TRANSPOWER

Listed Project Application

Ōtāhuhu – Whakamaru A&B lines reconductoring – Auckland wider region section

Attachment 2: Demand and Generation Scenarios

December 2025

Purpose

This Attachment forms part of the OTA–WKM A&B Reconductoring Listed Project Application.

The purpose of this Attachment is to provide an overview of the demand and generation scenarios that we have used for the OTA–WKM A&B reconductoring analysis and in our cost-benefit analysis. To undertake cost-benefit analysis we must make assumptions about the future demand and generation in the region, which drive the need for this condition-based replacement investment.

Contents

1 Approach to Developing Demand and Generation Scenarios

We conduct economic evaluations of options using a range of market development scenarios. A market development scenario is an internally consistent set of input assumptions that represents a plausible future of the electricity system. Using market development scenarios ensures that our economic analysis considers a range of different demand and generation futures.

A market development scenario includes assumptions about:

- future electricity demand, including assumptions regarding base demand, electric vehicle (EV) uptake, solar PV uptake, distributed energy storage, etc.
- existing, decommissioned and future new generation connected to the national grid
- capital and operating costs for both existing and future generation assets
- fuel and carbon costs associated with generation
- grid-connected energy storage solutions.

We have used the market development scenarios produced by the Ministry of Business, Innovation and Employment (**MBIE**) with a number of updates. MBIE's scenarios are called the Electricity Demand and Generation Scenarios (**EDGS**).[1]

For this investigation we have based our analysis on the 2019 EDGS with several updates and variations. We updated the 2019 EDGS to reflect consultation we undertook as part of the Net Zero Grid Pathways 1 (**NZGP1**) workstream in 2021 (we refer to these as the 2019 EDGS Variations)[2]. These updates aimed to ensure the EDGS reflect the potential for rapid change in New Zealand's energy sector and are plausible futures to use in our evaluation of investment proposals.

The EDGS focus on national and island level demand, meaning we must use a variety of allocation mechanisms to allocate the national and island level information to the regional and Grid Exit Point (**GXP**) levels to complete our analysis. To do this, we incorporated information from electricity distribution businesses about GXP level growth. We also updated some of our generation assumptions to reflect more recent information.

To simplify the modelling while using a wide range of demand and generation inputs, we used three of the 2019 EDGS scenarios (with variations) for our OTA–WKM modelling:

1. **Reference:** Current trends continue.
2. **Growth**: Accelerated economic growth.
3. **Environmental:** Sustainable transition.

We consider three scenarios are sufficient to consider for this project. Consistent with prior investigations, we have not considered the Global scenario due to its unreasonably low level of growth. We have also omitted the Disruptive scenario, as it is within the range of the three selected scenarios so does not provide additional insights. The Growth scenario (with 60% weight) has a

1 See Electricity Demand and Generation Scenarios (EDGS)
2 See NZGP Phase One | Transpower

medium demand growth compared to the other two selected scenarios i.e., Reference being low and Environmental being high.

In July 2024, MBIE released a new version of EDGS. We have continued to base our analysis for this project on the 2019 EDGS Variations we have developed and consulted on. As noted in our consultation material for this project, the new EDGS contain limited regional information, such that if we were to adopt them, we would still have to draw heavily on the regional detail we have gathered for this project. Our view is that the 2019 EDGS Variations and our forecasts presented below remain a suitable basis for assessing this project.

2 Demand Assumptions

This Section presents the demand forecasts we have used for our analysis. These are unchanged from the demand forecasts we consulted on.

2.1 Regional Forecasts and Assumptions

This Subsection provides a brief overview of the demand forecast and assumptions for the Waikato and Upper North Island (**WUNI**) region. This is the most relevant region for considering flows on the OTA–WKM A&B lines.

2.1.1 Forecast Overview

Figure 1 and Figure 2 present our peak demand and energy demand forecasts, respectively, for the WUNI region for each of the selected 2019 EDGS scenarios.

Table 1 presents peak demand forecasts in 2025, 2035, 2045 and 2055, broken down by the factors contributing to the growth:

- Base growth – the underlying growth in demand driven by factors such as population and economic growth.
- Step loads – new demand that might appear from new developments, such as new commercial and residential developments.
- EV – the uptake of EVs and the “smartness” of their charging.
- Solar – the uptake of residential and commercial solar photovoltaic panels.
- Battery – the uptake of residential and commercial battery storage packs.
- Electrification – the electrification of industrial processes such as the conversion of coal and diesel boilers to electric boilers.

Each scenario has different assumptions for each of these factors, leading to the overall variation in the forecasts. The methodology we have employed to model these components is similar to that used in recent short-list consultations such as the HVDC Link Upgrade Programme.

The forecasts below are described as “gross” because they include the demand met by non-residential embedded generation. However, the residential embedded generation from rooftop solar and batteries is not netted off.

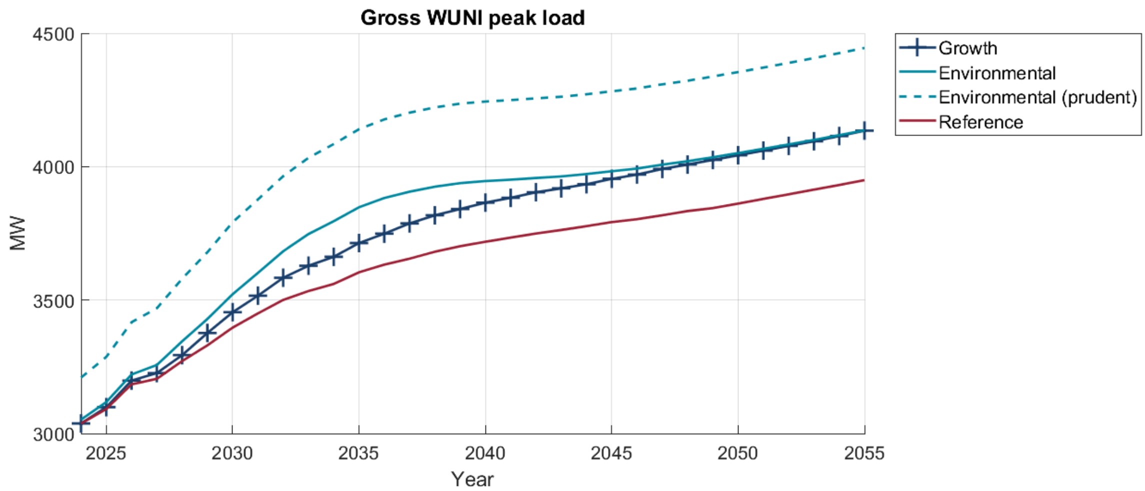

Figure 1: WUNI gross peak demand forecasts, MW

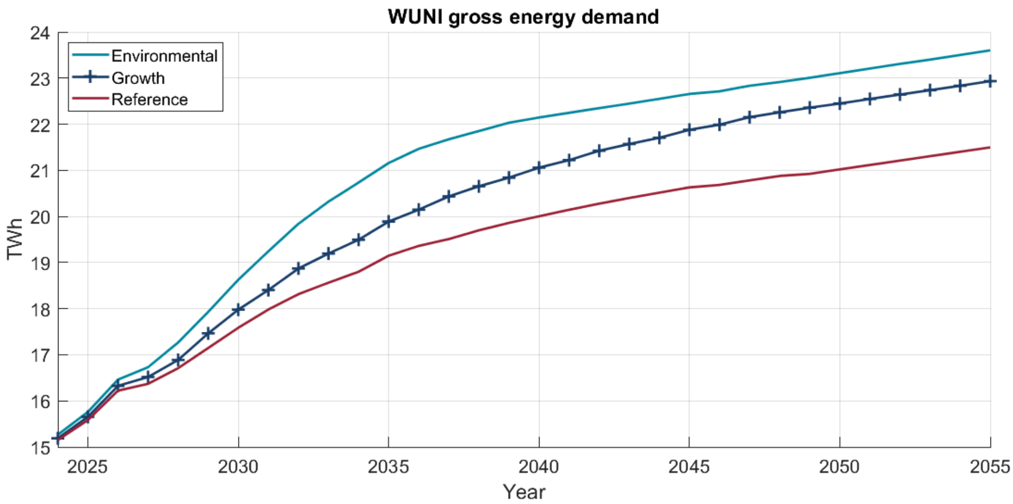

Figure 2: WUNI gross energy demand forecasts, annual TWh

Table 1: WUNI gross peak demand forecast assumptions, MW

Scenarios	Year	Peak	Base	Step loads[3]	EV	Solar	Battery	Electrification
Growth	2025	3099	2949	124	17	0	0	4
	2035	3714	3124	387	68	-12	-3	112
	2045	3954	3302	400	193	0	-64	122
	2055	4135	3501	400	295	0	-168	120
Environmental	2025	3118	2947	124	36	0	0	9
	2035	3848	3094	387	115	-6	-18	261
	2045	3983	3234	400	233	0	-158	286
	2055	4136	3395	400	306	0	-233	283
Reference	2025	3092	2943	124	17	0	0	2
	2035	3604	3061	387	75	-10	-3	56
	2045	3792	3190	400	192	0	-53	61
	2055	3949	3335	400	296	0	-133	61

3 The numbers presented here are the maximum demand of each step load, rather than their demand at the time of WUNI peak. This gives a clearer indication of the variation in step loads between scenarios.

2.1.2 Demand Forecasts in Other Regions

The focus of our analysis is around the WUNI region. In addition, we have developed a full set of forecasts for the rest of New Zealand. Section 2.2 presents the national peak demand and energy forecasts we have used for our analysis in combination with our WUNI peak demand and energy forecasts.

2.2 National Demand Forecasts

Figure 3 and Figure 4 present national peak demand and energy forecasts consistent with the model runs we used to create the WUNI region forecasts.

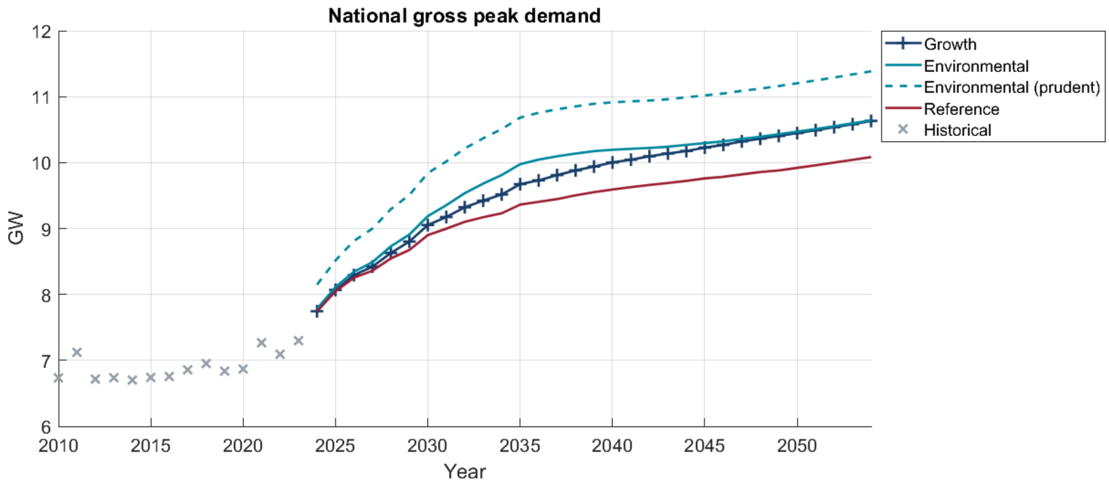

Figure 3: National gross peak demand forecasts, GW

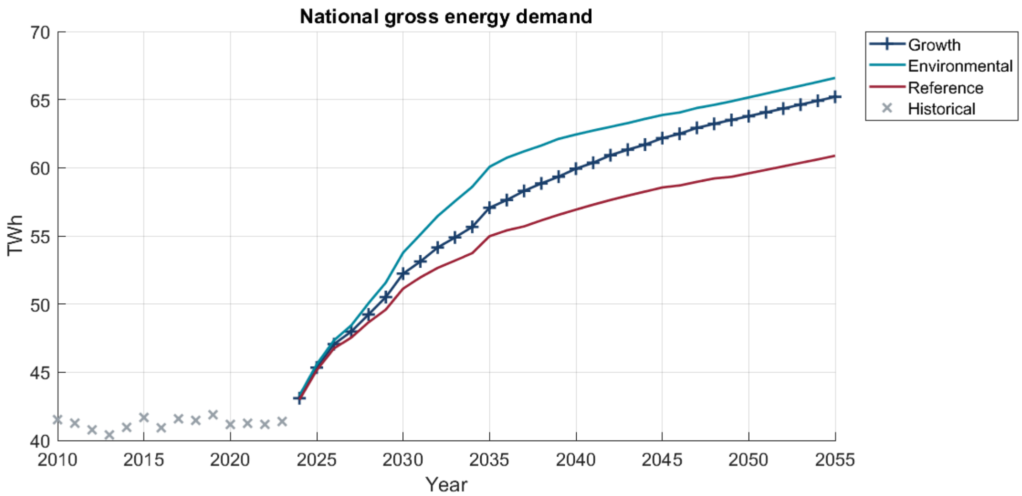

Figure 4: National gross energy forecasts, annual TWh

2.3 Updates from NZGP1

Our assumptions are based on those made for our NZGP1 project. However, we have made some refinements to the data and approach to reflect new information since that time. These include:

- updating data based on recent historical information and feedback from electricity lines businesses, and
- assuming the Tiwai Point aluminium smelter remains operational throughout the forecast horizon.

3 Generation Assumptions

This Section presents information relating to the generation assumptions used for our analysis. Generation assumptions apply to our:

- Generation expansion plan model, **OptGen**, which determines the location, timing, and technology of new (modelled) generation.
- Dispatch model, **SDDP**, which simulates the wholesale electricity market by calculating a least cost optimal dispatch over the study horizon.

We use these models to evaluate the electricity market benefits for different investment options. The only change we have made since consultation is minor refinement of our generation expansion assumptions.

Section 3 of Attachment 3 – Benefits Modelling provides further details of the generation expansion model and plan we have used in our analysis.

3.1 Basis of Our Assumptions

Generation assumptions for our SDDP and OptGen modelling are based on the Benefit-Based Charges Assumptions Book v.2.0 (**Assumptions Book**)[4], with the exceptions listed in Section 4.

3.2 Existing Generation

The WUNI region has over 2.6 GW of total installed capacity with over 92% of this located in the Waikato region. Therefore, the normal flow of electricity is northwards from Whakamaru to Ōtāhuhu and Pakuranga. The capacity by technology and region, as of January 2025, is shown in Figure 5.

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4 Assumptions Book | Transpower. The Assumptions Book contains inputs and assumptions we use to calculate benefit-based charge allocations under the transmission pricing methodology.

We assume that most existing generation will continue to operate throughout the analysis period, except for the plants expected to retire as shown in Figure 6 and as set out in the Assumptions Book.

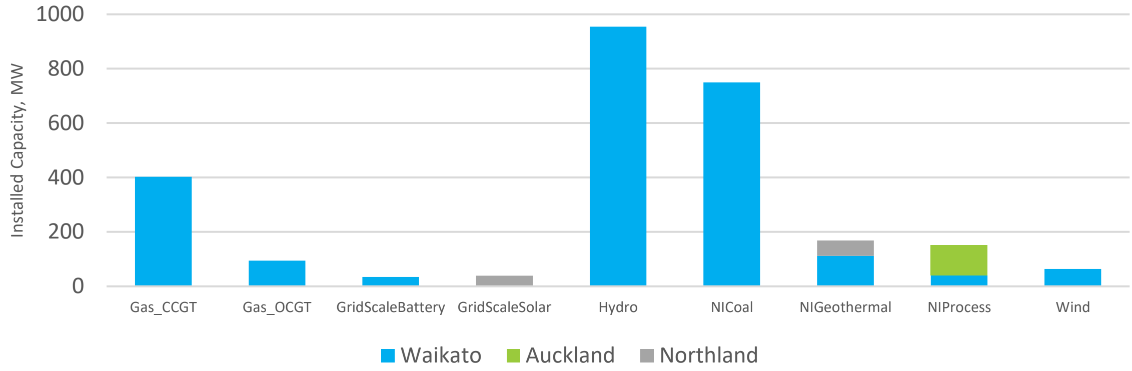

Figure 5: Installed capacities by technology in the WUNI region

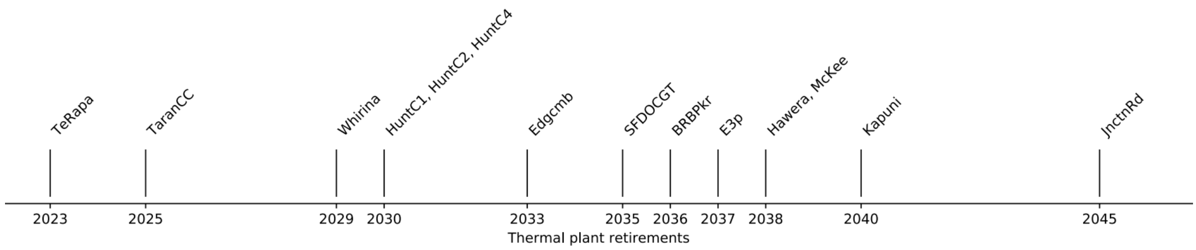

Figure 6: Modelled thermal plant retirement timeline

3.3 Committed Generation

In our generation expansion modelling we include 'committed' generation projects which we judge as likely to proceed. The criteria for classifying a project as committed are specified in clause D8(1) of the Transpower Capital Expenditure Input Methodology 2012 (as amended) (**Capex IM**).[5] These plants are listed in Table 2. The timing of these builds is exogenously specified in the generation expansion model based on publicly reported development schedules.

Table 2: Modelled WUNI committed generation

Type	Modelled Transmission Node[6]	Name	Capacity (MW)
GridScaleSolar	WHU110	Solar_WHU_1	147
GridScaleSolar	BRB220	Solar_BRB_1	120
GridScaleSolar	OHW220	Solar_OHW_1	119
GridScaleSolar	OHW220	Solar_OHW_2	152
GridScaleSolar	KPU110	Whitianga	24

5 Transpower Capital Expenditure Input Methodology (IM Review 2023) Amendment Determination 2023. Although this aspect of the investment test in the Capex IM is not a requirement for listed projects, it is a useful reference point when considering modelled projects.

6 We model the AC transmission network down to 66 kV in SDDP. Generation which connects below this level is represented at a nearby model node.

GridScaleBattery	BRB220	Ruakaka	100
GridScaleBattery	HLY220	HLY_PS2h	100
GridScaleBattery	GLN220	Glenbrook_2h	100
Wind	MPE110	Kaiwaikawe	73

While there is considerable interest in other renewable generation development in the region, we judge other projects to be less certain at present.

3.4 Potential Generation

The WUNI region has significant potential for the development of different generation projects. The potential generation projects in our stack are listed in the Assumptions Book. The generation expansion model determines a capacity expansion plan from these candidate projects based on a least cost optimisation condition (i.e., the capacity expansion plan provides the lowest cost mix of generation that can meet demand).

Details of the capacity plans, including the adjustments in the upper North Island region generation expansion plans are provided in Section 3.3 of Attachment 3 – Benefits Modelling.

4 EDGS and BBC Assumptions Book Variations

Below we summarise the main EDGS and Assumptions Book variations we have used for our analysis.

4.1 EDGS Variations

Table 3: Demand variations

<table>
<tr><th>Assumption</th><th>2019 EDGS Value</th><th>Variation from EDGS</th><th>Rationale</th></tr>
<tr><td>Tiwai closure</td><td>Tiwai stays operational in all scenarios.
The reference scenario has a sensitivity case where Tiwai closes in 2030</td><td>Tiwai remains operational in all scenarios.</td><td>See Section 2</td></tr>
<tr><td>Base energy growth rate</td><td><table><tr><td>Scenario</td><td>CAGR (%)[7]</td></tr><tr><td>Reference</td><td>0.8</td></tr><tr><td>Growth</td><td>1.2</td></tr><tr><td>Global</td><td>0.2</td></tr><tr><td>Environmental</td><td>0.9</td></tr><tr><td>Disruptive</td><td>0.7</td></tr></table></td><td><table><tr><td>Scenario</td><td>CAGR (%)</td></tr><tr><td>Reference</td><td>0.5</td></tr><tr><td>Growth</td><td>0.7</td></tr><tr><td>Global</td><td>0.1</td></tr><tr><td>Environmental</td><td>0.6</td></tr><tr><td>Disruptive</td><td>0.4</td></tr></table></td><td>Consistent with NZGP1</td></tr>
<tr><td>Electrification of Process heat</td><td>2050 energy demand:<table><tr><td>Scenario</td><td>2050 demand by temperature (TWh)</td></tr><tr><td>Reference</td><td>Low: 1.5</td></tr><tr><td>Growth</td><td>Low: 1.9</td></tr><tr><td>Global</td><td>Low: 1.2</td></tr><tr><td>Environmental</td><td>Low: 1.9
Med: 4.6</td></tr><tr><td>Disruptive</td><td>Low: 1.9
Med: 4.9
High: 6.5</td></tr></table></td><td>2050 energy demand:<table><tr><td>Scenario</td><td>2050 demand by temperature (TWh)</td></tr><tr><td>Reference</td><td>Low: 4</td></tr><tr><td>Growth</td><td>Low: 5.1</td></tr><tr><td>Global</td><td>Low: 3.2</td></tr><tr><td>Environmental</td><td>Low: 5.1
Med: 3</td></tr><tr><td>Disruptive</td><td>Low: 5.1
Med: 3.2
High: 0</td></tr></table>Process heat electrification has been modelled using an updated s-curve.</td><td>The amount of low and medium temperature process heat is consistent with NZGP1.
Conversion of high temperature heat has been removed. A s-curve has been used to better reflect the likely path of electrification.</td></tr>
<tr><td>EV demand</td><td>2050 energy demand by scenario (No assumptions around smartness given)<table><tr><td>Scenario</td><td>2050 EV demand (TWh)</td></tr></table></td><td><table><tr><td>Scenario</td><td>2050 EV demand by smartness (TWh)</td></tr><tr><td>Reference</td><td>Fixed: 3.2
Smart: 2.3</td></tr></table></td><td>Consistent with NZGP1 with minor updates.</td></tr>
</table>

[7] Compound Annual Growth Rate.

<table>
<tr><th>Assumption</th><th>2019 EDGS Value</th><th>Variation from EDGS</th><th>Rationale</th></tr>
<tr><td></td><td><table><tr><td>Reference</td><td>4.1</td></tr><tr><td>Growth</td><td>5.0</td></tr><tr><td>Global</td><td>3.2</td></tr><tr><td>Environmental</td><td>7.6</td></tr><tr><td>Disruptive</td><td>7.6</td></tr></table></td><td><table><tr><td>Growth</td><td>Fixed: 3.2
Smart: 3.5</td></tr><tr><td>Global</td><td>Fixed: 3.3
Smart: 0.9</td></tr><tr><td>Environmental</td><td>Fixed: 3.4
Smart: 5.6</td></tr><tr><td>Disruptive</td><td>Fixed (Light): 3.4
Smart (Light): 5.6
Fixed (Heavy): 1.7</td></tr></table></td><td></td></tr>
<tr><td>EV charging smartness</td><td>Not specified</td><td>Smartness by 2050:<table><tr><td>Scenario</td><td>Smartness by 2050 (%)</td></tr><tr><td>Reference</td><td>40</td></tr><tr><td>Growth</td><td>50</td></tr><tr><td>Global</td><td>20</td></tr><tr><td>Environmental</td><td>60</td></tr><tr><td>Disruptive</td><td>50</td></tr></table></td><td>The smartness in all scenarios except the Disruptive scenario is consistent with NZGP1. The smartness in the Disruptive scenario is set to 50% to better reflect uncertainties in EV charging.</td></tr>
<tr><td>Solar generation</td><td><table><tr><td>Scenario</td><td>Generation in 2050 (TWh)</td></tr><tr><td>Reference</td><td>2.3</td></tr><tr><td>Growth</td><td>2.8</td></tr><tr><td>Global</td><td>0.9</td></tr><tr><td>Environmental</td><td>4.6</td></tr><tr><td>Disruptive</td><td>4.6</td></tr></table></td><td><table><tr><td>Scenario</td><td>Generation in 2050 (TWh)</td></tr><tr><td>Reference</td><td>3.1</td></tr><tr><td>Growth</td><td>3.9</td></tr><tr><td>Global</td><td>1.1</td></tr><tr><td>Environmental</td><td>6.4</td></tr><tr><td>Disruptive</td><td>6.4</td></tr></table></td><td>Consistent with NZGP1</td></tr>
<tr><td>Residential solar uptake</td><td><table><tr><td>Scenario</td><td>Number of 3 kW solar installations in 2050</td></tr><tr><td>Reference</td><td>531,620</td></tr><tr><td>Growth</td><td>655,330</td></tr><tr><td>Global</td><td>190,210</td></tr><tr><td>Environmental</td><td>1,076,300</td></tr><tr><td>Disruptive</td><td>1,076,300</td></tr></table></td><td><table><tr><td>Scenario</td><td>Number of 3 kW solar installations in 2050</td></tr><tr><td>Reference</td><td>797,420</td></tr><tr><td>Growth</td><td>983,000</td></tr><tr><td>Global</td><td>285310</td></tr><tr><td>Environmental</td><td>1,614,440</td></tr><tr><td>Disruptive</td><td>1,614,440</td></tr></table></td><td>Consistent with NZGP1</td></tr>
</table>

Table 4: Generation variations

<table>
<tr><th>Assumption</th><th>2019 EDGS Value</th><th>Variation from EDGS</th><th>Rationale</th></tr>
<tr><td>Generation stack</td><td>Details in generation stack not specified e.g., capital costs, named projects, capacity factor</td><td>Incorporate information from the 2020 generation stack updates, recent Transpower connection queries and news articles.</td><td>To incorporate newer and more detailed information.</td></tr>
<tr><td>Wind repowering</td><td>Wind repowering not mentioned in EDGS</td><td>Assume that all wind farms are repowered at the end of their 30-year lifetime (with increased capacity), or earlier if indicated by developers.</td><td>Assumption is consistent with those specified in the Assumptions Book.</td></tr>
<tr><td>BESS (batteries)</td><td>Grid scale batteries not mentioned in EDGS</td><td>Include two, four and eight-hour batteries in our generation stack, based on cost information from the National Renewable Energy Laboratory (NREL).</td><td>To add an alternative peaking option.
Assumption is consistent with the Assumptions Book.</td></tr>
<tr><td>New generation cost decline</td><td>LRMC changes by 2050 are specified for wind and solar generation.

<u>Solar</u>
<table>
<tr><td>Scenario</td><td>Change</td></tr>
<tr><td>Reference</td><td>-50%</td></tr>
<tr><td>Global</td><td>-50%</td></tr>
<tr><td>Disruptive</td><td>-45%</td></tr>
</table>

<u>Wind</u>
<table>
<tr><td>Scenario</td><td>Change</td></tr>
<tr><td>Reference</td><td>-13%</td></tr>
<tr><td>Global</td><td>-7%</td></tr>
<tr><td>Disruptive</td><td>-27%</td></tr>
</table>
</td><td>Use future cost decline scenarios from NREL's 2023 annual technology baseline (ATB) to scale capital and fixed O&M (FOM) costs of generation stack projects. Wind, solar, geothermal and BESS project costs are scaled, and the cost decline is varied by scenario. The change in the costs by 2050 are given in the tables below.

Solar
<table>
<tr><td></td><td>FOM change</td><td>CAPEX change</td></tr>
<tr><td>Environmental Disruptive</td><td>52%</td><td>40%</td></tr>
<tr><td>Reference Growth</td><td>60%</td><td>49%</td></tr>
<tr><td>Global</td><td>70%</td><td>64%</td></tr>
</table>

Wind
<table>
<tr><td>Scenario</td><td>FOM change</td><td>CAPEX change</td></tr>
<tr><td>Environmental Disruptive</td><td>51%</td><td>62%</td></tr>
<tr><td>Reference Growth</td><td>77%</td><td>68%</td></tr>
<tr><td>Global</td><td>88%</td><td>81%</td></tr>
</table>
</td><td>Assumption is consistent with the BBC Assumptions Book 2.0.</td></tr>
<tr><td>Geothermal emissions</td><td>Not mentioned in EDGS but provided in 2020 geothermal generation stack.</td><td>Reduce emission rates from geothermal generation stack by 50% in the Growth scenario.</td><td>To account for the potential of CO2 reinjection.</td></tr>
</table>

Biofuel	Not mentioned in EDGS.	Add biofuel as a potential fuel source in our thermal generation stack	To add an alternative dry year option.
Long-term carbon price	NZ$66/t by 2050, except Environmental scenario (NZ$154/t by 2050)	Use long-term carbon prices from CCC8 i.e., NZ$250/t by 2050 in all scenarios except Environmental. The carbon price from the International Energy Agency's Net Zero Emissions scenario9 is used for the Environmental scenario.	Assume long term carbon prices are consistent with net-zero emissions.

4.2 Assumptions Book Variations

- The Ruakākā grid scale battery project schedule is updated from 2024 to 2025 based on more recent information.
- AC losses for the WUNI region and the rest of the North Island were adjusted from the approach outlined in the Assumptions Book as described in Section 2.2 of Attachment 3 – Benefits Modelling.

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8 Climate Change Commission Ināia tonu nei: a low emissions future for Aotearoa

9 Net Zero Emissions by 2050 Scenario (NZE) – Global Energy and Climate Model – Analysis - IEA

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