TRANSPOWER

Whakamana i
Te Mauri
Hiko

Monitoring Report

September 2022

The Whakamana i Te Mauri Hiko Monitoring Report indicates how New Zealand is tracking against our energy futures

This report

In 2018 Transpower launched Te Mauri Hiko to start a discussion on New Zealand's Energy Future. Taking a scenario-based approach we considered what the future may look like in the year 2050, as a mechanism to understand the opportunities and discussions stakeholders need to focus on.

Since the first Te Mauri Hiko, we have further refined our understanding and released Whakamana i Te Mauri Hiko (WiTMH) in 2020, and the Electrification Roadmap in 2021.

We also have more refined scenarios. Nearly four years have passed since the original Te Mauri Hiko and the pace of social, political, scientific and environmental concern around climate change has continued to accelerate. At the same time, the rate of development and price reductions across a range of renewable energy technologies has continued to increase.

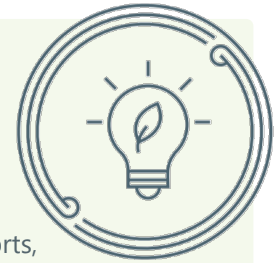
It is critical we continue to monitor the signs and drivers that underpin our scenarios. This active intelligence gathering will provide insight to help us identify both likely to be realised future scenarios, as well as new and divergent alternative scenarios.

This report is designed to identify, within the key drivers of Te Mauri Hiko, those factors that are consistent—or vary—from the expected course of our scenarios. We aim for this to be a discussion and an industry resource like Te Mauri Hiko, so we welcome feedback and suggestions on how to improve our monitoring.

If you have comments please send them to: communications@transpower.co.nz

For all our reports in the Te Mauri Hiko series, visit https://www.transpower.co.nz/about-us/transmission-tomorrow

This edition



It has been two years since we reinvigorated our reporting to align them with our WiTMH scenarios. WiTMH continues to guide us, and by publishing these six-monthly reports, we want to share with the rest of Aotearoa the trends we observe as we are on a journey to decarbonise our economy. You can see our March 2022 report and previous editions here

As we get a better understanding of the underlying electrification and decarbonisation trends, and have access to richer, more comprehensive data, we are continuously improving this report to bring readers newer, and more relevant insights.

What you might notice is that some of the data may not be refreshed every edition, and for some sources, the latest data refers to previous years. This is because some data sources are only published annually. However, the indicators we've chosen help tell New Zealand's story.

Our Whakamana i Te Mauri Hiko scenarios

The base case:
Accelerated Electrification

A realistic yet aspirational future, that anticipates large-scale transformation of energy in New Zealand

Tiwai Exit:
Electric Tiwai Exit

A variation of *Accelerated Electrification* where the Tiwai Aluminium smelter exits around 2025

Higher demand:
Mobilise to Decarbonise

Higher demand for electricity is driven by significant and rapid efforts to mitigate climate change after years of 'sitting on our hands'

Slower case:
Measured Action

A variation of *Accelerated Electrification* where transport electrification is slowed by factors such as policy or technology

Lower case:
Business as usual

Significant electrification fails to eventuate and other climate change mechanisms such as forestry abatement are prioritised

At a glance: New Zealand stays on course for the *Accelerated Electrification* scenario, supported by positive signs of electrification growth

Summary

In our last update, we reported that New Zealand is taking steps towards a net zero carbon economy. Since then, the government has released its Emissions Reduction Plan and committed its targets into regulation. This adds further momentum to the policies and incentives supporting process heat and transport electrification. These are good signs, but are dampened by the continuing growth in global emissions.

We continue to see very strong interest in both new generation and demand enquiries, with key new projects announced, including the first grid scale solar project executing a contract to connect them to the grid. Also of note is the emergence of NZ as a world-class resource for offshore wind. In the last report, wind made up only 24% of new generation interest; it now makes up 45%, with more than half of this new potential capacity being offshore.

Peak demand is also now clearly beginning to ramp up, with the top 10 largest peak demands all occurring in the past two winters and 6 out of those 10 occurring this year. This continues to put pressure on supply. Winter energy margins are reducing, and distribution businesses are forecasting significant increases to load. On the other hand, EVs are emerging as a potentially large resource for demand response. Our estimate shows almost 250 MW of capacity distributed throughout NZ.

Overall, the indicators in this report confirm that despite this uncertainty, we are entering the early phases of a new period of electrification growth consistent with the *Accelerated Electrification* trajectory.

How our indicators are tracking against our forecasts

Utility scale generation interest remains strong in anticipation of growing electrification demand.	▲ Consistent	**Electric vehicle numbers** have been boosted by recent transport policy and funding and are expected to continue rising.	▲ Consistent
Climate change continues to be a concern for New Zealand and the rest of the world, but overall carbon emissions continue to rise.	● Inconsistent	**Electric passenger vehicles** are becoming more attractive due to the new Clean Car Discount and lower running costs.	▲ Consistent
Electricity demand is beginning to show signs of increasing residential demand.	▲ Consistent	**Battery technology and flexible demand** is beginning to provide solutions to meet peak and energy demand.	▲ Consistent
Drivers of base demand have been slow caused by the COVID-19 pandemic but future population growth is uncertain.	● Uncertain	**Distributed solar installations** continue to grow in number and capacity, with falling long-term costs.	▲ Consistent
Overall energy efficiency and energy intensity continues to improve, though residential demand is growing.	▼ Consistent	**Capability to meet energy demand and peak demand** is currently sufficient but peak demand is rising.	● Uncertain
Industrial energy users are still relying on fossil fuels, rising costs are causing issues and new entrants are also on the way.	● Uncertain	**Electricity maintains affordability and high renewability** but significant action still must come to meet renewable targets.	● Uncertain
Process heat decarbonisation is continuing to grow through support of the Government Investment in Decarbonising Industry fund.	▲ Consistent	**Progress against the ten Whakamana i Te Mauri Hiko industry themes is ongoing** and may shift with future energy policy.	▲ Consistent

Renewable utility scale generation interest remains strong in anticipation of growing electrification demand

Consistent

New grid connected demand and renewable energy generation enquiries continue to increase

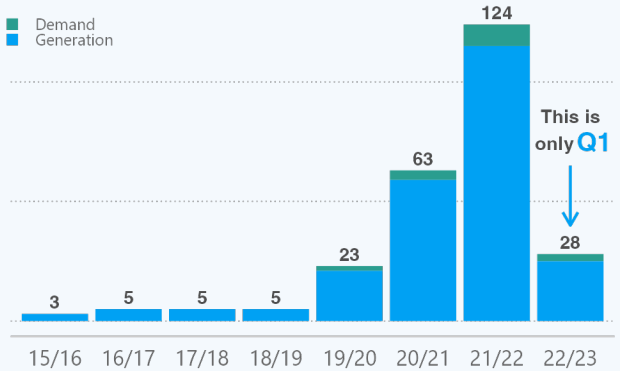
As the Grid Owner, Transpower receives enquiries from potential grid scale generators and load developers about connecting to the grid. While not all enquiries eventuate in built projects, the volume of enquiries is a good indicator of developer appetite.

Over the past three years, there has been a significant increase in the volume of enquiries from potential developers of new generation. The 21/22 financial year saw a total of 124 enquiries (9 demand / 115 generation) – around double the previous year.

The current financial year looks likely to be another year of strong activity with 28 enquiries in the first quarter already. Overall, these enquiries signal strong and growing interest in both large-scale demand and new renewable generation.

Generation and demand customer enquiries

Count by financial year, excludes GXP enquiries from EDBs.



Source: Transpower. Last updated September 2022.

Consistent

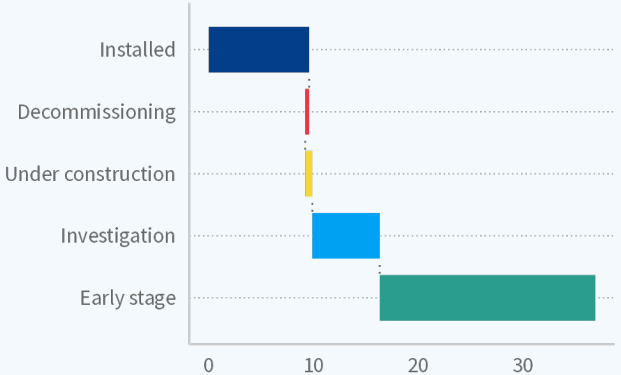
NZ has over 27 GW of potential generation interest in the pipeline

The total potential capacity of generation in the pipeline now is 27 GW including battery energy storage systems (BESS). If two–thirds of this was installed by 2050, this would meet our *Accelerated Electrification* projection of 22 GW total installed capacity. Much of this is still in the early stages of investigations and still uncertain.

There is a good amount of generation in the pipeline, including a 115 MW Solar farm in Edgecombe developed by new entrant Helios Energy, as well as three new wind projects by Mercury: Kaiwakawe (72 MW), Hurunui (76 MW), and Kaiwera Downs (43 MW). Mainpower is developing a 93 MW wind farm at Mt Cass. Nova Energy have announced a 400 MW solar farm near Taupō. There is also a growing amount of BESS work, including a grid-connected battery and solar farm being planned by Meridian Energy. Meridian has purchased 105 hectares of land adjacent to the Marsden Point oil refinery, which will house a battery energy storage system at least 100 MW in capacity.

Forecast utility scale generation pipeline

GW, includes generation decommissioning by the end of 2023.



Source: Transpower. Last updated September 2022.

Consistent

Offshore wind interest contributes to large increase in new generation enquiries

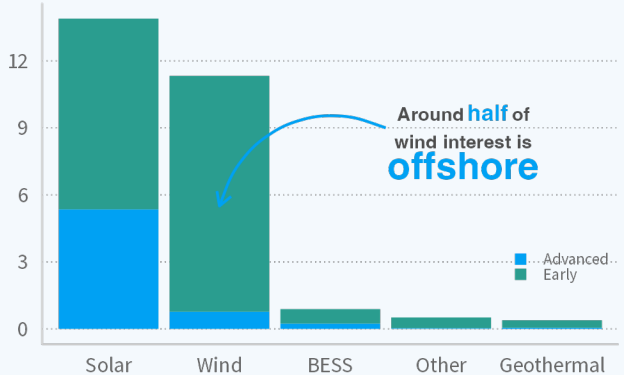
Of the new generation in the pipeline, just around half of this interest is for grid scale solar (53%). However, the big shift since the last monitoring report is a large increase in wind generation, which now comprises 43% of current interest and over half of early stage enquiries. This interest is in line with the *Accelerated Electrification* scenario, which projected 6.5 GW of wind generation capacity by 2050.

One of the key drivers for the growth in wind enquiries is the recent and significant interest in offshore wind. Of new generation enquiries for wind, around half are offshore projects.

The government has committed to supporting the development of offshore wind. This includes a commitment to develop a regulatory framework specifically for offshore renewable energy, in conjunction with work on a national energy strategy and a roadmap for development and use of hydrogen.

Breakdown of enquiries by generation type

GW. Excludes projects in delivery.



Source: Transpower. Last updated September 2022.

Climate change continues to be a concern for New Zealand and the rest of the world, but overall carbon emissions continue to rise

Inconsistent

Global concern is high with gap between commitments and action

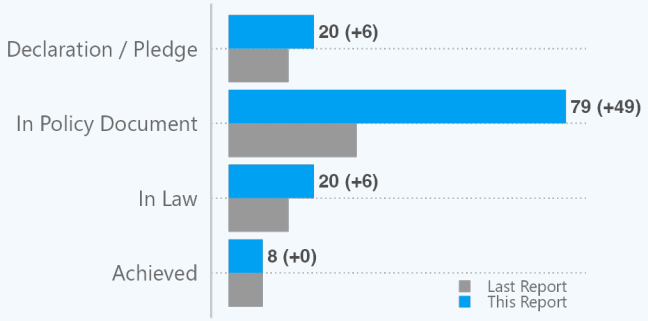
Countries and companies around the world are increasingly recognising the need for climate action, so that the globe avoids the catastrophic consequences of inaction.

The IPCC Summary for Policymakers report released in February 2022 reinforced the importance of infrastructure resilience and reliable power systems in the energy system transition. However, a recent report led by the World Meteorological Organization warns that the world is still going in the wrong direction and much more urgent action is required to avoid a significant climate disaster. The IEA also reported that only 2 of their 55 indicators are on track to meet net zero.

Since March 2022, an additional 49 countries have introduced net zero carbon targets into policy, with a further 20 including targets in law. Currently, approximately 90% of the world's emissions are covered by net zero carbon targets. Despite this, however, global greenhouse gas (GHG) levels still reached their highest levels on record in 2021 and more action is needed.

Countries with policies committed to net zero carbon by 2060 or earlier

Number of countries



Climate Action Tracker. Excludes countries with targets under discussion. Some European countries do not have a separate target from the EU.

Consistent

New Zealand government has enacted the Emissions Reduction Plan

New Zealand's emission reduction targets:

- **Domestic net zero target:** NZ legislation outlines a domestic target to reduce emissions to net zero by 2050 (other than biogenic methane). In addition to these targets there will be five-yearly interim targets in the form of emissions budgets.
- **International target under Paris Agreement:** NZ has also revised its target under the Paris Agreement from 30% to 50% of net emissions below our gross 2005 level by 2030. This target can be met through both domestic action and offshore mitigation.

Policy continues to be strengthened:

- The Government announced its first **Emissions Reduction Plan (ERP),** which set out policies and strategies for meeting emissions budgets. The first three emission budgets covering 2022-2035 were set by the Government in May 2022. A National Energy Strategy is in development, due to be released in 2024. In advance of this, the Aotearoa Circle has released a Low Carbon Aotearoa, Energy Roadmap to 2030.
- The **Emissions Trading Scheme (ETS)** continues to be updated ahead of a new ETS framework coming into effect 1 January 2023.
- In February 2022, the Government passed the Land Transport (Clean Vehicles) Amendment Bill to allow for the expansion of the existing **Clean Car Discount (CCD)** and introduction of the **Clean Car Standard (CCS)**. From 1 April 2022 the CCD imposed charges on high-emitting vehicles, and rebates for low-emitting ones. The CCS will encourage supply of low and zero emission vehicles to NZ by placing CO_2e reduction targets for vehicle importers from 2023.

Sourced from various media updates. Last updated September 2022.

Inconsistent

Greenhouse gas emissions have not yet begun to decline

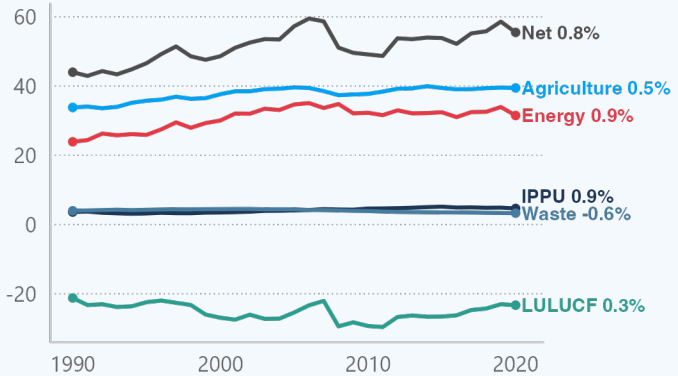
Since 1990, New Zealand's net GHG emissions have grown an average of 0.8% per year, a total increase of 26% due to the underlying increase in gross emissions. In the latest Greenhouse Gas Inventory, total gross emissions decreased 3% between 2019 and 2020, and net emissions decreased by 5%.

Emissions from the energy sector (including transport) in 2020 were 32% higher than in 1990.

Between 2019 and 2020, emissions from the energy sector decreased by 7%. However, this decrease was primarily due to impacts from COVID-19 which were felt across the sector. This saw decreases in emissions from road transport, domestic aviation and manufacturing. Emissions from electricity and heat production increased, likely driven by increased coal and gas use for electricity production during 2020 due to low hydro lake inflows.

New Zealand emissions by sector

Mt CO_2e, annual, with 1990-2020 CAGRs



Source: Ministry for the Environment. Last updated September 2022.

*IPPU stands for Industrial Processes & Product Use
*LULUCF stands for Land Use, Land Use Changes, & Forestry

Electricity demand is beginning to show signs of increasing residential demand

Consistent

Annual electricity demand slowly beginning to increase

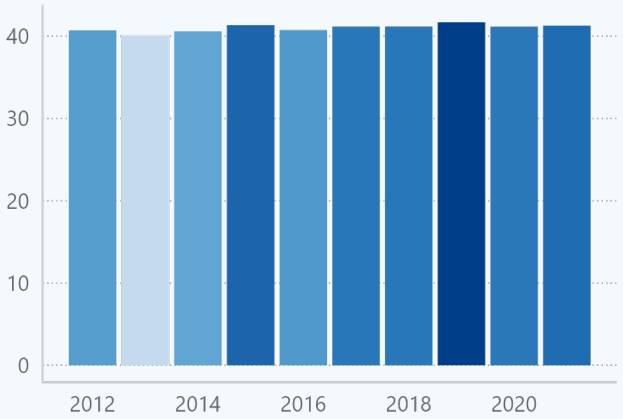
When we refer to demand we are referring to the volume of energy required to meet consumer and system requirements and ensure reliability. In the chart below, electricity demand is met from both generation that is grid connected and embedded, such as rooftop.

Electricity demand has been relatively stable in recent years, decreasing at an average of 0.2% per annum from 2012 to 2021. Whakamana i Te Mauri Hiko estimates a 68% increase in electricity demand by 2050 in the 'Accelerated Electrification' scenario. This demand is expected to come primarily through the electrification of private vehicles and process heat.

Although we're not seeing a significant ramp up in annual demand yet, other indicators suggest that it is imminent. Distribution businesses are also beginning to forecast load increases as part of their planning assumptions.

Annual electricity demand

TWh



Source: Electricity Authority. Last updated September 2022.

Consistent

Winter electricity demand is growing faster than summer

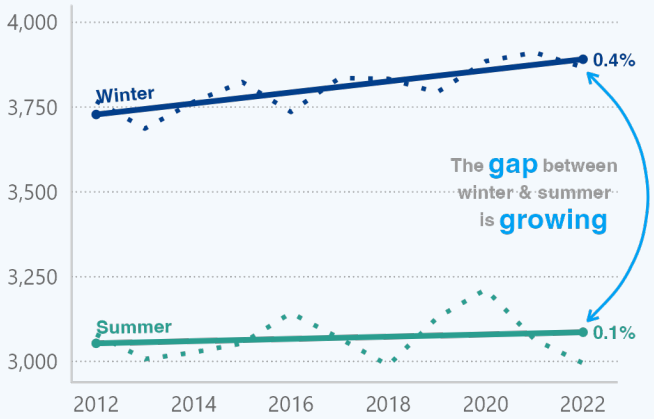
Electricity demand typically follows a seasonal pattern, with consumption being higher in the winter period, as New Zealanders use more power to light and heat their homes.

The chart below looks at the difference in the average winter vs summer demand over time. In the decade between 2012-2022, winter electricity demand has grown by an average of 0.4% per annum – twice the overall average and four times the average summer growth. This is also matched by higher peak demand in winter, discussed later in this report.

The difference in growth between the two seasons suggests that the main driver is the increasing electrification of heating. As carbon prices further increase the cost of fossil fuels, we expect this to continue. This will create significant challenges in meeting demand during a typical dry year, where lake levels are usually lower during winter, requiring significant energy from other sources.

Summer vs winter electricity demand

GWh, July vs February consumption and linear trend line



Source: Electricity Authority. Last updated August 2022.

Consistent

Residential electricity demand had material increase in last two years

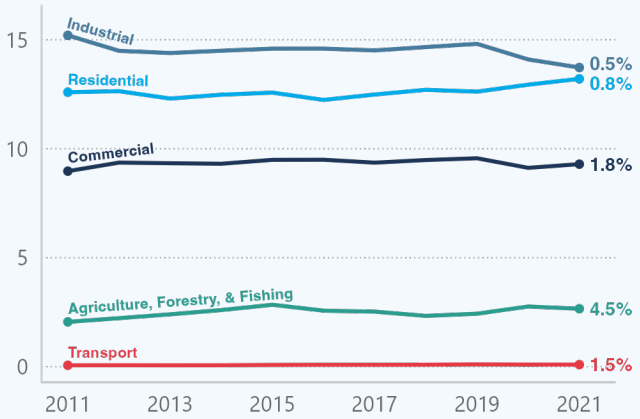
Electricity demand across the different sectors has been stable over the past ten years, in line with the country's total demand.

Since 2021, the industrial sector has seen a decline in demand, largely due to closure of plant, curtailed operations due to higher electricity prices and the effect of COVID-19 restrictions. The wood, pulp and paper sector was the single largest contributor to the decline. However, there are indications of likely step changes in industrial load in the future from switching to electricity and/or dual fuel such as biomass.

Electricity demand grew in the residential sector by 2.1% in the past 12 months to June 2022 compared to a 0.8% annual average since 2014. The increase in demand is due to a higher number of ICP connections from a boom in residential building consents and higher electricity consumption per ICP, partly due to increased working from home.

Annual electricity demand by sector

TWh, with CAGRs over the decade 2011-2021



Source: MBIE. Last updated September 2022.

Drivers of base demand have been slow due to the COVID-19 pandemic and future growth is uncertain

Uncertain

Population continues to grow at a slower rate due to COVID-19

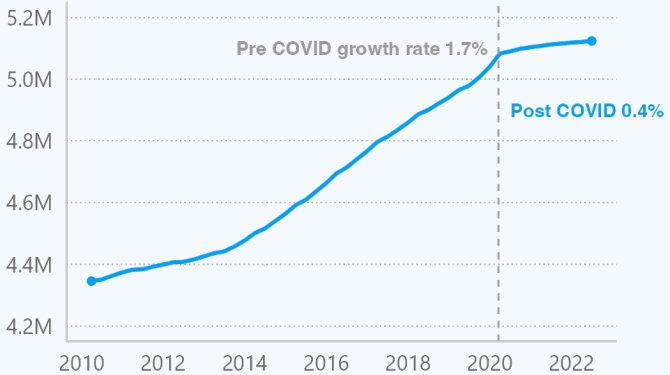
Because each New Zealander consumes electricity in their day-to-day life, population is an important driver of base demand. When excluding the impacts of increasing energy efficiency, we can expect base demand to increase with population growth.

Prior to COVID-19, the New Zealand population was growing at 1.7% per annum since 2010. However, since COVID-19, our population has grown at just 0.4%, with December 2021 and March 2022 seeing the third and fourth biggest net population losses per month since 1990. Historically, net migration losses from NZ were driven by NZ citizens heading overseas, but the COVID-19 border and travel restrictions have seen a reversal, and the net migration losses are driven by non-New Zealand citizens leaving.

Longer term, the latest Stats NZ population projections still expect growth roughly in line with pre-COVID levels out to 2030. Growth is expected to begin slowing after this, due to an aging population and a low birth rate.

Estimated NZ resident population

Millions of people, annual



Source: Stats NZ. Last updated September 2022.

Inconsistent

The road to recovery is bumpy, but growth expected in coming years

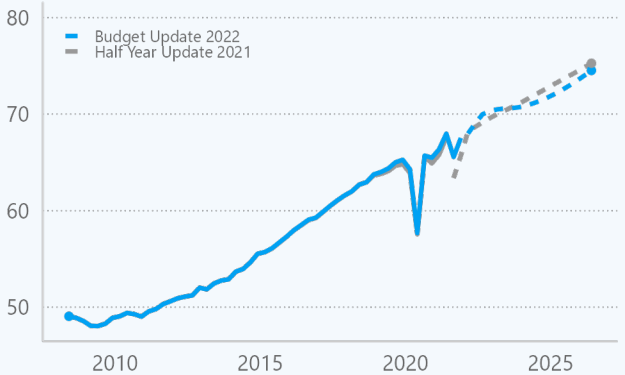
Economic activity is also a driver of base electricity demand as businesses use energy to deliver their goods and services.

We can expect base demand to increase with economic growth, although some of this is offset by increases in efficiency. The changing composition of the economy (e.g. increasing share of services) will also have an impact on base demand as some industries are more energy intense than others.

The below chart compares the previous Half-Year Update 2021 to the Budget Update 2022. While GDP is expected to recover to a broadly similar trajectory as pre-COVID-19, inflation has emerged as the principal economic challenge. This year, economic activity is still expected to be supported by the reopening of the international border, but a softening is expected due to rising interest rates and a reduction in COVID-19 related government spending.

Historical and forecast real production GDP

NZD billions, 2009/10 prices, quarterly



Source: Treasury. Last updated September 2022.

Consistent

Growth in ICP volume gradually returning after COVID-19

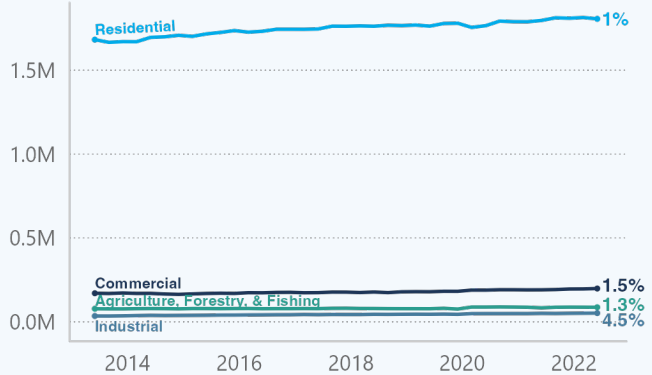
Installation Control Points (ICPs) are the physical points of connection on a local network. When new ICPs are added – for example when new houses are built – it is likely that there is an increase in electricity demand.

As with population and GDP growth, any growth in base demand will not be directly proportionate to ICP number growth due to energy efficiency and the specific consumer behaviours associated with those new ICPs.

In the 12 months to June 2022, the total number of ICPs hasn't change significantly. The residential sector, the largest by ICP count, grew by 9,613 (+0.5%), which is below the average of the past decade, but follows the largest annual increase since 2015 in the previous year. The agriculture, forestry and fishing sector increased by 3,391 (4.1%), well above its norm; industrial increased by 1,557 (+3.1%); and commercial increased by 7,702 (+4%) also strongly higher.

Number of ICPs

Millions of ICPs, quarterly, 2014-2022 CAGRs



Source: MBIE. Last updated June 2022.

Overall energy efficiency and energy intensity continues to improve, though residential demand is growing

Consistent

Energy intensity is decreasing at a national level

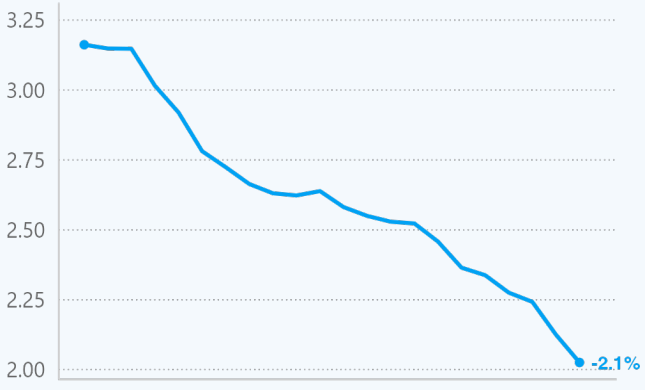
Energy intensity is a measure of the energy inefficiency of an economy. It is calculated as energy use divided by gross domestic product (GDP), and it tells us the amount of energy required to produce goods and services. High energy intensity means more energy is required per dollar of GDP.

According to MBIE's latest Energy in New Zealand, energy intensity improved in 2021, with the national average energy intensity indicator falling 4.6% in 2021. Up to 2021, the national average energy intensity had been improving (falling) on an average of 2.1% per annum since 2000.

This decrease has been driven by both efficiency improvements in the industrial sector and continued economic growth in the commercial sector which, being service based, is relatively less energy intensive than other parts of the economy.

Energy intensity across New Zealand

MJ/$ GDP in real 2009/2010 prices, annual. 2000-2021 CAGR



Source: MBIE. Last updated September 2022.

Consistent

Industrial sector continues to have highest intensity but improving

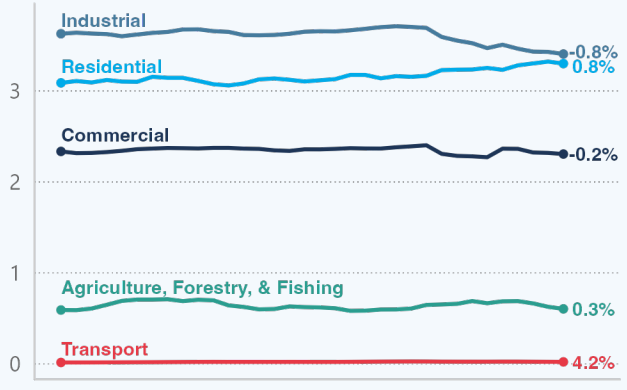
Energy intensity differs across sectors, and tends to be higher in capital-intensive industries and lower for more service-based industries.

Therefore, the industrial sector has consistently had a higher energy intensity since 2000, but has been falling at a rate of 1.7% per annum. WiTMH projects significant decarbonisation of industrial process heat over the coming decades, as technology (such as high temperature heat pumps) improves and electricity becomes more economical – not least as a result of carbon pricing. As this happens, we expect to see the industrial energy intensity decline even further.

Agriculture, forestry and fishing follows next, with only a modest change in the past 20 years. The commercial sector, being largely service based, has the lowest energy intensity and has been declining at an average rate of 1.6% per year.

Electricity demand by sector

TWh quarterly, rolling 4 quarter average, CAGRs 2014-2022



Source: MBIE. Last updated July 2022.

Uncertain

Residential electricity consumption per ICP is resurgent

The average electricity consumed at a residential ICP can be an indicator for improvements in energy efficiency in New Zealand homes. From 2000-2010, the average consumption remained constant. However, between 2010 and 2017, it fell by an average of 1.3% per year, reaching its lowest point this century at 7,055 kwh / ICP.

Since 2017, however, average consumption has been increasing at an average rate of 1%. Some of the more recent increase may be explained by increased working from home due to COVID-19; however, the trend was apparent before the first lockdown, suggesting that it is driven by changes in electricity consumption more broadly. Whilst efficiency remains an extremely important means of ensuring lowest cost energy, it's likely that residential consumption per ICP will continue to increase with electrification along with EV uptake and increasing electrification of space heating.

Average residential consumption per ICP

kWh, annual. 2000-2021 CAGR

Source: MBIE. Last updated September 2022.

Industrial energy users are still relying on fossil fuels, rising costs are causing issues and new entrants are also on the way

Consistent

Industrial demand weakens with little change in renewables

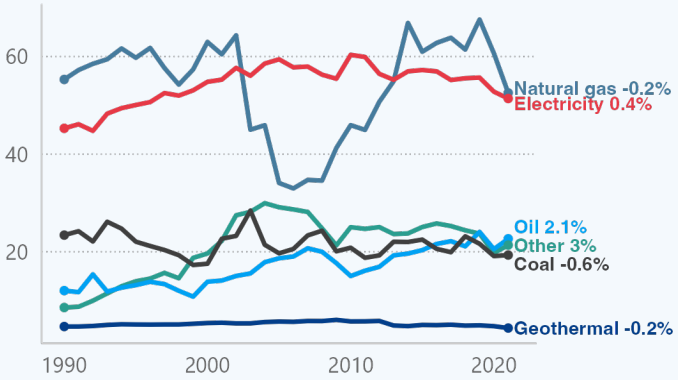
New Zealand's industrial sector relies on both fossil fuels and renewable energy sources. Due to COVID-19 restrictions and supply issues, industrial sector energy consumption in 2021 was 13% lower than pre-COVID levels. Although there was a fall in total consumption, the relative share of renewable and non-renewable fuels remained the same: the sector's consumption was 55% non-renewable, compared with a 30-year average of 54%.

Due to gas supply issues in 2021, natural gas consumption for industrial use decreased 13% compared with 2020. However, this appears to have been largely offset by a 10% increase in oil consumption. Electricity also fell (by 3%) but has been growing by an average of 0.4% per annum since 1990.

Overall industrial energy consumption has remained relatively constant over the past 30 years with an average growth rate of 0.5%. Total consumption in 2021 was 172 petajoules (PJ).

Industrial energy consumption

Petajoules, 1990-2021 CAGRs by fuel



Source: MBIE. Last updated September 2022.

Uncertain

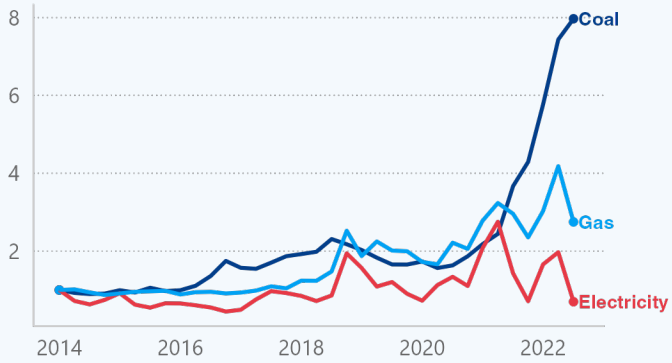
The gap between electricity and fossil fuels is increasing

Fuel costs have been significantly higher so far this year.

- **Increasing carbon prices:** The NZU spot price has increased by more than 150% in the past two years, from around $35 over $88 in September 2022. This will increase the cost of higher carbon fuels such as gas for electricity generation.
- **Coal:** Internationally, coal prices have surged in recent months due to international supply and demand factors, such as the halt in exports from Indonesia, the energy crunch in Europe and geopolitical tensions from the war in Ukraine.
- **Gas:** Tight supply from the Pohokura gas field last year drove higher NZ gas spot prices. The scarcity of supply has eased since 2021.
- **Electricity**: During early 2021, prices were higher, linked to low hydro storage, and constrained gas supply. Prices stayed high in early 2022, but eased off over winter due to above average hydro inflows. Electricity has held its price relative to the other fuels.

Change in fuel prices

Average price indexed against 2014, quarterly (incl. carbon)



Source: Electricity Authority, emstradepoint, theecanmole, & investing.com. Last updated September 2022.

Uncertain

Large energy users continue to adapt amidst high energy prices

Large energy user reviews

- **Tiwai Aluminium smelter –** Rio Tinto has signalled that the planned closure date in 2024, when its current electricity contracts ends, is not final. They have entered negotiations to cover their energy needs. Combined with high aluminium prices, the smelter might remain until 2034, which could play a role in dry-year cover.
- **Fonterra –** Fonterra is replacing a coal boiler at its Waitoa factory in the Waikato with a wood biomass boiler as part of its goal to achieve net zero emissions at its manufacturing sites by 2050.
- **Channel Infrastructure –** Channel Infrastructure completed their conversion to an import-only terminal in April 2022 and are now exploring several options: solar installation, hydrogen production, manufacturing sustainable aviation fuel, and import/export of biofuels.
- **Oji Fibre Solutions** – Oji Fibre Solutions entered into a partnership with the NZ government to explore opportunities to develop the Kinleith Mill to commercially produce wood products such as biofuels.

Potential large energy user entrants

- A number of new data centres are progressing, including DataGrid who are currently looking at options to connect their first module of 10 MW, eventually building to 150 MW. Vector in Auckland are progressing with several potential data centres including Microsoft, Amazon (30 MVA) and one other planned at Albany, sized at 50 MW.
- Meridian Energy and Contact Energy announced two potential partners for their Southern Green Hydrogen project: Woodside Energy and Fortescue Future Industries. Final investment decisions could be made as early as 2024.

Power Purchase agreements

- Local government PPAs were highlighted as an important mechanism in the ERP to promote new generation. Since this announcement, we have not recorded any other new PPA announcements.

Sourced from various media updates. Last updated September 2022.

Process heat decarbonisation is continuing to grow through support of the Government Investment in Decarbonising Industry fund

Consistent

Policy and investment are accelerating process heat decarbonisation

Decarbonising process heat is a large opportunity for New Zealand as it contributes 10% of gross emissions and 27% of energy-related emissions.

In May 2022, the Government released New Zealand's first emissions reduction plan (ERP) which sets out the policies and strategies for meeting future emissions budgets. As part of the announcement, the Government expanded the size and scope of the Government Investment in Decarbonising Industry (GIDI) fund. The fund is administered by the **Energy Efficiency and Conservation Authority** (EECA) to accelerate emission reductions from process heat used in industry.

In the first three rounds the fund has invested $185.5m in total Government and applicant funding across 53 approved projects. Collectively, this represents a reduction in lifetime emissions of 7.5 million tonnes at an average marginal abatement cost of $44 per tonne of CO_2e.

Through a tenfold increased contribution to the fund, the Government will invest an additional $650m over the next four years. Based on the average private applicant and Government funding ratio, it is expected an additional $1.1bn will be invested from the private sector.

The fund now includes partnerships with large energy users, decarbonisation and energy efficiency projects and funding for renewable fuel supply infrastructure such as electricity grid capacity.

The Government is also expected to make an announcement on the national direction for industrial GHG emissions in late 2022 to be carried through under the proposed Natural and Built Environments Act.

Sourced from various media updates. Last updated September 2022.

Consistent

Electrification of process heat is being boosted by the GIDI fund

The latest GIDI round was awarded in April 2022. Across the first three rounds of GIDI funding, 29 electricity projects were awarded a total of $33.8m in government co-funding, equating to an expected 2.9m tCO_2e in emissions reductions.

GIDI round	# of projects	GIDI co-funding	Lifetime emissions reductions (tCO2-e)
1	7	$11,907,075	945,480
2	12	$15,321,382	1,433,927
3	10	$6,566,644	533,606
Total	**29**	**$33,795,101**	**2,919,013**

EECA has opened Round 4 of the new GIDI fund and successful projects are expected to be announced in November 2022.

DETA Consulting, EECA, Transpower and local electricity distribution businesses (EDBs) continue to undertake research to quantify the potential fossil-based process heat demand in New Zealand. Full results of the South Island study findings have been released, and have identified 1.46 GW of non-renewable heat capacity representing 24.3 PJ of heat demand per annum. The study has started data collection on North Island sites.

EECA, together with Transpower, local EDBs and other regional stakeholders are piloting a Regional Energy Transition Accelerator Pilot in Southland to identify opportunities for process heat decarbonisation. The aim is to develop a coordinated approach for regional decarbonisation.

Sourced from various media updates. Last updated September 2022.

Consistent

Biomass and energy efficiency are also decarbonising process heat

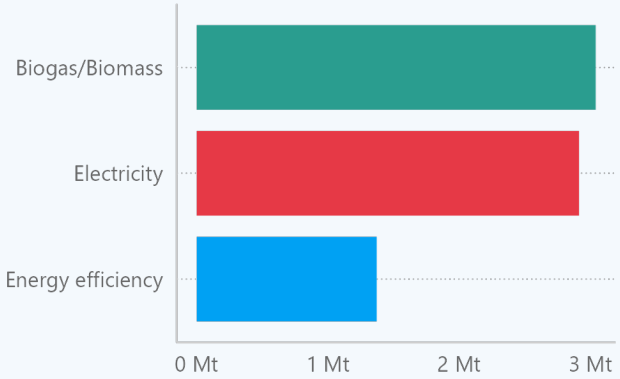
Other fuels outside of electricity are also playing their part. Across the first three rounds of GIDI funding, 24 projects that achieved emissions reductions via use of biogas, biomass, geothermal or energy efficiency were awarded a total of $35m in GIDI co-funding, equating to an expected 4.5m tCO_2e in emissions reductions. Biomass and electricity have so far been the key fuels, with a similar emissions reductions so far.

Type	# of projects	GIDI co-funding	Lifetime emissions reductions (tCO2-e)
Biogas	2	$669,222	43,980
Biomass	12	$21,505,520	2,996,015
Energy Efficiency	9	$11,163,457	1,371,495
Geothermal	1	$1,650,000	136,610
Total	**24**	**$34,988,199**	**4,548,100**

In August 2022 the Ministry for Primary Industries consulted on a draft Industry Transformation Plan for the forestry and wood processing sector that has a priority to increase the use of woody biomass to assist with energy decarbonisation.

GIDI projects emissions reductions

Mt CO_2e over project lifetime



Source: Various media updates. Last updated September 2022.

Electric vehicle numbers have been boosted by recent transport policy and funding and are expected to continue rising

Consistent

Light EV uptake is climbing but eclipsed by hybrids

There are currently around 38,000 EVs in NZ, or 1% of the total light vehicle (LV) fleet. To this, roughly 1,500 EVs are being added to the fleet each month, which makes up around 8% of all LVs and around 1 in 5 new vehicle sales.

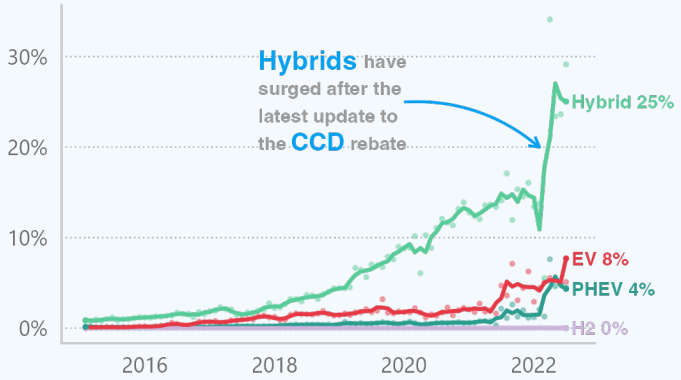
This growth in EVs has been supported by the Clean Car Discount (CCD), through which new zero emissions vehicles are eligible for a rebate of $7,500. As of April 2022, other low emissions vehicles are eligible for rebates based on the amount of CO_2 they emit – including most hybrids.

Interestingly, in comparison with the first three months of 2022, there has been a significant increase in the number of hybrids being registered each month. This now averages almost 5,000 compared to 3,000 prior to the change (an increase of 70%).

This trend is likely driven in part by the CCD but also by the greater availability of low-cost hybrids in comparison to EVs. However, many more EVs are expected to come to market, with research suggesting global price parity later this decade.

Light low emission vehicle registrations

Percentage of registrations, rolling 3 month average



Source: NZTA. Last updated August 2022.

Consistent

Small but consistent increase in numbers of heavy electric vehicles

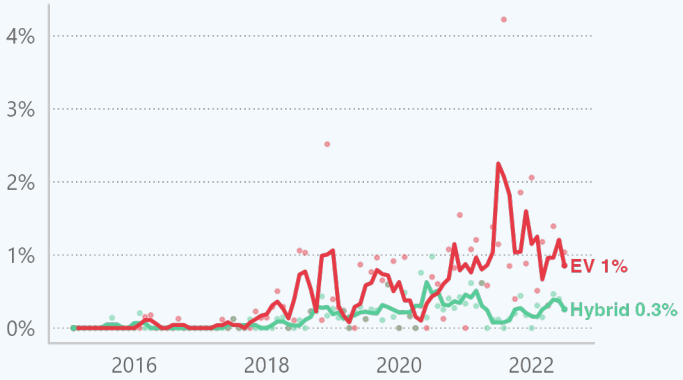
Heavy vehicles are also starting to electrify, but at a slower pace than light passenger vehicles, due to the technology being in earlier stages.

Since the start of 2022, there have been 21 heavy electric trucks added to the fleet, 0.4% of trucks this year. The number of new electric heavy trucks per month has remained consistent with previous years at around three. This contrasts with light trucks (< 3,500t), with 189 battery electric (BEV) trucks added so far this year and a further 31 plug-in electric trucks (PHEVs), together comprising 0.8% of trucks so far. Light trucks per month this year averages 24, compared with just 6 in 2022. There have also been 50 EV buses added to the fleet, 3.7% of buses this year.

Hydrogen fuel cell technology is also a potential competitor to battery electric trucks. NZ's largest transport company, HW Richardson, is currently piloting dual fuel hydrogen/diesel hybrid heavy trucks with a plan to roll out 10 trucks and refuelling infrastructure in 2023. Whilst these are not EVs, their electrolysers will still result in increased electricity demand.

Heavy low emission vehicle registrations

Percentage of registrations, rolling 3 month average



Source: NZTA. Last updated August 2022.

Consistent

Road transport decarbonisation supported by Government policy

EECA has announced Rounds 2, 3, and 4 of the Low Emission Transport Fund, which focus on supporting technology and infrastructure solutions to accelerate the decarbonisation of the transport sector. A total of $43.4m co-funding has been provided for 233 projects to date through the scheme, boosting the number of co-funded EV chargers to 1300+.

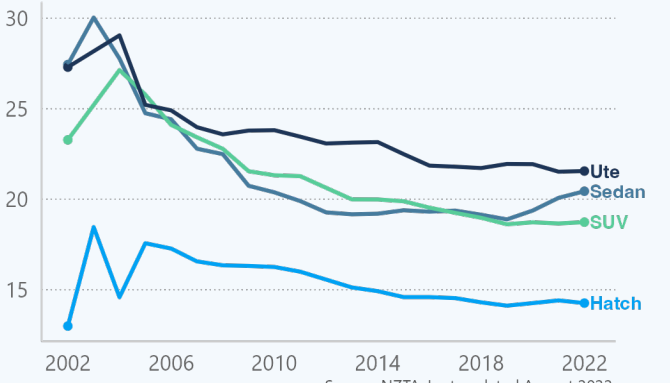
In May 2022, the Government released the ERP, which included the following targets for transport:

- **Reduce total kilometres travelled by the light fleet by 20% by 2035**
- **Increase zero-emissions vehicles to 30% of the light fleet by 2035.**
- **Reduce emissions from freight transport by 35% by 2035.**
- **Reduce the emissions intensity of transport fuel by 10 per cent by 2035**

This support is as timely as it is needed. Whilst emissions per 100 km in the light vehicle fleet have generally declined over the past 20 years, recent progress shows signs of stagnation, with average emissions for sedans even growing. The national fleet weighted average CO_2e per 100km is still 18.7; and, at an average of around 9,100 km per person annually, this amounts to over 1.7 t CO_2e per person per year.

Average emissions of new registrations

Kg CO_2e per 100km, annual fleet weighted average. Light vehicles only.



Source: NZTA. Last updated August 2022.

Electric passenger vehicles are becoming more attractive due to new Clean Car Discount and lower running costs

Consistent

EV purchase price parity still higher than ICE but is narrowing

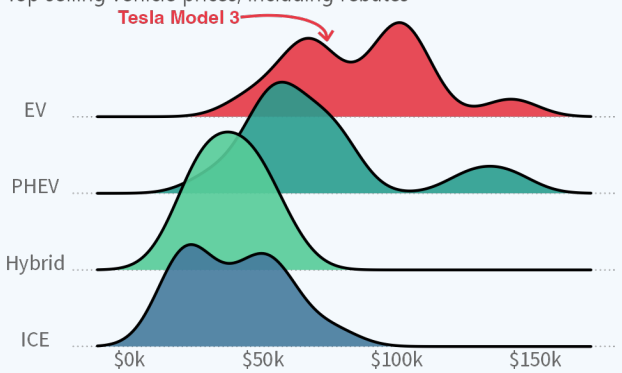
Upfront purchase price is a key barrier to adoption of electric vehicles. EV purchases will start to grow significantly once the purchase price of EVs is on par with internal combustion engine (ICE) vehicles. Research by Bloomberg suggests global price parity with petrol and diesel equivalents between 2026-2030.

The CCD rebate has helped to drive a significant increase in EV purchases since July 2021. The upfront cost of an EV, however, is still higher than an ICE equivalent, as shown below. On the other hand, hybrids are now broadly similar in price to ICE vehicles, helping drive their uptake.

The all-time most popular EV in NZ is the Nissan Leaf with 17,225 currently registered. However, in the past 12 months, the Tesla Model 3 has overtaken the Leaf as the current best seller. There have been 4,401 Model 3s registered so far this year (6,445 in total). But at $66,275 (incl. rebate) this model is still considerably more expensive than an average ICE vehicle. The cheapest EV is currently the MG ZS at $41,365.

Distribution of vehicle prices

Top selling vehicle prices, including rebates



Source: NZTA for vehicle registrations. evdb, driven, turners, & toyota for price data. Last updated September 2022.

Consistent

EV running costs significantly lower than petrol and diesel equivalents

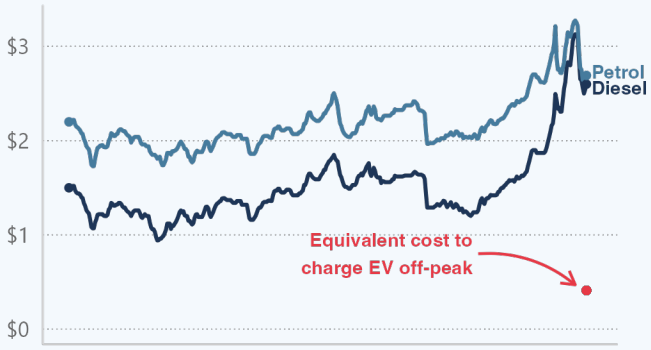
The total cost of ownership (TCO) is a more accurate cost comparison, and factors in both purchase price and operating expense over the lifetime. Electric vehicles have lower running costs than their petrol and diesel equivalents and therefore, in some cases, lower total cost of ownership.

Fuel is a large component of a vehicle's running costs. Petrol prices fell as the pandemic hit in 2020, but have now risen higher than pre-COVID-19 levels. Fuel prices have continued to increase during 2022 from a weaker NZD-USD exchange rate, higher import costs, and supply chain issues due to COVID-19. They continue to rise amid volatility from higher oil prices and geopolitical instability from the Russia-Ukraine war.

Higher petrol costs make charging an EV more attractive and the gap is widening with petrol 6.5x times more expensive than (off-peak) electricity on a per litre equivalent basis. In March 2022, the Government announced a 25 c/litre reduction of the petrol fuel excise duty, but this will resume in Jan 2023.

Vehicle fuel prices

Dollars per litre (nominal). Petrol refers to regular.



Source: MBIE. Last updated September 2022.

Consistent

Total and per capita travel has decreased due to COVID

According to Ministry of Transport's Annual Fleet Statistics, prior to 2019, both total and per capita vehicle kilometres travelled (VKT) was increasing. However in 2020, total annual light VKT decreased 3.6% and 5.6% on a per capita basis compared to the prior comparable year.

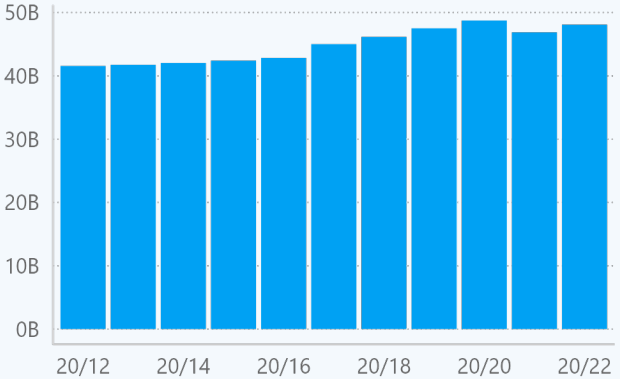
Recent VKT figures show that VKT has largely bounced back to pre-COVID-19 levels in the latest year-to-June, and our car ownership continues to be one of the highest in the world at 818 light vehicles per 1,000 people.

In the longer term, the Government has set a target to reduce VKT by 20% by 2035 as part of its emissions reduction plan.

This strong reliance on private vehicles highlights the crucial role electrification will play in reducing our transport emissions. It also emphasises the need for alternative modes of transport, such as walking, cycling, micro mobility and public transport, as well as reducing the need for travel in general.

Vehicle kilometres travelled

Billion kms, annual



Source: NZTA. Last updated July 2022.

Battery technology and flexible demand is beginning to provide solutions to meet peak and energy demand

Consistent

Grid-scale battery projects are emerging in New Zealand

Overseas, batteries are proving that they can access multiple value streams through energy markets, network deferral and providing ancillary services.

Recent announcements across New Zealand's electricity industry suggest that both micro-grid and large grid-scale batteries could soon play a bigger role in NZ's power system.

- **WEL Networks** through Infratec to build a 35 MW battery energy storage system in Waikato. It will provide electricity reserves into the market and is expected to be commissioned by October 2022.
- **Meridian Energy** announced that it is planning to build a renewable energy park near Marsden Point by mid-2023. It includes utility scale solar and a 100 MW capacity grid-connected battery.
- **Contact Energy** are investigating the economics of a 100 MW battery energy storage system, with an investment decision expected by late-2022.
- **Vector** issued a ROI for non-wires alternatives in the wider Warkworth region. Non-wires alternatives includes solutions such as distributed generation, energy storage, demand-side management and demand response.

These are not the only battery projects in New Zealand and it is expected that further large-scale projects will occur by 2030. According to the IEA, installation of utility-scale batteries jumped by 50% worldwide last year, driven by the global uptake toward renewables and the fall in battery costs.

Sourced from various media updates. Last updated September 2022.

Consistent

Flexible demand an option for supporting energy security

Flexible demand (such as demand response) provides another layer in supporting energy security as it allows for electricity consumption to flex (either up or down) in line with available supply. This dynamic potential is particularly useful at times when energy supply is tight. Flexible demand can be deployed to help avoid outages in the electricity system by preventing demand from exceeding supply line limits.

Demand response progress in NZ is quietly continuing. Recent developments include:

- **Smart meters to smooth EV shift** – Network Tasman are the latest distribution network to start using smart meter data to estimate likely changes to loads and load diversity as more electric vehicles come into its region.
- **EECA consults on EV smart charging** – EECA is now consulting on improving the performance of electric vehicle chargers, which outlines the issues and proposes setting standards for basic charger functions, communication capabilities and monitoring abilities.
- **Influx launches hot water management for retailers** – Influx, a cloud-based energy data solution provider has launched a service that makes hot water demand management available to retailers, opening the possibility of greater retail and customer engagement in demand response.

There are already several forms of flexible demand in New Zealand's electricity system:

- **Ripple control** has been in place since the 1950s and allows distribution businesses to turn off consumers' hot water systems at times of peak demand.
- **Tiwai's demand response agreement with Meridian**, which can be triggered to assist with managing low hydro periods.

Sourced from various media updates. Last updated September 2022.

Consistent

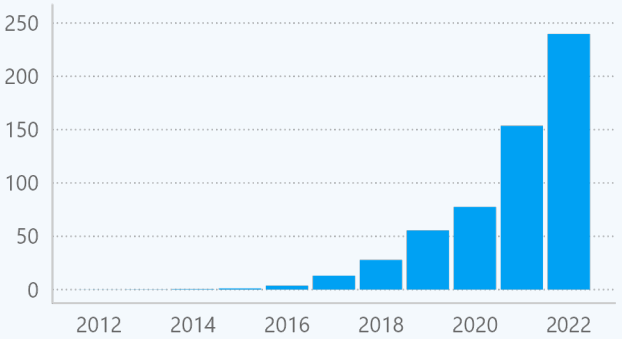
Electric vehicles present a rapidly growing potential resource

Distributed energy resources (DER) are growing in large volumes globally as consumers seek to benefit from their own controllable systems, and networks take advantage of wider energy system benefits. One potentially very significant source of DER is electric vehicles (EVs). EVs can be used to provide flexible demand response through smart charging. In the future, EVs may also provide energy back into the grid through technology known as Vehicle-to-grid (V2G). V2G trials are already underway in California.

The average EV battery size in NZ has been steadily increasing. Over the past decade it has risen from 32 kWh to 53 kWh (weighted by vehicle sales) – an average growth rate of 5.1% per year. Taken together, this results in at least 1,710 MWh of combined EV battery storage in NZ as of August 2022. However, EV energy available for demand response or V2G is limited by AC charging constraints. Yet this capacity is increasing too, having doubled from a volume-weighted average of 4.2 kW in 2012 to 8.2 kW in 2022.

Potential distributed energy in EVs

MW, Cumulative NZ EV battery power capacity, noting AC charging constraints. (Excl. heavy vehicles & buses).



Source: NZTA for registrations. evdb.nz and ev-database.org.uk for battery facts. Last updated August 2022.

Distributed solar installations continue to grow in number and capacity, with falling long term costs

Consistent

Residential solar installations continue to grow

More New Zealand households are installing solar photovoltaic (PV) systems on their rooftops to take advantage of lower electricity costs.

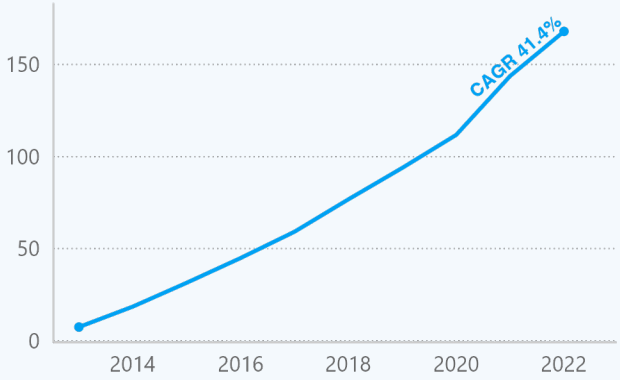
Over the past decade, the total number of solar installations have grown by an average of 38% per year, from 2,114 ICPs to 38,638 ICPs in 2022 – this equates to approximately 2.1% of households. The vast majority (99%) of these installations are < 10 kW, however the average size has been growing, from 3.5 kW to 5.3 kW.

A record 32 MW of residential solar was installed in 2021, up 72% on the prior 12 month period; this compares with an average addition of only 17.8 MW. As of July 2022, 24.2 MW has been installed, which sets it on track to at least equal the 2021 record. At a current 170 MW, we are well on track against the *Accelerated Electrification* projections to have 300 MW by 2025.

This year, Octopus Energy also launched in NZ, and is explicitly targeting residential solar with a 17c buy-back rate for solar exported to the grid.

Residential Solar in New Zealand

MW, total installed distributed capacity



Source: Electricity Authority. Last updated July 2022.

Consistent

Commercial solar installations continue to grow

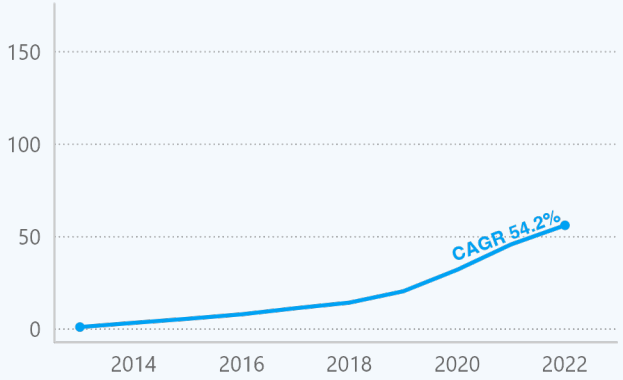
As with residential sites, commercial and industrial solar installations have also been increasing. These installations are embedded and do not include any grid-connected solar installations.

Over the past decade, the total number of solar installations have grown from 163 ICPs to 1,236 ICPs by July 2022. The majority of installations are still under 10 kW, but the proportion of large installations has been steadily increasing: from 11% in 2013 to 34% in 2022. The average capacity for new installations is approximately 35 kW in 2022.

Last year 14 MW were added to commercial solar, the largest increase so far. However, already this year 10 MW have been added, suggesting that over 20 MW might be completed by the end of this year. Although commercial solar lags behind residential, it is rapidly catching up, with an average annual growth rate of 54.2% (vs only 41.4% for residential).

Commercial Solar in New Zealand

MW, total installed distributed capacity



Source: Electricity Authority. Last updated July 2022.

Consistent

Distributed solar costs forecast to continue on sharp decline

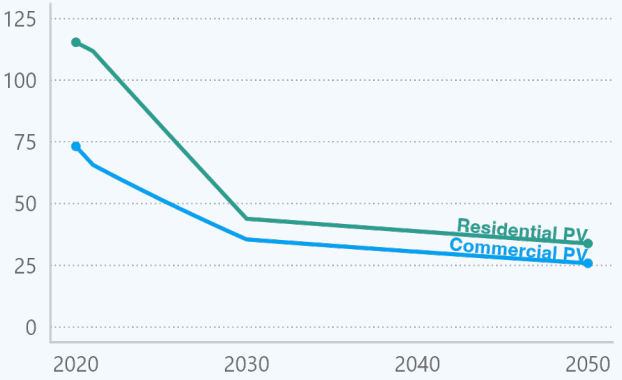
The National Renewable Energy Laboratory (NREL) releases industry updates on forecast solar PV levelised cost of energy (LCOE). Between now and 2030, the cost of solar is expected to fall by 58% and 43% for residential and commercial respectively.

According to NREL, the global PV module price stayed relatively flat (-$0.01/W USD) after rising significantly in 2021. Current higher prices are largely driven by the higher cost of polysilicon, a key feedstock to most PV modules, supply chain disruptions caused by the global pandemic, and inflation. A recent report by the International Energy Association noted that over 80% of the global supply solar PV chain is located in China, leading to lower supply chain resilience.

As a result of supply chain shortages and component price increases, consistent price increases in PV systems were seen for the first time. Despite this, analysts expect that the pace of installations will continue to increase, buoyed in part by the United States Inflation Reduction Act, which includes $128bn USD in tax credits supporting wind, solar, and storage.

Levelised cost of energy for distributed solar

$/MWh (USD)



Source: NREL. Last updated September 2022.

Capability to meet energy demand and peak demand is currently sufficient, but peak demand is rising

Uncertain

La Niña results in unusual hydro patterns once again

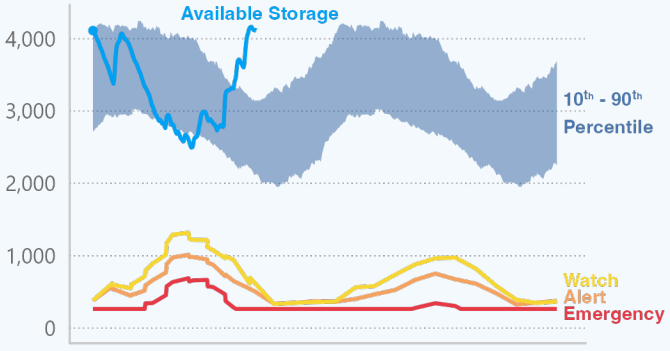
The industry needs to ensure there is enough electricity to meet energy demand, particularly during dry years when low rainfall impacts hydro generation. Transpower regularly assesses New Zealand's security of supply to help the industry with decision making to avoid shortages.

This year saw a repeat of last year's La Niña climate conditions. This again resulted in trends opposite to our normal patterns, with below average rainfall in the hydro catchments during summer and autumn, followed by above average during winter. 2022 storage levels remained comfortable above the risk curve due to a single large inflow event in February, and unlike 2021, gas production was less constrained, primarily due to increased output from the Maui production facility. Looking ahead to 2023, we are expecting another La Niña climate event, the first threepeat since the 1970s and further increases in national gas production.

In the long term, large-scale storage and flexible demand could have a role to play in the future of security of supply.

Electricity risk status curve

Available storage, GWh



Source: Transpower. Last updated September 2022.

Uncertain

Generation capacity exists to meet peaks but some slow start concerns

The above average winter inflows associated with the La Niña climate saw reduced baseload thermal running consistently in the market. Due to its slow start nature, this resulted in low margins during periods of high demand and low wind generation. This put the power system at increased risk due to potential plant breakdown or material deviation from forecasts. Of note was 23 June when, due to plant failure, the system operator called a Grid Emergency to ensure sufficient generation was available to meet demand.

Plant, comm. date and capacity	Announced developments
Huntly Rankines (U1,2,& 4) 1982, 750 MW Coal/Gas	• Commitment to no coal after 2025 in normal year and zero coal by 2030. • Biomass trial 4,000 tonnes for use in one of the 250 MW units (in progress). • Three units available until end of 2023.
Huntly U5 2007, 403 MW Gas	• No announced plans.
Huntly U6 2004, 51 MW Gas	• No announced plans.
Taranaki Combined Cycle 1998, 377 MW Gas	• Contact Energy expects Taranaki Combined Cycle (TCC) will retire in 2024 after Tauhara geothermal power station commences operation. • "ThermalCo" proposal in which all fossil-fuel generation is owned by a single entity. Still in discussion.
Stratford Peaker 2011, 210 MW Gas	
Whirinaki Peaker 2004, 155 MW Diesel	
McKee Peaker 2013, 100 MW Gas	• No announced plans.
Junction Rd Peaker 2020, 100 MW Gas	• No announced plans. • Commissioned May 2020.

Sourced from various media updates. Last updated September 2022.

Consistent

Peak demand is noticeably growing

The power system must ensure that the highest demand at any one point in time can be met. Peak demand follows a seasonal pattern, with higher levels during winter, specifically in the mornings and evenings as people light and warm their homes.

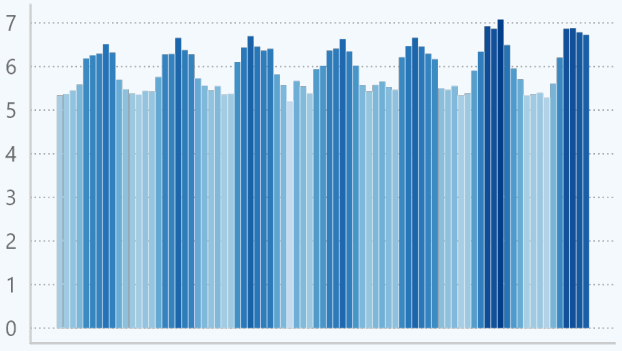
Peak demand had seen little variation over the five years to 2020. However, recent peak electricity demand has raised concerns for security of supply. The top 10 largest demand peaks have all occurred in the past two winters; 6 out of those 10 occurred in 2022.

Interestingly, peak demand has not uniformly shifted higher. Since 2016, the median peak demand has increased by an average of only 0.2% per annum (and only 0.1% in summer); however, the winter peak has grown by 0.9% per annum over the same period, mostly in the last 2 years.

Peak demand is expected to grow as electrification ramps up. Looking forward, new generation will be needed to meet peak demand, as well as non-network solutions like demand response.

Peak demand over time

GW, monthly highest peak demand



Source: em6. Last updated September 2022.

Electricity maintains affordability and high renewability but significant action still must come to meet renewable targets

Uncertain

Residential electricity bill falls due to lower consumption

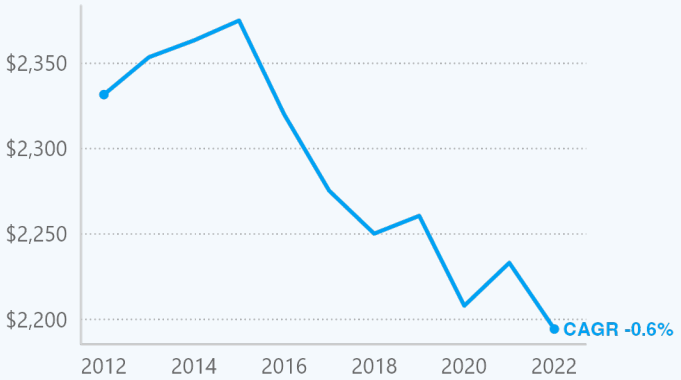
Energy affordability is a core pillar of the energy trilemma. Electrification is only likely to occur if electricity is affordable and competitive against other forms of energy.

At a household level, the real average cost of electricity hasn't changed much in the last decade: the average price per kWh decreased from $0.31 in 2012 to $0.30 in 2022. Over the same period, the average household consumption has fallen 4.6%. As of March 2022, the average household uses 7,261 kWh per year, down from 7,609 in 2012. Consequently, the real average household bill has also decreased and is now $2,194 per year – a reduction of 5.9% since 2012.

However, whether these trends continue is uncertain: on 1 April 2022, the Government announced the phase out of the low user fixed charge tariff. In addition, household electricity consumption is likely to increase as electric vehicles become more common. Changes in consumption and cost trends will become evident in future data releases.

Average annual residential household cost

NZD (real)



Source: MBIE. Last updated September 2022.

Uncertain

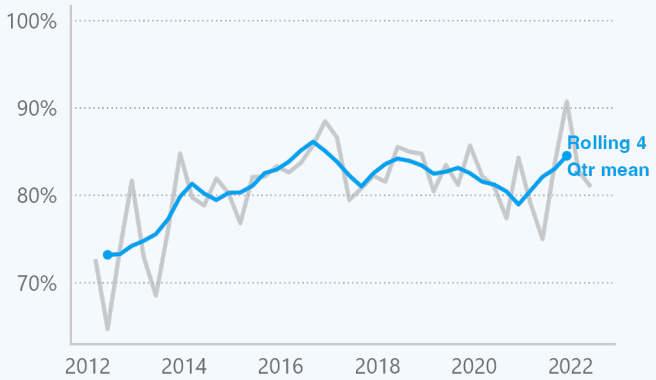
Renewable electricity generation continued dependence on hydro

For the majority of the past decade, New Zealand's electricity system had an average of 81% renewable generation. The past 18 months have set records for renewable electricity generation. In the June quarter of 2021, renewability of the electricity system fell to 74.9%, the lowest level since the June quarter of 2013. This was due to dry hydro conditions and the need to ramp up coal generation to maintain security of supply. However, by the December quarter, a rise in hydro inflows and increased wind generation saw renewability increase to 90.7%, the highest quarter in 26 years. This current quarter is on track to equal or better that with renewability for July and August 2022 both sitting above 90%.

These recent swings in renewability highlight some of the challenges with our current generation mix. As the NZ electricity system is highly dependent on hydro (55% on average in the past 10 years), dry conditions strongly affect the proportion of fossil fuels in the mix. Adding more diverse renewables such as wind and solar will improve this.

Renewable share of electricity generation

Average percent, quarterly



Source: MBIE. Last updated September 2022.

Uncertain

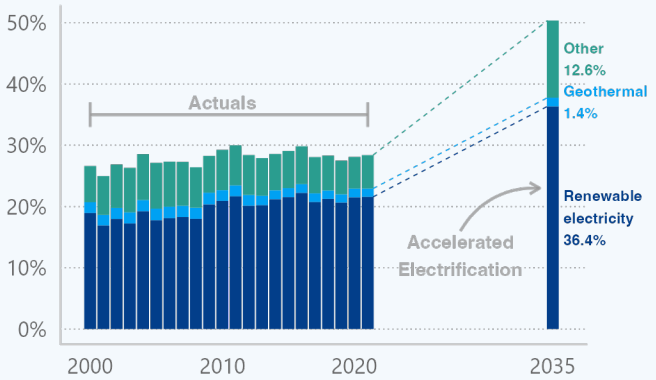
Renewable energy consumption is still a long way short of the target

Overall, renewable energy consumption has consistently averaged around 28%. 20% of this comes from renewable electricity. The remaining 8% was made up of around 2% Geothermal and 6% from other renewables, such as biomass. These proportions have remained remarkably stable for the past few decades. The next few decades, however, will look very different.

The government has posed an ambitious target of 50% renewable final energy consumption by 2035 to deliver on its decarbonisation goals. This target is in line with WiTMH's *Accelerated electrification* scenario. To achieve it, renewable electricity will need to increase from 20% total consumption to 36%. The remaining 14% will come through other fuel switching possibilities such as gas to hydrogen, and the use of biomass/ biofuel. The forestry draft Industry Transformation Plan outlines goals to produce more biomass and biofuel, and MBIE is expected to release its Energy Strategy in 2024 that addresses this gap.

Renewable share of energy consumption

Annual, total final consumption vs Accelerated Electrification



Source: MBIE. Last updated September 2022.

Progress against the ten Whakamana i Te Mauri Hiko industry themes is ongoing and may shift further with future energy policy

1 Streamlining our connections process

- We consulted on our queue management system and are further engaging with industry to develop a revised Queue Management Framework.
- Revised our harmonic allocation policy and developed guidelines for connecting distributed generation that impacts the core grid.
- We continue to develop our fast-track process for very simple grid connections.

2 Integrated system planning

- Transpower is continuing with its Net Zero Grid Pathways (NZGP) project, which aims to ensure New Zealand can take an integrated view of future investment needs.
- We consulted on our shortlist of options for investment into the central North Island, Wairakei ring and the HVDC. Currently refining options.

3 Getting the incentives right for electrification and renewables

- The Climate Change Commission proposed changes to the ETS, which (if adopted) would result in higher cost containment reserve prices and fewer NZ Units available.
- EECA-managed funding and support available to transport and process heat electrification.
- Introduction of new policy, e.g. new coal boiler ban, Clean Car Discount, Clean Car Standard.
- Schemes such as Meridian's Electrification Programme.

4 Removing barriers to low carbon infrastructure

- National and Built Environment Act legislation, as part of the Resource Management Act Reform is expected later this year.
- MBIE's Building for Climate Change programme to reduce emissions from constructing and operating buildings.

5 Demand-side management of peaks

- EECA and EEA are leading a project across NZ's electricity supply industry to trial OpenADR standard for EV smart charger communications.
- EECA has published a green paper on EV charging to discuss the need for standardisation.
- Distribution businesses conducting various projects: South Island DSO, Orion's LV monitoring, Vector's smart charging trial, Wellington Electricity's EV Connect consultation, Aurora's non-network alternatives project.

6 Ensuring generation meets peaks

- Increased pipeline of generation projects.
- Interest in grid-scale and flexible energy is rising
- MDAG's work on wholesale market settings under a 100% renewable electricity supply, and proposal to use 'green peakers' run on biomass or green hydrogen.

7 Managing dry year risk

- MBIE's NZ Battery project is underway; early feasibility studies look positive with options analysis due Dec 22.
- Genesis energy trialling biomass to displace coal.
- Flexible demand projects are being investigated to assist with dry-year management, e.g.: Clyde Data Centre, Southern Green Hydrogen project, Tiwai and Methanex flexibility.

8 Protecting system stability

- Transpower continues to monitor risks to system stability.
- Transpower is working with the Electricity Authority on understanding the future security and resilience of the electricity system. The roadmap has now been released.

9 Access to skilled workforce

- Registered as an Accredited Employer Work Visa (AEWV) to enable us to recruit migrant employees for specific roles
- Second pilot of the Wonder Project – Power Challenge has begun with 71 Transpower staff teaching STEM.
- Transpower Graduate and Internship Programmes have been extended to 20 and 30 placements in 2023 respectively.

10 Collaboration

- Transpower is investigating the concept of Renewable Energy Zones in New Zealand.
- The Aotearoa Circle and partners have released a Low Carbon Energy Roadmap .
- Transpower is currently working with EECA and electricity distribution businesses on collecting data on process heat end use.