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6 June 2023

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By email: energyinfo@mbie.govt.nz

Transpower submission on the Electricity Demand and Generation Scenarios (EDGS)

Tēnā koe

We welcome the opportunity for stakeholders to submit views and information to MBIE's EDGS 2023 work. Thank you for your decision to extend the consultation period. Our submission comprises this letter and our detailed feedback in the form requested by MBIE (attached).

EDGS are used by Transpower in its role as the grid owner – for transmission planning purposes. Specifically, the Commerce Commission requires us to use them (or reasonable variations of them) in the modelling that informs our investment proposals, and now they link to transmission pricing outcomes under the new Transmission Pricing Methodology. We also use them as the system operator for our Security of Supply Annual Assessment, a vital piece of analysis as we transition to a system with higher levels of variable renewable generation.

Given Transpower's central role in the electricity sector, the EDGS 2023 update is critical to enabling electricity transmission's key role Aotearoa New Zealand's electrification journey, where electricity is the primary energy vector to decarbonise the economy. EDGS 2023 will also be used by investors as independently and impartially determined scenarios informing decisions to invest in generation and demand – and the energy sector more broadly.

The EDGS 2023 update is an opportunity to modify the approach to presenting and specifying EDGS so they can better support the transparency and currency of input assumptions. Our submission proposes a *flexible assumptions-based matrix framework for specifying EDGS (**FAM-EDGS**).* We consider it would be practical for MBIE to adopt a FAM-EDGS approach for its EDGS 2023 and expect it will reduce the size of the modelling task for the EDGS 2023 team. Doing this would also help us to more efficiently and robustly test our investment decisions against inherent uncertainties and – importantly – enable stakeholders to better engage with and inform them.

Our submission also proposes EDGS 2023 express the input assumptions we use for our investment proposals in tabular format (we have provided illustrative examples) and responds in detail to matters raised in the response template.

We appreciate MBIE consulting at this stage in its process and request further information about the EDGS 2023 process and the planned approach for further stakeholder engagement. We would welcome the opportunity to discuss our submission with your team given the criticality of EDGS to supporting our decarbonisation journey.

Our submission is not confidential and we will publish it to our Regulatory Submissions webpage on 7 June 2023.

Yours sincerely,

John Clarke
GM Grid Development

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Transpower submission on the Energy Demand and Generation Scenarios (EDGS) 2023

Contact details

Name	Privacy of natural persons
Organisation (if applicable)	Transpower NZ Ltd
Contact email address	Privacy of natural persons

Release of information

☒ We agree to be contacted by MBIE about any points I have raised or obtain more information about the content of my submission.

☒ We agree to having quotes from my submission included in the compiled list of next steps.

Transpower appreciates MBIE consulting at this stage in its process. We ask MBIE to share information about its EDGS 2023 process and the planned approach to further engagement with stakeholders.

We would welcome the opportunity to discuss our submission with your team given the criticality of EDGS to supporting our decarbonisation journey.

Our submission is not confidential and we will publish it to our Regulatory Submissions webpage on 7 June 2023.

Responses to questions

Introduction	
1	a) Do you agree with the stated purpose of EDGS? (Please select one)
	☒ Yes ☐ No ☐ Don't know
	b) Why, or why not?
	We agree with the stated purpose of the EDGS Transpower is required to use the EDGS specified by MBIE (or reasonable variations) to apply the Investment Test for investments in the transmission grid (including Major Capex Proposals (**MCPs**)). The Investment Test requirements are set by the Commerce Commission (**Commission**) in its Transpower Capex IM.[1] To that end, we encourage MBIE to focus on

[1] See the Commerce Commission's Transpower Capital Expenditure Input Methodology Determination 2012 (Capex IM). The Investment Test that applies to MCPs is in Schedule D. The requirement for MBIE's EDGS, or a reasonable variation on them, to be used in in clause D3. The Commission is currently reviewing the Capex IM.

	developing scenarios that are suitable for evaluating investments in the transmission grid that will be needed to enable Aotearoa New Zealand to meet its decarbonisation targets and commitments. We note the importance of MBIE's EDGS 2023 team's engagement with the Commission to ensure alignment with the Commission's ongoing review of the Capex IM – and in also ensuring alignment with other MBIE workstreams including the Energy Strategy. We recognise that other parties may see value in having a set of scenarios for other purposes e.g., for the evaluation of policy implementation, or to inform generation investment decisions. We recognise the value in such other uses and use them ourselves in our role as the system operator. However, we consider the scenarios specified for use in evaluating transmission investment should not be confused by being designed for multiple purposes. If MBIE sees value in developing scenarios for other purposes, then we suggest MBIE make it clear that these other scenarios are not EDGS that Transpower must use to apply the Investment Test.
2	How do you use EDGS?
	Transpower uses the EDGS to apply the Investment Test and the TPM The most recent example of our use of EDGS for an MCP is our Net Zero Grid Pathways (NZGP) 1.1 Major Capex Proposal[2] which we submitted to the Commerce Commission in December 2022. As part of preparing our MCP we put considerable effort into reviewing, developing, and consulting with stakeholders over reasonable variations to the EDGS. This resulted in some significant variations to reflect possible changes in the uptake of new technologies, climate policy, and future generation. We also use EDGS (or reasonable variations) as inputs to determine customer allocations and benefit-based charges for interconnection projects >$20m under the new Transmission Pricing Methodology (TPM).[3] The TPM, as set by the Electricity Authority, requires that the assumptions and other inputs we use in applying the TPM to high-value interconnected grid investments including MCPs, "must be as consistent as reasonably practicable with the assumptions and other inputs used in applying the investment test".[4] This important new use of the EDGS, as a key input to transmission charges, has been confirmed since the last EDGS release, and has increased the importance of transparent development and specification of the EDGS. This consultation is an important and welcome part of that process. **Transpower also uses the EDGS as the system operator** The system operator publishes its Security of Supply Annual Assessment (SOSA) each year.[5] It uses a 10-year forecast of electricity demand, including sensitivities, for its assessment. EDGS are provided in the consultation papers and final report as a benchmark against which stakeholders can form their own view of the demand forecast used in the SOSA. **The context for the EDGS in transmission planning** In order to best support the use of EDGS for transmission planning purposes (and by extension TPM purposes) it is important, that:

2 See our MCP proposal to the Commission NZGP1 submission | Transpower and more information about our Net Zero Grid Pathways programme Net Zero Grid Pathways | Transpower.

3 See Transmission Pricing Methodology | Transpower for information about the TPM. The Electricity Authority's TPM is in Part 12 of the Electricity Industry Participation Code (Schedule 12.4)

4 TPM cl 43(5)

5 Security of Supply Annual Assessment | Transpower

a. **EDGS are plausible futures that explore uncertainties**

For our purposes it is critical that EDGS enable our work to explore options and test future uncertainties through a set of diverse – but plausible - scenarios.

There is considerable uncertainty about future electricity demand and supply, which we must consider when making transmission investments. Some of this uncertainty can be reduced with clear strategic and policy direction from the government, and corresponding EDGS. Other uncertainties are inherent in any forecasting task reflecting market-led evolution of demand and the generation fleet supplying it.

b. **EDGS have sufficient breadth across generation and demand**

EDGS need to have sufficient variance across both supply and demand to enable us to adequately test transmission investments across a reasonable range of possibilities.

Further, for the purposes of transmission planning we must make assumptions that are diverse not just about the magnitude of future demand, but also in its location and the location of the generation that will supply it: getting transmission investment decisions "right" relies on information about both demand and its location relative to generation.

Similarly, the EDGS should avoid duplicative scenarios with similar assumptions and trajectories of demand as this increases our effort without adding value to an investigation.

c. **The form of EDGS is usable for transmission investment analysis**

EDGS are inputs into our internal process to assess the need and optimal way to upgrade the transmission network. We need to model future electricity demand and generation across the transmission network at a detailed level. The following information, out to at least 2050, is essential as part of EDGS:

1. National electricity demand (p.a.)
2. The generation cost stack
3. Generation cost stack trajectories (i.e., how generation costs will evolve over time)
4. Future fuel prices (and carbon charges)
5. Other relevant input parameters

We support EDGS that set national electricity demand forecasts

We support MBIE's established practice of setting higher-level, national annual electricity demand forecasts to which we can align. We have developed methods of producing GXP level peak and energy demand forecasts, with sufficient temporal resolution, that are consistent with a nationally determined set of EDGS demand forecasts. We consult with our customers as part of this process to ensure the forecasts are reasonable.

We also consider generation expansion plans should not form part of EDGS assumptions. Currently, we derive generation expansion plans for a range of transmission options as transmission constraints may have a meaningful impact on generation expansion. Given this necessity in applying the Investment Test we do not see value in a generation expansion plan being part of the assumptions that we need to align with in applying the Investment Test.

If MBIE need to produce and publish generation expansion plans for other purposes, we consider they should instead be a source for comparison against rather than something we must align with.

We propose EDGS input assumptions specified in tabular format

In our view, EDGS specification of input assumptions needs to be clearer so the underlying assumptions are more transparent. This will increase stakeholder confidence in the process we follow for analysing grid investment and make it easier for our customers to reconcile EDGS with their own views of the future. It will also increase the transparency of the forecasts that the system operator prepares for the SOSA. For that reason, we propose EDGS input assumptions should be expressed as a table of input assumptions, which we consider would be:

(i) easier for our stakeholders to engage with through our MCP processes, including consultation by Transpower and the Commission (and through MBIE's EDGS update processes), including where we propose to vary from them;

(ii) more straightforward to align with in our transmission planning and Investment Test modelling; and

(iii) easier for MBIE to keep up to date as things change, on a more frequent cycle than is practicable for a full modelling exercise such as the EDGS 2023 update.

We have attached to this submission (at page 20) detailed tables of input assumptions as an example of how EDGS could be specified. We would welcome the opportunity to work with MBIE and stakeholders in populating such assumption tables for EDGS.

We propose a *flexible assumptions-based matrix* framework for the EDGS to better support transmission planning and investment analysis

In our view, EDGS described in MBIE's consultation document, and previous versions of the EDGS, do not sufficiently explore the drivers of transmission investment. Transmission investment depends on both the magnitude of demand and its location relative to generation - EDGS needs to explore the variation of supply and demand uncertainties independently of one another.

We propose an alternative *flexible assumptions-based matrix* for specifying EDGS ***(FAM-EDGS)*** framework which, alongside our proposal for input assumptions in tabular format, would allow us to explore the key drivers of investment directly. We have appended (at page 17) to our submission a detailed description of our FAM-EDGS proposal - to demonstrate how we consider it would provide EDGS that better support our transmission planning purposes (and by extension TPM purposes). We reference our FAM-EDGS proposal throughout this submission.

We recognise that other aspects of the approach to EDGS updates to date (for example the current EDGS 2019) may have content that is useful to retain for others who have a different purpose.

3 a) Do you agree with the frequency of the EDGS? (Please select one)

☐ Yes ☒ No (please elaborate below) ☐ Don't know

b) If NO, how frequently do you think it should be?

☐ Annually ☐ Every two years ☐ Every three years ☒ Other (please specify)

As outlined above some aspects of the EDGS date quickly as new information comes to light. Generally, the frequency of the EDGS should be around three years and not longer. However, if there are significant changes in the sector or the underlying assumptions become outdated then the EDGS should be updated earlier.

By specifying EDGS as a table of input assumptions, and through an approach such as our FAM-EDGS proposal, it would be more straightforward to update the EDGS. We consider this is a significant benefit of our proposal.

Scenarios

4	Does the set of four scenarios adequately explore the potential future states that you think will be important? (Please select one)
	☐ Yes ☒ No ☐ Don't know

5 a) Is each scenario's story internally consistent and coherent? (Please select one)

☐ Yes ☒ No ☐ Don't know

b) If NO, why not?

Unclear

As outlined above it is important that the scenarios we apply in the Investment Test adequately explore uncertainties in electricity demand and the location and type of generation that could be installed. This is not clear from the information presented.

The Reference scenario should reflect current policy direction, not historical trends

We think the Reference scenario's story is not plausible and needs to be reconsidered and redefined. The narrative suggests the Reference scenario both:

- assumes historical trends continue at current pace; and
- captures the impact of transformative policies which have recently been implemented or are about to implemented.

It does not seem possible for the scenario to satisfy both conditions. For example, we are at the early stages of demand growth driven by government policy such as the GIDI fund and EV subsidies, but we expect the impacts of these policies (and others) to pick up pace over time.

We also consider that there is little value in a scenario that assumes current rates of uptake for electric vehicles, residential solar photovoltaics, industrial heat electrification, and residential batteries. It is much more likely these will follow the s-curve uptake typical of most new products.

A Reference scenario that focuses on historical trends may have some value for policy evaluation, but we do not think it has value in terms of transmission planning. We propose that the Reference scenario is changed and becomes a Central scenario that has assumptions around electrification that would meet with broad consensus.

The scenarios should explore diverse drivers that affect the location and type of generation

We do not consider the scenarios adequately explore the drivers that affect differences in demand and in the location and type of generation. In the past, when we have applied EDGS in our generation expansion tools, we have found EDGS scenarios result in relatively similar outcomes in terms of generation composition and location. We consider there is an opportunity to make EDGS more diverse, better reflecting future uncertainty in where and what technology might comprise new generation (which in turn impacts where generation connects to the grid).

Weighting for each scenario

The consultation document outlines that 'these four scenarios are not expected to cover all possible futures, nor are they intended to be equally likely'. Whilst that is reasonable and practical from MBIE's point of view, it does create a quandary for Transpower with respect to exploring all relevant futures in our investigations and assigning weightings.

The Capex IM requires that "…each relevant demand and generation scenario is accorded the explicit or implicit weighting assigned to it by the party who developed the scenario, unless

Transpower considers that alternative weightings should apply and has consulted on these as part of its consultation on the short list of investment options."[6] In most cases we will not have an alternative view on weightings and will want to use the "default" weightings, but if these don't exist, it is not clear what weighting we should use. Therefore, it would be helpful if MBIE were to specify weightings, or – if not - include a generic statement such as "We have no information to suggest any of the scenarios is more likely than any other, so would accord equal weighting in any analytical use of such scenarios".

6 a) Are there other aspects that should be considered in our scenario planning? (Please select one)

☒ Yes ☐ No ☐ Don't know

b) If YES, please write here:

There is potential to expand the consideration of future uncertainties

EDGS could explore more variance in demand to better support our assessment of the drivers of transmission investment which come from demand growth. We note that the proposed EDGS include only the electrification of process heat and road transportation. By our estimate this covers approximately 70% of the fossil fuel consumed for domestic uses.

It would be beneficial for the scenarios to explore:

- electrification of natural gas and LPG use for residential heating
- electrification of off-road vehicles and machinery
- electrification of domestic aviation and shipping
- electricity consumed to produce green fuels for use in aviation and shipping (including international aviation and shipping)

The EDGS also need to have sufficient variation in generation: for transmission planning, where generation gets built relative to demand is of critical importance. There is uncertainty around the relative amount of wind, solar and geothermal which are developed, when existing thermal generation is retired and how peak and dry year firming are provided.

Our proposed FAM-EDGS approach would better support exploration of uncertainties

We consider our proposed FAM-EDGS framework approach appended to this submission would be more appropriate for developing scenarios to assess transmission investment. This framework would support better exploration of uncertainties in future demand variability and in the location and type of future generation.

EDGS need to be compatible with net-zero in 2050

It is not clear whether the proposed scenarios are aligned with the 2050 net-zero target for long-lived greenhouse gases. In these scenarios electrification will reduce energy system emissions by 2050 by switching energy supply to low emission renewable resources. The scenarios with higher electrification should drive deeper reductions in energy system emissions. However, residual energy system emissions from electricity generation and remaining fossil fuel consuming applications will need to be offset by carbon sequestration (e.g forestry). It is not clear how much residual energy system emissions in 2050 are acceptable, nor is the extent of energy electrification in these scenarios clear. Therefore, we are not assured that the EDGS are compatible with net-zero.

As the transmission grid owner, Transpower has an important role in ensuring the transmission grid keeps pace with enabling a low emissions economy. It is important EDGS,

[6] Capex IM, Clause D2.

which must be used for transmission planning, are aligned with the necessary electrification to enable us to achieve this task.

Key assumptions

7 Do these assumptions align with the four scenario definitions? (Please select one)

☐ Yes ☐ No ☒ Don't know

8 a) Do you agree with these assumptions? (Please select one)

☐ Yes ☐ No ☒ Don't know

b) If NO, please explain or add any specific changes to the table provided below.

We support tabular specification of scenarios - but more information is needed

We appreciate the table of assumptions provided, and more generally support tabular specification of scenarios. However, the current table does not provide sufficient information to make informed comments because it:

- is not explicit about some assumptions e.g., the cost of wind, it is described as "medium", but no cost is given or description of how "medium" was derived.
- is not descriptive of the impact of some assumptions e.g., the table specifies GDP and population growth rates but does not specify levels of demand growth.

The limited information presented has restricted our ability to assess whether the four scenarios proposed by MBIE would provide the diversity of futures we believe is required for transmission planning purposes. Consequently, it is not clear to us they do. We encourage MBIE to significantly expand on the information provided in the table for each scenario.

We have commented already (at Q5) that the Reference scenario narrative is not internally consistent, and proposed it be changed to a Central scenario which projects the continued evolution of current policies, rather than historical trends.

In our view, the FAM-EDGS framework we propose would better support the transmission planning and Investment Test processes for which the Capex IM requires EDGS to be used. Refer to Attachment A for a full description of this proposal.

Specific comments

We note down some specific comments relating to the table of assumptions below:

General	Carbon price (NZD / t CO_2-e)	$250/T$CO_2$ should not be considered as an absolute maximum emissions price. EDGS could include higher emissions price – although we are not sure what scenario narrative this fits within.			
	Crude oil price *(USD / barrel)*	It is not clear how this assumption impacts scenario outcomes. We do not use this assumption in our modelling.			
	Exchange rate *(NZD/USD)*	We agree that this assumption should be constant across scenarios. It is our view that variances in capital costs of generation would be better expressed explicitly.			
	Real discount rate				
	GDP	More information needs to be provided on how this assumption affects demand growth. Our modelling uses a higher-level assumption (e.g base electricity demand forecasts) as an input into our processes.			

	Population	More information needs to be provided on how this assumption affects demand growth. Our modelling uses a higher-level assumption (e.g base electricity demand forecasts) as an input into our processes.
Electricity generation	Gas availability for electricity generation[7]	We see value in exploring the future availability of gas for electricity generation but require further explanation of the gas sector narrative to which this restriction pertains. It is unclear whether this setting is to reflect a policy constraint or a physical shortage in supply.
	Cost of wind generation	The cost reductions for wind and solar change consistently across the scenarios. However, there is uncertainty in the relative future costs of this (and geothermal) generation which will affect the future mix of generation. We suggest the EDGS generation assumptions do more to promote diverse generation outcomes. It is not clear how to do this with the existing framework and scenario narrative, however the FAM-EDGS framework we propose is designed to explore these affects.
	Cost of grid solar generation	
Technology uptake	Residential solar PV	We have provided discussion on PV uptake in section 22 below.
	Electric vehicles	The rate and extent of EV uptake has a significant impact on the scenario outcomes. We have provided additional detail in section 22 below.
Electricity demand	Peak demand	We propose that peak demand is not specified as an assumption in EDGS and instead the drivers of peak demand are specified (such as EV uptake, process heat electrification etc). This would allow us to derive peak demand using our own modelling tools to the accuracy necessary for transmission planning. The percentage of the transport fleet smart charging, and the amount of residential and commercial battery storage are key assumptions in this space that could be specified in EDGS.
	Demand-side response	We are unable to comment on this assumption as no detail has been provided.
Energy demand	Energy efficiency improvements	We are unable to comment on this assumption as no detail has been provided.

For cost and price assumptions a currency year needs to be specified as inflation has been significant over recent years.

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

9	a) Do you agree with these process heat assumptions? (Please select one)
	☐ Yes ☒ No ☐ Don't know
	b) If NO, why not?

No – it could be better defined and broader

Our preference would be for EDGS to separate out industrial process heat from commercial sector space/water/cooking heating as is the convention in EECAs Energy End Use Database. Commercial sector heating has a different time of use profile and regional profile than industrial process heat. We currently assume that electrified commercial heating has the same time of consumption profile as industrial process heat. However this likely understates the capacity requirements of electrifying commercial heating. Our view is it is increasingly important for our modelling to reflect this difference.

The proposed process heat assumptions have little breadth and we are unsure whether the scenario outcomes adequately reflect future uncertainty. For example, the Government currently has no policy to eliminate natural gas use in process heat or in commercial buildings. However, such a policy might be adopted in the future so it is important to consider when planning the transmission grid. Notwithstanding our view that there is a better framework for EDGS we suggest the following assumptions for industrial process heat and commercial heating.

Ability to electrify process heat

Fuel	Temperature requirement	Reference (Central)	Growth	Constraint	Innovation
Coal	Low	Y	Y	Y	Y
	Medium	Y	Y	Y	Y
	High				Y
Gas/Diesel/LPG	Low	Y	Y		Y
	Medium	Y	Y		Y
	High				Y

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 below.

As we understand it, the practicality of using solid biomass for industrial process heat depends on the temperature requirement. Additionally, the relative economics of using electricity for heating depends on the temperature and the ability to use heat pumps. We propose that in the EDGS different shares of biomass are assumed for low-medium temperature and high temperature process heat. The shares should be constant across scenarios.

Low-medium temperature process heat

We have undertaken analysis on the likely substitutions of coal, gas, and diesel process heat to electricity and biomass.[8] These are provided below and could be the basis for the EDGS assumptions. We note that EECA's Regional Energy Transition Accelerator is developing

[8] A Roadmap for Electrification, Transpower

detailed regional outlooks for process heat fuel switching and that these could be incorporated into EDGS as they become available.

Proposed fuel share assumptions for low temperature process heat

Fuel type	Reference	Growth	Constraint	Innovation
Electricity	81%	81%	81%	81%
Biomass	19%	19%	19%	19%

Proposed fuel share assumptions for medium temperature process heat

Fuel type	Reference	Growth	Constraint	Innovation
Electricity	52%	52%	52%	52%
Biomass	48%	48%	48%	48%

Note that these are specified as the share of useful energy which is provided by these fuels. It would be useful for MBIE to specify an assumed coefficient of performance for electrified heating.

High-temperature process heat

We understand that biomass is not a suitable fuel for high-temperature process heat. These industries may be able to directly electrify, or hydrogen could be required for some processes. We have no evidence on the practicality of electrifying high-temperature process heat in Aotearoa and propose equal shares of electricity and hydrogen.

Proposed fuel share assumptions for high-temperature process heat

Fuel type	Reference	Growth	Constraint	Innovation
Electricity	NA	NA	NA	50%
Hydrogen	NA	NA	NA	50%

Note that these are specified as the share of useful energy which is provided by these fuels.

As we understand it, much of the industrial process heat classified as high temperature in Aotearoa is associated with petrochemical production. These industries are represented as special industries in SADEM and we seek clarification as to whether the high temperature process heat totals in EDGS include these industries. These industries are concentrated in Taranaki and so electrifying them has significant grid implications.

Commercial heating

Although some biomass could be used for commercial heating, we assume that the fuel handling requirements make it unsuitable for most commercial users. For EDGS we propose that all of this heat is electrified.

Proposed fuel share assumptions for commercial heating

Fuel type	Reference	Growth	Constraint	Innovation
Electricity	100%	100%	100%	100%
Biomass	0%	0%	0%	0%

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?
	Consistency with Government strategies We typically assume large energy users remain at current levels of electricity demand unless we have information to suggest otherwise (e.g. the recent announcement of an electric arc furnace at NZ Steel site in Glenbrook). We welcome MBIE's views on these assumptions – in particular their consistency with Government energy and industrial strategies and decarbonisation goals. Where individual energy users are significant, it would be useful to itemise them, so sensitivity analysis can be undertaken where a particular plant is very important to a region of the grid.
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?
	See question 11.
13	a) Do you agree with our approach to the possible closure of Tiwai Point? (Please select one)
	☒ Yes ☐ No ☐ Don't know
	b) If NO, why not?
	Central assumption with alternative timing considered through sensitivity analysis We agree that it is appropriate to treat the potential closure of the aluminium smelter at Tiwai Point through sensitivity analysis. Our understanding is that the smelter's current electricity supply contract concludes at the end of 2024 and that a future contract has not yet been secured. Based on the information publicly available we still consider our transmission planning processes need to investigate a future where the smelter closes at the end of 2024.

Generation stack	
14	What timeline do you believe we should use for the **refurbishment** of existing plants?
	Renewable generation is refurbished at the end of its technical lifetime We consider that EDGS should assume windfarms are repowered at the end of their 30-year lifetime. Turbine modernization (e.g. replacing old turbines with larger current models) can result in significant capacity uplifts. For solar generation we consider EDGS should assume that panels are replaced after 25 years of operation. It would be helpful for the EDGS to provide guidance on expected refurbishment dates for other generation types and whether any capacity uplift or derating should be assumed. For hydro generation we understand that unit replacements can increase capacity by 10-15%, but that in some instances a renewed consent can restrict operating capacity because of environmental reasons.

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

Use disclosed retirement dates where possible

EDGS should use disclosed retirement dates where these are available. We understand that Contact have signalled the closure of the Te Rapa cogeneration plant in 2023 and the TCC in 2024.

Assumptions for the retirement of Huntly Rankine units need to be consistent with dry year solution assumptions across the scenarios. We understand that Genesis have demonstrated the capability to burn biomass in the units and that, with refurbishment, they could be operated until 2040. However, in a scenario with an alternative dry year solution we expect an earlier retirement.

For other generation, the 2020 generation stack reports provide the best evidence for plant technical lifetime. In our modelling we assume the retirement of thermal generation at the completion of the plant's technical life and consider the same should apply with the EDGS.

16 a) Do you feel your views on the refurbishment or retirement of plants would be affected by scenario? (Please select one)

☒ Yes ☐ No ☐ Don't know

b) If YES, please provide details.

Yes – some guidance in the EDGS would be helpful

Our expectation is that thermal plant retirement should have a dependence on emissions price. Scenarios with higher emissions price trajectories could see the earlier closure of Huntly Rankine units and CCGT. Generation scenarios need to ensure revenue adequacy for thermal plant.

We also expect a dependence on the availability of other storage technologies – both dry year (e.g. Lake Onslow) and capacity. Alongside our proposal that the EDGS include an alternative dry year solution as a sensitivity, thermal plant retirement assumptions should be consistent with the assumed storage available in the scenario.

It would be helpful for EDGS to provide guidance on the refurbishment or retirement of high-emission geothermal generation. In high carbon price scenarios, it can be difficult for this generation to achieve revenue adequacy in our modelling - unless we assume reductions in field emission intensity.

17 If you know of any additional plants that need to be considered, please provide information below.

Not all proposed plants will be built

We caution against assuming that all of the proposed plants in Table 2 of the consultation document will be developed. International experience is typically that only around 20% of proposed projects are ultimately developed. We consider it likely that many of the listed proposed plants will not be developed and although it is appropriate that they are included in the generation stack, their development should not be forced in EDGS.

18	a) Do you agree with our definition of potential plants? (Please select one)
	☐ Yes ☐ No ☒ Don't know
	b) If NO, why not?
	We are not clear how they will be used We are not clear on the significance of the proposed plants as opposed to the potential plants within EDGS and generation expansion modelling. Without this knowledge it is difficult to comment on the definition of potential plants. However, we note projects that have previously been consented but are not currently active may ultimately be very different from the original consent e.g., Castle Hill windfarm was 850 MW, but Genesis are seeking to re-consent it at 300 MW.

19	a) Do you agree with what we have presented in Table 4 in Appendix A of the Consultation document around generic plants? (Please select one)
	☐ Yes ☐ No ☒ Don't know
	b) If you have amendments or additional information, please provide details below.
	Treat offshore wind as a sensitivity The described approach of representing offshore wind as generic plants included in the generation stack does not adequately represent the real-world conditions under which we expect offshore wind is likely to be developed. Generation expansion models are unlikely to build offshore wind using this approach. The economics of offshore wind becomes favourable when the scale of the development is significant. We think that offshore wind development would most likely occur alongside significant new industrial demand – for example the establishment of a large green jet fuel production facility. The development of significant offshore wind capacity could have significant transmission implications and is best considered as a sensitivity rather than a core assumption. Such a scenario needs to be carefully crafted.

20	a) Given the information presented in the Generation stack section and Appendix A of the Consultation document, are there any other generation types that we are missing from our generation stack? (Please select one)
	☒ Yes ☐ No ☐ Don't know
	b) If YES, please specify.
	Include Battery Energy Storage System We believe that battery energy storage system (BESS) solutions should be included within a capacity expansion model, as is the approach in the Optgen model which we use. The availability of storage influences the model's generation selection. It would be useful if EDGS included BESS solutions in the generation stack and provided assumptions on the capital cost of utility grid connected batteries over time. **Include Bio-peakers** We consider biofuel peakers (fuelled by biomethane or biodiesel) should be included in the generation cost stack with 1GW of potential beyond 2035. These plants have the same operational and financial assumptions as a conventional OCGT. It would be useful if the EDGS provided biofuel cost assumptions.

Other potential sensitivities

A pumped storage scheme at Lake Onslow is being investigated as a dry year solution. The development of such a scheme, and the manner in which it operates in the market, have significant transmission implications. We suggest this is considered as a sensitivity in EDGS. We would welcome MBIE specifying financial and operating assumptions for such a scheme.

We are aware of industry promoting combining natural gas generation with carbon capture and storage (CCS) to negate emissions. We have no information on the costs of such an approach and would welcome these assumptions being specified in EDGS. This option could be appropriate as a sensitivity in EDGS as we believe that NZ would have to pursue a certain path in order for CCS to be realised. To be useful for transmission planning, we would require capital and operating cost assumptions for CCS and capture efficiency.

Views on new and emerging technologies

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

Align with international baselines and utilise available reports and analysis

Outlooks generally project significant cost reductions for wind, solar and battery technologies due to the continuation of established learning curves. There are independent information sources to inform cost trajectories that we suggest MBIE use within EDGS. For example, for renewable generation cost trajectories, NREL's annual technology baseline could be used and scaled to actuals in the generation stack report.

Battery electric vehicles are projected to become cheaper on a total cost of ownership basis than internal combustion engine vehicles within the coming years. This is driven largely by projected reductions in battery costs. The timing of cost parity will depend on the size of the vehicle and the utilisation. EECA analysis[9] last year showed that for many light vehicles the total cost of owning an EV is significantly less than owning a petrol car. Others, including the Climate Change Commission (CCC), have done significant analysis on future total costs of ownership. We consider the EDGS should reflect the CCC's work in this area.

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

EV uptake should be compatible with climate targets

EDGS EV uptake assumptions should span a reasonable range to reflect uncertainties but ultimately have uptake aligned with the level required to meet NZ's climate targets. A scenario should include the levels of uptake assumed by the CCC in their Demonstration path where in 2035 45% of all vehicle-kilometers-travelled (vkt) is electric and by 2050 95% of vkt is electric. The current level of EV uptake is considerably higher than historical projections and MBIE should reflect this actual uptake in EDGS assumptions.

Some of the factors which could influence EV uptake are:

- Consumer behaviour. For example, individuals may base their vehicle purchase on things other than total cost of ownership. However commercial and freight operators are much more likely to adopt EVs as they become cheaper.
- The supply of electric vehicles, particularly for the used market, may constrain uptake.
- Policy can also influence the rate of uptake. The clean car discount for example has accelerated the uptake of electric vehicles during 2022-2023. Some other countries have signalled a ban on the sale of ICE vehicles in the 2030s.

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[9] https://genless.govt.nz/stories/total-cost-of-ownership-evs-vs-petrol/

Include a wide range of uptakes for distributed PV

It is difficult to forecast the level of uptake for residential photovoltaic. Although there could be significant uptake, the main drivers might not be financial as we expect the levelised cost of electricity produced on a (domestic) rooftop solar to be higher than a utility solar installation. There may be a clearer business case for commercial rooftop PV where generation can be used directly onsite. For example EECA have demonstrated that for some businesses investing in PV is currently economic.[10] The EDGS should span a range of PV uptakes as these can have significant influence on grid connected demand.

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

MBIE's hydrogen roadmap is the best-informed view in regard to the uptake of hydrogen in New Zealand

We recognise that hydrogen has a role to decarbonise 'hard-to-abate' applications. 'Hard-to-abate' are activities which are difficult to directly electrify and could include high-temperature process heat, industrial feedstocks and long-distance transport. However, we are seeing many views about what 'hard-to-abate' should include and we note the rapid technological developments in this space. To provide the best, least regrets forecast, we recommend that EDGS use MBIE's hydrogen roadmap.

Hydrogen consumption could be included under the high electrification scenario in EDGS

At this stage we suggest that the consumption of green hydrogen is included in high electricity demand assumptions for hard to electrify applications.

Hydrogen could support the power sector, but its role is uncertain and best treated as a sensitivity in EDGS

In terms of supporting the power sector:

- Hydrogen could be produced for long duration storage and used to back up a highly renewable electricity system. This might fit within a portfolio type dry year solution.
- If there is large scale hydrogen production facility then it could also provide some flexibility services.

Although the sector is exploring producing green hydrogen for export, we see the long-term economics of this as challenging and consider it will not happen at scale. Hydrogen production for export could be treated as a sensitivity in EDGS.

Next steps

24 Which of the below products would you find MOST beneficial? Please rank them from 1 (most beneficial) to 4 (least beneficial).

4 **Electricity Generation Investment Opportunities Report**

3 **Energy Outlook**

2 **Generation Stack Report**

1 **Levelised Cost of Electricity Generation (LCOE)**

[10] https://www.eeca.govt.nz/insights/eeca-insights/commercial-scale-solar-in-new-zealand/

Additional feedback	
25	Do you have any additional feedback that you would like to provide on the EDGS or the options we have proposed? If yes, please provide below.
	Publication of submissions would be preferable Our preference would be for the EDGS submissions received through this consultation to be made public. Transparency would increase the sectors confidence in the assumptions underpinning our grid investment proposals. We will publish this submission to our Regulatory Submissions webpage on 7 June 2023. **Check the generation stack is still current** MBIE should consider whether the information in the generation stack (particularly costs) is still current. Our view is that it appears largely accurate, but confirmation of this would be beneficial. **The use of GEM should be reviewed** Further, we understand MBIE is still using GEM to derive expansion plans. While we do not consider generation expansion plans should form part of the EDGS, if MBIE elected to make them part of the EDGS we would want assurance that GEM adequately deals with factors such as: hydrology, battery storage, and intermittency (amongst other things). We understand GEM has not been updated in recent times. Given the growing importance of intermittent generation we are not convinced GEM is a suitable tool for developing generation expansion plans. **An industry forum or working group would be useful** We encourage MBIE to consider the use of an industry forum or working group to inform its decisions on the detailed assumptions that underpin its EDGS. We have found such approaches valuable in the past and consider it would help stakeholders to engage with EDGS 2023 assumptions.

Attachment A: Transpower's proposal - a *flexible assumptions-based matrix* approach to the EDGS

This attachment describes a *flexible assumptions-based matrix* approach to specifying the EDGS 2023 and future versions ***(FAM-EDGS)***, which we consider would promote transparency and stakeholder engagement that can better inform transmission investment processes. In our view the FAM-EDGS approach we propose would:

- more directly explore diversity in the key drivers for transmission investment - generation and demand;
- be easier to update and so adapt more easily as new information comes to light, including between formal EDGS updates by MBIE;
- both encapsulate a broader range of future uncertainties and also allow us to focus analysis on the factors most relevant for a particular investigation;
- be easier to directly incorporate into the complex models we use for transmission investment analysis; and
- provide a more clearly articulated foundation for our engagement with stakeholders on a particular investigation – and for the Commerce Commission's engagement during its decision-making processes.

A1 The proposed alternative framework for the EDGS

The key features of our proposed FAM-EDGS approach are described in Table A1 below:

Table A1: Key features of proposed flexible assumptions-based matrix to specifying the EDGS (FAM-EDGS)

Assumptions tables	A range of input assumptions (for each of the demand and supply sides, and some general assumptions) are specified in tabular format
EDGS as combinations of assumptions	A matrix is specified from which EDGS will be built up as combinations of demand and supply side assumptions for a particular investigation
Binary assumptions as sensitivities	Binary assumptions (for example Tiwai remains or exits, Lake Onslow is built or not) are identified as potential sensitivities
Number of EDGS reflects the situation	The number of scenarios can vary to reflect the particular uncertainties reflective of the particular investigation

The remainder of this attachment expands on each of these features, including through illustrative examples.

A2 Assumptions tables

MBIE would consult on and then specify - in tabular format - the EDGS core input assumptions, comprising:

- **demand assumptions** detailing the components which make up national annual electricity demand (e.g., base demand, light vehicles, heavy vehicles, industrial process heat etc) and are built up from underlying assumptions around activity, electrified share, and efficiency. These assumptions also include the amount of embedded generation and distributed batteries as they act to reduce demand on the grid.
- **supply assumptions**, including generation stack assumptions. The supply assumptions specify the cost reductions and other economic drivers for existing and new generation. These would apply to the *Generation stack* which specifies the cost, yield and operating assumptions of potential generation.
- **general assumptions** would include financial assumptions, fuel prices and another other assumptions which are not varied between scenarios.

Included at the end of this proposal are illustrative assumption tables with sufficient detail for our proposed FAM-EDGS approach to the EDGS. Refer to Tables A2 (demand assumptions), A3 (supply assumptions) and A4 (general assumptions) below.

A3 EDGS as combinations of assumptions

We propose MBIE would also consult on and specify the form of a matrix of demand and supply side assumptions, the selections of which would be varied to provide a diversity of scenarios appropriate to the investment being assessed. The matrix approach is conceptually illustrated below:

		Demand variation		
		Low	Medium	High
Supply variation	Central			
	More wind			
	More grid solar			
	More geothermal			
	More thermal			

The low/medium/high demand assumptions reflect the implications on electricity demand of how much fossil fuel consumption is electrified, the extent of base demand growth and the "smartness" of demand.

The supply variations promote different (in terms of the type and where it is located) generation expansion outcomes by varying generation cost assumptions or other drivers.

The low/medium/high demand variations refer to energy as well as peak. However, peak demand growth would be tempered relative to energy growth due to demand management such as smart charging and the operation of batteries.

The central supply assumptions would be based on the published generation stack and apply consistent cost reductions and discount rates to plants. Our experience is that with the current generation stack these settings give generation expansion plans which are predominantly wind with bio-peakers built to provide firming in later years. The supply variations proposed here would result in more wind, solar, geothermal or fossil thermal by varying generation and emissions cost assumptions from these central assumptions.

A5 Binary assumptions as sensitivities

In addition to the more generic uncertainties, which the matrix explores, there may be a number of binary uncertainties that MBIE considers important for the EDGS to explore. These could include:

- the development of offshore wind
- large-scale hydrogen production
- pumped hydro storage at Lake Onslow
- the closure of the aluminium smelter at Tiwai Point

Where a binary uncertainty is considered to be less likely to occur than to not occur, we propose that is included by MBIE as a sensitivity for the EDGS rather than as assumption to be varied across scenarios within the matrix. Varying low probability uncertainties across scenarios would mix more generic assumptions and the binary change, such that the impact of each is unknown. Dealing with these binary changes independently as a sensitivity, will act to separate out the impact of the binary change. Also, not all binary changes will be material for some grid investment decisions such that there is no need to consider them in the base scenarios.

A4 Number of EDGS reflects the situation

It is not practical to consider the entire matrix for an investigation. We propose the matrix would be sampled (by Transpower for an MCP process) to ensure the scenarios used for a particular investigation are diverse in terms of demand and generation expansion.

The number of scenarios considered in any investigation should be commensurate with the degree of uncertainties which could have implications for it. In general, if the uncertainty is high, a higher number of scenarios may be relevant to identifying a good option. We agree with MBIE's proposal to limit the number of scenarios analysed, however it would be beneficial to vary the scenarios considered to best test an investment decision. Where future uncertainty is higher or lower, for instance, a different number of scenarios (e.g 3 or 6) may be more appropriate.

The number of scenarios, how they are constructed using the matrix and which sensitivities are applied to them are matters that Transpower would consult with its stakeholders through its Investment Test processes for a particular investment - consistent with the rules specified by the Commerce Commission in the Capex IM.

A6 Examples of the framework application

To illustrate the usefulness of this framework, shown below is how it would be applied to two real-world transmission investigations.

<u>Example 1 -A regional investigation</u>

We are currently investigating options for maintaining security of supply in the western Bay of Plenty – mostly the region around urban Tauranga and Mt Maunganui. We are not aware of any material potential generation in the region and therefore the variation in demand is most relevant for this investigation. As such, we consider it is appropriate to focus the analysis on exploring demand uncertainty and not supply side uncertainties as shown below.

		Demand variation		
		Low	Medium	High
Supply variation	Central			
	More wind			
	More grid solar			
	More geothermal			
	More thermal			

<u>Example 2 – A core grid investigation</u>

The Commerce Commission are currently evaluating a proposal from Transpower to enhance the HVDC, central North Island core grid lines and Wairakei Ring lines. The capacity requirement for this part of the grid is influenced by where future generation is built, as much as electricity demand. The future mix of wind, solar and geothermal generation is relevant, as are some of the listed sensitivities. In this case it would be reasonable to explore more of the generation uncertainty. As such, it would seem appropriate to model more scenarios, such as those highlighted below.

		Demand variation		
		Low	Medium	High
	Central			

	More wind			
	More grid solar			
	More geothermal			
	More thermal			

A7 Detailed illustrative assumption tables

To help with the development of the EDGS we have listed in the tables below some of the key input assumptions along with our view of what is a reasonable range to consider.

These assumptions are presented as illustrative examples in a form which is usable with our proposed framework. However, we propose MBIE adopt a tabular approach of this kind whether it adopts our FAM-EDGS proposal or not.

We consider it would be beneficial for MBIE to seek wide feedback towards a consensus view of these detailed assumptions, including by holding workshops with stakeholders focussed on the information to be populated into the tables.

Table A2: Demand assumptions – an illustrative example

		Low	High	Notes/Other assumptions
Base demand				
	Base demand growth	0.1% p.a	0.7% p.a	
Transportation				
Light vehicle	EV proportion of vehicle kilometres travelled (%)	28% in 2035 89% by 2050	55% in 2035 95% in 2050	- Light vehicle includes light passenger vehicles, light commercial vehicles and motorcycles - S-curve electrification uptake assumed - Assumptions source is CCC headwinds and tailwinds scenarios - Vkt projections are the base case from MOT's transport outlook, but with 20% reduction in VKT applied to reflect ERP target - Charging flexibility increases throughout the forecast period
	Annual electricity demand (TWh)	2.2TWh in 2035 8.0TWh in 2050	5.5TWh in 2035 8.7TWh in 2050	- Electrical efficiency (vkt averaged) of 0.18kWh/VKT assumed
Heavy vehicle	EV proportion of vehicle kilometres travelled (%)	19% in 2035 81% in 2050	40% in 2035 88% in 2050	- Heavy vehicles includes trucks and buses - S-curve electrification uptake assumed - Assumptions source is CCC headwinds and tailwinds scenarios - Vkt projections are the base case from MOT's transport outlook - Charging flexibility increases throughout the forecast period
	Annual electricity	1.0TWh in 2035	2.1TWh in 2035	- Electrical efficiency (vkt averaged) of 1.3kWh/VKT assumed

	demand (TWh)	4.6TWh in 2050	5.0TWh in 2050	
Rail	Electrification (% share of tonne-km)	19% in 2035 81% in 2050	40% in 2035 88% in 2050	- Rail freight tonne-km projections are the base case from MOT's transport outlook - S-curve electrification uptake assumed - Assume same electrification as EV uptake rate as for heavy vehicles - Charging flexibility increases throughout the forecast period
	Annual electricity demand (TWh)	0.05TWh in 2035 0.22TWh in 2050	0.11TWh in 2035 0.24TWh in 2050	- Electrical efficiency of 0.054kWh/tonne-km assumed
Coastal shipping	Electrification of coastal shipping (% share of tonne-km)	19% in 2035 81% in 2050	40% in 2035 88% in 2050	- Coastal shipping freight tonne-km projections are the base case from MOT's transport outlook - S-curve electrification uptake assumed - Assume same uptake rate as for heavy vehicles - Charging flexibility increases throughout the forecast period
	Annual electricity demand (TWh)	0.1TWh in 2035 0.4TWh in 2050	0.2TWh in 2035 0.4TWh in 2050	- Electrical efficiency of 0.1kWh/tonne-km assumed
Domestic air travel	Electrification of domestic air travel (share of aircraft-km)	None	None to 2030 10% in 2035 30% in 2050	- Aircraft-km projections are the base case from MOT's transport outlook - S-curve electrification uptake assumed - Targets only turbo-prop style flights (assume these can be directly electrified) - Charging flexibility increases throughout the forecast period
	Annual electricity demand (TWh)		0.2TWh in 2035 0.7TWh in 2050	- Electrical efficiency of 0.02 MWh/aircraft-km assumed
Industry				
Process heat	low-medium temperature process heat (% share electrified)	100% of coal by 2037	100% of coal by 2037 100% of gas, diesel by 2050	- Assume activities are constant at current levels - Electricity provides 80% of low temp and 50% of medium temp useful heat demand - COP of 3/2 for low/medium temperature applications - Linear fuel switching profile
	Annual electricity demand (TWh)	0.8TWh in 2035 1.2TWh in 2050	1.5TWh in 2035 2.6TWh in 2050	
	high temperature process heat	0%	100% by 2050	- Assume constant useful heat demand of 7.3 PJ p.a (net of large single site industrials) - Only electrified in high demand scenario

	(% share electrified)			- Linear fuel switching profile from 2030-2050 - Assume 50% of heating requires green hydrogen which is produced on site at 70% efficiency
	Annual electricity demand (TWh)		0.8TWh in 2035 3.0TWh in 2050	
Off-road vehicles and machinery	EV proportion of useful energy demand	19% in 2035 81% in 2050	40% in 2035 88% in 2050	- Assume constant useful energy demand at current levels - Electrification profile is as for heavy vehicles - S-curve uptake
	Annual electricity demand (TWh)	0.6TWh in 2035 2.4TWh in 2050	1.2TWh in 2035 2.6TWh in 2050	- Relative efficiency of EV to ICE is 50%
New industrial load	Annual electricity demand (TWh)	250MW in 2030	500MW in 2030	- Assumed to be datacentres
Other				
Residential	Share of domestic LPG/natural gas electrified (%)	0% in 2050	100% in 2050	- Assume useful heat demand is constant at current level - COP for space heating/water heating/cooking = 3/2/1 (e.g assumes water heating is a mixture of heat pumps and resistive) - Linear fuel switching
	Annual electricity demand (TWh)		0.5TWh in 2035 1.0TWh in 2050	
Commercial/public	Share of commercial/public heating electrified (%)	0% in 2050	100% in 2050	
	Annual electricity demand (TWh)		0.5TWh in 2035 1.0TWh in 2050	- Assume useful heat demand is constant at current level - COP for space heating/water heating/cooking = 3/2/1 - Linear fuel switching
Embedded solar	Annual electricity generation (TWh)	3.4TWh in 2050	6.4TWh in 2050	- As we model grid connected demand, embedded solar is included as a demand assumption as this generation reduces the demand to the grid.

Notes:

1. We distinguish "base" (non-industrial) demand growth from growth due to electric vehicles, residential/commercial solar photovoltaics panels, industrial heat electrification, and residential/commercial battery storage. This is to treat differently growth that we consider is more likely to be based on historical growth rates from disruptive growth.

2. The EDGS need to explicitly specify any additional embedded generation which is assumed to be developed and specify gross demand. Following this convention avoids confusion and will ensure accurate representation of the EDGS in our analysis.

Table A3: Supply assumptions- an illustrative example

<table>
<tr><th></th><th>Central</th><th>More wind</th><th>More rooftop solar</th><th>More grid solar</th><th>More geothermal</th><th>More fossil thermal</th></tr>
<tr><td>Wind cost reduction</td><td>Moderate*</td><td>Advanced*</td><td colspan="4">Moderate*</td></tr>
<tr><td>Grid solar cost reduction</td><td colspan="3">Moderate*</td><td>Advanced*</td><td colspan="2">Moderate*</td></tr>
<tr><td>Geothermal field emissions reinjection</td><td colspan="4">NA</td><td>80% field emissions reduction</td><td>NA</td></tr>
<tr><td>Emissions price</td><td colspan="5">$160/tCO2 in 2035
$250/tCO2 in 2050</td><td>$93/tCO2 in 2035
$144/tCO2 in 2050</td></tr>
</table>

*Moderate/Advanced refer to NREL technology baseline scenarios

Table A4 General assumptions – an illustrative example

	Assumption
Exchange rate (NZD/USD)	0.65
Real discount rate	6% for generation
Gas price ($/GJ)	*
Coal price ($/GJ)	*
Diesel price ($/GJ)	*
Biofuel price ($/GJ)	*

*We require MBIE to provide these fuel price assumptions.