions of the data are supplied to the end users of data. Only data that meet the end users' requirements and access rights (covered by explicit support agreements) are supplied and only for the purposes of network management and operation.

Electricity retail prices and taxes

New Zealand's industry and household electricity prices follow the average trend of IEA countries. New Zealand's industry price in 2021 was 119.0 USD/MWh (IEA average: 130.2 USD/MWh), with a 0% tax rate, as the good and services tax is refunded for purchases for commercial consumers (IEA average: 11%). Household electricity prices reached 212.2 USD/MWh (IEA average: 225.2 USD/MWh), with a tax rate of 13% (IEA average: 22%) (Figures 7.4 and 7.5). Electricity prices for industry in New Zealand are relatively low compared to other IEA countries but are around the average for households.

Figure 7.4 Electricity prices for industry and households in IEA countries, 2021

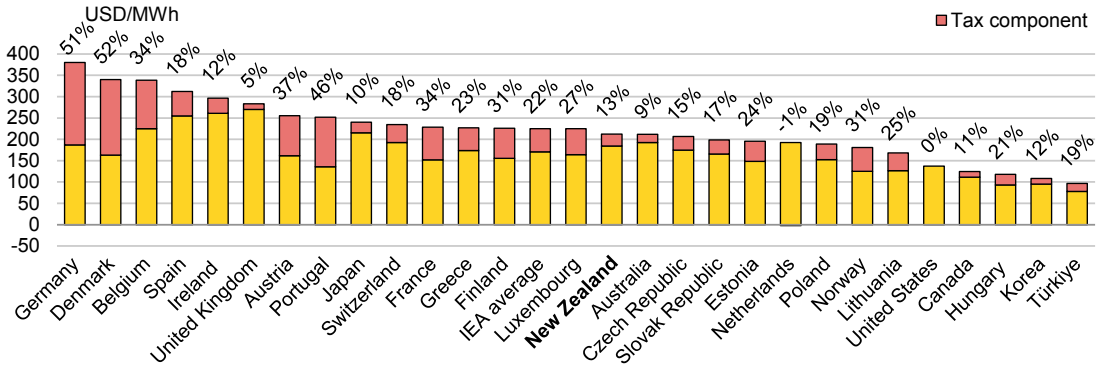
Industry



In 2021, New Zealand's industry electricity prices were below the IEA average.

Notes: MWh = megawatt hour. Industry price data are not available for Australia, Italy, Mexico and Sweden.
Source: IEA (2022).

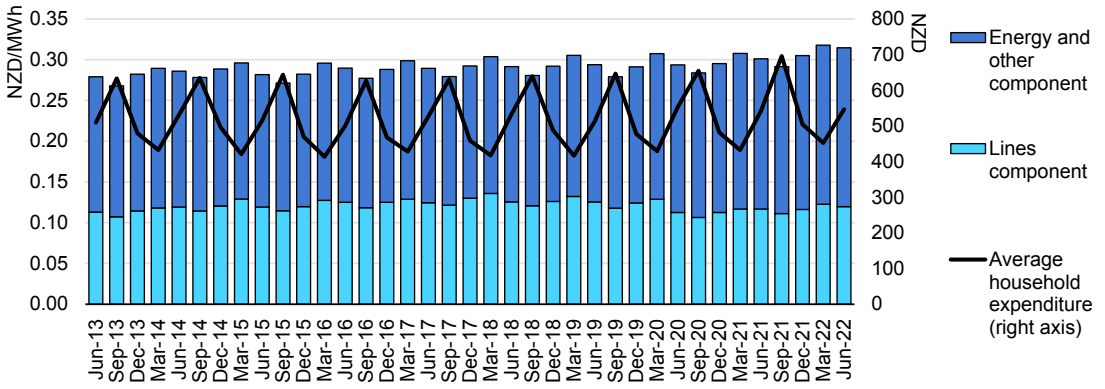
Households



In 2021, New Zealand's household electricity prices were around the IEA average.

Notes: MWh = megawatt hour. Household price data are not available for Italy and Mexico.
Source: IEA (2022).

Figure 7.5 Residential electricity prices by component in New Zealand, June 2013 to June 2022



On average, household expenditure slightly increased in 2022 due to an increase in the energy component of electricity bills.

Note: NZD/MWh = New Zealand dollar per megawatt hour.

Source: MBIE (2022a).

Tariffs

Electricity tariffs in New Zealand generally comprise two components – a fixed charge and a variable charge. The fixed charge component is designed to cover the "fixed" costs (i.e. not dependent on how much electricity is used) associated with delivering electricity to households, such as the costs of maintaining and upgrading lines, as well as metering. This is charged at a flat daily rate. The variable charge, measured per kWh, covers the costs of electricity generation and is dependent on a household's electricity consumption.

Low fixed charge tariffs

The Electricity (Low Fixed Charge Tariff Option for Domestic Consumers) Regulations 2004 (the LFC regulations) were introduced following calls for intervention on rising electricity prices from the Consumers' Institute and other bodies.

The regulations require that retailers offer residential consumers with low consumption a low fixed charge tariff of no more than NZD 0.30/day (excluding the GST). The result of charging network tariffs that do not cover the network costs through LFC tariffs is that retailers recover these costs from households not on LFC tariffs, artificially increasing costs for them.

Based on a recommendation of the 2019 Electricity Price Review, the Cabinet decided to phase out the LFC regulations as they were poorly targeted and had a number of unintended consequences, including: pushing some households not on LFC tariffs into greater energy hardship; promoting inefficient choices for the adoption and use of new technologies and for electrifying the economy; and increasing pricing complexity and confusion, making it harder for consumers to shop around for the right electricity plan, hampering retail competition and likely raising average bills for consumers. Phasing out the regulations will see the maximum low fixed charge increase gradually over five years until it is about the same as the standard fixed charge. Each year, the maximum low fixed charge will increase by 30 cents. The first step of the phase-out started on 1 April 2022.

Winter Energy Payment

In December 2017, a new Winter Energy Payment was announced as part of the government's Families Package. The measure aims to help eligible New Zealanders heat their homes during the coldest months from May to September. The Winter Energy Payment is available for every New Zealander aged 65 and over who receives New Zealand Superannuation or a veteran's pension, as well as people receiving certain welfare benefits. The Winter Energy Payment is paid weekly at a rate of NZD 20.46 for a single person with no dependent children or NZD 31.82 for couples or a single person with dependent children.

Electricity security

The principal legal instrument governing electricity security in New Zealand is the Electricity Industry Act 2010, which also established the Electricity Authority. The Electricity Authority's statutory objectives require that it promote "reliable supply" in the electricity market. The Electricity Authority's primary operational mechanism in relation to security of supply is the Electricity Industry Participation Code administered by the Electricity Authority.

The environmental impact assessment provides that the Electricity Industry Participation Code must specify the functions of the system operator (SO), Transpower, and how those functions are to be performed, and set requirements relating to transparency and performance.

Under the environmental impact assessment, Transpower is required to provide information and short- to medium-term forecasting on all aspects of security of supply, and to manage supply emergencies.

The Electricity Industry Participation Code outlines what monitoring steps the SO must undertake concerning security of supply and defines what responses are available to the SO when a potential security of supply situation arises. The Code requires Transpower, as the SO, to prepare and publish at least annually a security of supply assessment that contains detailed supply and demand forecasts. The Code also requires the SO to:

- implement an Official Conservation Campaign when future hydro storage reaches a pre-determined level (defined as the emergency zone on the Hydro Risk Curves)
- develop and maintain a rolling outage plan, and co-ordinate the outage plans of distributors
- implement rolling outages should they be required.

In addition, the code allows for emergency grid reconfiguration to maintain security of supply and outlines the criteria for when the system operator would commence an official conservation campaign.

Long-term energy security

Each year, the SO is required to publish ten-year forecasts of electricity supply and demand in both the North and South Islands. The forecasts include an assessment of likely future generation projects along with an assessment of the Winter Energy Margin and Winter Capacity Margin for each year. The Winter Energy Margin is calculated by dividing the expected supply for New Zealand (or the South Island) by the expected demand for

the whole of New Zealand (or the South Island) and subtracting one. The Winter Capacity Margin is calculated by subtracting a metric of North Island expected demand from North Island expected capacity.

Short-term electricity security

The SO is also required to monitor hydro storage and publish assessments of short-term security by comparing hydro storage against hydroelectricity risk curves. Hydroelectricity risk curves are designed to reflect the risk of future electricity shortages using a range of likely inflows and taking into account any transmission constraints. The hydro risk curve is updated weekly and plots actual storage against the probability of water shortage based on historical inflow sequences followed since 1932.

Storage and supporting measures

Moving to a highly renewable electricity supply will require new sources of backup energy supply as coal- and gas-fired thermal generation is retired. The government is exploring options to address New Zealand's dry year risk, including the use of pumped hydro storage to manage peak demand, dry hydrological years and the variability of renewable energy sources such as wind. This analysis will consider a pumped hydro storage project at Lake Onslow in Central Otago and will also include the assessment of smaller potential pumped storage options in the North Island, as well as other alternative technologies (see above).

System performance and resilience

New Zealand's Commerce Commission has established an online performance accessibility tool for electricity distribution businesses to monitor the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI).

Over the last five years, the SAIDI has fluctuated between 100 and 300 minutes of disruptions per year and stood at 180 minutes in 2021. Forty-five per cent of supply interruptions were planned; defective equipment, third-party interference and vegetation accounted for another 40%.

The SAIFI has consistently improved over the last couple of years, dropping from an average of 2.26 interruptions in 2018 to 1.6 outages in 2021.

In 2019, the Commerce Commission published an independent expert review of electricity distributors' risk preparedness (with a focus on network resilience and high-impact/low-probability events). That review concluded that distributors' asset management plans specifically referred to resilience investments, and that some common themes were evident in the disclosures. These include seismic strengthening, replacing larger pole-mounted substations with ground-mounted units, replacing oil-filled cables, works to enable network reconfiguration and meshing, and the deployment of mobile substations. The review made some recommendations on enhancing the Commerce Commission's disclosure requirements for asset management plans. The commission is currently conducting a targeted review of its disclosure requirements for electricity distributors to ensure those requirements are fit-for-purpose, and this review will benefit from those recommendations.

Assessment

Given its location, New Zealand's electricity market has no connections to other jurisdictions, so the country is self-sufficient in electricity production to cover its demand. An inter-island high-voltage direct current system links the North and South Islands grids. In 2022, the total installed capacity of New Zealand's power supply system was 9.92 GW (Transpower, 2022b). Hydropower has historically been the main source of electricity generation (54% in 2021), followed by geothermal (19%), natural gas (11.2%), coal (7.5%), wind (5.9%), bioenergy (1.8%), and small shares from solar (0.5%) and oil (0.1%). There are more than 220 electricity generation facilities in New Zealand. The five largest generation companies produce the vast majority of electricity (over 90%).

In 2021, the industrial sector accounted for 44% of electricity consumption, followed by residential consumers with 33% and the service sector with 23%. The aluminium smelter at Tiwai accounts for 13%, on average, of electricity consumption in New Zealand and, given its size, will continue to play a significant role in the electricity market until at least the end of 2024; uncertainty about continuation after 2024 has an impact on electricity prices and investment decisions.

Transpower is designated as the system operator of New Zealand's electricity transmission network and is fully state-owned. New Zealand's Exchange and Transpower are responsible for operating the wholesale market. New Zealand has a competitive electricity retail market with multiple independent suppliers, the number of which has increased in recent years. Also, some businesses are both generators and retailers, the so-called gentailers. New Zealand has, compared to other countries and relative to its size, a large number of electricity distribution companies. The majority of them are very small.

Evidently, the New Zealand electricity market will need to further expand renewable capacity to deliver on the government's aspirational target of achieving 100% renewable-based electricity by 2030. Moreover, achieving the government's target of 50% renewables in total energy consumption by 2035 will require accelerated electrification of the industry and transport sectors, which will increase challenges for New Zealand's electricity system. In that sense, a well-functioning electricity market that provides the right price signals for new investments in renewable energy as well as the development of sufficient flexibility in the energy system will be crucial elements in the Energy Strategy that is currently being developed by the government and which is due to be finalised in 2024.

In recent years, the Electricity Authority, which serves as the market regulator, has successfully implemented several market reforms. In 2019, an Electricity Price Review, an independent review of the electricity market, was undertaken to address increased electricity prices, especially for residential consumers. Whereas previous market reviews of this kind merely focused on prices being efficient and competitive, this review also addressed the need for fair and affordable prices. It was focused on consumer participation as well as making the electricity sector future-proof and ensuring its proper functioning during the transition away from fossil fuels.

The EPR recommendations led to several reforms, principally undertaken by the Electricity Authority, including new rules for disclosure of information for participants in the wholesale electricity market, ensuring access to data and enhancing the responsibilities of the Electricity Authority in consumer protection. Another notable reform that arose from the EPR recommendations is the phase-out of the LFC regulations in 2021. The LFC

regulations were introduced in 2004 and aimed to reduce power bills for low-use, low-income households. However, they were poorly targeted, helping only some low-use households while pushing others with higher electricity consumption into greater energy hardship. These regulations were also recognised as a barrier to introducing innovative distribution pricing structures, such as time-of-use pricing.

A related reform that has been undertaken is the Real-Time Pricing Project. It aims to increase flexibility in the electricity system by having accurate and reliable spot prices on the wholesale market published immediately after each trading period. This enhances dispatching opportunities for large industrial consumers as well as the participation of demand response (including aggregated demand response) and distributed energy resources in the wholesale market. The IEA commends New Zealand for the above-mentioned market reforms.

Given the large share of electricity generated by hydro projects, a predominant question for New Zealand is how to deal with the risks from lower output in a dry year or a series of dry years. The necessity to address this long-standing adequacy question is increasing in the current context, where dispatchable fossil fuel generation is being phased out due to the government's target of achieving 100% renewable-based electricity by 2030. Following a recommendation from the Interim Climate Change Committee, in July 2020, the government announced that options would be explored to manage peak demand, dry hydrological years as well as the increasing share of variable renewable energy sources in the electricity system.

This announcement kicked off the so-called NZ Battery Project. The initial stage of the project considers the option of a new large-scale (5 TWh) pumped hydro storage project at Lake Onslow but is also assessing other potential smaller pumped storage projects and alternative technologies such as electricity from flexible geothermal sources, hydrogen or biomass. The NZ Battery Project was established with an initial funding commitment of NZD 30 million from the government to conduct the needed research, and – if built – will be the government's largest single investment in the electricity system since the creation of the wholesale market. The first phase of the project includes a technical feasibility analysis of the Lake Onslow pumped hydro option (planned delivery in the first half of 2023), which will inform a decision by the government on whether to commit a second budget of NZD 70 million for a detailed business model assessment (2023-2024). If it is ultimately decided to proceed, an eventual realisation of the Lake Onslow project is roughly estimated to be by 2030.

In its last in-depth review of New Zealand (2017), the IEA recommended that the government consider a strategic reserve option to address the dry year risk and enhance system adequacy for the longer term. The IEA praises New Zealand for the steps taken to address the dry year problem as a top priority on its policy agenda. At the same time, the open-ended discussion and lack of clarity on the direction in which the NZ Battery Project will move forward is creating short-term uncertainty in the market and has the potential to delay investment decisions for new renewable energy projects. It is, thus, important to clarify the direction and the outcome of the NZ Battery Project as soon as possible.

The NZ Battery Project is well-resourced and has been underway for nearly two years. Other policy projects in the renewable energy area have only recently been resourced and are only now scaling up. Care will be needed to ensure that the development of policies to incentivise the uptake of other renewable electricity options advance at the same rate to

avoid co-ordination issues and potential delays. If this is the case, it would be detrimental to the overarching objective, notably the government's ambitious renewable electricity target for 2030. Therefore, it is important that NZ Battery, on which final decisions might only be taken a few years from now, does not jeopardise the urgent development of additional renewable electricity capacity in the coming years. In that regard, the IEA advises the government to urgently develop strategies to unlock New Zealand's potential for offshore wind, hydrogen and distributed energy resources, on top of creating an enabling environment for continued strong expansion of solar and onshore wind. A wide portfolio of options will be important as the electricity system becomes more dependent on variable renewable generation, and the "dry year issue" needs a cost-effective resolution.

A significant reform in the NZ electricity market due to take effect from April 2023 is the revision of the transmission pricing methodology, established by the Electricity Authority. The TPM sets out how the transmission grid operator, Transpower, must recover its transmission costs from its customers, i.e. grid-connected generation and load, as well as the electricity distribution businesses. The new TPM aims to address several problems with the current TPM that were identified as barriers to the energy transition and were perceived to lead to inefficient outcomes. First, the so-called usage-based network charges will be replaced by fixed-based charges in order to reduce inefficient and costly charge avoidance behaviour. It will also avoid imposing a high congestion charge at peak times, even when (and where) there is no congestion on the transmission grid. With this revision, the Electricity Authority aims to allow more cost-effective renewable generation to be built to meet future demand growth.

Second, the Electricity Authority changed the design of charging for the high-voltage direct current link connecting the North Island and the South Island grids. These charges are only allocated to the South Island generators in the current TPM. Under the revised TPM, there will be benefit-based charges, so all customers who benefit, including North Island loads, will pay a portion of the charge.

Third, the new TPM introduces benefit-based charges whereby customers will pay for interconnection costs in proportion to their expected benefits, as determined by Transpower – and will not pay for grid investments they do not expect to benefit from. The underlying objective is to encourage potential new generators to scrutinise their investment decisions and make them efficient, taking into account the costs of transmission as well as generation. In this way, benefit-based charging combined with nodal prices would send efficient locational signals for new generation and lead to new electricity being produced and transported around the country at the least overall cost, keeping the total cost of the electricity system for New Zealanders as low as possible.

The new TPM also includes measures to remove barriers to new investment in renewable generation and electrification of load. For example, the new TPM addresses "first-mover disadvantages"[3] by: levelling the playing field between early investors (the first movers) and those who invest after, by charging second and subsequent movers a funded asset component which is rebated to the first mover; and ensuring first movers do not pay for connection capacity that is built in anticipation of other future investments. Instead, the TPM allocates 50% of the costs relating to anticipatory capacity to identified regional

[3] These could arise if the first customers to connect to the grid would bear a relatively greater share of connection charges than customers that connect later, and therefore are discouraged from or delay investing, either because they are at a cost disadvantage to second movers or they have to pay for extra capacity that they do not want.

beneficiaries (through a benefit-based approach), while 50% are "pooled and shared" across all transmission customers (through an addition to the asset component of the connection charge).

The IEA commends the Electricity Authority for its efforts to make New Zealand's transmission pricing system more future-oriented and for improvements in the TPM to increase efficiency, support the country's transition to a 100% renewable electricity system, and ensure the right generation is built in a timely fashion and in the right location. Still, it remains uncertain to what extent the objectives of the revised TPM will be met in practice. Notably, the pre-existing charging system for the use of connections has the potential to hinder investments in offshore wind projects, given the scale of their development. In this respect, the IEA recommends that the New Zealand government assess examples in other IEA countries and consider the feasibility of exempting new renewable projects from grid connection charges. This option could also be included in the offshore wind regulatory framework that is currently being considered.

In New Zealand, all electricity is bought and sold via the wholesale spot market. Generators are required to offer power for security reasons into a pool where retailers and large consumers submit half-hourly bids. The market is cleared on an *ex post* basis using generation offers and actual metered demand volumes with no capacity markets or capacity payments; it is an energy-only market.

In addition to the implementation of real-time pricing, several smaller reforms have aimed to increase confidence and competition in the wholesale electricity market, including reforms in the forward electricity market to increase opportunities for market participants to hedge their price risks. A notable recent reform is the so-called revised trading conduct rule, which requires all generators to offer in the market as if they were constantly under competitive pressure. Furthermore, the Electricity Authority initiated a review of competition in the wholesale market in 2021 in response to persistently high electricity prices. An initiative that appears to be part of this review – while still under consultation with industry – is to provide power to the Electricity Authority to scrutinise large electricity contracts that potentially distort the market.

Following earlier reviews of the electricity sector, the government has sought to address the market dominance of the five big gentailer companies. Competition at both the retail and wholesale levels has improved, but New Zealand still has a relatively concentrated market. This might bring the vertically integrated gentailers into a position where they could influence – through their behaviour in the wholesale market – the degree of competition in the retail market. Some participants in the retail market have perceived such market power behaviour, noting the persistent margin differentials between the retail and wholesale markets. The Electricity Authority indicated that it has been monitoring the revised trading conduct rules on a weekly basis since their introduction in mid-2021 and that it has not identified any deviating behaviour relative to market conditions so far. The IEA emphasises the importance of highly competitive electricity markets and strongly advises the responsible authorities to continue their efforts in monitoring wholesale and retail price developments and market behaviour. Moreover, as New Zealand is moving forward with increasing the penetration of variable renewables into its energy system, authorities should carefully consider the future design of retail and wholesale markets so as to facilitate new entrants and, where necessary, remove and avoid barriers. By doing so, the level of market concentration should gradually erode with the entry of new parties into the market.

While a number of government reviews have focused on competition and end-consumer prices, New Zealand should also assess whether the energy-only model for the electricity market will provide sufficient signals to bring about the necessary investment in large electricity security projects like NZ Battery and in the future enable the deployment of dispatchable, low-carbon assets that can contribute to grid stability and resilience.

Enhancing the role of distributed energy resources

The deployment of distributed energy resources (DER) has the potential to play a major role in enhancing flexibility in a highly renewables-based electricity and energy market. DER-enabling technologies include rooftop solar, EVs, storage and smart meters. DER can lead to efficiency gains, increase affordability for consumers and help mitigate congestion on the distribution grid, among other benefits. Notably, DER will increase opportunities for demand-side management tools, including through the emergence of aggregators, to play a greater role in balancing the electricity market, improving its overall efficiency and security.

Currently, less than 2% of New Zealand's installed capacity comes from DER, mainly in the form of rooftop solar installations. Neither the uptake of rooftop solar nor that of EVs (0.9% of the fleet) has developed at the pace and scale the government expected. As a result, the deployment of DER in New Zealand is lagging compared to other IEA countries (including neighbouring Australia).

There are currently no targets for the deployment of DER in New Zealand and the government does not subsidise or directly incentivise its deployment. The general approach of the government, as well as of the Electricity Authority, is to be technology neutral and allow the market to develop new flexibility options. From that perspective, until now, there simply does not appear to have been much urgency for the New Zealand electricity market to develop more flexibility options such as DER. Still, the Real-Time Pricing Project that came into effect at the end of 2022 will increase opportunities for DER to participate in the wholesale market and could thereby add flexibility to the electricity system. In addition, DER access to the grid is facilitated through market arrangements, such as streamlined connection processes that are part of the Electricity Industry Participation Code.

New Zealand's success in rolling out smart meters could be leveraged to support growth in demand response services. In 2022, retailers had close to 2 million smart meters installed and, in general, they measure consumption at least every 30 minutes. Notably, more sophisticated data collection could support the creation of demand aggregators to play a greater role in market balancing, especially as more variable renewables are introduced into the system.

Recently, the EDBs, Transpower, generators and retailers have started co-operating in building new business models for DER technologies in New Zealand. In February 2022, the multi-stakeholder FlexForum was established to identify the specifications of the services that DER can provide, resolve barriers to their development and identify practical steps that can be taken.

The lack of specific incentives, such as net metering programmes found in other jurisdictions, likely explains the slow progress in DER penetration. However, it is evident that the electricity distribution sector has an important role to play in the emergence and deployment of new technologies. It is also evident that more recent growth in rooftop solar,

along with new incentives for EV purchases, will mean that the DER sector is already poised for some growth in the coming years. In its last in-depth review in 2017, the IEA raised concerns about the ability of distribution companies to respond to the introduction of DER in an efficient and timely manner to maximise its potential benefits. The IEA recommended a review of the distribution sector to improve its productivity and flexibility and examine the structure and governance of the sector. The IEA reiterates its suggestion to undertake such a review to ensure that the distribution sector is fit-for-purpose and that distributed generation and demand response tools can be efficiently and appropriately integrated into the system.

The IEA sees a number of possible actions and best practices that the New Zealand government could pursue when addressing the challenge of accelerating the development of DER:

- investigate how the current regulatory regime could be adapted to enable the rapid uptake of DER, possibly benefiting from the upcoming recommendations by the FlexForum
- readdress the issue of distribution pricing, which seems to play a pivotal role in enabling DER development
- ensure the availability of data and clear rules for disclosure of information (by retailers as well as EDBs)
- allow and encourage EDBs to spend more of their allowed resources on innovation (currently 0.1-0.5% of their regulated income, as set by the Commerce Commission, is an additional allowance potentially available to be spent on innovation)
- look into best practices of other IEA countries in the area of setting up local energy communities and similar co-operatives that allow for aggregation of demand and pooled funding models
- allow for more regulatory flexibility and promote small-scale trials for certain DER solutions.

Recommendations

The government of New Zealand should:

- ☐ Consider the future design of retail and wholesale markets to facilitate new entrants while removing and avoiding potential barriers.
- ☐ Provide clarity on the direction and outcome of the NZ Battery Project as soon as possible to reduce uncertainty in the electricity market.
- ☐ Urgently develop strategies to unlock New Zealand's potential for offshore wind, hydrogen and distributed generation.
- ☐ Assess the feasibility of exempting new renewable projects from grid connection charges to facilitate investments.
- ☐ Facilitate the accelerated deployment of distributed energy resources, including by ensuring that distribution grids are fit-for-purpose and that the regulatory regime and data availability facilitate demand aggregation and demand response services.

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8. Coal

Key data

(2021)

Production: 2.9 Mt, 72 PJ, -42% since 2011

Net imports: 0.6 Mt, 7 PJ (1.8 Mt imports, 1.2 Mt exports)

TES: 3.2 Mt, 63 PJ (production + net imports - 0.3 Mt stock changes)

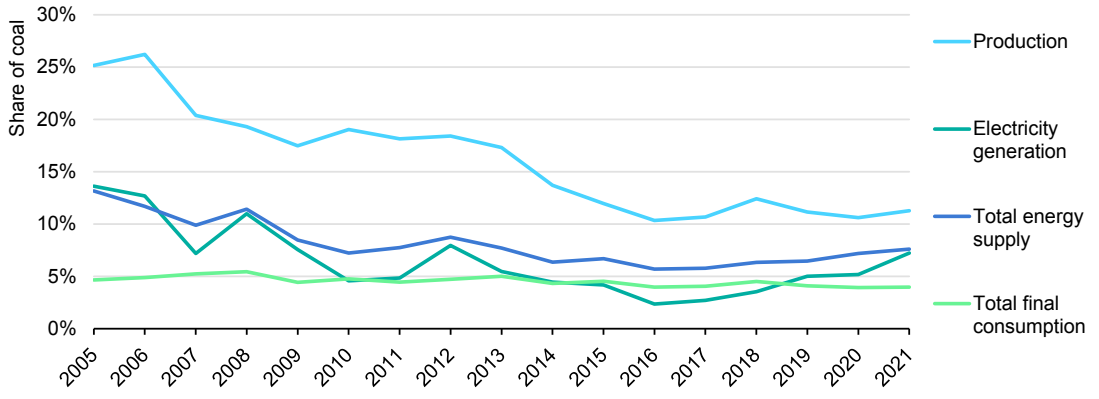
Share of coal: 11% of energy production, 8% of TES, 7.2% of electricity generation and 4% of TFC

Demand by sector: industry 61%, heat and electricity generation 38%, buildings 1%

Overview

The share of coal in New Zealand's energy mix has declined since 2005 (Figure 8.1). However, the share of coal has increased since 2017, reaching 8% of TES in 2021. Similarly, the share of coal in electricity generation has fallen since 2005, despite an increase from its low in 2017, to 7.2% in 2021. In 2022, New Zealand proposed a ban on new low to medium-temperature coal boilers and to phase out existing ones by 2037 (New Zealand Government, 2022).

Figure 8.1 Share of coal in different energy flows in New Zealand, 2005-2021



Coal's share in total final consumption remains constant but has increased in electricity generation and total energy supply.

Source: IEA (2023).

Coal supply and demand

TES from coal reached a low in 2016 but has started to increase since, and was 3.2 Mt in 2021 (Figure 8.2). From 2011 to 2021, total coal imports increased more than tenfold while total exports decreased by 43%. With production falling by 42%, coal in TES decreased by 7%. New Zealand was a net exporter of coal until 2020, when it became a net importer of 0.6 Mt. In 2020, net coal trade has been close to zero due to equal levels of exports and imports each year. Almost all (98%) coal imports in 2021 came from Indonesia, while coal exports are more diversified, even though data on coal exports by country have not been available since 2016.

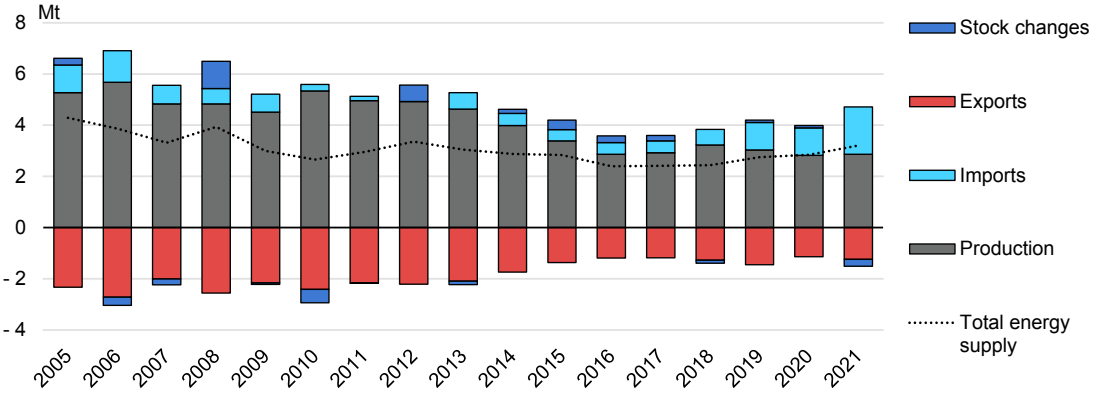
Coal production consists of different types of coal. In 2021, 46% of coal production was sub-bituminous coal, 44% coking coal and other bituminous coal, and 10% lignite.

Since 2012, the number of coal mines operating in New Zealand has declined from 25 to 14 operating mines in 2022. In January 2016, Roa Mining announced the closure of New Zealand's last operating underground coal mine due to the prolonged period of depressed premium hard coking coal prices.

The largest part of coal demand in 2021 came from industry (61%), followed by electricity and heat generation (38%) (Figure 8.3). Buildings accounted for a very small share of coal demand (1%).

The Huntly Power Station is New Zealand's only coal-fired generator and can switch between coal and natural gas at two 250 MW units. During periods of natural gas supply shortages (and high prices) and low hydro levels (such as in 2018), the station relies on coal to supply electricity.

Figure 8.2 Coal supply by source in New Zealand, 2005-2021



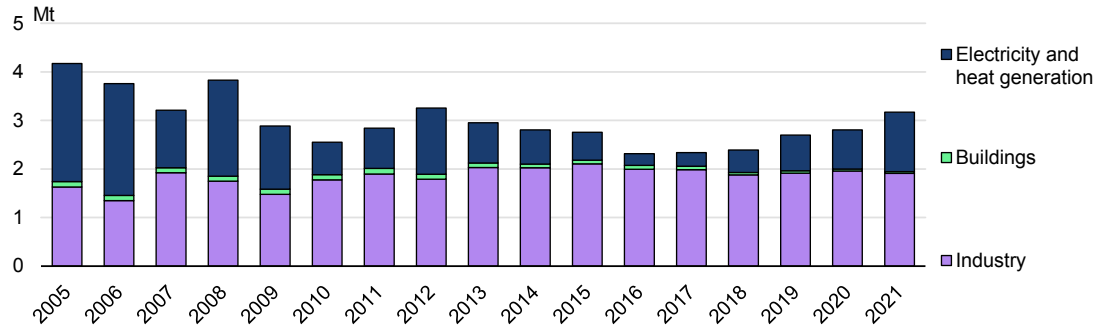
Since 2005, coal production has declined. Total energy supply rebounded in 2021, following increased imports.

Note: Mt = million tonnes.
Source: IEA (2023).

New Zealand's coal industry can be broadly divided into three markets: North Island domestic, South Island domestic and the export market. The North Island market is characterised by four large coal users and the current inability of domestic supply to meet demand. The South Island domestic market is characterised by numerous small coal

consumers that currently make importing coal uneconomic, and therefore supply meets demand on that island. In 2022, freight costs made it uneconomic for the South Island mines to supply coal to the North Island market. In general, all coking coal produced in New Zealand from the west coast coalfields is exported from the port of Lyttelton for use in the international steel-making industry.

Figure 8.3 Coal demand by sector in New Zealand, 2005-2021



The use of coal for electricity and heat generation has been trending downward since 2005.

Note: *Industry* includes energy use in industry sectors and transformation in coke ovens and blast furnaces.
Note: Mt = million tonnes.
Source: IEA (2023).

Coal policy

Coal mining policies

In New Zealand, legislation and regulation overseeing mineral exploration and development is dependent on the ownership of the minerals. While the Crown owns all gold, silver, uranium and petroleum by statute, non-statute minerals (including coal) can either be owned by the government or privately owned, with ownership tied to when the land was separated from the Crown.

The Crown Minerals Act 1991 sets the broad legislative framework for prospecting, exploration and mining of Crown-owned resources, including Crown-owned coal. The Act aims to promote the prospecting, exploration and mining of Crown-owned minerals for the benefit of New Zealand. It provides for the efficient allocation of rights, management and regulation of the rights, ensuring work is undertaken in accordance with good industry practice and gives a fair financial return to the Crown. The Crown Minerals Act is currently undergoing a review, with the intent to ensure it is in line with the government's overarching strategy.

A permit issued under the Crown Minerals Act does not grant access to the land or approval to undertake the proposed activities. Access to land is granted through an access arrangement (commercial contract), and approval from regional and district councils to undertake activities is given under the Resource Management Act 1991. For privately owned coal, exploration or mining activities still require the landowner's consent and approval for the activities under the RMA.

Solid Energy, New Zealand's state-owned coal mining company, was placed into voluntary administration in 2015 to allow for a structured and orderly liquidation of the company. In 2017, ownership and control of all but two operating mines (Huntly East and Spring Creek) were transferred to the new owners. Mines that were unable to be sold were closed and rehabilitated.

Coal mining companies in New Zealand require many other approvals under other pieces of legislation to operate a coal mine, in particular the Health and Safety at Work Act 2015 and associated mining regulations, the Climate Change Response Act 2002 and the subsequent Climate Change (Emissions Trading) Act 2008, in which coal producers are required to register and pay for carbon emissions associated with the mining (fugitive emissions) and with the combustion of their coal.

Coal demand reduction policies

In the electricity sector, the government relies on the carbon price stemming from the New Zealand Emissions Trading Scheme to increase the price of coal relative to natural gas to motivate fuel switching at the Huntly Power Station.

The government is working to reduce the demand for coal for process heat and electricity generation as part of the May 2022 Emissions Reduction Plan. This includes investigating options to manage dry year risk through the NZ Battery Project, a ban on new low- and medium-temperature coal boilers, as well as phasing out existing coal boilers by 2037. Initiatives that encourage fuel switching will further reduce the demand for coal.

The proposed national direction on industrial GHG as part of the RMA was put up for public consultation in 2021. The proposals would ban new low- and medium-temperature coal boiler installations, phase out existing coal use in low (<100°C) and medium (100°C<300°C) process heat by 2037, and require industrial sites to have GHG emissions plans when applying for resource consents that demonstrate how they are applying best practicable options to reduce emissions. The proposed national direction is expected to be in place in the first half of 2023. High-temperature coal users are not intended to be captured by the ban and phase-outs, as they do not currently have viable low-emissions alternatives.

Other measures are also expected to reduce the use of coal, including:

- the Government Investment in Decarbonising Industry Fund, which aims to accelerate the decarbonisation of industrial process heat
- support for businesses to decarbonise through the EECA's business programmes and funds
- developing an action plan for decarbonising industry by the end of 2024
- developing a mandatory energy and emissions reporting scheme for large energy users by mid-2024
- electricity market measures to support the energy transition and the NZ Battery Project
- the NZD 220 million State Sector Decarbonisation Fund that aims to increase energy efficiency and the use of renewable energy in the state sector.

In addition, New Zealand is a signatory to the 2017 Power Past Coal Alliance, the 2021 Global Coal to Clean Power Transition Statement, the 2021 No New Coal Power Compact and the 2021 Proposal on Ending Coal Support within the OECD Export Credit Arrangement.

Coal subsidies

There are no subsidies for coal production or consumption in New Zealand (other than ETS units allocated to trade-exposed industries). In 2021, the Ministry for the Environment announced a review of the ETS settings with a particular focus on the allocation of units to trade-exposed industries. Work on this review is still underway. In 2022, the government announced that it would be making changes to industrial allocation and plans to change the baseline rates used to calculate the allocation of free climate credits to New Zealand businesses operating under the scheme.

Since 2009, the New Zealand government has committed to the Asia-Pacific Economic Cooperation leaders' pledge "to rationalise and phase out inefficient fossil fuel subsidies that encourage wasteful consumption while recognising the importance of providing those in need with essential energy services."

As part of the 2013 support package and 2015 voluntary administration and liquidation process of Solid Energy, the government indemnified Solid Energy for rehabilitation obligations of its mine sites up to September 2014. The total net present value of these indemnities was NZD 103 million. It has been argued that these indemnities constituted a subsidy to the new private owners of the former Solid Energy mines. However, in their September 2015 peer review on fossil fuel subsidy reforms in New Zealand, the APEC reviewers noted that since the government does not set or subsidise prices and because consumers in New Zealand are not required to purchase coal from Solid Energy, this does not constitute a subsidy.

Assessment

The share of coal in New Zealand's energy mix has declined since 2005. However, after reaching a minimum share of coal in TES at 5.7% in 2016, it started to increase in 2017, reaching 8% in 2021. This was driven mainly by changes in the use of coal in electricity generation, which was 2.4% in 2016 and rebounded to 7.2% in 2021. Electricity accounted for 38% of coal demand in 2020, while the largest part of demand comes from industry (61%). Industry uses coal notably to produce low-medium temperature heat for food processing and high-temperature heat for cement and steel making.

Domestic coal production used to be higher than domestic demand, but it has decreased over time. In 2021, New Zealand became a net importer of coal for the first time, with imports coming mainly from Indonesia. Since 2012, the number of coal mines operating in New Zealand has declined from 25 to 14 operating mines today. Most mines are relatively small and, when depleted, can be replaced by opening another mine nearby if governments allow. In January 2016, Roa Mining closed New Zealand's last operating underground coal mine due to the prolonged period of depressed premium hard coking coal prices.

New Zealand is a signatory to the 2017 Power Past Coal Alliance, the 2021 Global Coal to Clean Power Transition Statement, the 2021 No New Coal Power Compact and the 2021 Proposal on Ending Coal Support within the OECD Export Credit Arrangement.

Nationally, the government is working to reduce the demand for coal in industry. This includes a planned ban on new low- and medium-temperature coal boilers, as well as phasing out existing coal boilers by 2037 through a National Environmental Standard to guide regional councils taking decisions under the RMA. Initiatives that encourage fuel switching to low-carbon fuels in other industries will further reduce demand for coal. Such initiatives can be supported through the GIDI Fund, which aims to accelerate the decarbonisation of industrial process heat, and through the EECA's business programmes and funds. The government is developing an action plan for decarbonising industry and a mandatory energy and emissions reporting scheme for large energy users, both by 2024.

Unlike some other IEA countries, the government has not imposed the phase-out of coal in electricity generation. Instead, the government is making coal burning less attractive through the ETS, which creates a price signal to incentivise natural gas instead. But when hydropower and/or natural gas is scarce and expensive, as in 2018-21, the power plant switches back to coal to ensure security of electricity supply. As gas and coal-fired generation provide flexible electricity production that can compensate for insufficient hydro generation in a dry year, the government is looking into alternative flexibility options and launched the NZ Battery study.

The Climate Change Response Act 2002 and subsequent Climate Change (Emissions Trading) Act 2008 require coal producers to register and pay for carbon emissions associated with mining (fugitive emissions) and with the combustion of their coal. Trade-exposed industries can get part of their ETS allowances for free. In 2021, the Ministry for the Environment announced a review of the ETS settings, with a particular focus on the free allocations to trade-exposed industries. Work is still underway on this review.

Recommendations

The government of New Zealand should:

- ☐ Evaluate whether existing policies provide enough incentives for a phase-out of coal in electricity generation by 2030, in line with the aspirational 100% renewable electricity target, and develop additional incentives if needed.
- ☐ Engage with local communities and mining companies to ensure a smooth transition in coal regions when coal mines are closed.

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IEA (International Energy Agency) (2022), World Energy Balances (database), https://www.iea.org/data-and-statistics/data-product/world-energy-balances (accessed on 19 September 2022)

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9. Natural gas

Key data

(2021)

Natural gas production: 4.0 bcm; -9% since 2011

Share of natural gas: 24% of energy production, 17% of total energy supply, 11% of electricity generation, 17% of total final consumption

Demand by sector: industry 62.7%, power generation 27.7%, service sector buildings 4.9%, and residential buildings 4.6%.

Overview

Natural gas makes a significant contribution to New Zealand's energy mix and its economy. It underpins electricity supply security, supports a sizeable petrochemicals sector, and is used by many export industries and close to 300 000 consumers.

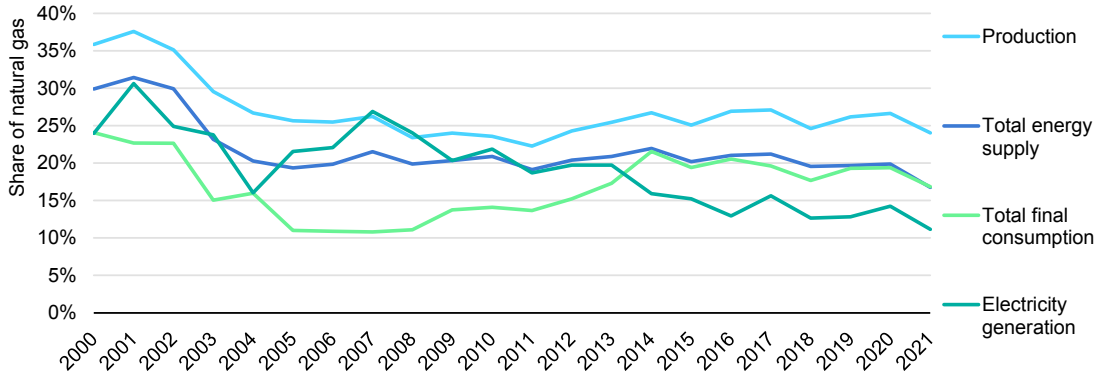
While in 2000, the share of natural gas in total energy production still stood at 36%, it has fallen ever since, with only small fluctuations. In 2005, it was close to 26% and decreased to 23% in 2011 before rebounding to slightly above 25% for most of the 2010s. It levelled at 24% in 2021 (Figure 9.1). The share of natural gas in TES nearly halved from 30% in 2000 to 17% in 2021, while its share in TFC reached 17% in 2021, down from 24% in 2000. The share of natural gas in electricity generation declined from 24% in 2000 to 11% in 2021.

New Zealand neither exports nor imports natural gas and does not have any infrastructure to support gas trading. All domestic natural gas production is consumed in the country, and annual consumption thus varies depending on availability. Limited gas supply in 2021 led to higher levels of coal being used for electricity generation instead of natural gas. Greater availability of natural gas may lead to increased gas use in electricity generation in years that hydropower generation is lower due to reduced water inflows.

The government's forecast for natural gas projects a steady production downtrend over the coming decade. While gas supply has recently shown signs of improvement from field development work after technical constraints experienced in 2021 and is expected to increase again to over 200 PJ[4] in 2023-2024, it will drop sharply after that to around 75 PJ by 2030, around half of today's levels. This will force a commensurate drop in demand that may be especially challenging in industry. However, there is uncertainty around production profile trends for the future – these are a function of investment and ongoing field development work.

[4] The IEA uses a conversion factor of 40 PJ per 1 billion cubic metres of natural gas (1 bcm=40 PJ; 1 PJ=0.025 bcm).

Figure 9.1 Shares of natural gas in New Zealand's energy system, 2000-2021



In 2021, the shares of natural gas dropped for electricity generation, total energy supply and production.

Source: IEA (2023).

Natural gas supply and demand

Supply

Domestic production of natural gas was 143 PJ (4.0 bcm) in 2021. After a peak at 223 PJ (6.4 bcm) in 2001, gas production declined, fluctuating between 135 PJ and 180 PJ per year from 2000 to 2021. Since the IEA's last in-depth review, gas demand peaked in 2017 (at around 174 PJ) and declined to 142 PJ in 2021. This has been driven by a technical problem limiting production at the Pohokura field.

New Zealand is self-sufficient in terms of gas supply, and a steep decline in production at existing fields is expected to result in only 75 PJ of output in 2030 (although uncertainty remains as to the exact volumes). Moreover, in April 2018, the government announced that no further offshore oil and gas exploration permits would be granted, preparing for a gradual shift away from natural gas in the country to address climate change.

A potential faster-than-expected wind down of gas production will have implications for decommissioning of producing (and exploratory) wells, as well as for the repurposing of existing gas infrastructure. A 2021 amendment to the Crown Minerals Act introduced more stringent requirements for decommissioning fields, which will help limit the government's potential liability for these activities. Nonetheless, there will still be a number of challenges related to phasing out gas and repurposing the existing infrastructure for alternative uses, such as renewable gases or hydrogen.

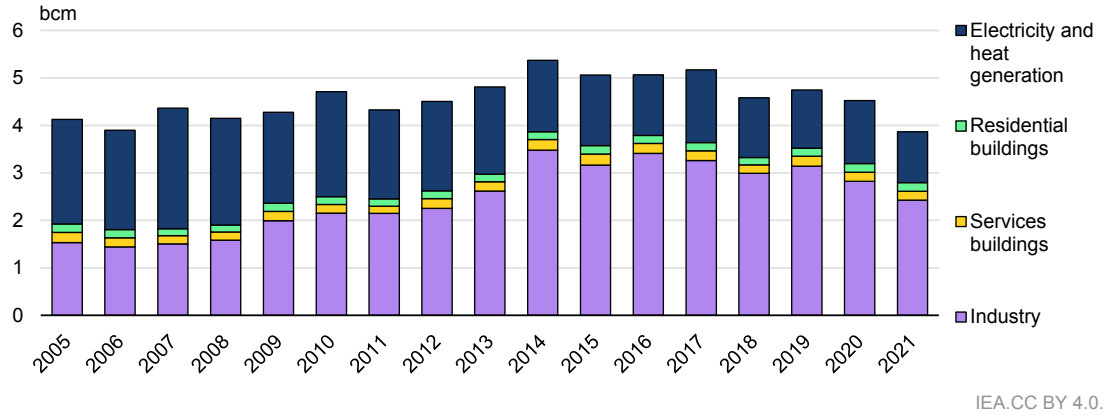
Demand

New Zealand's consumption of natural gas stood at 3.9 bcm in 2021 (Figure 9.2). For most of 2000-21, the industry sector was the largest consumer of natural gas, accounting for 53% of consumption on average throughout the period. Electricity and process heat is the second main gas-consuming sector in the country, covering on average 39% of demand for the 2000-21 period. In 2021, the industry sector covered 62.7% of natural gas demand, electricity and heat generation 27.7%, followed by services buildings at 4.9%, and residential buildings at 4.6%.

The closure of two major gas users in 2022, Norske Skog's Tasman Paper Mill and the petroleum refinery at Marsden Point, will lead to reduced overall gas demand from baseline levels in the future. As gas supply improves from field development work (notably at the Maui and Pohokura fields), it is expected that the overall level of demand will increase again but may not reach the levels that it has hit historically.

Methanex (the world's largest producer and supplier of methanol) is New Zealand's largest gas user, consuming approximately 45% of the country's natural gas supply per annum. As the largest consumer by a very large margin, the overall level of gas demand is highly influenced by Methanex's activities (such as scheduled and *ad hoc* maintenance work or technical failures). In response to limited gas supply conditions, Methanex mothballed its Waitara Valley methanol plant in early 2021. This was the smallest of Methanex's three plants in New Zealand and contributed to the reduced level of gas demand in 2021 and 2022.

Figure 9.2 Natural gas demand by sector in New Zealand, 2005-2021



Natural gas demand comes mainly from the industry sector.

Notes: bcm = billion cubic metres. *Industry* includes non-energy use and uses for the energy sector, apart from electricity and heat generation.

Source: IEA (2022).

Natural gas industry structure

First Gas is the sole transmission system operator in New Zealand. After it purchased the transmission assets of Maui Development Ltd and Vector Gas Ltd in 2016, the company has effectively become the country's key gas player and is integrated across the transmission, distribution and gas storage components of the gas industry.

The Gas Industry Company (GIC) is the industry body (owned by industry shareholders) and co-regulator under the country's co-regulatory model, in which downstream gas governance arrangements are developed in a partnership between industry and the government. GIC monitors activities and developments in the wholesale market. It can propose approval by the Minister of Energy and Resources for regulated or non-regulated governance arrangements consistent with the government's objectives. The Gas Act 1992 requires that the Board of GIC has a majority of independent directors; as a result, it comprises seven directors: four are independent and three are associated with industry stakeholders (usually senior executives of industry participants). GIC is

financed by a gas industry levy and market fees as stipulated by the Gas Act, as well as by an annual fee paid by industry shareholders.

Wholesale market policies and structure

The New Zealand wholesale market is small and relatively concentrated. Competitive tendering for gas supply occurs, and industry participants have not raised any specific concerns about buying or selling gas as a commodity. Several producers and wholesalers are active in the market. Some producers sell gas directly to end users. Wholesale gas trading is characterised by a predominance of bilateral contract arrangements.

Secondary trading has traditionally also been arranged bilaterally between parties. Accordingly, for both primary and secondary trading, there is no transparency of terms enabling price discovery or other information, such as volume or trading.

Since 2013, emsTradepoint, a subsidiary of the national electricity grid owner/operator, Transpower, has operated a wholesale gas-trading platform for same-day and future-dated delivery contracts. The platform provides a degree of price transparency for short-term gas trade and has strong year-on-year volume growth but still represents a very small proportion (<5%) of wholesale gas volumes sold.

Retail market policies and structure

The retail gas market continues to grow, with 25 000 additional consumers in the past five years. The gas network is also steadily growing, with over 300 000 individual connections. Twelve retail brands compete in the New Zealand market, but Nova Energy, together with Genesis Energy and Greymouth Gas, held some 75% of retail gas volumes in 2021. Of the 12 retail brands, Greymouth Gas and On Gas supply only commercial and industrial users and are also the only two gas companies not engaged in selling electricity.

Market contestability has strengthened, and over 99.8% of gas consumers have a choice of seven or more retailers, which translates into an annual switching rate of about 14.2%. Stronger retail competition is also evidenced by reduced market concentration, reflecting new retailers entering the market and smaller retailers increasing their market share.

The industry is performing well against government policy objectives for the retail market and the protection of small consumer interests. A retail contract evaluation scheme introduced by GIC in 2010 has resulted in a major improvement in the transparency of retailers' supply arrangements with small consumers. A suite of other market improvements benefiting small consumers includes a switching regime to enable consumers to efficiently change their retail supplier and the implementation of a formal consumer complaints scheme through utilities disputes.

Retail pricing

Retail gas prices in New Zealand are largely unregulated. The Commerce Commission (see below) sets the maximum revenue each transmission and distribution operator can collect from their customers and the minimum quality standards they must maintain. New Zealand's 15% GST tax also applies to natural gas prices paid by consumers.

Gas prices vary considerably across different customer segments. This is due to commercial pricing strategies, as retail gas prices are not set by regulation.

While there are no subsidies for natural gas consumption in New Zealand, a Winter Energy Payment scheme is available for eligible individuals to help with the cost of heating their

homes over the winter months (1 May-1 October). People do not have to apply for this support; it is paid automatically to all entitled households together with other payments from the government (including Jobseeker Support, Sole Parent Support or the Emergency Benefit). It is available to around 850 000 people at a rate ranging from NZD 20.46 to NZD 31.82 a week.

Natural gas regulation and policy

The Gas Act of 1992 is the primary legislation governing the gas industry in New Zealand. In relation to the Gas Act, the Minister of Energy and Resources has a range of statutory powers for sector regulation.

The MBIE has the primary responsibility for advising the minister/government on energy and resources policy. With respect to gas, its responsibilities include the Crown Minerals Act (upstream), the Gas Act (primarily downstream) and the role of gas as a thermal fuel. It also includes policies relating to competition and energy safety.

The Commerce Commission is the primary competition regulatory authority. Its responsibilities include economic controls on natural monopoly infrastructure services, like electricity lines, gas pipelines, telecommunications and airports.

Recent reforms in the gas market have focused on the disclosure of production information following several prolonged gas supply outages in 2018 and 2019. An amendment to the Gas Act enables regulation of disclosure of information, such as planned and unplanned outages.

GIC has subsequently recommended a regulated information disclosure regime for the disclosure of gas production and storage facility outages, following gas producers who have implemented a voluntary code for the disclosure of outages. This new regulated information disclosure regime is expected to come into force in April 2023.

GIC also reviewed the application of the government's Electricity Price Review recommendations to the retail gas market. This review did not identify any significant changes to the retail gas market but proposed some additional guidance for retailers on their interactions with vulnerable consumers. This will ensure that processes in the gas and electricity market are broadly aligned.

Emissions Reduction Plan and Gas Transition Plan

Since the IEA's last in-depth review, New Zealand has implemented stronger and more ambitious climate policies (see Chapter 3). Decarbonisation will necessarily require a reduction in emissions associated with natural gas, which is likely to lead to a substantial reduction in its use. Emissions reductions are likely to occur through lower demand (for example, greater energy efficiency, electrification) and lower carbon intensity (for example, blending in renewable gases).

Natural gas plays an important role in the electricity sector, displacing coal-fired generation. The Huntly Power Station is New Zealand's only coal-fired electricity generator and can fuel switch between gas and coal. The availability of gas reduces the consumption of coal at the site and reduces overall emissions for the electricity sector.

The pace for phasing out natural gas and the "end-state" of the sector is currently uncertain and is dependent on a range of factors, such as emissions pricing, technological adaptation and other economic factors.

Decarbonisation will necessarily require lower emissions associated with natural gas, which is likely to lead to a substantial reduction in its use. A key policy to deter gas consumption is the Emissions Trade Scheme price, which adds to the price of natural gas for consumers.

To achieve further emissions reductions from natural gas, GIC and the MBIE are developing a Gas Transition Plan. The purpose of the GTP is to establish transition pathways for decarbonising the gas sector in line with the first three emissions budgets defined in the Emissions Reduction Plan. The plan will be a key input into a broader Energy Strategy and will show how emissions from gas can be reduced in line with targets in legislation and with New Zealand's international commitments. The plan is also expected to establish a strategic view on the potential role of renewable gases, including potential measures for accelerating their uptake, and for carbon capture and utilisation technology. New Zealand has already looked into possible carbon capture, utilisation and storage activities in the country, especially using depleted gas fields to store carbon dioxide. The GTP is expected to be completed by the end of 2023.

Biogas and biomethane

While the full GTP focuses on setting out fossil gas transition pathways, its second pillar establishes a strategic view on the potential role of renewable gases and measures for accelerating their uptake. This includes the role of biogas/biomethane in the energy system and measures to accelerate its uptake.

There is one major biogas project underway in New Zealand. Ecogas' Reporoa biogas/biomethane facility opened in October 2022, and the biomethane upgrade unit will be commissioned in 2023. The NZD 30 million Reporoa facility will turn 75 000 tonnes of organic food waste from businesses and kerbside food scrap collections throughout the North Island into biogas, equivalent to the natural gas consumption of 2 500 homes and businesses.

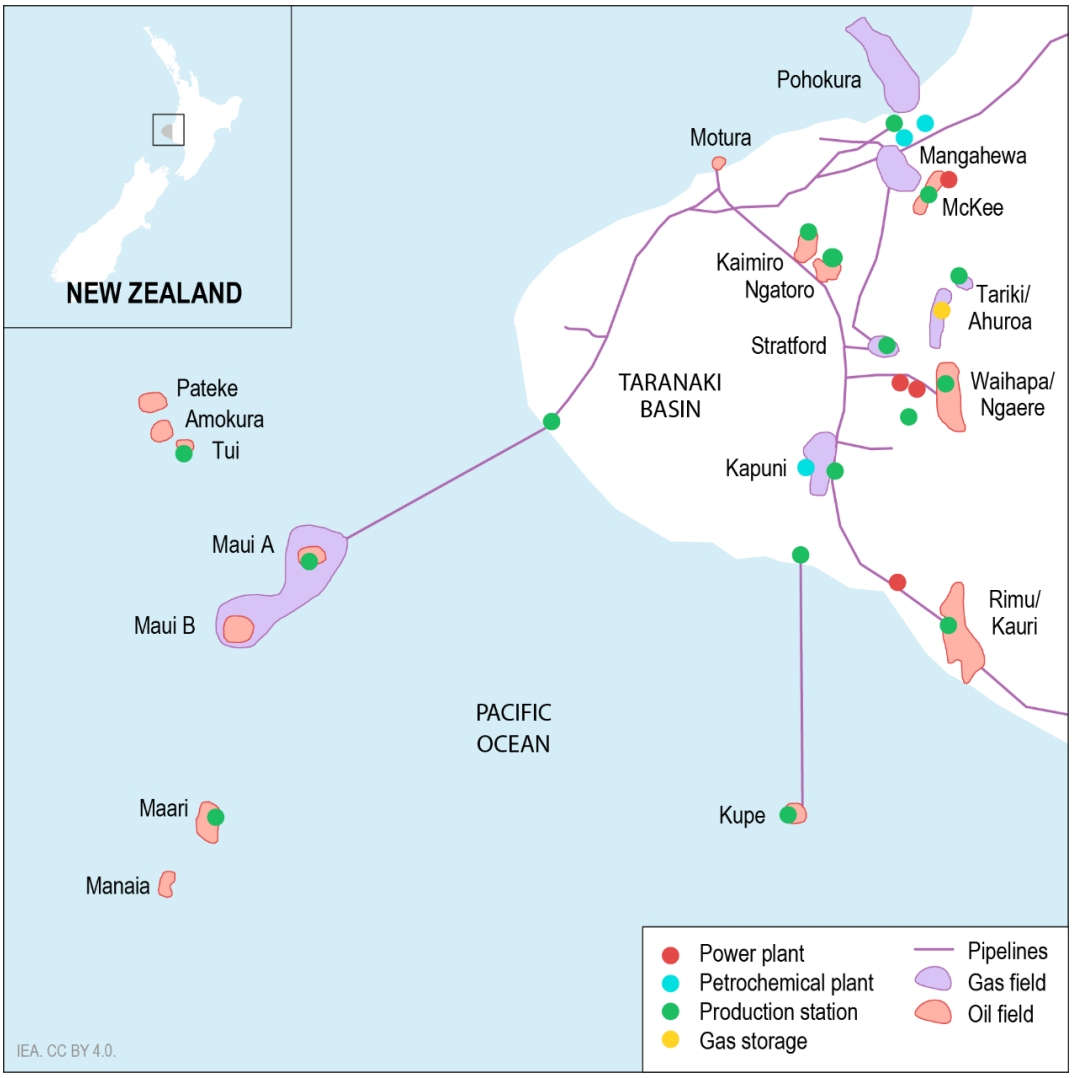
However, the country's potential is much higher. A report from Beca consultants into biogas feedstock availability in New Zealand commissioned by First Gas, Fonterra and the Energy Efficiency and Conservation Authority in 2021 shows a high level of natural gas displacement potential of around 17 PJ per year, or some 10% of current production and consumption of natural gas. This is equivalent to the yearly natural gas consumption of residential and commercial consumers and could offset half of today's residential gas emissions.

Natural gas infrastructure

Upstream

The upstream part of New Zealand's gas sector includes gas exploration and production as well as some aspects of gas processing activities. This sector is governed primarily through the Crown Minerals Act 1991 and administered by the MBIE. Gas in New Zealand is produced from 15 fields, all within the Taranaki Region (Figure 9.3), with the Pohokura and Maui fields dominating production.

Figure 9.3 Upstream gas production in New Zealand



New Zealand's major gas fields and their respective owners include:

- Pohokura (operated by OMV New Zealand Ltd and Todd Energy Ltd)
- Mangahewa/McKee (Todd Energy Ltd)
- Turangi (Greymouth Petroleum Ltd)
- Kupe (Beach Energy Ltd, Genesis Energy Ltd, NZOG Ltd)
- Maui (OMV New Zealand Ltd)
- Kowhai (Greymouth Petroleum Ltd).

OMV and Todd Energy control almost 75% of gas production in New Zealand, holding some 40% and 35% of market shares, respectively.

Transmission

First Gas owns and operates New Zealand's high-pressure gas transmission system, which transports natural gas from Taranaki to industrial consumers throughout the North Island through 2 513 km of pipelines, with approximately 137 km installed in urban areas and the remainder in rural areas (Figure 9.4).

The transmission system is divided into two sub-systems:

- 309 km Maui pipeline from Oaonui, in south-west Taranaki, to near the Huntly Power Station
- 2 204 km of the former Vector pipeline system; this system transports gas more widely throughout the North Island and connects power plants and other industrial customers.

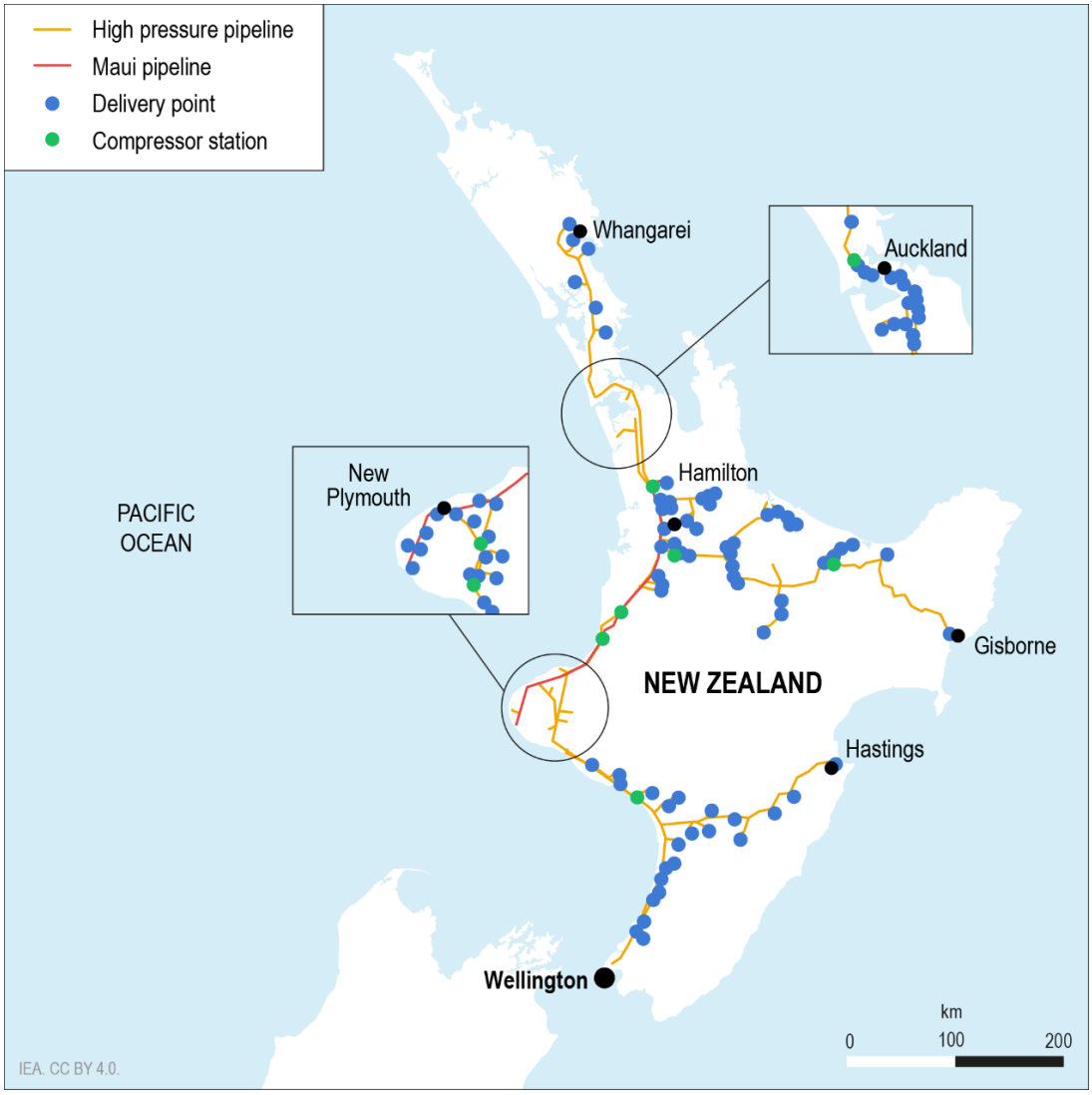
Distribution

The 17 500 km gas distribution network is owned by four distribution companies. First Gas operates more than 4 800 km of gas distribution networks across the North Island, while Powerco, Vector and GasNet own and operate the remainder.

Third-party access

Although gas substantially contributes to New Zealand's primary energy supply, the country's gas industry itself is small by international comparison. Access regimes have consequently been built on fit-for-purpose codes and contracts rather than formal regulations generally found in larger jurisdictions.

Figure 9.4 Natural gas transmission infrastructure in New Zealand



Storage

New Zealand has one gas storage facility – the Ahuroa Gas Storage Facility, owned by FlexGas (a subsidiary of First Gas). The capacity of Ahuroa is up to 18 PJ in an underground reservoir, covering just over 10% of the country's annual demand.

The facility enables FlexGas to inject and store gas on behalf of others in the reservoir during periods of low demand, such as during summer when electricity demand is low or when renewable energy is abundant, and extract it during periods of high demand. The facility bridges the gap between the way gas fields would like to produce, with steady demand, and the way in which the energy market uses gas, when it is needed. In September 2020, the facility underwent a major upgrade. The commissioning of three new gas compressors and a gas dehydration unit has allowed the facility to increase its daily gas injection and gas extraction rates to 65 terajoules (TJ) per day.

To date, the Ahuroa storage facility has played a relatively small part in the gas sector. However, it is expected to play an increasingly important role over time, with the depletion of several of the larger gas fields.

Gas emergency policy

Gas emergency response organisation and decision making

The National Emergency Management Agency has shared responsibilities with the MBIE to respond to infrastructure emergencies in the natural gas sector.

The decision to establish the National Emergency Management Agency was part of the government's response to a ministerial review into better responses to natural disasters and other emergencies, commissioned after the November 2016 earthquake and tsunami and the 2017 Christchurch fires. The National Emergency Management Agency replaced the Ministry of Civil Defence and Emergency Management to provide for greater flexibility and autonomy. The government has also given the National Emergency Management Agency an important stewardship role that requires it to lead and co-ordinate across the emergency management system (including central and local government) for all hazards and all risks.

The legal framework for gas security in New Zealand is set out in the Gas Governance (Critical Contingency Management) Regulations 2008 (CCM Regulations), administered by the MBIE. The regulations aim to effectively manage critical gas outages and other security of supply contingencies without compromising long-term supply security. The CCM Regulations achieve this principally through the appointment of a critical contingency operator (CCO), who has a range of powers, particularly to curtail gas consumption during critical contingencies.

The CCM Regulations require the TSO to produce a Critical Contingency Management Plan (CCMP), which sets out actions the TSO will take to implement the CCO's curtailment directions and communicate with gas distributors, retailers, large consumers and other stakeholders during a critical contingency. The CCMP also contains information about pipeline pressures that would trigger a critical contingency.

The roles of the CCO include:

- determine and declare the onset of a critical contingency
- call for load curtailment as required to balance the system
- monitor the supply/demand balance and adjust load curtailment directions as necessary
- determine when it is safe to terminate a critical contingency.

Gas emergency preparedness

The Gas Governance Regulations of 2008 require the CCO to conduct annual exercises to test the effectiveness of the TSO's CCMP unless there has been a critical contingency in the previous 12 months that has effectively acted as a test. Since First Gas took ownership of the pipelines in 2016, there have been seven exercises. Following each of these test exercises, the CCO produces a report that evaluates the effectiveness of the CCMP and identifies areas in which the CCMP and other critical contingency arrangements can be improved.

All seven exercise reports concluded that the CCMP substantially complies with the CCM Regulations and is effective in achieving the purpose of the regulations. The recommendations made in each of the reports have been incorporated into processes and included in an updated version of the CCMP for the purpose of continuous process improvement.

The Gas Industry Company's supply and demand reports set out projections for medium-term supply and demand and an indication of short- and medium-term gas availability for contingency preparedness. While N-1 assessments of the gas system are not performed in New Zealand, the TSO has continuously found information on network adequacy to be sufficient.

Recent emergencies

There have not been any recent supply disruptions that have caused security of supply emergencies. However, there were two unplanned outages at the Pohokura production facilities in 2018 that provided useful lessons for the industry. The first was a pipeline outage that occurred in March 2018 and resulted in volumes dropping by about 100 TJ per day, or almost 50% of the field's output. The second was a shutoff valve outage in September of the same year, which caused a similar drop in production.

During the first event, Methanex was able to bring forward planned maintenance and scale back gas consumption. In the second event, Methanex again scaled back consumption but was not able to reduce to the same level as in the first event. In both events, the decrease in production at Pohokura was similar, but the second event had visible impacts on the market. During the second event, which occurred at a time of low hydrology, volumes offered on emsTradepoint dropped, and prices markedly increased, indicating tightened supply conditions.

These events highlighted the fact that the small and concentrated nature of New Zealand's gas production sector means that an outage at one of the main gas fields can have a significant effect on gas market conditions.

Emergency response measures

Supply-side measures

New Zealand has limited flexibility to increase domestic production. The nature of its gas fields is such that there is limited flexibility in field deliverability that would increase gas supply in an emergency.

New Zealand has no emergency gas stocks. However, market participants do keep some gas volumes for their purposes at the Ahuroa Gas Storage Facility.

New Zealand does not have infrastructure in place to import natural gas from other jurisdictions. There is an ability to import LPG. While this can be mixed in small proportions into the transmission system to boost the supply of natural gas, this is not generally conducted.

Demand-side measures

There are no significant interruptible contracts in place in New Zealand. One interruptible user contract is in place, and three other small contracts are in place that enable gas wholesalers to move gas from one section of the transmission system to another. Interruptible contracts allow FirstGas to disrupt gas supply with relevant parties. In return, these parties get a discounted rate for the inconvenience.

Limited fuel switching is possible. The Genesis Energy Huntly Power Station has units that can operate on either gas or coal. These currently play an important role in helping New Zealand meet winter electricity demand peaks. Coal is an option if the gas supply to this plant is restricted.

Load shedding was introduced as part of the Gas Governance (Critical Contingency Management) Regulations 2008. The regulations detail a process for mandatory load shedding and offer incentives for voluntary load shedding and increasing supply through a contingency price mechanism. They also enable the establishment of the CCO.

Assessment

Natural gas makes a significant contribution to New Zealand's energy mix and to its economy. It underpins electricity supply security and industrial operations and is used by close to 300 000 consumers.

New Zealand has no international gas connections and must be self-sufficient in terms of natural gas supply, so national consumption depends on domestic production levels. The upstream part of New Zealand's gas sector includes gas exploration and production as well as some aspects of gas processing activities. This sector is governed primarily through the Crown Minerals Act 1991 and is administered by the MBIE. Gas in New Zealand is produced from 15 offshore and onshore fields geographically limited to the Taranaki Region of the North Island. Austrian OMV and local Todd Energy control almost 75% of gas production in New Zealand, holding around 40% and 35% of the market share, respectively. In the last decade, natural gas production peaked in 2014 at close to 184 PJ (5.2 bcm) and has declined sharply since then by 25% to reach 142 PJ (3.9 bcm) in 2021.

The government forecasts a steady decline in production over the coming decade. Gas supply increased over 2022 after field development work in 2021 and is expected to rise again to over 200 PJ in 2023-2024. Production will then start a steep decline to around 75 PJ by 2030, or around half of today's levels; however, uncertainty about the exact volumes remains. This will force a proportionate drop in the use of gas.

Industry is the largest gas-consuming sector in New Zealand (62.7% in 2021), followed by electricity and heat generation (27.7%), services buildings (4.9%), and residential buildings (4.6%). The largest gas consumer in New Zealand is Methanex, which is responsible for around 45% of the country's natural gas use. As such, Methanex may choose to reduce demand when gas availability in the market decreases, or when wholesale electricity prices are high, and sell gas to the electricity sector.

Decarbonisation will require lower emissions associated with natural gas, which is likely to lead to a substantial reduction in its use. To achieve emissions reductions from natural gas, GIC and the MBIE are developing a Gas Transition Plan. The purpose of the GTP is to establish transition pathways for decarbonising the gas sector in line with the first three emissions budgets defined in the Emissions Reduction Plan. The plan will be a key input into a broader Energy Strategy and will show how emissions from gas can be reduced in line with targets in legislation and with New Zealand's international commitments. The plan is also expected to establish a strategic view on the potential role for renewable gases, which have not yet started contributing to climate targets nationwide. Previous assessments of biogas production potential in New Zealand have uncovered 17 PJ of resources that could be tapped as part of this strategic view.

The application of carbon capture, utilisation and storage on large-scale installations that use natural gas would be in line with the government's climate policy. New Zealand has emptied gas fields that are suitable for CO_2 storage. As such, the government could investigate whether continued gas use for electricity generation, coupled with carbon capture, utilisation and storage, could be an option to provide flexibility to the grid when penetration of variable renewables becomes mainstream and to overcome the "dry year" problem when water inflows to hydropower stations are lower.

On the upstream side, in April 2018, the government announced it would no longer grant new offshore oil and gas exploration permits as a step toward addressing climate change and creating a sustainable future for New Zealand. This will result in a gradual reduction of exploration and production, which requires thoughtful planning given the role domestically produced natural gas has played in the electricity and industry sectors to date.

New Zealand's gas regulatory framework has the unique feature of being governed by regulations and rules jointly developed by GIC and the government. GIC represents private market players and can propose regulated or non-regulated governance arrangements consistent with the government's objectives. Regulated arrangements from GIC are subject to approval by the Minister of Energy and Resources.

New Zealand's natural gas market is fully liberalised. Since the IEA's last in-depth review, the private company First Gas has become an important stakeholder in the country, after having taken over assets from other players. First Gas owns and operates the country's gas transmission system and is the designated TSO. It is also one of the largest distribution companies and owns the only gas storage site in the country. While this model may serve the market well, close monitoring by the government is essential to ensure customer protection and infrastructure resilience in view of expected significant changes to gas usage patterns.

Natural gas is transmitted in New Zealand by two open-access, high-pressure transmission pipeline systems owned by the TSO to virtually all regions of the North Island then delivered to consumers through lower pressure local distribution networks. The networks of gas distribution pipelines are owned by four distribution companies, and network access regimes have fit-for-purpose codes and contracts rather than formal third-party regulations generally found in larger jurisdictions.

The New Zealand wholesale market is relatively concentrated, with a limited number of producers and wholesalers active in the market. However, industry participants have not raised any specific concerns about buying or selling gas. Wholesale gas trading is characterised by a predominance of bilateral contract arrangements, with less than 5% of volumes traded on a wholesale gas-trading platform.

The retail gas market continues to grow, with around 25 000 new consumers in the past five years. Twelve retail brands compete in the New Zealand market, but Nova Energy, together with Genesis Energy and Greymouth Gas, held roughly 75% of retail gas volumes in 2021. Still, market contestability has strengthened, and nearly 100% of gas consumers have a choice of seven or more retailers. Gas customer switching totalled over 44 000 between July 2021 and June 2022. Annual customer churn has increased from 5% to 14% over the last five years.

Recommendations

The government of New Zealand should:

- ☐ Expedite the finalisation of the Gas Transition Plan to quickly provide clarity to the market on the role of natural gas in the economy over both shorter and longer time horizons.
- ☐ Leverage the country's sizeable potential, including in the agriculture sector, to stimulate increased biomethane production to offset declines in natural gas production and lower emissions from the gas supply.
- ☐ Ensure that a possible wind-down of natural gas production is accompanied by a robust decommissioning and/or repurposing strategy for both upstream and downstream infrastructure.

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IEA (International Energy Agency) (2022), World Energy Balances (database), https://www.iea.org/data-and-statistics/data-product/world-energy-balances (accessed on 19 September 2022)

10. Oil

Key data (2021)

Crude oil production: 21 kb/d, -55% since 2011

Net imports of crude oil*: 55.9 kb/d (total imports 67.5 kb/d, total exports 11.6 kb/d), -13% since 2011

Domestic production of oil products: 92 kb/d, -19% since 2011

Net imports of oil products: 60.4 kb/d, +71% since 2011

Share of oil: 48% of TFC, 34% of TES**, 7% of domestic energy production and 0.1% of electricity generation

Oil consumption: 146 kb/d (domestic transport 70%, industry including non-energy consumption 19%, international bunkering 5.7%, buildings 5.2%, electricity and heat generation 0.1%)

* Imports/exports of crude oil includes crude oil, natural gas liquids and feedstock.

** Total energy supply does not include oil used for international bunkering.

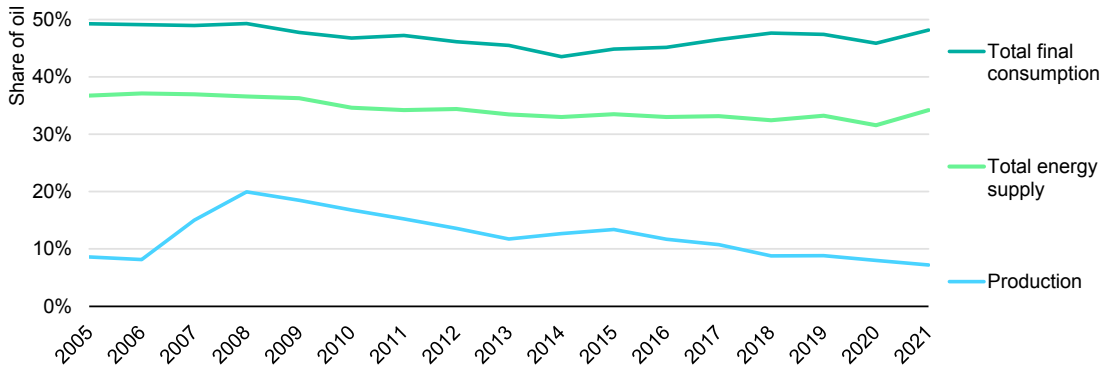
Overview

New Zealand's shares of oil in its energy supply and overall demand (TFC) have been steady since 2005, accounting for 31% of TES and 46% of TFC in 2021 (Figure 10.1). In 2021, oil covered almost all of transport demand (99.8%) and had significant shares in industry (22%) and buildings (11.4%). New Zealand has very limited domestic crude oil production, and the share of oil in domestic energy production has been steadily declining since 2008.

New Zealand's oil sector has undergone significant changes since the last IEA review in 2017. The closure of the only refinery is forcing changes to traditional distribution patterns. In addition, the strong slowdown in oil production and the ban on new offshore production licences effective from 2018 means that New Zealand's upstream sector is shrinking and will be marginalised over the next decade, in line with the country's ambitious emissions reduction targets.

However, liquid fuels like petrol, diesel and jet fuel are still essential for industry, business and New Zealanders' day-to-day activities. The government regularly commissions reviews of the fuel system to assess risks and identify ways to improve security of supply.

Figure 10.1 Shares of oil in New Zealand's energy sector, 2005-2021



Oil represents almost half of New Zealand's total final consumption and its share has only slightly decreased since 2005.

Source: IEA (2023).

Oil supply and demand

Crude oil production and trade

Total indigenous crude oil production in 2021 stood at 6.9 million barrels (mb) [19 thousand barrels per day (kb/d)], 13% lower than in 2020 and 54% lower than in 2016. Oil is extracted from 19 fields (4 offshore and 15 onshore), all of them based in the Taranaki Region on the west coast of the North Island. New Zealand's five largest oil fields account for over 80% of the oil produced in the country. The Maari, Pohokura, Maui and Mangahewa fields make up the largest share of domestic oil production (Figure 9.3).

Oil production in New Zealand is forecast to further drop to below 4 mb within the next five years and below 2 mb shortly after 2030. This is due to the natural decline in the productivity of fields that have been in operation for decades. As of 1 January 2022, 2P (probable) oil reserves of New Zealand were 58.6 mb, down 4 mb (6.4%) from reserves estimated on 1 January 2021.

New Zealand's high-quality, light, sweet crude finds premium prices on the international market, and the country's crude oil is entirely exported. Even before its permanent closure in March 2022, the Marsden Point Refinery was better suited to process heavier imported crudes than those produced in the country.

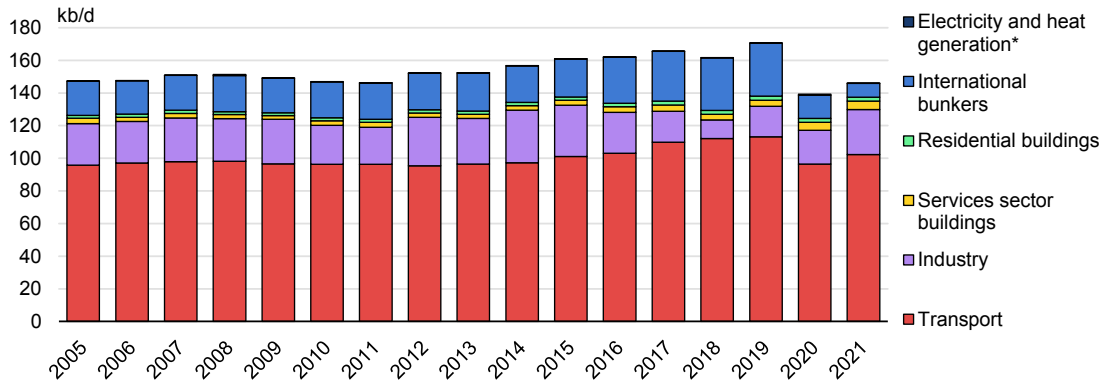
Crude oil imports declined sharply in 2021 as the Marsden Point Refinery ran down its crude stocks in anticipation of its closure. In 2021, New Zealand's total net imports of crude stood at 51 kb/d.

Oil products production, demand and trade

New Zealand's oil consumption was relatively stable from 2005 to 2021, with a slight increase observed from 2012. From 2019 to 2020, oil consumption sharply decreased from 171 kb/d to 139 kb/d in 2020 due to the Covid-19 pandemic, but rebounded slightly in 2021 (146 kb/d), though still at its lowest level since 2011 (Figure 10.2). The transport sector consumed most oil (70.1% of total demand), followed by international bunkers (5.7%), industry (18.8%), services sector buildings (3.5%) and residential buildings (1.7%). The

pandemic's travel restrictions also explain the significant decrease in oil consumption in international bunkers, from 32.5 kb/d in 2019 to 8.4 kb/d in 2021.

Figure 10.2 Oil products demand by sector in New Zealand, 2005-2021



Transport and industry account for most oil product demand.

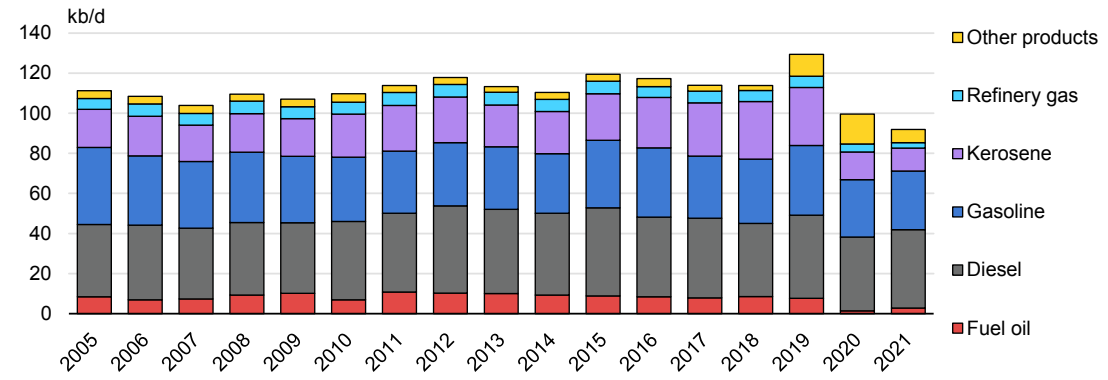
* Electricity and heat generation is poorly visible on this scale.

Note: kb/d = thousand barrels per day.

Source: IEA (2023).

In 2021, New Zealand produced 92 kb/d of oil products, a 19% decline since 2011 (Figure 10.3). Of that, 39 kb/d was diesel (43%), 29 kb/d was gasoline (32%), 12 kb/d was kerosene (13%), 3 kb/d was refinery gas (3%) and 3 kb/d was fuel oil (3%). Production of each oil product has remained relatively stable over the past decade, while production of kerosene and fuel oil dropped by 49% and 74%, respectively, in 2021, compared to 2011.

Figure 10.3 Oil products production in New Zealand, 2005-2021



In 2021, diesel, gasoline and kerosene were the main oil products produced in New Zealand.

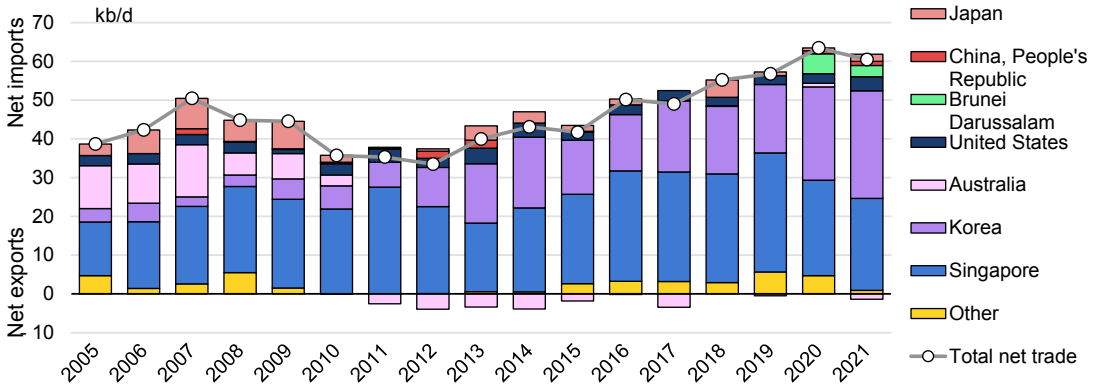
Note: kb/d = thousand barrels per day.

Source: IEA (2023).

New Zealand is a net importer of oil products, and total net trade has been increasing since 2012. In 2021, New Zealand traded with a wide range of countries, with 62 kb/d of oil products imported and 1.4 kb/d of oil products exported (Figure 10.4). During this year, New Zealand imported 26 kb/d from Korea, 23 kb/d from Singapore, 3 kb/d from the

United States and 2 kb/d from Japan. The same year, New Zealand exported small volumes of oil products, mainly to Australia.

Figure 10.4 New Zealand's net imports of oil products by country, 2005-2021



In 2021, most oil products imports came from Korea and Singapore.

Note: kb/d = thousand barrels per day.
Source: IEA (2023).

Biofuels

Transport contributes about one-fifth of New Zealand's gross domestic GHG emissions and accounts for almost half of domestic CO_2 emissions. For that reason, the government intends to increase the use of biofuels from sustainable sources with a lower carbon footprint than fossil fuels and to develop domestic biofuel production capacity. Currently, the use of biofuels in New Zealand is almost non-existent, with very limited domestic production and no blending obligation.

The Sustainable Biofuels Obligation Bill was introduced to the parliament and was planned to come into effect from April 2024 (delayed from 2023). Under the obligation, rather than set a volumetric blending mandate, fuel wholesalers will have to reduce the GHG intensity of the transport fuels they sell by a set percentage each year, mainly by including biofuels in their fuel supply. The draft obligation gives fuel wholesalers flexibility in the type of biofuels they supply as long as the percentage reduction targets are met. Fuel wholesalers would need to meet emissions intensity reduction targets of 2.4% for 2024 and 3.5% for 2025, with provisional targets already set for 2026 and beyond that reach 9.0% in 2035 (MBIE, 2022a). However, the government has decided not to move forward with the Sustainable Biofuels Obligation for the time being.

The obligation would likely impact fuel prices as biofuels are more expensive than fossil fuels and some, such as ethanol, require specific storage and blending infrastructure to be developed. Currently, ethanol – used with petrol in the light-duty transport segment – has an excise tax exemption. The price impacts would depend on the portfolio of fuels that fuel suppliers choose to use and their associated costs (which will depend on the infrastructure required for those biofuels), as well as how they choose to spread the costs across different customers. However, as there is no excise tax on diesel, biodiesel does not benefit from a tax exemption.

Oil policy and institutions

The MBIE has a central role in monitoring and advising on energy markets to ensure that electricity, gas and liquid fuels are delivered in a safe, efficient, fair, reliable and environmentally sustainable manner.

New Zealand Petroleum and Minerals, within the MBIE, carries out the country's energy regulatory function by administering the Crown Minerals Act of 1991. New Zealand Petroleum and Minerals regulates the right to prospect, explore and mine Crown-owned minerals on behalf of the MBIE. Under the Crown Minerals Act, the MBIE also issues permits to operators to explore and develop New Zealand's mineral and petroleum resources.

The Commerce Commission is an independent Crown entity responsible for monitoring competition in fuel markets in New Zealand and enforcing the Fuel Industry Act 2020. The MBIE and the Commerce Commission both have roles in monitoring the fuel market to ensure there is effective competition.

Exploration and production

In April 2018, the government announced no further offshore oil and gas exploration permits would be granted, as a step towards addressing climate change. The ban also limited new petroleum exploration and mining permits in the onshore Taranaki Region, the country's only producing region. This announcement did not impact existing rights.

Downstream competition

In 2019, the Commerce Commission completed a market study into the retail fuel sector – the Fuel Market Study. The Commerce Commission observed that fuel companies were making persistently higher profits than would be expected in a competitive environment. This was reflected in large regional differences in retail fuel prices and fast-growing premium petrol margins. The predominant problem that the commission found was that an active wholesale fuel market did not really exist in New Zealand.

The commission identified some retail market measures to address competition. However, the most significant recommendations involved promoting more wholesale competition to address tight wholesale supply relationships between the majors and resellers. As a result, the Fuel Industry Act was passed in 2020 to promote competition in fuel markets for the long-term benefit of end users. The act introduced the following interventions, which were based on the commission's recommendations from the 2019 Fuel Market Study:

- requirements and prohibitions that aim to reduce restrictive or dependent wholesale supply relationships
- a terminal gate price regime to create a wholesale spot market to reduce barriers to entering the wholesale market
- consumer information requirements that require retail sites to display fuel prices on boards to improve information for consumers to compare prices
- requirements for certain fuel companies to disclose information to the MBIE or the commission to improve the monitoring of the market
- a dispute resolution scheme for disputes between wholesale suppliers and resellers under the act.

The study and resulting improvements to New Zealand's fuel market brought immediate effects and added to fair competition. However, the closure of the country's only refinery has again changed the market environment in the country. The Commerce Commission and the MBIE will continue to monitor the competitive performance of fuel markets using the information that fuel companies are now required to make available to them on a regular basis under the Fuel Industry Act information disclosure requirements.

Market structure

Upstream

Oil exploration in New Zealand has steadily declined since the oil price crash in late 2014 and the subsequent offshore exploration ban of 2018. Major players such as Chevron, Shell, Woodside, Mitsui, Equinor and Anadarko have all exited the country, leaving Austrian OMV as the only remaining significant multinational, and Todd Energy and Greymouth Petroleum as the only significant local companies involved in petroleum exploration.

The most recent exploration success was in March 2020, when OMV drilled the offshore Toutouwai-1 well. The well encountered hydrocarbons, but due to Covid-19 restrictions preventing the procurement of specialised personnel and equipment, OMV was unable to test the discovery and hence reserves have not yet been established. OMV intends to drill an appraisal well at Toutouwai in 2023.

Oil production in New Zealand is dominated by condensate derived from six gas condensate fields: Kapuni, Maui, Kupe, Mangahewa, Pohokura and Turangi. Crude oil is also produced from a number of smaller onshore oil fields as well as the Maari offshore oil field.

The Tui offshore oil field ceased production in late 2019 and is currently being decommissioned. Early indications are that 90% of the subsea infrastructure will be recycled or reused. Phase 3 involves the plugging and abandonment of the five production wells, scheduled for early 2023. The government amended the Crown Minerals Act in the wake of issues affecting Tamarind Taranaki's ability when the operator failed to finance decommissioning of the Tui field, and now Treasury is paying for the MBIE to conduct all the necessary works. The amendment, enacted in December 2021, imposed a statutory obligation on all current and future oil exploration permit and licence holders to decommission their wells and infrastructure. It also enables the regulator to periodically assess permit and licence holders' financial capability to meet their decommissioning obligations, requires permit and licence holders to maintain adequate financial security for decommissioning purposes, requires permit and licence holders to make a financial contribution toward any post-decommissioning work, and expands enforcement powers.

Downstream

Currently, five companies import fuel into New Zealand: BP, ExxonMobil, Z Energy, Tasman Fuels and Gull. BP, ExxonMobil and Z Energy are regarded as "the majors" in New Zealand's downstream fuel industry. The five companies import already refined petrol, diesel and jet fuel, mostly from Asia, with the largest import terminals located at Marsden Point, Mount Maunganui, Wellington and Lyttelton.

Since the Marsden Point Refinery has shut down permanently and became a fuel import terminal on 1 April 2022, all refined fuel products are delivered by international tankers to ports across New Zealand. Domestic coastal tankers are no longer used to deliver fuel products between ports within New Zealand.

Wholesale and retail

New Zealand's downstream fuel industry is essentially a vertically integrated oligopoly. Collectively, three majors (Z Energy, BP and ExxonMobil) control the supply of fuel to more than 1 300 retail stations under 20 different retail brands, either directly or indirectly through distributors. Distributors acquire fuel at wholesale terminals and sell and distribute it to commercial customers and/or through a network of truck stops and retail sites that carry their brand. The majors supply more than 90% of the retail fuel sold through a network of retail sites they own and operate, dealer-owned retail sites that carry their brands, and distributors that, in turn, supply their own dealers and/or retail sites they own and operate.

Gull is the fourth-biggest player in the country, considered an independent one. It imports fuel and supplies its own retail sites. Gull is estimated to have had 7% of the retail market share by volume in 2021, while the biggest, Z Energy, had a 40% share by volume.

In its 2019 Fuel Market Study, the Commerce Commission estimated that approximately 57% of retail fuel by volume is sold through importer-owned and operated retail sites and 27% is sold through franchisees or commissioned agents that are importer-branded, dealer-owned retail sites.

Since 2016, there has been an increase in the number of retail sites, few of which are operated by the majors. Along with Gull, brands in distribution and retail have expanded. The number of sites operated by the majors has only marginally changed. Approximately 60% of petrol stations carry brands outside of the majors. However, these sites account for approximately only 20% of fuel volumes sold, and many are located outside of the major metropolitan areas.

One recommendation from the Commerce Commission's 2019 Fuel Market Study that has not yet been implemented is the development of a regulatory backstop to the wholesale fuel market. A threat of wholesale price regulation will incentivise wholesale suppliers to offer competitive prices at the terminal. This is to mitigate the risk that the terminal gate pricing is used as a co-ordination vehicle or that wholesale suppliers do not offer competitive prices at the terminal due to market power. During the development of the act, the government agreed to the regulatory backstop recommendation in principle, but due to the significant design requirements, had agreed to defer the implementation of a backstop regime. In late 2022, the government announced that it would progress a regulatory backstop and the Fuel Industry Amendment Bill is currently before the Select Committee, which would give effect to this. Changed fuel import patterns after the closure of the refinery have yet to show the extent to which a regulatory backstop can support wholesale price competition.

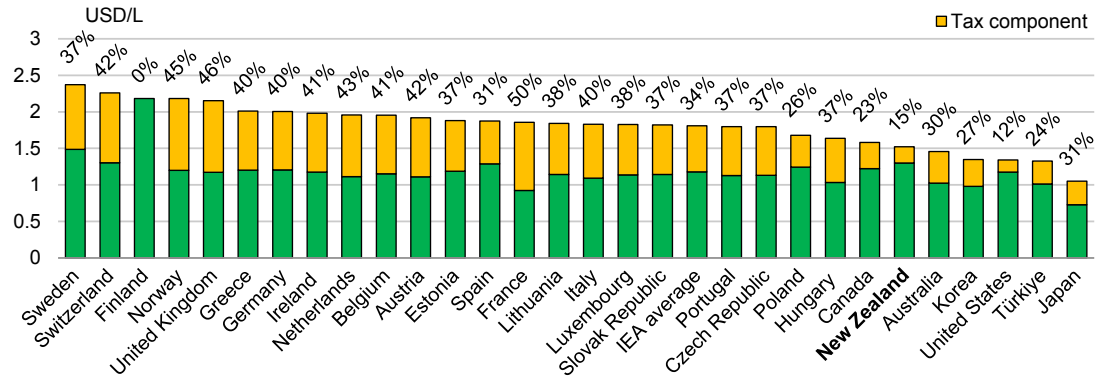
Prices and taxation

New Zealand's automotive diesel prices in the fourth quarter of 2022 were the sixth lowest among IEA countries, at 1.52 USD/litre (compared to the IEA average price of 1.81 USD/L) with a tax rate of 15% (compared with the IEA average tax rate of 34%) (Figure 10.5).

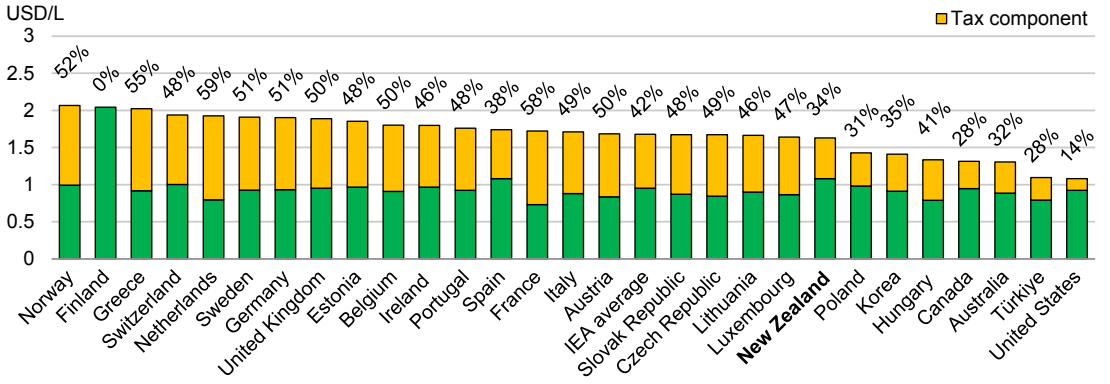
New Zealand's unleaded gasoline price in Q4 2022 was 1.63 USD/L, close to the IEA average of 1.68 USD/litre, with a tax rate of 42%. New Zealand's unleaded gasoline prices in Q4 2022 were ranked 8th lowest in an IEA comparison.

Figure 10.5 Oil price comparisons in the IEA, 4Q 2022

Price comparison for automotive diesel in the IEA, 4Q 2022



Price comparison for unleaded gasoline (95 RON) in the IEA, 4Q 2022



New Zealand's automotive diesel prices are below the IEA average. New Zealand's unleaded gasoline prices are around the IEA average.

Notes: Automotive diesel data are unavailable for Denmark and Mexico for 4Q 2022; premium unleaded gasoline (95 RON) data are unavailable for Denmark, Japan and Mexico for 4Q 2022. Breakdown not available for Finland in 4Q 2022.

Source: IEA (2023).

The MBIE conducts weekly fuel price monitoring and the results are made publicly available (MBIE, 2022b). Fuel companies are required to disclose certain information to the Commerce Commission under the Fuel Industry Act 2020 to enable more granular monitoring of margins and the monitoring of a wider range of matters that impact competition in fuel markets. This wider range of matters includes: fixed wholesale contracts, profitability, discounting practices, fuel supply and terminal gate pricing.

Oil infrastructure

Transport

New Zealand has 12 terminal locations (including the former Marsden Point Refinery), 10 of which are coastline terminals. The four major import terminals are Marsden Point (where the former refinery was located), Mount Maunganui, Wellington and Lyttelton. All port terminals are connected by pipe from the wharves and failures of these would prevent terminals from filling. There are also several pipelines taking fuel from port/wharf terminals to other terminals and transferring fuel between terminals, including:

- Refinery-Auckland Pipeline (today, the Marsden Point import fuel Terminal-Auckland), which used to transport approximately half of the former refinery's product to the Wiri Terminal, providing around 95% of Auckland's fuel requirements. As of March 2022, after the refinery's closure, it transports exclusively imported fuels.
- Wiri-Airport Pipeline, which supplies Jet-A1 to Auckland International Airport from the Wiri Terminal.
- The pipeline from fuel terminals at Lyttelton to the inland Woolston Terminal in Christchurch, which is a critical piece of infrastructure for the South Island (Jet A-1 fuel is not distributed through this pipeline, it is trucked from Lyttelton).

The distribution of oil products across New Zealand is challenging, as the country is large and the population density is low in some parts. Before the Marsden Point Refinery closed, the four oil companies that had a processing agreement with the refinery arranged a system by which they allowed access to each other's storage facilities and products across the country (infrastructure sharing). If a company was short of products in a particular region, it could make an accounting swap for products in another region where it had a surplus at the time. Other companies couldn't access the distribution system, as commercial terms and conditions of access were so high that it was difficult for other companies to enter New Zealand's fuel distribution market. This "borrow and loan" arrangement is now largely disbanded (except for the Wiri Terminal in the Auckland area), as the majors have begun arranging their own fuel import shipments following the closure of the refinery. The country's transport system will have to adapt to the new situation over time.

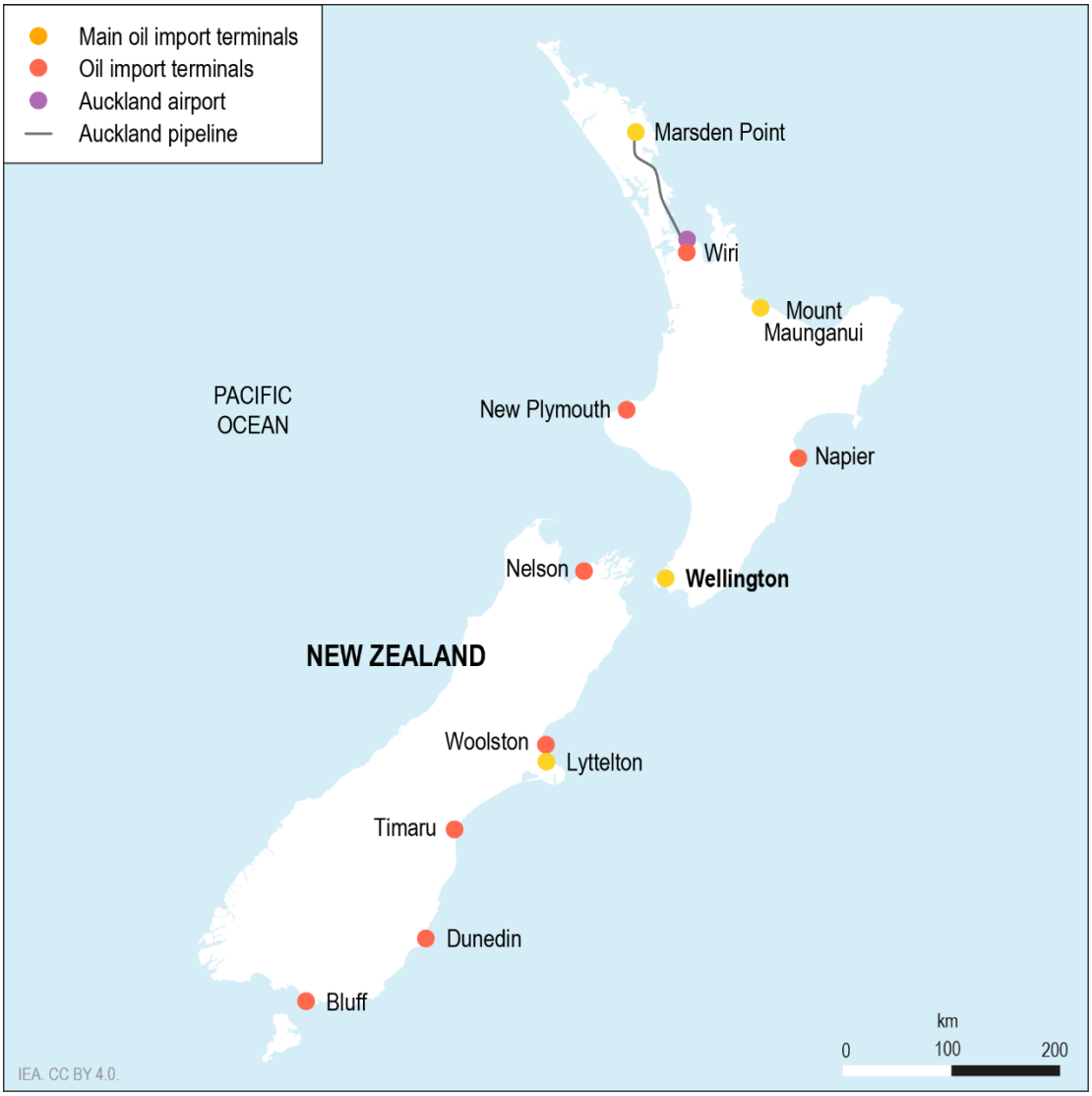
Gull and Tasman Fuels were not a party to the infrastructure-sharing arrangements. Gull imports refined fuel to its Mount Maunganui terminal and from there trucks it to its retail stations. Gull also operates in the South Island by sourcing fuel from other importers. TOSL, which has only recently commenced operations and has yet to make a significant impact on the market, imports refined fuels to its Timaru Terminal. A further terminal is planned in Mount Maunganui, but resource consents were declined.

The road transport of fuel from terminals to retail sites is typically contracted out to third parties and/or undertaken by distributors who also own/operate retail sites, such as Waitomo and NPD. Allied Petroleum has a nationwide contract to distribute fuel for Mobil, and owns and operates retail outlets.

Storage

New Zealand's storage capacity is all commercial capacity controlled by the majors located at the country's 12 terminals (including Marsden Point), with a total capacity of 5.45 mb (Figure 10.6).

Figure 10.6 New Zealand's oil storage locations, 2022



Oil emergency policy and stockholding

Oil emergency response organisation

The National Fuel Plan of 2020 provides the framework for fuel emergency management in New Zealand. It is based on the Petroleum Demand Restraint Act 1981, which provides for regulations for restraining oil demand, and the Civil Defence Emergency Management Act 2002, as oil security falls within the civil protection system. The National Fuel Plan is expected to be updated in the near future to reflect recent changes to fuel logistics following the refinery's closure.

With the permanent closure of the refinery, the government had to take pre-emptive measures to ensure the country's oil security. In September 2021, the Cabinet requested an investigation of the option of increasing the minimum levels of fuel stock held in

New Zealand. Following the government's review, it presented a six-point Fuel Resiliency Plan (to be decided upon in 2023), which includes:

- improving fuel resilience monitoring
- dedicating additional resources to update and implement the National Fuel Plan
- amending the statutory purpose of the petroleum or engine fuel monitoring levy to fund onshore fuel resilience initiatives
- streamlining the decision-making process for the release of reserve oil stocks
- government procurement of reserve fuel stocks
- introducing a minimum onshore fuel stockholding obligation on fuel importers/wholesalers.

The preferred option for minimum onshore fuel stockholding levels is similar to what has been proposed in Australia, namely 28 days of cover for diesel and 24 days of cover for petrol and jet fuel.

Currently, New Zealand meets the IEA 90-day reserve obligation by purchasing oil stock tickets on the global market to top up the commercial stocks held by the fuel industry onshore. Without minimum operating requirements on the industry, the government always has to cover the difference between what is held by national operators and the 90-day requirement. Oil stocks are, therefore, a mixture of private stocks held by the major oil companies and traders and reserve oil tickets held by the New Zealand government in other IEA countries. These reserve oil tickets are obtained in two annual tenders held around January/February and July/August each year. Traditionally, to maintain 90 days of oil stocks, New Zealand has held about two-thirds in private stocks and one-third in tickets. With the closure of the refinery, this ratio is changing with the number of tickets increasing as commercial stocks decrease.

Oil emergency response decision making

The oil stockholding system is administered by the MBIE under delegated authority from the New Zealand Cabinet.

While the MBIE has the delegated authority to purchase oil tickets, it does not hold the authority to release them or to purchase oil in the case of IEA collective actions. The Minister of Energy and Resources has the delegated authority to agree to an oil stock release and is expected to provide an oral update to Cabinet following the release. A Cabinet decision will be sought for any purchase of oil under an oil ticket for delivery to New Zealand.

If a decision is to be taken on an emergency draw down to participate in an IEA collective action, the MBIE will rank oil stock tickets in order of release for a decision by the minister. The ranking used will reflect the value of each stock ticket to New Zealand. In general, tickets with a longer duration and lower price will be maintained, as will those that preserve a wider geographic distribution. With the closure of the refinery, stocks that can no longer be processed in New Zealand will have a priority for release.

Oil emergency response measures

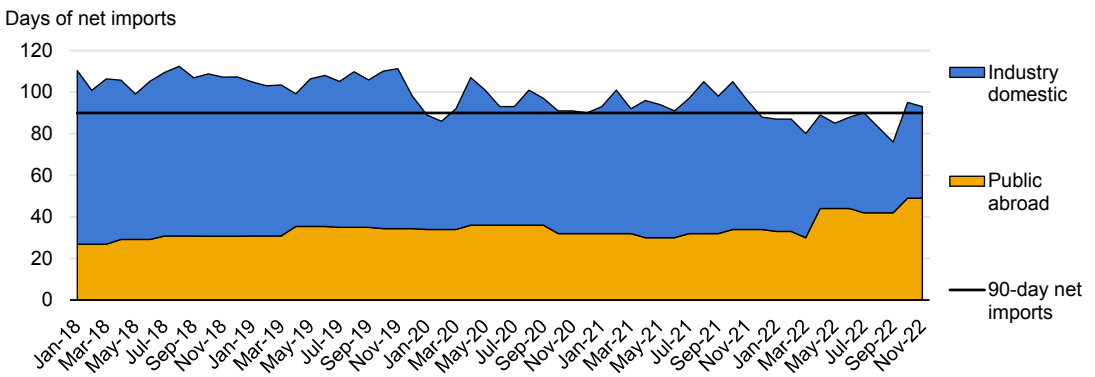
New Zealand's oil emergency response policy is based on an escalating series of measures ranging from the release of oil stock tickets to voluntary demand restraint measures, which are likely to be used as a last resort, and have never been used.

The Petroleum Demand Restraint Act of 1981 authorises regulation making for reducing consumption or equitable distribution of petroleum products in New Zealand. Under this act, the government may implement such regulations if petroleum products are or are likely to be in short supply in New Zealand. Pre-drafted regulations exist; these would be reviewed and adapted if required to suit the nature of the emergency at hand.

Emergency oil reserves

New Zealand held 93 days of stocks as of November 2022, of which 44 days consist of industry stocks and 50 days of public stocks held abroad (tickets) (Figure 10.7). New Zealand was below the IEA 90-day stock level from September 2021 to September 2022, prior to the IEA's collective actions launched after the Russian Federation's (hereafter "Russia") invasion on Ukraine. This was initially due to a faster-than-expected closure of the refinery and the associated decline in crude oil stocks, followed by a release of emergency stocks in the IEA collective actions following the invasion of Ukraine.

Figure 10.7 Emergency oil stocks by type in New Zealand, January 2018-November 2022



New Zealand holds 93 days of emergency stocks. More than half are public stocks; the rest is held by industry.

Source: IEA (2022).

IEA collective actions in 2022

New Zealand took part in both collective actions (1 March and 1 April) co-ordinated by the IEA in 2022 in response to the war in Ukraine and related global oil shortages. The country contributed well in excess of its share to the first release, contributing 369 kb of crude oil against its share of 246 kb. New Zealand released 483 kb of crude for the second release, also above its share.

Assessment

Although New Zealand has committed to a very ambitious climate agenda, oil still plays a significant role in its energy system. Shares of oil in energy supply and demand have been steady since 2005, accounting for 34% of TES and 48% of TFC in 2021. Oil covered almost all of transport demand (99.8%) and had significant shares in industry (22%) and buildings

(11%) but almost none in electricity generation. New Zealand has limited and declining domestic oil production. New Zealand has always been and continues to be a net importer of oil but has to rely fully on imports of oil products since the closure of the country's only refinery at Marsden Point in March 2022.

Total indigenous crude oil production in 2021 stood at 6.9 mb (19 kb/d), 11% lower than in 2020 and 42% lower than in 2016. Almost all crude production has typically been exported, as the country's refinery was geared to process imported lighter grades. Oil is extracted from several fields in the Taranaki Region on the west coast of the North Island, with the Maari, Pohokura, Maui and Mangahewa fields making up the largest share of domestic oil production. According to official forecasts, New Zealand's oil production will further decline to less than 4 mb within the next five years and below 2 mb shortly after 2030. This is due to the natural decline in field productivity and reinforced by the government's 2018 decision to stop issuing new offshore oil exploration permits.

New Zealand's oil consumption has been relatively stable over the last two decades. After a slight increase observed from 2012 onwards, it settled at 171 kb/d in 2019, dropped to 139 kb/d in 2020 and rebounded to 146 kb/d in 2021. In 2021, the transport sector consumed most oil (70%), followed by industry (19%), international bunkers (6%), services sector buildings (4%) and residential buildings (2%).

New Zealand has ten terminals to import fuels. The country's storage capacity is all commercial capacity controlled by the same major companies that operate the country's port terminals (Z Energy, BP and ExxonMobil), with a total capacity of 5.45 mb. The distribution of oil products across New Zealand is challenging, as the country is large and its population density low.

New Zealand's oil market is liberalised and operated by private entities, with no price control mechanisms and no state involvement in the market. However, the Commerce Commission's 2019 Fuel Market Study identified that the country's downstream fuel industry was essentially a vertically integrated oligopoly and price competition in the fuel market was not working as well as it could be. The Commerce Commission identified some retail and especially wholesale market measures to promote competition. As a result, the Fuel Industry Act was passed in 2020 to address most of these issues.

Forthcoming regulations to the fuel market, labelled as "the Fuel Resiliency Plan 2022", if implemented as planned in 2023, will result in additional stockholding obligations for fuel companies – the first ever minimum stockholding obligation, and onshore ticketing system.

The Sustainable Biofuel Obligation that was planned to take effect from 1 April 2023 was postponed by a year to April 2024. The main objective of the obligation is to support decarbonisation objectives by increasing the supply and use of biofuels for transport. Biofuels are currently used in New Zealand on a voluntary basis, but their share in transport fuel consumption is negligible.

The government will also need to consider changes to the tax treatment of ethanol and biodiesel to drive desired outcomes of lowering fossil fuel consumption. Currently, ethanol has an excise tax exemption. There is no excise tax on diesel, so biodiesel cannot be exempted from that tax. The government should, therefore, seek to advantage the use of biodiesel in heavy-duty segments in other ways, as electrification options in that sector are more challenging.

More broadly, New Zealand's energy transition will require more concerted efforts to lower oil consumption, especially in the transport sector. The Biofuels Obligation can quickly reduce emissions as EVs are gradually entering the market. Biofuels will be a more important tool to lower oil demand in the heavy-duty segment as well as in harder-to-abate sectors such as shipping and aviation. Green freight measures can also show results in later years. However, New Zealand needs to move faster to finalise these measures to send investment signals to the industry across alternative fuels areas.

Recommendations

The government of New Zealand should:

- ☐ Closely monitor fuel market competition and improve price transparency following market changes stemming from the refinery closure and passage of the 2020 Fuel Industry Act.
- ☐ Proceed ambitiously with the implementation of the biofuels mandate to allow timely compliance and the preparation of necessary infrastructure.
- ☐ Ensure that the tax treatment of ethanol and biodiesel aligns with objectives to reduce emissions and oil demand.

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ANNEX A: Review team and supporting stakeholders

Review criteria

The Shared Goals, adopted by the IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews. The IEA Shared Goals are available on line.

Review team and preparation of the report

The IEA's in-depth review visit of New Zealand took place on line from 20 to 26 September 2022 in Wellington. The review team met with government officials, energy suppliers, market participants, interest groups, consumer associations, research institutions and other stakeholders. This report was drafted based on information obtained in these meetings, the review team's assessment of New Zealand's energy policies, the government's response to the IEA energy policy questionnaire and subsequent research by the IEA. The members of the team were:

IEA member countries

Shane Gaddes, Australia (team leader)

Marina Kelly, United States

Yasushi Ninomiya, Japan

Jungwoo Lee, Korea

Wieger Wiersema, Netherlands

Jakub Kristin, Slovak Republic

International Energy Agency

Aad van Bohemen

Divya Reddy

Milosz Karpinski

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Organisations visited

350 Aotearoa

Ara Ake

Bioenergy Association of New Zealand

BP Oil New Zealand

Business New Zealand Energy Council

Carbon and Energy Professionals New Zealand

Channel Infrastructure (formerly Refining NZ)

Climate Change Commission

Commerce Commission

Community Energy Network

Consumer New Zealand

Contact Energy

Ecologic

Ecotricity

Energy Efficiency and Conservation Authority (EECA)

Electric Kiwi

Electricity Authority

Electricity Networks Association

Electricity Retailers Association

Energy and Resource Aotearoa (PEPANZ)

Environmental Defence Society

ESP

First Gas Ltd

Flick

Gas Industry Council

GasNZ

Genesis Energy

GNS

Greenpeace New Zealand

Gull

IEGA

Inland Revenue

Lighting Council

Major Electricity User Group

Major Gas Users Group (MGUG)

Manawa Energy (ex Trustpower)

McDermand

Mercury

Meridian Energy

Methanex

Ministry for Environment

Ministry of Business, Innovation and Employment (MBIE) (oil and minerals regulator)

Ministry of Transport

Mobil

New Zealand Climate and Health Council

New Zealand Geothermal Association

New Zealand Wind Energy Association

Nova Energy

Octopus Energy

OMV Group

Parliamentary Commission for the Environment

Powerco

Powershop

Royal Society of New Zealand Panel on Climate Change Mitigation

SEANZ

Simply Energy

Smartpower

The Aotearoa Circle

Todd Energy

Transpower

Treasury

Uni Otago – Sally

Utilities Disputes (Electricity and Gas Complaints Commission)

Vector

Z Energy

ANNEX B: Energy balances and key statistical data

Unit: PJ

SUPPLY		1973	1990	2000	2010	2019	2020	2021E
TOTAL PRODUCTION		**163.8**	**481.4**	**590.4**	**684.4**	**642.4**	**616.6**	**594.3**
Coal		48.3	59.6	86.8	130.2	76.0	69.6	71.5
Peat		-	-	-	-	-	-	-
Oil		7.4	82.3	81.4	114.9	56.4	49.1	43.0
Natural gas		11.8	162.1	211.7	161.4	166.9	163.0	141.8
Biofuels and waste[1]		-	29.6	38.3	42.1	39.6	36.4	38.3
Nuclear		-	-	-	-	-	-	-
Hydro		51.5	83.5	88.0	89.0	92.1	87.4	87.2
Wind		-	-	0.4	5.9	8.1	8.3	9.5
Geothermal		44.7	62.5	82.0	138.7	201.0	200.7	200.3
Solar/other[2]		-	1.9	1.9	2.1	2.2	2.1	2.7
TOTAL NET IMPORTS[3]		**168.2**	**56.1**	**105.0**	**74.9**	**200.2**	**210.9**	**241.8**
Coal	Exports	0.9	10.0	46.7	71.5	41.7	32.5	35.4
	Imports	-	0.0	0.5	5.5	25.6	25.1	42.8
	Net imports	-0.9	-10.0	-46.3	-66.0	-16.1	-7.4	7.4
Oil	Exports	-	61.0	61.7	108.3	53.1	39.4	26.6
	Imports	191.1	159.6	248.3	295.8	337.5	287.2	273.3
	Int'l marine and aviation bunkers	-22.0	-32.5	-35.3	-46.6	-68.0	-29.6	-12.4
	Net imports	169.1	66.0	151.3	141.0	216.3	218.3	234.4
Natural gas	Exports	-	-	-	-	-	-	-
	Imports	-	-	-	-	-	-	-
	Net imports	-	-	-	-	-	-	-
Electricity	Exports	-	-	-	-	-	-	-
	Imports	-	-	-	-	-	-	-
	Net imports	-	-	-	-	-	-	-
TOTAL STOCK CHANGES		**-1.9**	**-1.3**	**12.2**	**-12.5**	**13.8**	**-6.8**	**17.6**
TOTAL SUPPLY (TES)[4]		**330.1**	**536.1**	**708.4**	**747.7**	**859.3**	**823.6**	**857.5**
Coal		47.2	49.6	46.3	54.0	62.9	66.0	87.8
Peat		-	-	-	-	-	-	-
Oil		174.7	147.0	239.0	258.9	282.9	257.3	290.0
Natural gas		11.8	162.1	211.8	156.1	167.6	162.5	138.1
Biofuels and waste[1]		-	29.6	39.0	42.9	42.5	39.4	41.9
Nuclear		-	-	-	-	-	-	-
Hydro		51.5	83.5	88.0	89.0	92.1	87.4	87.2
Wind		-	-	0.4	5.9	8.1	8.3	9.5
Geothermal		44.7	62.5	82.0	138.7	201.0	200.7	200.3
Solar/other[2]		-	1.9	1.9	2.1	2.2	2.1	2.7
Electricity trade		-	-	-	-	-	-	-
Shares in TES (%)								
Coal		*14.3*	*9.3*	*6.5*	*7.2*	*7.3*	*8.0*	*10.2*
Peat		-	-	-	-	-	-	-
Oil		*52.9*	*27.4*	*33.7*	*34.6*	*32.9*	*31.2*	*33.8*
Natural gas		*3.6*	*30.2*	*29.9*	*20.9*	*19.5*	*19.7*	*16.1*
Biofuels and waste[1]		-	*5.5*	*5.5*	*5.7*	*4.9*	*4.8*	*4.9*
Nuclear		-	-	-	-	-	-	-
Hydro		*15.6*	*15.6*	*12.4*	*11.9*	*10.7*	*10.6*	*10.2*
Wind		-	-	*0.1*	*0.8*	*0.9*	*1.0*	*1.1*
Geothermal		*13.6*	*11.7*	*11.6*	*18.6*	*23.4*	*24.4*	*23.4*
Solar/other[2]		-	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*
Electricity trade		-	-	-	-	-	-	-

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: PJ

DEMAND							
FINAL CONSUMPTION	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021E**
TFC	**244.2**	**395.9**	**524.2**	**528.3**	**615.7**	**563.1**	**..**
Coal	35.9	28.3	20.9	25.2	27.6	24.4	..
Peat	-	-	-	-	-	-	..
Oil	146.1	168.6	222.2	247.0	290.6	257.2	..
Natural gas	4.8	75.3	126.1	74.4	118.3	108.7	..
Biofuels and waste[1]	-	13.4	23.5	28.1	28.4	25.1	..
Geothermal	-	7.8	8.5	9.1	7.9	7.8	..
Solar/other[2]	-	-	-	0.4	0.4	0.4	..
Electricity	57.3	102.6	123.0	144.1	142.5	139.6	..
Heat	-	-	-	-	-	-	..
Shares in TFC (%)							
Coal	*14.7*	*7.1*	*4.0*	*4.8*	*4.5*	*4.3*	..
Peat	-	-	-	-	-	-	..
Oil	*59.8*	*42.6*	*42.4*	*46.8*	*47.2*	*45.7*	..
Natural gas	*2.0*	*19.0*	*24.1*	*14.1*	*19.2*	*19.3*	..
Biofuels and waste[1]	-	*3.4*	*4.5*	*5.3*	*4.6*	*4.5*	..
Geothermal	-	*2.0*	*1.6*	*1.7*	*1.3*	*1.4*	..
Solar/other[2]	-	-	-	*0.1*	*0.1*	*0.1*	..
Electricity	*23.5*	*25.9*	*23.5*	*27.3*	*23.1*	*24.8*	..
Heat	-	-	-	-	-	-	..
TOTAL INDUSTRY[5]	**91.4**	**164.6**	**228.1**	**195.3**	**241.5**	**215.8**	**..**
Coal	28.6	22.7	18.1	21.5	24.5	21.7	..
Peat	-	-	-	-	-	-	..
Oil	41.2	25.2	26.9	32.0	39.2	31.5	..
Natural gas	1.4	64.0	112.0	61.5	103.3	93.9	..
Biofuels and waste[1]	-	6.9	15.7	20.0	19.0	15.8	..
Geothermal	-	4.7	5.4	5.7	4.9	4.7	..
Solar/other[2]	-	-	-	-	-	-	..
Electricity	20.2	41.2	50.0	54.5	50.8	48.1	..
Heat	-	-	-	-	-	-	..
Shares in total industry (%)							
Coal	*31.2*	*13.8*	*7.9*	*11.0*	*10.1*	*10.1*	..
Peat	-	-	-	-	-	-	..
Oil	*45.1*	*15.3*	*11.8*	*16.4*	*16.2*	*14.6*	..
Natural gas	*1.5*	*38.9*	*49.1*	*31.5*	*42.7*	*43.5*	..
Biofuels and waste[1]	-	*4.2*	*6.9*	*10.3*	*7.9*	*7.3*	..
Geothermal	-	*2.8*	*2.4*	*2.9*	*2.0*	*2.2*	..
Solar/other[2]	-	-	-	-	-	-	..
Electricity	*22.1*	*25.0*	*21.9*	*27.9*	*21.0*	*22.3*	..
Heat	-	-	-	-	-	-	..
TRANSPORT[4]	**81.3**	**123.8**	**170.1**	**191.2**	**226.4**	**193.3**	**..**
OTHER[6]	**71.5**	**107.5**	**126.0**	**141.9**	**147.8**	**154.0**	**..**
Coal	7.3	5.5	2.8	3.7	3.2	2.7	..
Peat	-	-	-	-	-	-	..
Oil	23.7	22.2	25.5	24.3	25.8	32.9	..
Natural gas	3.5	8.9	14.1	12.9	15.0	14.8	..
Biofuels and waste[1]	-	6.5	7.7	7.8	9.1	9.1	..
Geothermal	-	3.1	3.1	3.4	3.0	3.0	..
Solar/other[2]	-	-	-	0.4	0.4	0.4	..
Electricity	37.0	61.2	72.8	89.4	91.4	91.1	..
Heat	-	-	-	-	-	-	..
Shares in other (%)							
Coal	*10.3*	*5.1*	*2.2*	*2.6*	*2.2*	*1.7*	..
Peat	-	-	-	-	-	-	..
Oil	*33.2*	*20.7*	*20.2*	*17.1*	*17.4*	*21.4*	..
Natural gas	*4.9*	*8.3*	*11.2*	*9.1*	*10.2*	*9.6*	..
Biofuels and waste[1]	-	*6.1*	*6.1*	*5.5*	*6.1*	*5.9*	..
Geothermal	-	*2.9*	*2.5*	*2.4*	*2.1*	*2.0*	..
Solar/other[2]	-	-	-	*0.2*	*0.2*	*0.2*	..
Electricity	*51.7*	*56.9*	*57.8*	*63.0*	*61.8*	*59.1*	..
Heat	-	-	-	-	-	-	..

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: PJ

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021E**
ELECTRICITY GENERATION[7]							
Input (PJ)	129.4	221.9	281.7	342.5	383.0	384.0	..
Output (PJ)	66.7	117.4	141.8	162.0	162.6	160.4	157.3
Output (TWh)	18.5	32.6	39.4	45.0	45.1	44.5	43.7
Output shares (%)							
Coal	*8.5*	*2.0*	*3.9*	*4.6*	*5.0*	*5.2*	*7.5*
Peat	-	-	-	-	-	-	-
Oil	*6.1*	-	-	-	-	-	*0.2*
Natural gas	*1.4*	*17.5*	*24.0*	*21.9*	*12.8*	*14.3*	*7.1*
Biofuels and waste[1]	-	*2.6*	*2.2*	*1.7*	*1.8*	*1.8*	*4.0*
Nuclear	-	-	-	-	-	-	-
Hydro	*77.3*	*71.1*	*62.0*	*54.9*	*56.7*	*54.5*	*55.5*
Wind	-	-	*0.3*	*3.6*	*5.0*	*5.2*	*6.0*
Geothermal	*6.7*	*6.5*	*7.4*	*13.1*	*18.3*	*18.6*	*19.2*
Solar/other[2]	-	*0.2*	*0.2*	*0.1*	*0.4*	*0.5*	*0.6*
TOTAL LOSSES	**91.5**	**144.6**	**180.3**	**230.8**	**264.3**	**266.2**	**..**
of which:							
Electricity and heat generation[8]	62.7	104.5	139.9	180.5	220.5	223.7	..
Other transformation	11.0	6.1	1.3	5.3	-3.3	3.0	..
Own use and transmission/distribution losses	17.8	34.0	39.1	45.0	47.1	39.6	..
Statistical differences	**-5.6**	**-4.4**	**3.8**	**-11.5**	**-20.7**	**-5.7**	**..**
INDICATORS	**1973**	**1990**	**2000**	**2010**	**2019**	**2020**	**2021E**
GDP (billion 2015 USD)	68.32	87.57	118.23	152.87	200.94	196.76	207.83
Population (millions)	2.97	3.37	3.87	4.36	5.01	5.10	5.13
TES/GDP (MJ per 2015 USD)[9]	4.83	6.12	5.99	4.89	4.27	4.19	4.13
Energy production/TES	0.50	0.90	0.83	0.92	0.75	0.75	0.69
Per capita TES (GJ per capita)	111.09	158.95	183.27	171.37	171.41	161.59	167.29
Oil supply/GDP (MJ per 2015 USD)[9]	2.56	1.68	2.02	1.69	1.41	1.31	1.39
TFC/GDP (MJ per 2015 USD)[9]	3.58	4.52	4.43	3.45	3.06	2.86	..
Per capita TFC (GJ per capita)	82.18	117.37	135.63	121.09	122.83	110.48	..
CO_2 emissions from fuel combustion ($MtCO_2$)[10]	16.7	21.7	28.9	30.4	33.4	30.8	..
CO_2 emissions from bunkers ($MtCO_2$)[10]	1.0	1.1	0.8	1.1	1.1	0.6	..
GROWTH RATES (% per year)	**73-90**	**90-00**	**00-10**	**10-18**	**18-19**	**19-20**	**20-21**
TES	2.9	2.8	0.5	1.2	4.2	-4.1	4.1
Coal	0.3	-0.7	1.6	-0.4	20.1	4.9	33.0
Peat	-	-	-	-	-	-	-
Oil	-1.0	5.0	0.8	0.4	5.8	-9.0	12.7
Natural gas	16.6	2.7	-3.0	0.4	4.0	-3.0	-15.0
Biofuels and waste[1]	-	2.8	1.0	0.0	-1.1	-7.2	6.4
Nuclear	-	-	-	-	-	-	-
Hydro	2.9	0.5	0.1	0.8	-2.5	-5.2	-0.2
Wind	-	-	29.8	3.0	9.1	2.2	14.6
Geothermal	2.0	2.8	5.4	4.4	2.3	-0.1	-0.2
Solar/other[2]	-	0.0	1.0	0.8	-0.8	-2.6	27.6
TFC	2.9	2.8	0.1	1.4	4.4	-8.5	..
Electricity consumption	3.5	1.8	1.6	-0.2	0.8	-2.1	..
Energy production	6.5	2.1	1.5	-1.0	2.0	-4.0	-3.6
Net oil imports	-5.4	8.6	-0.7	5.9	-3.2	0.9	7.4
GDP	1.5	3.0	2.6	3.1	2.9	-2.1	5.6
TES/GDP	1.4	-0.2	-2.0	-1.8	1.3	-2.1	-1.4
TFC/GDP	1.4	-0.2	-2.5	-1.7	1.5	-6.6	..

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Footnotes to energy balances and key statistical data

- *Biofuels and waste* comprises solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
- *Other* includes tide, wave and ambient heat used in heat pumps.
- In addition to coal, oil, natural gas and electricity, *total net imports* also includes peat, biofuels and waste, and trade of heat.
- Excludes international marine bunkers and international aviation bunkers.
- Total supply of electricity represents net trade. A negative number in the share of total primary energy supply indicates that exports are greater than imports.
- *Industry* includes non-energy use.
- *Other* includes residential, commercial and public services, agriculture/forestry, fishing, and other non-specified.
- Inputs to electricity generation include inputs to electricity, co-generation and heat plants. Output refers only to electricity generation.
- Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and solar thermal; 10% for geothermal; and 100% for hydro, wind and solar photovoltaic.
- Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
- Toe per thousand US dollars at 2010 prices and exchange rates.
- "CO_2 emissions from fuel combustion" have been estimated using the IPCC Tier I Sectoral Approach from the *2006 IPCC Guidelines.* In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2013 and applying this factor to forecast energy supply. Projected emissions for coal are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

ANNEX C: Glossary and list of abbreviations

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

Acronyms and abbreviations

APEC	Asia-Pacific Economic Cooperation
BfCC	Building for Climate Change
CCM	Critical Contingency Management
CCMP	Critical Contingency Management Plan
CCO	critical contingency operator
CERF	Climate Emergency Response Fund
DER	distributed energy resource
EDB	electricity distribution business
EECA	Energy Efficiency and Conservation Authority
EEUD	Energy End Use Database
EPR	Electricity Price Review
ERP	Emissions reduction plan
ETS	Emissions Trade Scheme
EV	electric vehicle
GDP	gross domestic product
GHG	greenhouse gas
GIC	Gas Industry Company
GIDI	Government Investment in Decarbonising Industry
GNS	Institute of Geological and Nuclear Science
GST	goods and services tax
GTP	Gas Transition Plan
IPCC	Intergovernmental Panel on Climate Change
LFC	Low Fixed Charge
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
MBIE	Ministry of Business, Innovation and Employment
MEPS	Minimum Energy Performance Standards
NDC	Nationally Determined Contribution
NZAS	New Zealand Aluminium Smelter
NZD	New Zealand dollar
NZEECS	New Zealand Energy Efficiency and Conservation Strategy
NZU	New Zealand unit
OECD	Organisation for Economic Co-operation and Development
RD&I	research, development and innovation
RDTI	Research and Development Tax Incentive
REZ	renewable energy zone
RMA	Resource Management Act

RUC	road user charge
SAF	sustainable aviation fuel
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SO	system operator
SSIF	Strategic Science Investment Fund
TES	total energy supply
TFC	total final consumption
TFEC	total final energy consumption
TPM	transmission pricing methodology
TSO	transmission system operator
WKH	Warmer Kiwi Homes

Units of measure

bcm	billion cubic metres
CO_2-eq	carbon dioxide-equivalent
g CO_2	gramme of carbon dioxide
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
kb/d	thousand barrels per day
kg CO_2	kilogramme of carbon dioxide
km	kilometre
km^2	square kilometre
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
mb	million barrels
MJ	megajoule
Mt	million tonnes
Mt CO_2	million tonnes of carbon dioxide
Mt CO_2-eq	million tonnes of carbon dioxide-equivalent
MW	megawatt
PJ	petajoule
t CO_2	tonne of carbon dioxide
TJ	terajoule
TWh	terawatt hour

International Energy Agency (IEA).

Unless otherwise indicated, all material presented in figures and tables is derived from IEA data and analysis.

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New Zealand 2023

Energy Policy Review

The International Energy Agency (IEA) regularly conducts in-depth peer reviews of the energy policies of its member countries. This process supports energy policy development and encourages the exchange of international best practices and experiences.

New Zealand has set ambitious targets for reducing greenhouse gas emissions, including achieving net zero emissions by 2050. The country enjoys many natural advantages for its energy transition, including an enviable renewable resource base.

New Zealand already has a low emissions electricity system, with significant production from both hydropower and geothermal, and therefore has an attractive opportunity to leverage this clean electricity to decarbonise end-user sectors. This will require not only sizeable technological investments to efficiently electrify transport and industry, but will also necessitate a sizeable buildout of additional renewables generation capacity, along with supplemental grid and storage investments. Notably, the transport sector accounts for the highest share of emissions and is almost entirely dependent on oil. Industry is also a major contributor to New Zealand's emissions and is heavily reliant on fossil fuels.

In this report, the IEA provides energy policy recommendations to help New Zealand effectively manage the transformation of its energy sector in line with its climate targets.