Electricity Demand and Generation Scenarios (EDGS) 2023

CONSULTATION DOCUMENT

May 2023

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
New Zealand Government

Ministry of Business, Innovation and Employment (MBIE)

Hīkina Whakatutuki – Lifting to make successful

MBIE develops and delivers policy, services, advice and regulation to support economic growth and the prosperity and wellbeing of New Zealanders.

MORE INFORMATION

Information, examples and answers to your questions about the topics covered here can be found on our website, mbie.govt.nz

DISCLAIMER

This document is a guide only. It should not be used as a substitute for legislation or legal advice. The Ministry of Business, Innovation and Employment is not responsible for the results of any actions taken on the basis of information in this document, or for any errors or omissions.

ISBN: **978-1-99-106979-5**

May 2023

Purpose of this document

The Ministry of Business, Innovation and Employment (MBIE) produces the Electricity Demand and Generation Scenarios (EDGS) for use by the Commerce Commission in assessing major investment proposals by Transpower. This involves preparing a range of scenarios that explore potential futures of electricity demand and generation in New Zealand.

As part of this process, MBIE seeks input from stakeholders to ensure that these scenarios and the resulting modelling reflect the potential pathways that the electricity sector could take.

This document presents our proposed approach to the scenarios that will be modelled as part of the 2023 update of EDGS and seeks feedback and input to shape them.

How to have your say

Submissions process

MBIE seeks written submissions on the issues raised in this document by **5pm on Monday, 22 May 2023**. Your submission may respond to any or all of these issues. Where possible, please include evidence to support your views, for example, references to independent research, facts and figures, or relevant examples. Please include your contact details in your submission.

You can make your submission by completing the submission template and sending your submission as a Microsoft Word document to
energyinfo@mbie.govt.nz.

Please direct any questions that you have in relation to the submissions process to energyinfo@mbie.govt.nz.

MBIE will analyse and publish a compiled list of next steps

After submissions close, we will analyse all submissions received and then use these to inform decisions around modelling for EDGS 2023. If you agree to be contacted, we may reach out to you to discuss points you have raised in your submission and/or to obtain more information.

We will publish a compiled list of next steps on the MBIE website. We will not be making any individual submissions public. Should you agree to having quotes from your submission included in the next steps, we will ensure that no part of your submission refers to any names of individuals. When businesses or organisations make a submission, MBIE will consider that you have consented to the content being included in the compiled next steps unless you clearly state otherwise. If your submission contains any information that is confidential or that you do not want published, you can say this in your submission. The Privacy Act 2020 applies to submissions and survey responses. Any personal information you supply to MBIE while making a submission will be used by MBIE only in conjunction with matters covered by this document.

Submissions and survey responses may be the subject of requests for information under the Official Information Act 1982 (OIA). Please set out clearly if you object to the release of any information in the submission, and in particular, which part (or parts) you consider should be withheld (with reference to the relevant section of the OIA). MBIE will take your views into account when responding to requests under the OIA. Any decision to withhold information requested under the OIA can be reviewed by the Ombudsman.

Contents

Introduction

EDGS explores potential future electricity demand and generation capacity out to 2050

The Commerce Commission is responsible for approving any major investments in transmission assets by Transpower. To perform this role, the Commerce Commission requires an independent set of electricity demand and generation scenarios. The Ministry of Business, Innovation and Employment's (MBIE's) Electricity Demand and Generation Scenarios (EDGS) fulfils this role, enabling the Commerce Commission to assess Transpower's planning proposals for future capital investment in the electricity transmission grid.

EDGS has an explicit role in the investment test for approving Transpower's proposals under the Transpower Capital Expenditure Input Methodology (Capex IM). The Capex IM is part of the Commerce Commission's individual price-quality path regulation of Transpower's electricity transmission services, under Subpart 7 of Part 4 of the Commerce Act 1986. For more information about the Capex IM, see the Transpower input methodologies on the Commerce Commission website.

EDGS is just one product that utilises MBIE's energy modelling suite

MBIE maintains a suite of energy modelling tools that it uses to prepare projections and inform advice and analysis on the energy sector. Products from this suite have contributed to the development of the country's first Emissions Reduction Plan and international reporting on New Zealand's progress in its climate change commitments.

MBIE's modelling suite comprises two main models

These are the Supply and Demand Energy Model (SADEM) and the Generation Expansion Model (GEM).

SADEM is a model owned and operated by MBIE. The model:

- projects energy demand for all sectors of the economy based on external drivers (such as population and economic growth), accounting for switching between different energy types within sectors
- provides a central hub to incorporate electricity supply information from GEM
- estimates energy sector greenhouse gas emissions based on projected energy supply and demand.

A version of the Electricity Authority's GEM is used to project the timing and type of new generation capacity that is built. GEM is a long-term planning model used to study capacity expansion in the New Zealand electricity sector. It requires fuel price and electricity demand projections from SADEM as inputs. It is important to note that GEM has limited representation of non-grid connection generation, which MBIE models separately in SADEM.

EDGS uses these two models to project energy demand across New Zealand under multiple scenarios, and to build generation capacity to meet future electricity demand while maintaining security of supply. You can find more information about previous releases of EDGS on the MBIE website.

QUESTION 1

1	Do you agree with the stated purpose of EDGS? Why, or why not?

We are interested in understanding how EDGS is used by our stakeholders. This will help us to ensure that the product remains fit-for-purpose and meets users' needs, and will also help us determine what to prioritise as part of our ongoing energy modelling work programme.

QUESTION 2

2	How do you use EDGS?

Frequency and timing of EDGS

We first published EDGS in its current form in 2016, with an update in 2019. We plan to publish an update this year, alongside an update of our Levelised Cost of Electricity comparison tool.

We decided not to update EDGS over the past three years due to the difficulty in accurately forecasting the impact of the coronavirus (COVID-19) pandemic on domestic and global economic activity.

Energy supply and use data published by MBIE[1] has demonstrated that as of late 2022, energy use in New Zealand has generally returned to pre-pandemic levels. Considering this alongside the numerous announcements made by participants in New Zealand's electricity sector, we believe that is timely to update EDGS in 2023.

QUESTION 3

3	Do you agree with the frequency of EDGS? If not, how frequently do you think it should be?

[1] MBIE. (2023). *New Zealand Energy Quarterly.* https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-publications-and-technical-papers/new-zealand-energy-quarterly/

Scenarios

Approach to scenarios

EDGS depicts a long-term forecast horizon from 2023 through to 2050. Each of the four EDGS scenarios depicts a **possible future** based on several high-level assumptions (which will differ from scenario to scenario). These four scenarios are not expected to cover all possible futures, nor are they intended to be equally likely: instead, they provide a useful and representative sample of potential outcomes which span the space of potential futures by examining plausible combinations of key assumptions. When defining the scenarios, we have considered a range of demographic, economic, policy, and technology dimensions.

Changes from EDGS 2019

For this release of EDGS we have taken the scenarios used in EDGS 2019 and updated them to reflect developments in the energy sector, the wider economy, and available technologies.

There have been numerous developments in the policy framework for climate change since EDGS 2019, such as the introduction of the Climate Change Response (Zero Carbon) Amendment Act 2019 and the launch of New Zealand's first Emissions Reduction Plan. We have considered these policies across all scenarios and do not believe that there is a need for a separate scenario examining the policy dimension. As a result we have removed the Environmental scenario, which considered a more ambitious Government response to climate change, from the set of scenarios considered as part of this EDGS update.

Scenario definitions

Each scenario is given an indicative name. These names have been chosen to help identify the scenarios and distinguish between them and are illustrative only. Scenario names and definitions may change based on feedback and during the modelling process.

The four scenarios in EDGS 2023 are:

- **Reference**: current trends continue.
- **Growth**: higher economic growth drives immigration while policy and investment focus on priorities other than the energy sector.
- **Constraint:** international trends leave little room for domestic growth or innovation.
- **Innovation**: current economic trends continue, alongside accelerated technological uptake and learning rates.

Descriptions of these scenarios, including general trends in key indicators, are given below. For a more detailed description of each scenario's key assumptions, please see the **Key Assumptions** section.

Reference

Population	GDP	Exchange rate	Crude price	Gas availability	Cost of Wind/Solar	Technology uptake	Electricity demand	Energy demand
■	■	■	■	■	■	■	■	■
▲: higher than Reference scenario; ▼: lower than Reference scenario; ■: same as Reference scenario.								

Under the Reference scenario, we assume that observed historical economic, technological, and policy trends continue at their current pace, with no major changes. This includes currently implemented and announced policies, as well as actions within the first Emissions Reduction Plan which have not yet been progressed.

Growth

Population	GDP	Exchange rate	Crude price	Gas availability	Cost of Wind/Solar	Technology uptake	Electricity demand	Energy demand
▲	▲	■	■	▲	■	▲	▲	▲
▲: higher than Reference scenario; ▼: lower than Reference scenario; ■: same as Reference scenario.								

Under the Growth scenario, we assume that New Zealand experiences both higher economic growth and increased immigration, while policy and investment are focused on priorities other than the energy sector. The economy transforms to emphasise high technology (resulting in an increased share of the commercial sector), while higher income growth and personal wealth drive higher uptake of new technologies such as electric vehicles (EVs). This scenario provides an assessment of what electricity demand could look like if the economy is doing well.

Constraint

Population	GDP	Exchange rate	Crude price	Gas availability	Cost of Wind/Solar	Technology uptake	Electricity demand	Energy demand
▼	▼	▼	▲	■	▲	▼	▼	▼
▲: higher than Reference scenario; ▼: lower than Reference scenario; ■: same as Reference scenario.								

Under the Constraint scenario, we assume that adverse international trends negatively impact New Zealand's economy, leaving little room for local growth or innovation. Lower income growth means lower uptake of technology such as EVs, while decreased international activity results in higher costs for wind turbines and solar power than in the Reference scenario. This scenario can broadly be considered as the inverse of the Growth scenario.

Innovation

Population	GDP	Exchange rate	Crude price	Gas availability	Cost of Wind/Solar	Technology uptake	Electricity demand	Energy demand
■	■	■	■	■	▼	▲	▲	▲
▲: higher than Reference scenario; ▼: lower than Reference scenario; ■: same as Reference scenario.								

Under the Innovation scenario, we assume that economic trends broadly mirror those of the Reference scenario. At the same time, we assume that rates of technological development and uptake outpace those observed in the Reference scenario. With new and improved technologies enabling rapid electrification of both transport and process heat, we see a faster reduction in technology costs across the economy (eg wind and solar generation and EVs).

QUESTION 4

4	Does the set of scenarios adequately explore the potential future states that you think will be important?

QUESTION 5

5	Is each scenario's story internally consistent and coherent? If no, why not?

QUESTION 6

6	Are there other aspects that should be considered in our scenario planning?

Key assumptions

The following table contains key assumptions for each of our four scenarios. Some of these variables are mapped against key reference documents or forecasts; in these cases, we have provided specific values or references. Settings for other variables will be determined at the time of modelling based on the most current available data and on feedback received through this consultation process. For the time being we have simply stated the relative levels across scenarios.

	Variable	Reference	Growth	Constraint	Innovation
General	Carbon price *(NZD / t CO_2-e)*	2023: $65 2035: $160 2050: $250[2]	2023: $65 2035: $93 2050: $144[3]	Same as Reference	Same as Reference
	Crude oil price *(USD / barrel)*	2023: $69 2035: $63 2050: $60[4]	Same as Reference	2023: $69 2035: $85 2050: $95[5]	Same as Reference
	Exchange rate *(NZD / USD)*	0.65	Same as Reference	Lower than Reference	Same as Reference
	Real discount rate	6%	Same as Reference	Same as Reference	Same as Reference
	GDP	Medium	Higher than Reference	Lower than Reference	Same as Reference
	Population	50th percentile	90th percentile	10th percentile	Same as Reference
Electricity generation	Gas availability for electricity generation[6]	Medium	Higher than Reference	Lower than Reference	Same as Reference
	Cost of wind generation	Medium	Same as Reference	High	Low
	Cost of grid solar generation	Medium	Same as Reference	High	Low
Technology uptake	Residential solar PV	Current trends continue	Higher than Reference	Lower than Reference	Higher than Reference
	Electric vehicles	Current trends continue	Higher than Reference	Lower than Reference	Higher than Reference

[2] He Pou a Rangi – Climate Change Commission. (2021). *Ināia tonu nei: a low emissions future for Aotearoa*. https://www.climatecommission.govt.nz/public/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa/Inaia-tonu-nei-a-low-emissions-future-for-Aotearoa.pdf

[3] A fixed 3 per cent annual increase has been applied to construct this.

[4] Announced Pledges Scenario (APS) from IEA. (2022). *World Energy Outlook 2022*. https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf, License: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)

[5] Stated Policies Scenario (STEPS) from World Energy Outlook 2022

[6] This is how much natural gas is available for electricity generation, not actual levels of usage.

	Variable	Reference	Growth	Constraint	Innovation
Electricity demand	Peak demand	Medium	Higher than Reference	Lower than Reference	Higher than Reference
	Demand-side response	Medium	Same as Reference	Same as Reference	Higher than Reference
Energy demand	Energy efficiency improvements	Current trends continue	Higher than Reference	Lower than Reference	Higher than Reference

QUESTION 7

7	Do these assumptions align with the scenario definitions?

QUESTION 8

8	Do you agree with these assumptions? If no, please explain or add any specific changes to the table provided in the submission template.

Industrial and commercial energy use

MBIE's energy projections split the industrial sector into two sub-sectors:

- Specific industry: large energy users that are modelled individually based on their expected production, including aluminium, methanol, steel, and ammonia-urea production.
- General industry: all remaining industrial and primary sector activities.

General industry and commercial process heat

Process heat is energy used for industrial processes, manufacturing, and warming spaces. Historically supplied primarily by fossil fuels, it offers a significant opportunity to reduce energy sector emissions through switching to lower emissions alternatives.

For our modelling we consider general industry and commercial process heat in three categories: low (< 100°C), medium (100-300°C), and high (>300°C) temperature heat. We assume the following types of process heat can be switched away from fossil fuels in each of our scenarios.

Temperature requirement	Reference	Growth	Constraint	Innovation
Low	✓	✓	✓	✓
Medium	✓	✓	✓	✓
High				✓

QUESTION 9

9	Do you agree with these process heat assumptions? If no, why not?

In EDGS 2019 we only considered process heat switching from fossil fuels to electricity, however there is now widespread consideration of biomass as an alternative fuel to switch to in some uses and applications. Examples of this include replacing coal used in a boiler with woody biomass.

QUESTION 10

10	What mix of electricity and biomass should we be assuming for process heat fuel-switching in each of our scenarios? Please fill out the table supplied in the submission template.

Specific industry (excluding aluminium production)

Specific industry applications are highly specialised and tend to require very high temperatures.

As described above, MBIE separately models large energy users involved in aluminium, methanol, steel, and ammonia-urea production. For these users we need to make assumptions around future activity and potential closure. For more information on our assumptions for aluminium production, see **Modelling the Tiwai Point Aluminium Smelter**.

QUESTION 11

11	What do you think we should be assuming for the **future activity** of large energy users involved in specific industry process heat applications in each of our scenarios?

QUESTION 12

12	What do you think we should be assuming for the **closure** of large energy users involved in specific industry process heat applications in each of our scenarios?

Modelling the Tiwai Point Aluminium Smelter

Tiwai Point Aluminium Smelter is one of the largest single consumers of electricity in New Zealand. Closure of the Smelter could have a marked effect on when and how New Zealand's electricity generation capacity develops.

Rather than creating a separate scenario to account for any potential closure of the Smelter, we will instead explore this issue as a sensitivity to our Reference scenario. This involves:

1. running our scenarios given our default assumption that Tiwai stays open for the full forecast horizon.
2. re-running our Reference scenario using our alternative assumption, in which Tiwai closes in 2035.

3. performing comparative analysis to understand how much our alternative assumption affects the outputs of the model (such as build schedule and timing for new generation capacity) under the Reference scenario.

QUESTION 13

13	Do you agree with our approach to the possible closure of Tiwai Point? If no, why not?

Generation stack

Our generation stack represents:

- existing generation plants
- plants which are proposed, seeking consent, consented, or under construction
- plants which could potentially be built to meet future electricity demand.

This section summarises the generation stack which EDGS 2023 will use as inputs for electricity modelling. It is important to note that the build pipeline will differ across scenarios as what is built and when depends on scenario-specific inputs and assumptions (such as costs of fuels).

A full list of plants is available in **Appendix A**. Information presented is correct as of 11 April 2023 and as a result may not reflect recent announcements.

Existing plants

This represents **plants which currently generate electricity within New Zealand** and which are included by MBIE in its **GEM modelling system**.

We include the following plants in our GEM modelling system:

- Plants which are directly connected to the national grid.
- Large (20 MW+) partially- or fully-embedded plants.
- Peaking plants, regardless of capacity.

Plants which do not fall under one of the above categories are modelled in **SADEM**. All peaking plants are included in GEM to ensure that security of supply is maintained throughout the forecast horizon.

Some hydro plants may also not appear on this list as we lack the hydrological data required to properly model them in GEM.

QUESTION 14

14	What timeline do you believe we should use for the **refurbishment** of existing plants?

QUESTION 15

15	What timeline do you believe we should use for the **retirement** of existing plants?

QUESTION 16

16	Do you feel your views on the refurbishment or retirement of plants would be affected by scenario? If so, please elaborate.

Proposed plants

This represents **all plants that have been announced by developers**. A summary of proposed plants is given below. Please see Appendix A for a full list.

Summary of proposed plants			
Status	**Generation type**	**Number of plants**	**Total capacity (MW)**
Proposed	Solar	8	593
	Wind	3	322
Applied for Consent	Solar	4	262
	Wind	2	138
Fully Consented	Diesel	2	24
	Geothermal	3	252
	Hydro	2	41
	Solar	12	1,010
	Wind	7	1,447
Under Construction	Geothermal	2	225
	Solar	2	71
	Wind	4	415

QUESTION 17

17	If you know of any additional plants that need to be considered, please provide information in the submission template.

Potential plants

This represents **all plants that have been previously investigated, proposed, or consented** but have now lapsed or are otherwise not being actively pursued due to a range of factors. We consider these plants on a case-by-case basis and, where we believe there is potential for the plant to be built, we include it in our generation stack. These plants are treated similarly to generic plants as outlined below.

QUESTION 18

18	Do you agree with our definition of potential plants? If no, why not?

Generic plants

This represents **a long list of possible future generating plant projects** and is intended to represent the range of plants indicative of the future build options out to 2050. It provides the model with an option list to build and forecast future electricity supply scenarios. This is not a view or opinion of what will actually be built over the modelling period, or what type of plant has a greater probability of being built.

Offshore wind

Multiple firms have announced their intention to apply for consent to construct offshore wind farm facilities within New Zealand's waters (Territorial Sea and Exclusive Economic Zone). While offshore wind has considerable potential to help New Zealand meet its renewable energy goals, the developing nature of offshore wind generation in New Zealand means that we cannot predict offshore wind generation projects and trends as accurately as we can for onshore wind.

As a result, we have included offshore wind in the generation stack via a series of generic plants located in viable sites (based on both generator announcements and subject matter expert analysis), rather than including specific projects.

QUESTION 19

19	Do you agree with what we have presented in **Table 4 in Appendix A** around generic plants? If you have amendments or additional information, please provide.

Other generation types

The above information reflects our current knowledge of New Zealand's generation stack, however we may include other generation types in our modelling based on announcements from developers and feedback from this consultation process.

It is important to note that we do not include grid-scale Battery Energy Storage Solutions (BESS) as part of our generation stack. These are separately modelled.

QUESTION 20

20	Given the information presented above, and in **Appendix A**, are there any other generation types that we are missing from our generation stack? If yes, please specify.

Capital cost methodology

GEM uses the capital cost (ie cost to build) as a key input when deciding which plants to build in order to meet demand.

To determine the capital cost of a plant, we use (in decreasing order of preference):

1. published estimates of project cost
2. estimates of project cost calculated by subject matter experts
3. estimates of project cost derived from general equations.

The cost to build a given plant is highly reliant on site- and plant-specific factors, so we have avoided using generic values where possible.

In this section we detail the sources and methods used to calculate plant capital cost in the absence of more accurate figures and provide information on the average capital cost (and range of cost) for each plant type. All values have been adjusted to 2022 prices using Stats NZ's Producer Price Index (PPI). A summary of capital costs for potential, proposed, and generic plants is given in **Figure 1**.

Geothermal

Information on geothermal plant capital cost is sourced from Lawless (2020). When generators have announced geothermal plants which were not included in this report, we have either used the quoted cost of construction as supplied by the generator, or we have estimated capital cost by comparing the capital cost for similar plants (based on capacity, field enthalpy, existing infrastructure, and greenfield status).

Hydro

Information on hydro plant capital cost is sourced from Roaring40s (2020a) and Parsons Brinckerhoff (2012). Where this data is not available, we have calculated capital cost based on equations outlined in Parsons Brinckerhoff.

Solar Photovoltaic

Information on generic solar plant capital cost is sourced from Miller (2020), including site- and scenario-specific costings provided in-confidence to MBIE alongside the report. Proposed plant capital cost (when not provided by the generator) is calculated based on a combination of cost to purchase land (if required), grid connection cost, and cost for labour and parts, as outlined in Miller. All costs are adjusted using Miller's standard learning curve (75% for modules and 80% for all other parts and labour).

Miller's report is based on modelling potential sites for solar plants in New Zealand. This means that announcements of new grid-connected solar plants in New Zealand need to be reconciled with similar plants in Miller's dataset to ensure that plants are not being double-counted in the generation stack. For example, if a generator announces a 100 MW capacity grid-connected solar plant near the Islington (ISL) substation, we would attempt to identify a similar plant (or plants) in Miller's dataset and remove it from our list of generic plants, to ensure our list accurately reflects remaining potential for solar capacity.

Thermal

In all cases we have used figures provided by WSP (2020) and Parsons Brinckerhoff (2012) to calculate capital cost for natural gas and diesel plants.

Wind

Information on generic onshore wind plant capital cost is sourced from Roaring40s (2020b), including site-specific costings provided in-confidence to MBIE.

We remove generic wind plants from our list as new wind plants are commissioned, using the same methodology as outlined for solar photovoltaic plants above.

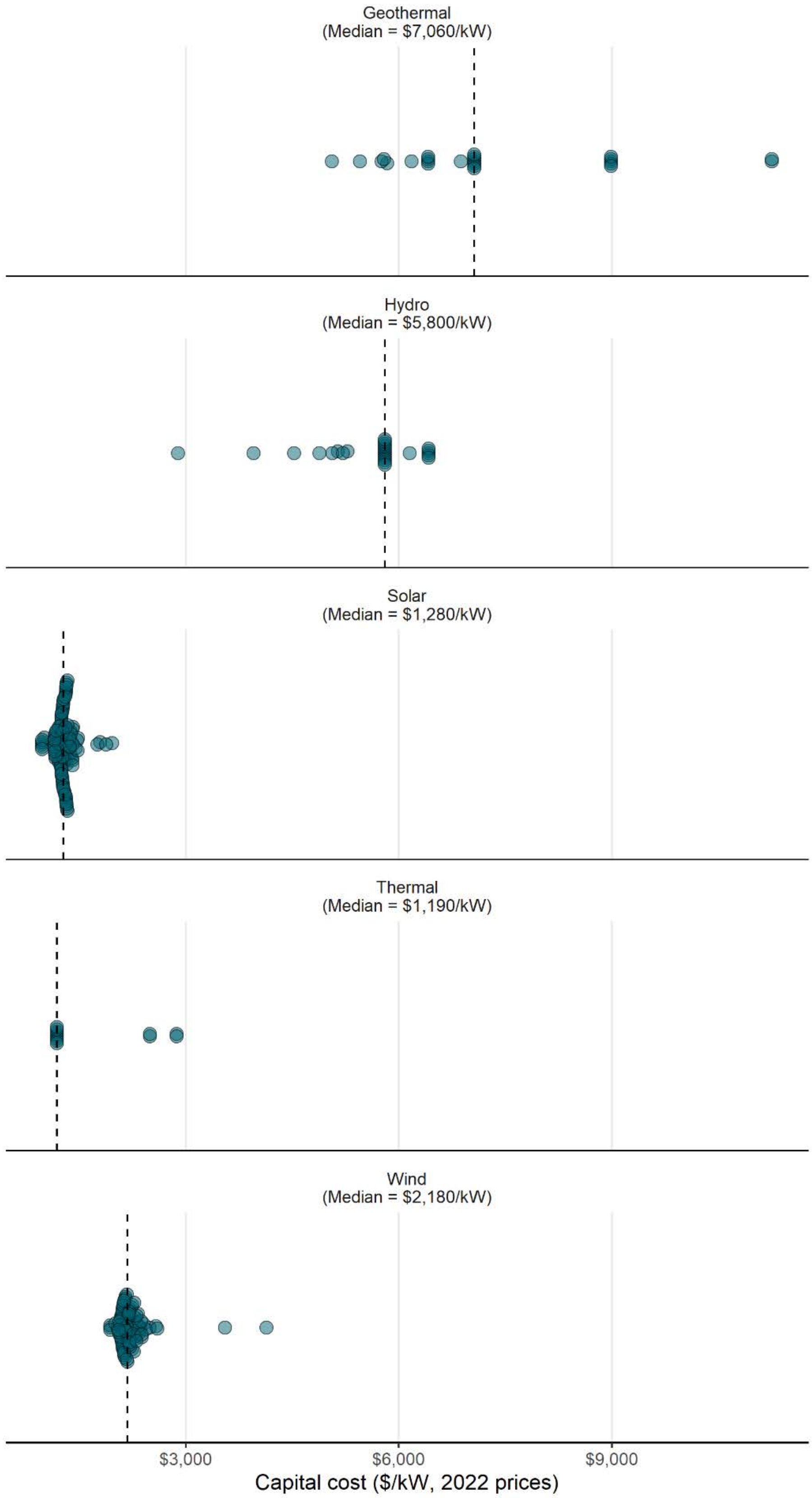

Figure 1. Capital cost for proposed, potential, and generic plants included in EDGS 2023. Each dot represents one plant, and the dashed line for each plot shows the median value. "Thermal" includes natural gas and diesel plants. All costs exclude connection costs and are adjusted to 2022 prices.

Views on new and emerging technologies

The uptake of new technologies such as electric vehicles (EVs) and solar photovoltaics (PV) is highly dependent on many economic and technological factors. Predictions of uptake and cost for these technologies are therefore highly uncertain.

QUESTION 21

21	How do you envision the cost for new technologies changing in coming years?

QUESTION 22

22	What do you think the uptake will be like for these new technologies?

Green hydrogen in New Zealand

Green hydrogen refers to the process of generating hydrogen in renewable ways, most commonly from water using renewable energy (such as wind and solar, often during periods of excess electricity supply). Green hydrogen has the potential to play a significant role in our energy system and in decarbonising parts of our economy, especially areas that are hard to abate or impractical or infeasible to electrify directly.

Hydrogen production at a large scale requires significant electricity and could place additional load on New Zealand's electricity network. However, it may also encourage the development of further generation (either at dedicated sites for hydrogen generation, or more generally to meet demand) and help build demand response.

We are currently awaiting the release of MBIE's interim Hydrogen Roadmap and hope to integrate the findings from this work in EDGS 2023.

QUESTION 23

23	How do you believe New Zealand's green hydrogen industry could develop between now and 2050? What role could hydrogen take in our electricity system in this time?

Next steps

Following the release of EDGS 2023, we are considering how we can best take advantage of the information that MBIE collects and holds to inform decision-making in the wider energy sector. We are currently considering several products, including (but not limited to):

- producing a regular **Electricity Generation Investment Opportunities Report** to facilitate investment in new renewable generation, as outlined by the Electricity Authority in their report *Promoting Competition in the Wholesale Electricity Market*
- regularly producing an **Energy Outlook**, which presents projections of future energy supply, demand, prices, and greenhouse gas emissions
- a regular **Generation Stack Report**, which catalogues our known list of existing, proposed, potential, and generic generation plants
- regular reporting on the **Levelised Cost of Electricity Generation (LCOE)** for generation projects within New Zealand.

QUESTION 24

24	Which of the above products would you find most beneficial? Please rank them.

References

Lawless Geo-Consulting (2020). *Future Geothermal Generation Stack.* MBIE https://www.mbie.govt.nz/assets/future-geothermal-generation-stack.pdf

Miller, A. (2020) *Economics of Utility-Scale Solar in Aotearoa New Zealand*. MBIE https://www.mbie.govt.nz/assets/Uploads/utility-scale-solar-forecast-in-aotearoa-new-zealand-v3.pdf

Parsons Brinckerhoff. (2012). *2011 NZ Generation Data Update*. MBIE https://www.mbie.govt.nz/assets/98fa09efab/2011-nz-generation-data-update-v006a.pdf

Roaring40s. (2020a). *Hydro generation stack update for large-scale plant.* MBIE https://www.mbie.govt.nz/assets/hydro-generation-stack-update-for-large-scale-plant.pdf

Roaring40s. (2020b). *Wind Generation Stack Update*. MBIE https://www.mbie.govt.nz/assets/wind-generation-stack-update.pdf

WSP. (2020). *2020 Thermal Generation Stack Update Report*. MBIE. https://www.mbie.govt.nz/assets/2020-thermal-generation-stack-update-report.pdf

Appendix A: Long list of generation plants

Information presented is correct as of 11 April 2023 and as a result may not reflect recent announcements.

Existing

The following table presents existing electricity generation plants that fall under one of the following categories:

- Plants which are directly connected to the national grid.
- Large (20 MW+) partially- or fully-embedded plants.
- Peaking plants, regardless of capacity.

Please note existing plants that are not presented in this list are modelled separately in SADEM.

Table 1

Existing plants				
Generation type	**Plant name**	**Substation**	**Capacity (MW)**	**Commissioned**
Coal/Natural gas	Huntly Rankine 1	Huntly (HLY)	250	1982
	Huntly Rankine 2	Huntly (HLY)	250	1982
Diesel, peaking	Whirinaki	Whirinaki (WHI)	155	2004
	Bream Bay Peaker	Bream Bay (BRB)	9	2011
Geothermal	Wairākei A & B	Wairakei (WRK)	117	1958
	Wairākei Binary	Wairakei (WRK)	15	2005
	Ōhaaki	Ohaaki (OKI)	69	1988
	Poihipi Road	Poihipi (PPI)	55	1996
	Rotokawa	Wairakei (WRK)	38	1997

Existing plants				
Generation type	**Plant name**	**Substation**	**Capacity (MW)**	**Commissioned**
	Ngāwhā Stage 1 & 2	Kaikohe (KOE)	28	1998
	Ngāwhā Stage 3 (OEC4)	Kaikohe (KOE)	32	2008
	Mokai	Whakamaru (WKM)	113	1999
	Kawerau	Kawerau (KAW)	106	2008
	Ngā Awa Pūrua	Wairakei (WRK)	136	2010
	Te Huka Units 1 & 2	Wairakei (WRK)	28	2010
	Ngātamariki	Ohaaki (OKI)	85	2013
	Kawerau (TOPP1)	Kawerau (KAW)	22	2013
	Te Mihi	Wairakei (WRK)	166	2014
	Te Ahi O Maui (KA22)	Kawerau (KAW)	25	2018
Hydro	Waipori	Berwick (BWK)	87	1907
	Coleridge	Coleridge (COL)	40	1914
	Mangahao	Mangahao (MHO)	39	1924
	Hawke's Bay/Waikaremoana hydro scheme	Tuai (TUI)	138	1929
	Waitaki hydro scheme	Waitaki (WTK)	1,732	1935
	Waikato River hydro scheme	Whakamaru (WKM)	1,090	1940
	Cobb	Stoke (STK)	32	1944
	Christchurch hydro scheme (embedded)	Culverden (CUL)	27	1945
	Clutha River hydro scheme	Roxburgh (ROX)	752	1956
	Bay of Plenty hydro schemes	Tauranga (TGA)	148	1967

Existing plants				
Generation type	**Plant name**	**Substation**	**Capacity (MW)**	**Commissioned**
	Manapōuri	Manapouri (MAN)	854	1972
	Bunnythorpe hydro scheme	Tokaanu (TKU)	360	1973
	Bay of Plenty hydro scheme (embedded)	Tauranga (TGA)	25	1982
	Pātea	New Plymouth (NPL)	33	1984
Natural gas	Taranaki Combined Cycle (TCC)	Stratford (SFD)	380	1998
	Huntly Unit 6 (P40)	Huntly (HLY)	51	2004
	Huntly Unit 5 (e3p)	Huntly (HLY)	403	2007
	Mangahewa Power Station	Stratford (SFD)	10	2009
Natural gas, cogeneration	Whareroa cogeneration plant	Hawera (HWA)	70	1996
	Kapuni cogeneration plant	Kaponga Tee (KPA)	25	1998
	Te Rapa cogeneration plant	Hamilton (HAM)	43	1999
Natural gas, peaking	Stratford Peaker	Stratford (SFD)	210	2011
	McKee Power Plant	Stratford (SFD)	100	2012
	Junction Road Power Plant	New Plymouth (NPL)	100	2020
Other, cogeneration	Glenbrook steel mill cogeneration plant	Glenbrook (GLN)	112	1997
	Kinleith cogeneration plant	Kinleith (KIN)	40	1998
Wind	Tararua Stage 1 & 2	Linton (LTN)	68	1999
	Tararua Stage 3	Woodville (WDV)	93	2007
	Te Āpiti	Woodville (WDV)	91	2004
	Te Rere Hau	Linton (LTN)	48	2006

Existing plants				
Generation type	**Plant name**	**Substation**	**Capacity (MW)**	**Commissioned**
	White Hill	Tiwai (TWI)	58	2007
	West Wind	Wilton (WIL)	143	2009
	Mahinerangi	Halfway Bush (HWB)	36	2011
	Te Uku	Hamilton (HAM)	64	2011
	Mill Creek	Wilton (WIL)	60	2014
	Turitea North	Linton (LTN)	119	2021
	Waipipi	Waverley (WVY)	133	2021

Proposed

These plants have been proposed by developers, are currently seeking consent, fully consented, or under construction within New Zealand.

Table 2

Proposed plants				
Status	**Plant name**	**Capacity (MW)**	**Technology**	**Expected online**
Proposed	Kōwhai Park solar	150	Solar	2025
	Ruapehu solar	100	Solar	2026
	Brookside solar (Stage 1)	14	Solar	
	Brookside solar (Stage 2)	54	Solar	
	Brookside solar (Stage 3)	76	Solar	
	Greytown solar	100	Solar	

Proposed plants				
Status	**Plant name**	**Capacity (MW)**	**Technology**	**Expected online**
	Hawke's Bay Airport solar	24	Solar	
	Ruakākā solar	75	Solar	
	Kaimai wind	100	Wind	2025
	Central Wind	132	Wind	
	Mt Munro wind	90	Wind	
Applied for Consent	Tekapo solar (Stage 1)	12	Solar	2024
	Edgecumbe solar (Helios)	115	Solar	
	Naseby solar	59	Solar	
	Tekapo solar (Stage 2)	76	Solar	
	Taumatatotara (Stage 2)	60	Wind	
	Te Rere Hau (Repower)	78	Wind	
Fully Consented	Belfast peaker	12	Diesel	
	Bromley peaker	12	Diesel	
	Wairākei C & D	40	Geothermal	
	Ngāwhā Stage 4 (OEC5)	32	Geothermal	
	Te Mihi (expansion)	180	Geothermal	
	Hāwea Gates hydro plant	17	Hydro	
	Ngākawau hydro scheme	24	Hydro	
	Lauriston solar	52	Solar	2024
	Lodestone 3 (Waiōtahe)	58	Solar	2024

Proposed plants				
Status	**Plant name**	**Capacity (MW)**	**Technology**	**Expected online**
	Ongaonga solar	70	Solar	2024
	Rangitāiki solar (Stage 1)	153	Solar	2026
	Rangitāiki solar (Stage 2)	141	Solar	2027
	Rangitāiki solar (Stage 3)	106	Solar	2028
	Lodestone 1 (Dargaville)	69	Solar	
	Lodestone 5 (Whitianga)	31	Solar	
	Maranga Ra solar	27	Solar	
	Pukenui solar	16	Solar	
	Tauhei solar	147	Solar	
	Waiterimu solar	140	Solar	
	Castle Hill wind (Stage 1)	300	Wind	
	Castle Hill wind (Stage 2)	280	Wind	
	Castle Hill wind (Stage 3)	280	Wind	
	Kaiwaikawe	73	Wind	
	Mahinerangi (Stage 2)	164	Wind	
	Puketoi wind	318	Wind	
	Taumatatotara (Stage 1)	32	Wind	
Under Construction	Tauhara expansion: Stage 1a	174	Geothermal	2023
	Te Huka Unit 3	51	Geothermal	2024
	Lodestone 2 (Kaitāia)	39	Solar	2023

Proposed plants				
Status	**Plant name**	**Capacity (MW)**	**Technology**	**Expected online**
	Lodestone 4 (Edgecumbe)	32	Solar	2024
	Turitea South	103	Wind	2023
	Mount Cass wind	93	Wind	2024
	Kaiwera Downs wind (Stage 1)	43	Wind	2024
	Harapaki wind	176	Wind	2025

Potential

This table shows plants that had been previously investigated, proposed, or consented but have now lapsed or are otherwise not being actively pursued.

Table 3

Potential plants			
Generation type	**Plant Name**	**Capacity (MW)**	**Proposed substation(s)**
Hydro	Arnold Valley hydro	46	Dobson (DOB)
	Clutha River - Beaumont Expansion	185	Roxburgh (ROX)
	Clutha River - Luggate expansion	86	Roxburgh (ROX)
	Clutha River - Queensberry expansion	160	Roxburgh (ROX)
	Clutha River - Tuapeka expansion	350	Roxburgh (ROX)
	Hurunui River at Lowry Peaks / Amuri Hydro	38	Culverden (CUL)
	Hurunui River (Balmoral) Hydro plant	15	Culverden (CUL)
	Lake Pūkaki hydro plant	35	Twizel (TWZ)

Potential plants			
Generation type	**Plant Name**	**Capacity (MW)**	**Proposed substation(s)**
	Mōhikinui hydro project	85	Inangahua (IGH)
	North Bank Tunnel project	260	Waitaki (WTK)
	Rakaia River dam	3	Ashburton (ASB)
	Wairau Hydro Expansion	72	Blenheim (BLN)
Wind	Āwhitu (expansion)	24	Southdown (SWN)
	Waitahora	177	Woodville (WDV)
	Hurunui Wind Farm	80	Waipara (WPR)

Generic

Possible future generic types of generating plant projects intended to represent the range of plants indicative of the future build options out to 2050. It provides the model with an option list to build and forecast future electricity supply scenarios. This is not a view or opinion of what will actually be built over the modelling period, or what type of plant has a greater probability of being built.

Table 4

Generic plants			
Generation type and source	**Plant name**	**Qty**	**Capacity (MW)**
Geothermal *Source: Parsons Brinckerhoff (2012), Lawless (2020)*	Ātiamuri geothermal	1	5
	Horohoro geothermal field	1	5
	Kawerau - additional generation	1	50
	Mangakino generic geothermal	1	25
	Mokai outflow	1	25

Generic plants			
Generation type and source	**Plant name**	**Qty**	**Capacity (MW)**
	Ngatamariki expansion	1	50
	Ngawha Expansion	2	25
	Reporoa	3	25
	Rotokawa Expansion	2	50
	Rotomā field	1	25
	Taheke	3	25
	Tauhara expansion	2	30-76
	Tikitere (Stage 1)	1	50
Hydro *Source: Parsons Brinckerhoff (2012), Roaring40s (2020a)*	Bush Stream hydro plant	1	30
	Clarence hydro	3	70-300
	Hope River hydro plant	1	55
	Lower Clarence River hydro plant	1	35
	Mātakitaki River generic hydro plant	1	40
	Mōhaka at Raupunga	1	44
	Potts River hydro	1	35
	Taramakau	1	50
	Waiau 21	1	140
	Whitcombe River	1	30
Natural gas, peaking *Source: WSP (2020)*	Generic OCGT peaker	8	100-200

Generic plants			
Generation type and source	**Plant name**	**Qty**	**Capacity (MW)**
Wind *Source: Roaring40s (2020b)*	Generic Offshore Wind	2	50-900
	Generic wind (<50 MW)	5	10-25
	Generic wind (50-149 MW)	32	50-125
	Generic wind (150-299 MW)	24	150-250
	Generic wind (300+ MW)	6	300-500
Diesel *Source: Parsons Brinckerhoff (2012)*	Generic Reciprocating Diesel	2	10
Solar *Source: Miller (2020)*	Generic solar (<100 MW)	14	40-80
	Generic solar (101-200MW)	34	100-180
	Generic solar (200MW+)	42	200