Deloitte.

Future Grid Cost Benefit Assessment

Methodology Document

Transpower
June 2026

Deloitte Access Economics

Contents

1. Executive summary

This report sets out a Cost Benefit Assessment methodology to identify the economically preferred network development plan that will inform the Future Grid Blueprint Development Plan.

The purpose of the Cost Benefit Assessment methodology is to provide a consistent, transparent, and analytically robust framework for comparing alternative transmission development pathways across five plausible future scenarios for Aotearoa's electricity system. It evaluates and ranks alternative transmission development pathways against selected guiding principles to enable the identification of an economically preferred single network development plan. This single network development plan will ultimately inform the Future Grid Blueprint Development Plan.

New Zealand's national grid operates in the context of increasing energy demand, a shift towards low-carbon energy sources and rapid technological development. These factors bring about inherent uncertainty around the state of the future supply of and demand for electricity and the scale and extent of the national grid required for the future. A robust analytical framework, that integrates modelling, engineering analysis and other technical inputs in a coherent way, is therefore needed to support decision making.

The CBA methodology set out in this report is guided by four key principles:

Guiding principles

1. The Blueprint is informed by the network development plan that delivers the most robust net electricity market benefits across the **entire electricity system as a whole**, consistent with the World Energy Council's Energy Trilemma by balancing energy security, energy equity and environmental sustainability, rather than focussing solely on transmission assets.
2. The Blueprint should be assessed under **all five Future Grid potential scenarios** representing Aotearoa's different possible futures, while remaining **robust to changes in key assumptions.**
3. The Blueprint should consider two conceptual metrics: 1) **maximising net electricity market benefits** and 2) **minimising regret**.
4. Blueprint options should be analysed to include any preparatory or enabling works that may provide greater **future optionality and flexibility**.

The methodology follows a structured step-by-step process to inform the Future Grid Blueprint Development Plan. These steps include starting from determining the lower and upper range of network development plans through to ranking network development plans, ultimately informing selection of the Future Grid Blueprint Development Plan.

The CBA methodology provides an approach for the ranking of alternative transmission pathways, determined by the net electricity market benefit, the extent of regret minimised and the likelihood of the future scenario underpinning the pathway. The CBA methodology is designed to provide a robust evidence base to support. the selection of the Future Grid Blueprint Development Plan.

2. Purpose, scope and structure

2.1. Purpose

Deloitte Access Economics (DAE) has been engaged by Transpower to develop a Cost Benefit Assessment (CBA) methodology. This CBA methodology will act as a framework for informing the Future Grid Blueprint Development Plan (Future Grid Blueprint or Blueprint) associated with the *Te Kanapu: Future Grid Blueprint for Aotearoa* work programme.

This report sets out the CBA methodology to ensure transparency and independence in the evaluation of costs and benefits associated with alternative transmission expansion and upgrade options across scenarios to fairly plan and optimise transmission investment.

2.2. Scope

Developing a multidecade Blueprint requires integrating economic modelling, engineering analysis and other technical inputs in a coherent way. The CBA methodology sets out how these inputs are brought together to support robust decision making. It should be noted that this CBA methodology assesses the costs and benefits associated with alternative transmission expansion and upgrade options on the electricity system. Complementary modelling would be required to capture broader economic impacts and outcomes for New Zealand.[1]

In this report we describe a CBA framework that will:

- Provide a standardised framework to compare sets of alternative transmission expansion and upgrade options[2] across scenarios, using Transpower's modelling outputs from market modelling, transmission cost modelling, power systems analysis, competition benefits, and reliability and resiliency assessments.
- Support transparent assessment of trade-offs between maximising net electricity market benefits (NEMB), minimising regret, meeting reliability standards, facilitating decarbonisation, enhancing competition and strengthening resilience.
- Allow planners to incorporate scenario weighting, optionality, staging and Transpower's risk appetite when interpreting modelling results and informing recommendations.

[1] Estimating broader economy-wide impacts (such as effects on GDP, employment, or regional economic outcomes) is outside the scope of this CBA methodology but could be undertaken as complementary analysis. Further discussion is provided in the *Considerations beyond the CBA* section of this report.

[2] Where 'option sets' are different combinations of independent transmission expansion or upgrade options. For example, an option set might include three options: an upgrade to circuits in the West Coast, a new line through Central North Island, and a new line north of Auckland.

2.3. Structure of this report

The structure of this report is provided below:

Chapter	Content
Te Kanapu: Future Grid Blueprint	• Description of Transpower's initiative to create a Future Grid Blueprint for Aotearoa New Zealand • Overview of the five scenarios developed to describe potential futures of Aotearoa's electricity system by 2050 • Description of the Future Grid Blueprint programme workflow, modelling and frequency of updates • Description of the role of the CBA within the Future Grid Blueprint Development Plan
Guiding principles	• Overview of how the guiding principles for the CBA methodology were developed and their purpose • Description of guiding principles that lay the foundations for the CBA methodology
CBA process	• Description of the step-by-step approach to assessing and selecting network development plans to determine the single preferred network development that informs the Future Grid Blueprint
Considerations beyond the CBA	• Describes how the CBA quantifies changes in high level electricity system costs, which are not equivalent to broader economic impacts and outcomes for New Zealand • Description of wider impacts of the Future Grid Blueprint that are not captured by the CBA methodology but may influence final judgement when selecting the Future Grid Blueprint

3. Te Kanapu: Future Grid Blueprint

Te Kanapu ('Kanapu' meaning 'lightning' and 'bright') aims to develop a Future Grid Blueprint that enables Aotearoa New Zealand to electrify and grow.

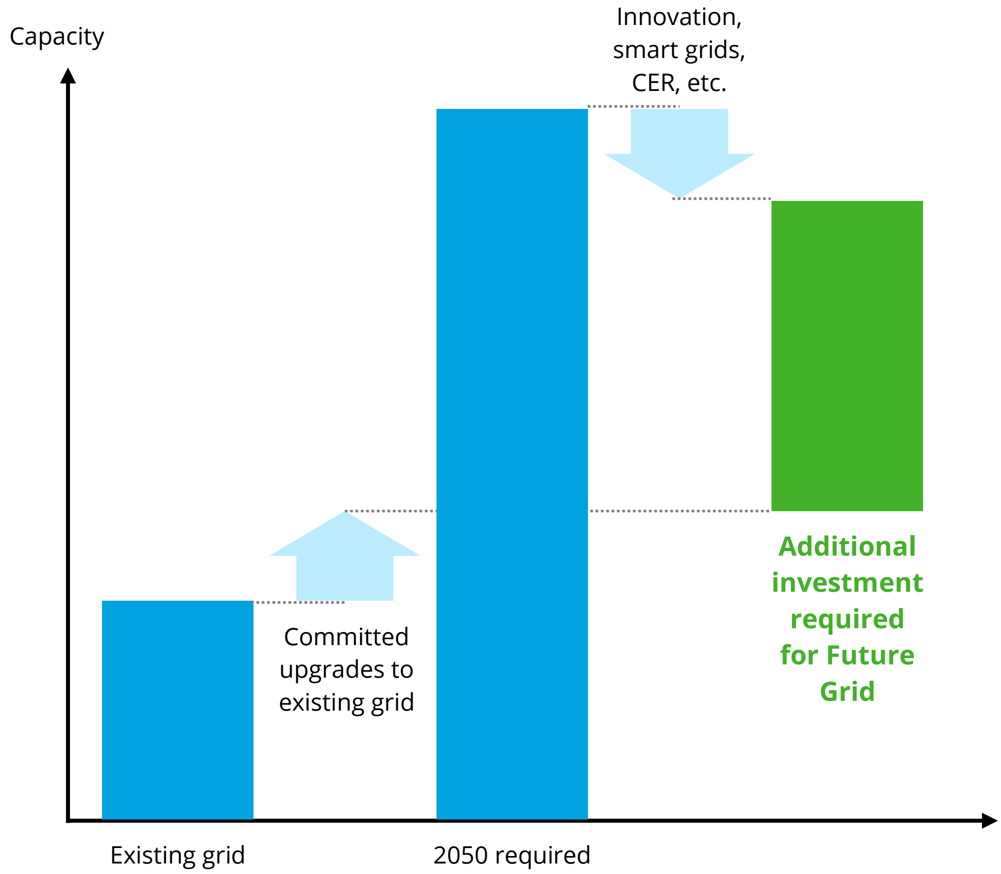
3.1. Future Grid Blueprint purpose

New Zealand's national grid operates in the context of increasing energy demand, a shift towards low-carbon energy sources and rapid technological development. Transmission investment plays a critical role in enabling this transition and supporting the evolving energy system in a cost-effective and reliable manner. However, designing the grid of the future requires navigating inherent uncertainty about the state of the future of supply of and demand for electricity.

Transpower's *Te Kanapu: Future Grid Blueprint* programme aims to develop a Blueprint for New Zealand's transmission network by 2050 through envisioning a range of possible scenarios against which potential development plans for the transmission network are assessed.

The diagram below illustrates, at a conceptual level, the growing gap between today's grid and the capacity required by 2050. The Future Grid Blueprint is the bridge to this capacity shortfall accounting for both committed upgrades to the existing grid and the role of future-focused innovations.

Figure 1: Transition from the existing grid to a Future Grid



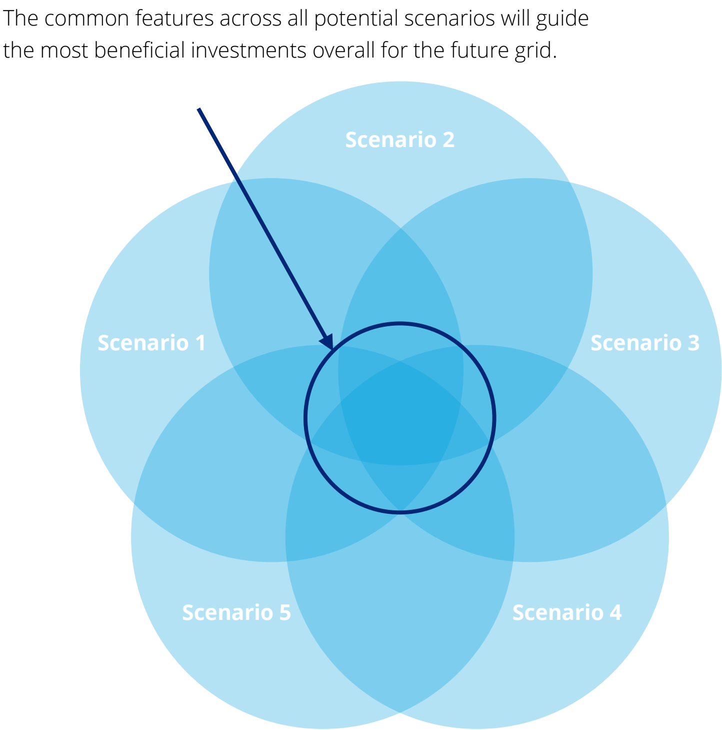
Source: Deloitte Access Economics, based on Transpower's *Te Kanapu – Technical Symposium Presentation*

3.2. Scenarios

Five scenarios were developed to describe potential futures of Aotearoa's electricity system by 2050.[3] For the purposes of this report, a 'scenario' is defined as an assumed future state of the context in which New Zealand's grid operates. Each scenario includes descriptions of the global and local contexts, the state of the economy, how electrification has progressed, social and demographic shifts and the generation mix of electricity. It is important to note that the scenarios do not explicitly reflect how the role of the grid itself may change over time.

[3] Transpower "A future grid blueprint for Aotearoa – Consultation 3: Future Direction – Our Energy Scenarios" (March 2026) <https://static.transpower.co.nz/public/uncontrolled_docs/Te%20Kanapu%20Consultation%203%20-%20Future%20Direction.pdf >

Figure 2: Future Grid Blueprint Scenarios



Scenario one: ***Patchwork nation***	*In a world of sluggish growth and unclear direction set by government, Aotearoa makes do with what it has. Communities, businesses, and industries rely on creativity, adaptability, and practicality to keep the economy moving.*
Scenario two: ***Aotearoa electrified***	*In a world where global priorities shift with each electoral cycle, Aotearoa chooses a steady, long-term path towards a low-carbon economy. By committing to a consistent strategy, the country leads by example, reducing emissions where possible and building enduring relationships. Aotearoa demonstrates that small nations can punch above their weight by staying the course and embodying the change they want to see in the world.*
Scenario three: ***Global green rush***	*Global coordination towards reducing emissions accelerates, driving down the costs of clean technologies and improving efficiency worldwide. Global warming is tracking towards 1.5˚C by 2100. Aotearoa rides this momentum, finding its path to net zero made cheaper and easier. By leveraging international advances and aligning with global action, the country achieves deep emissions reductions while strengthening key sectors of our economy, such as manufacturing, transport, and farming.*
Scenario four: ***Made in Aotearoa***	*A large expansion of goods production across the primary and manufacturing sectors drives growth. Aotearoa has historically been a strong producer of key products, especially food. This scenario explores the advantage gained from producing more high-value, clean green products for the world.*
Scenario five: ***Aotearoa intelligence***	*A pivot toward digitalisation and Artificial Intelligence (AI) where Aotearoa New Zealand leverages its strong advantage for data centres, given its highly renewable electricity system and low air temperatures. The country targets growth in high-tech sectors, such as creative industries, healthcare, space, and services. Its population grows as more people choose to live here in a perceived safe haven.*

Source: Transpower's *A future grid blueprint for Aotearoa Consultation 3: Future Direction – Our Energy Scenarios (March 2026)*

3.3. The role of the Cost Benefit Assessment within the Future Grid Blueprint

Developing a long-term network development plan requires a coherent approach to assessing costs and benefits from a range of development options and scenarios through integrating economic modelling, engineering analysis, and a wide range of technical inputs. Here the CBA provides a framework where different development options are evaluated independently and consistently across multiple scenarios to support transparent comparisons and fair, evidence-based optimisation of transmission investment.

A structured methodology is critical at this stage of planning, as it brings together diverse inputs and outputs of various economic and technical modelling to inform robust decision making, clarify trade-offs, and guide the selection of options that are combined to inform the Blueprint and deliver the greatest long-term value, reliability, and resilience.

Key inputs that will inform the CBA are explained below.

Table 1: Overview of inputs to CBA.

Model	Description	Costs and benefits determined by the model
Market modelling	Market modelling simulates the least-cost build and dispatch of generation and demand response against a user-defined demand forecast and generation retirement schedule to estimate system-wide costs and benefits for each development plan	• Capital expenditure for generation • Operating and maintenance costs • Fuel costs • Emissions costs • Transmission line losses • Energy deficit costs (arising due to unmet demand).
Power systems	Power systems analysis is a critical step and assesses the physics and engineering of transmission options and grid-connected generation.	• Dynamic stability costs • Static voltage and reactive support

Model	Description	Costs and benefits determined by the model
Competition benefits	The competition benefits model estimates the change in economic surplus which arise from an increase in competition due to infrastructure investment in a constrained network.[4]	• Lost economic welfare (deadweight loss) • Transfers between producers and consumers
Reliability and Resiliency	Reliability and resiliency analysis assesses the system's exposure to disruptive events and the system's capacity to recover and the costs involved.	• Reliability: o Independent circuit interruptions o Structural common-mode failures o Substation node failures • High Impact Resilience Hazards: o Extreme weather o Seismic and earthquakes o Volcanic activity o Tsunami

Source: Deloitte Access Economics, based on Transpower's modelling workstreams for *Te Kanapu*

[4] Economic surplus is not a cost; it is a benefit. However, a reduction in consumer surplus can be seen as a cost to consumers, and similarly for producer surplus. Competition benefits arise where transmission investment creates market outcomes closer to those expected under a perfectly competitive market. For a more detailed discussion of how we include competition effects in the cost benefit assessment, refer to Deloitte Access Economics "Quantifying the competition benefits of transmission investment: Methodology selection" (October 2025) <https://static.transpower.co.nz/public/uncontrolled_docs/Quantifying%20competition%20benefits%20of%20transmission%20investment.%20Methodology%20selection.pdf>

4. CBA: Objective and guiding principles

The guiding principles of the CBA methodology set the foundation for the selection of the Future Grid Blueprint.

4.1. Objective of the CBA

The objective of the decision support methodology is to establish:

- Decision framework and principles – The primary decision criterion and supporting principles that guide assessment across scenarios, including expectations for transparency and the role of professional judgement.
- Scenarios, weightings and sensitivities – A description of future scenarios considered as part of the CBA assessment, the relative likelihood weightings assigned to these different future scenarios and the sensitivity testing of assumptions made as part of the CBA assessment.
- Transmission expansion and upgrade option sets – A description of the process applied by Transpower for forming the sets of different transmission expansion and upgrade options across scenarios, including the potential consideration of staging, early works and deferral options to capture option value.
- Metrics, inputs and counterfactuals – The core inputs and metrics used to compare alternative transmission expansion and upgrade option sets, the definition of the counterfactual, and the pragmatic boundaries for CBA inputs, outputs and complexity.
- Ranking, decision rules and reporting – The rules for ranking alternative transmission expansion and upgrade option sets using scenario-weighted net benefits and regret-based measures, including the reporting requirements needed to clearly communicate scenario results, comparative performance, regret profiles and key sensitivities.

4.2. Principles that govern the CBA

A set of guiding principles have been developed with Transpower based on guiding principles adopted for CBA assessments in comparable overseas jurisdictions, with consideration of the applicability of such principles to assessing the range of possible scenarios for the New Zealand national grid. CBA assessments from overseas jurisdictions reviewed included:

- The Australian Energy Market Operator's (AEMO's) cost benefit methodology used to develop and test alternative development paths.[5]
- The U.S Department of Energy's Grid Deployment Office National Transmission Planning Study, which developed new national-grid-scale planning tools and methods to inform planning processes for regional and interregional transmission.[6]

---

[5] AEMO "ISP Methodology" (June 2025) <https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2024/2026-isp-methodology/isp-methodology-june-2025.pdf>

[6] U.S. Department of Energy "National Transmission Planning Study" (October 2024) <https://www.energy.gov/gdo/national-transmission-planning-study>

- The European Network of Transmission System Operators for Electricity (**ENTSO-e**) guidelines for cost-benefit analysis of grid development projects.[7]
- The Office of Gas and Electricity Market's (**Ofgem's**) Cost Benefit Analysis Guidance for Electricity System Operators.[8]

The guiding principles are intended to ensure a robust, consistent and evidence-based approach is applied when informing the Blueprint.

The guiding principles are set out below.[9]

Guiding principles

1. The Blueprint is informed by the network development plan that delivers the most robust net electricity market benefits across the **entire electricity system as a whole**, consistent with the World Energy Council's Energy Trilemma by balancing energy security, energy equity and environmental sustainability, rather than focussing solely on transmission assets.
2. The Blueprint should be assessed under **all five potential scenarios** representing Aotearoa's different possible futures, while remaining **robust to changes in key assumptions.**
3. The Blueprint should consider two conceptual metrics: 1) **maximising net electricity market benefits** and 2) **minimising regret**.
4. Blueprint options should be analysed to include any preparatory or enabling works that may provide greater **future optionality and flexibility**.

The guiding principles underpin the CBA methodology and the step-by-step process used to inform the Future Grid Blueprint. The CBA process is described in detail in the next section.

---

[7] ENTSO-e "4th ENTSO-E Guideline for cost-benefit analysis of grid development projects: Final version approved by the European Commission" (April 2024) <https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/news/2024/entso-e_4th_CBA_Guideline_240409.pdf>
[8] Ofgem "RIIO-2 Cost Benefit Analysis Guidance" (November 2019) <https://www.ofgem.gov.uk/sites/default/files/docs/2019/11/riio-2_eso_cba_guidance.pdf>
[9] World Energy Council "World Energy Trilemma Framework" (2024) < https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-framework>

5. CBA: Step-by-Step process

The CBA methodology follows a structured step-by-step process to inform the Future Grid Blueprint.

5.1. Introducing the concept of a Network Development plan

As the CBA methodology and process refers to a Network Development Plan (NDP) at each step of the process, this section of the report first sets out an explanation of what an NDP is.

The Future Grid Blueprint takes the future scenarios and a combination of transmission expansion and upgrade option sets as inputs. Scenarios represent potential future states in which New Zealand's grid operates as explained earlier in the report, while NDPs represent a set of network expansion and upgrade options that are designed to relieve constraints in the network. The box below provides a more detailed definition of an NDP.

What is an NDP?

An NDP, or network development plan, represents an assumption about the future of the transmission network. An NDP includes both an option set of transmission expansion and upgrades (over-and-above existing and committed infrastructure), as well as assumed commissioning dates of each option.

Expansion and upgrade options include upgrades to existing assets, new High Voltage Alternating Current (HVAC) lines and new High Voltage Direct Current (HVDC) lines. These options are limited to existing transmission technologies and do not consider new technologies or technological refinements. While these options may be able to collectively address network capacity requirements, they might not necessarily be least-cost for all components of the system. These independent transmission projects are combined into potential option sets which are referred to as NDPs.

NDPs are independent of scenarios, which describe the future context against which the transmission network exists. Outcomes under each NDP are assessed under each scenario.

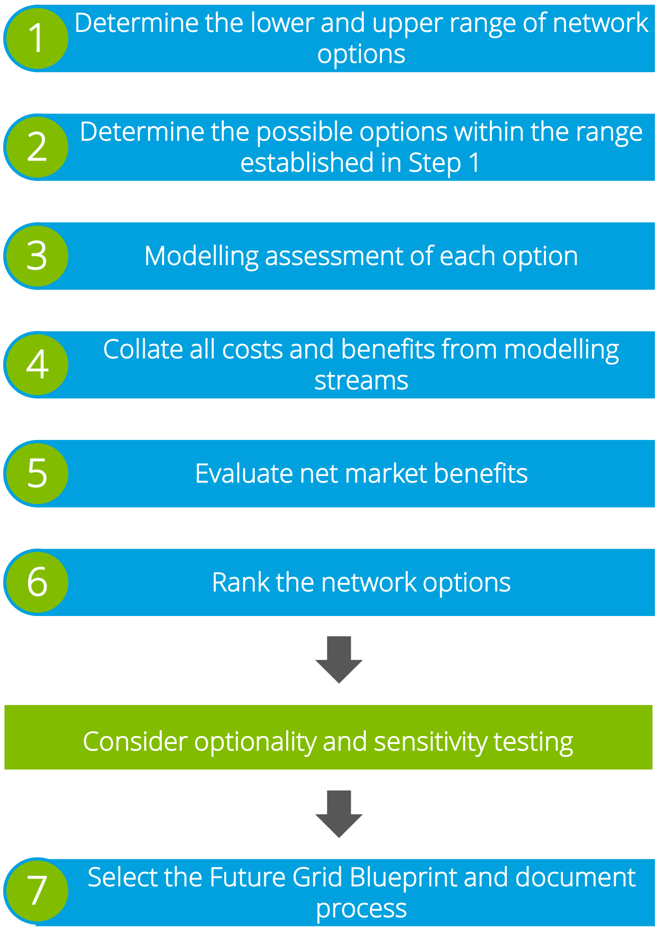
NDPs are then used as inputs into Transpower's key modelling streams outlined in Table 1 above and are assessed through an iterative process which is described in detail in the CBA process section.

5.2. Overview of CBA process

The CBA evaluates and ranks NDPs against selected guiding principles to enable the identification of a single preferred NDP which will ultimately inform the Future Grid Blueprint Development Plan. This single preferred NDP informs the Future Grid Blueprint or Blueprint.

The step-by-step process for the CBA methodology is illustrated below.

Figure 3: Overview of the CBA process through to selection of the Future Grid Blueprint



5.3. Step 1: Determine the *lower* and *upper* range of NDPs

The first step towards identifying suitable NDPs for analysis in the CBA is to identify the two 'guide rail' NDPs[10], representing the lower and upper bounds of potential transmission development in the network. The two guide rail NDPs are:

- The counterfactual NDP, a *lower* bound on transmission development defined by a transmission network with no further augmentation of the existing network beyond already committed transmission projects.
- The unconstrained network NDP, an *upper* bound on transmission development, defined by a fictitious NDP where there is no limit on circuit flows in the transmission network.[11]

[10] In this context 'guide rail' refers to a bounding scenario used to frame the reasonable range of network development outcomes for analysis.

[11] Transpower "Future Grid Blueprint Methodology: Te Kanapu Technical Approach" (December 2025) <https://static.transpower.co.nz/public/uncontrolled_docs/Future%20Grid%20Blueprint%20Methodology%20-%20Te%20Kanapu%20Technical%20Approach%20-%20V1.0%20-%20December%202025.pdf> at pg. 42-43

What is the counterfactual NDP?

The counterfactual NDP refers to a future of the transmission grid with no further augmentation of the existing network beyond committed transmission projects. It provides a benchmark against which to evaluate NDPs.

In their *Future Grid Blueprint Methodology*, Transpower define the counterfactual as an NDP made up of the existing network, plus all committed projects. Committed projects can be either be Transpower projects, or customer projects.

For Transpower projects, the threshold for committed projects includes:

- Funding is approved
- Delivery business case is signed
- Design is completed.

For customer funded projects the threshold for committed projects includes:

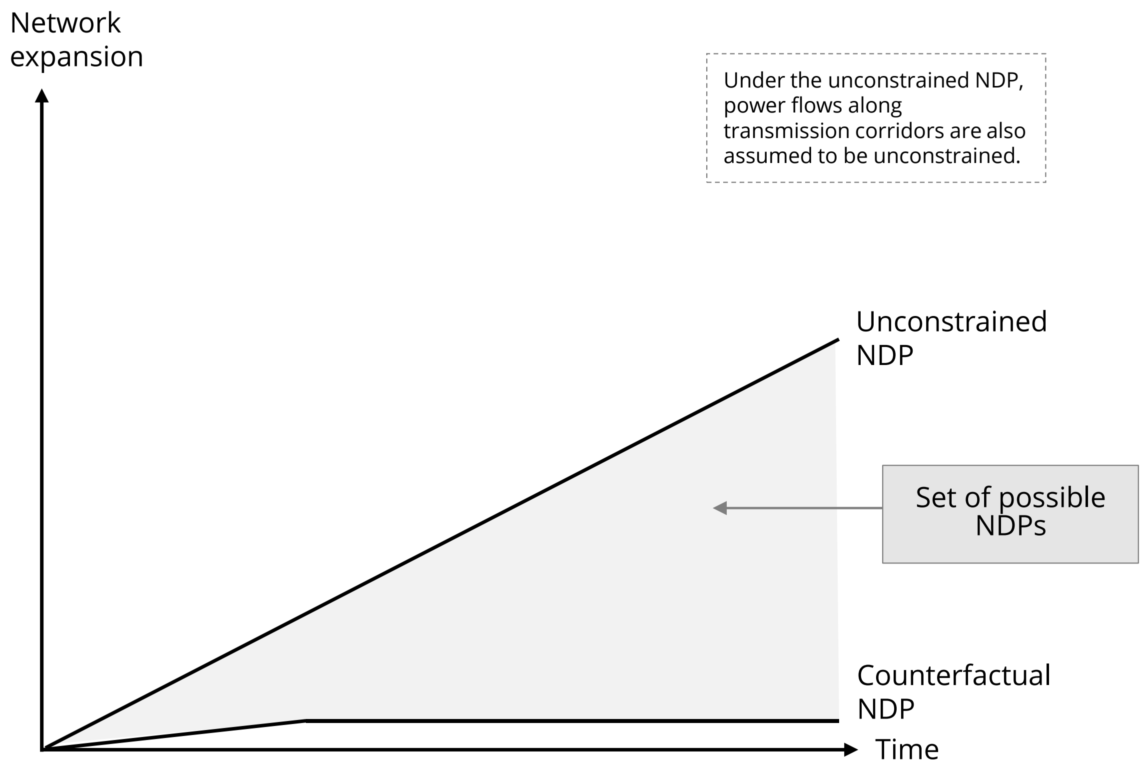
- Transpower works agreement is signed
- Final investment decision is approved
- Funding is secured
- Resource consents are approved
- Delivery business case is signed.

Each scenario has its own counterfactual. The assumed transmission network for the counterfactual in each scenario is the same, with differences relating to generation capacity and shunt elements. Shunt elements are devices connected in parallel to transmission lines to control voltage and reactive power, helping maintain system stability and power quality across the network.

Differences in assumed generation capacity and shunt elements for the counterfactual in each scenario are designed to ensure a realistic level of service for electricity supply, with the additional cost of local generation and shunt elements included in the total system cost of the counterfactual in question.

The primary purpose of this step is to narrow the scope of feasible development plans and ensure focus is dedicated to development plans that are more likely to be suitable candidates.

Figure 4: Stylised representation of guide rail NDPs



Source: Deloitte Access Economics

5.4. Step 2: Determine possible NDPs within the range established in Step 1.

Following Step 1, Step 2 considers a set of NDPs within the established range. This step uses transmission planning experience to determine suitable development pathways for further analysis, informed by the results of the guide rail NDPs.

This process is undertaken through the following sub-steps:

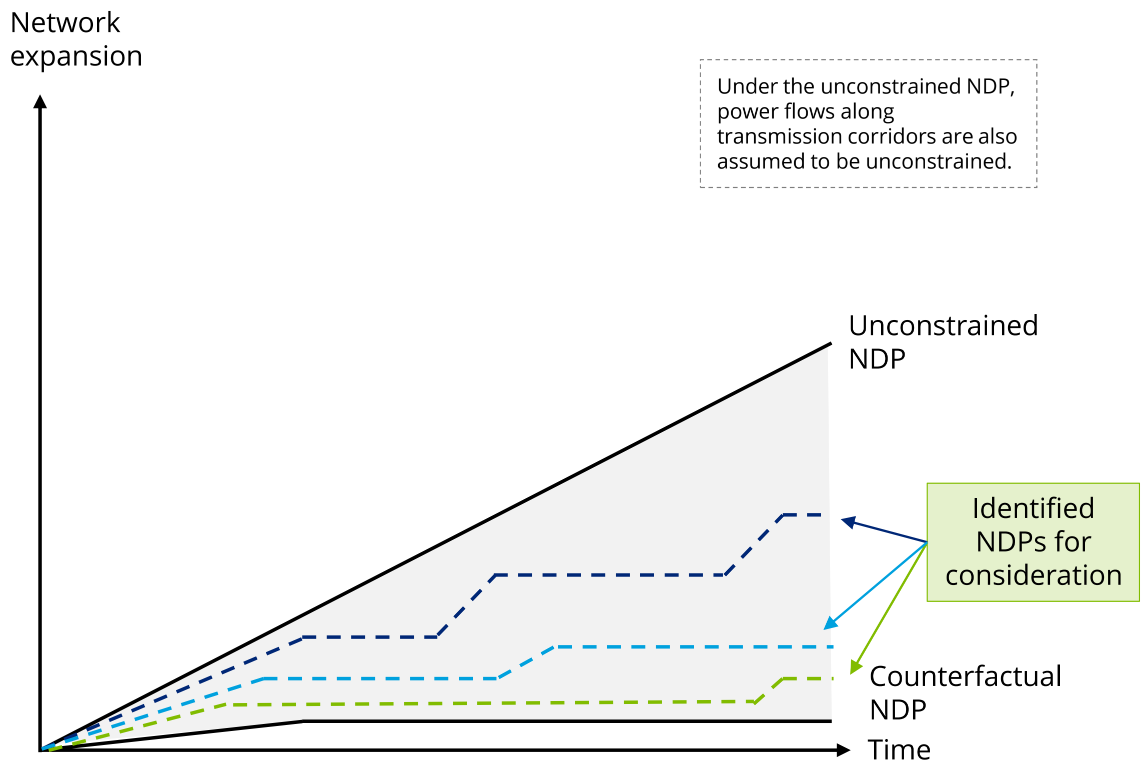
1. Identify candidate corridors: Identify transmission corridors where power flows are materially different between the counterfactual NDP and the unconstrained NDP. These corridors represent potential candidates for building additional transmission capacity.

2. Develop candidate options: Assess the magnitude of the differences in power flows and, using engineering judgement, propose candidate transmission options, such as a new transmission line or an upgrade to an existing asset.

3. Determine investment timing: Identify when the difference in power flows first becomes material to establish the indicative investment need date for each candidate option.

4. Repeat across scenarios and options: Repeat this process across different scenarios and for alternative transmission options to develop a range of candidate NDPs for assessment.

Figure 5: Stylised representation of candidate NDP identification



Source: Deloitte Access Economics

For example, the counterfactual NDP can be analysed to identify where transmission bottlenecks are most likely to occur across the national grid. The unconstrained network NDP can then be used to assess potential energy flows between regions and/or nodes without any limitations on new transmission build-out or bottlenecks to energy flow. These insights help inform the engineering judgement applied in defining the initial set of NDPs.

Because an NDP includes both a portfolio of projects and their sequencing, judgement is required to determine the appropriate commissioning dates for each project.

5.5. Step 3: Modelling assessment of each NDP

Building on the NDPs identified in Step 2, Step 3 involves modelling assessments of the identified NDPs. Energy market and power system modelling are conducted to evaluate the techno-economic performance of each identified NDP.

An iterative process is undertaken between the power system model and the energy market model to test whether the NDPs are able to meet both energy market and power system requirements. A key component of this iteration involves developing a system condition handover from the energy market model to the power system model to perform checks and verification of specific constraint equations.

The purpose of this step is to assess whether system constraints need to be adjusted to prevent network issues, including N-1 security violations in the power systems framework. In addition, transmission line losses and maintenance costs are incorporated to account for the additional costs associated with deploying the NDPs.

During this process, NDPs may be discarded or changed as they progress through Transpower's modelling workflow process if early results suggest the NDP is unlikely to be suitable (for example, if early modelling indicates unsuitably high costs or engineering limitations). These NDPs will not be considered in the CBA. Early power system and energy market modelling may also be used to inform additional NDPs that should be included. This step is therefore iterative, with NDPs assessed and refined on a rolling basis.

Once power system and energy market modelling has been conducted for each NDP, transmission cost analysis, competition modelling and reliability and resiliency modelling assessments are undertaken to estimate the total costs of each NDP. At this point, a decision must be made as to whether the NDP should progress to the CBA.

5.6. Step 4: Collate all costs and benefits from modelling streams for each NDP

This step takes the modelling costs and benefits for each NDP (including the counterfactual) under each scenario from all models and incorporates these into the CBA.

Annuitisation of lump sum costs

Where costs are lump sum costs (e.g., capital expenditure to construct a new transmission line), these costs are converted to annual cost flows incurred throughout the asset's useful life for the purposes of the CBA.[12]

This approach has several advantages. For projects that have an economic life that go beyond the CBA time horizon, the conversion of lump sum costs to annual cost flows allows matching annual benefit streams to annualised cost streams within the analysis time horizon. This avoids having to either include the lump sum of expenditure associated with an economic life beyond the analysis time horizon or estimating benefits beyond the analysis time horizon. An assumption underlying this approach is that costs and benefits are neutral for the remaining lives of assets beyond the modelling horizon. This also addresses differences in the analysis time horizons across the various models that provide outputs for the CBA. It also allows for like-for-like comparison of projects with differing commissioning dates and economic lives.[13]

Another benefit of converting lump sum costs to annual costs flows is that it allows a fair consideration of both capital and operating costs.

Annualised cost streams are calculated using a standard annuity formula, where *P* is the annualised cost of the asset (for each year of its estimated economic life), *C* is the lump sum capital cost, *WACC* is the weighted average cost of capital and *t* is the economic life of the asset.

$$P = \frac{C \times WACC}{1 - (1 + WACC)^{-t}}$$

The weighted average cost of capital (WACC) is used as the discount rate for annuitising lump sum costs as it reflects the cost of capital required to finance the transmission developments. This can be

[12] An alternative approach would be to include investment and capital costs as lump sum costs in the year they are incurred. This is the approach taken by the European Network of Transmission System Operators for Electricity (ENTSO-e). See ENTSO-e "4th ENTSO-e Guideline for cost-benefit analysis of grid development projects: Final version approved by the European Commission" (April 2024) < https://tyndp.entsoe.eu/resources/guideline-for-cost-benefit-analysis-4.0> at pg. 27

[13] AEMO "ISP Methodology" (June 2025) < https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2024/2026-isp-methodology/isp-methodology-june-2025.pdf> at pg. 94-95

thought of as mimicking the cashflows if the lump sum cost was borrowed and repaid over the project life.[14]

Terminal Value

A terminal value is used to capture costs and benefits beyond the modelling horizon. It is applied only where a clear and consistent trend is evident in the modelled results and can be reliably extrapolated. Where no such trend exists, the terminal value is set to zero, implying the investment is cost-neutral beyond the modelling horizon.

Discounting

The discounted total cost and benefits of a development path represents the present value of annual costs and benefits accrued during the modelling horizon, i.e., costs and benefits are discounted to a present value cost using a discount rate. The modelling horizon for the purposes of the CBA assessment extends out to 2050. The discounting formula used is given below, where X_t is the cost or benefit flow in period t, r is the discount rate and T is the number of periods being considered (e.g., 31 for a CBA covering 2025 to 2050).

$$PV = \sum_{t=1}^{T} \frac{X_t}{(1+r)^t}$$

Discounting annual costs and benefits of a development path out to 2050 assumes that any costs and benefits beyond 2050 are neutral. Such an approach is supported by the inherent uncertainty associated with electricity system development over longer-time horizons and the fact that a discounted cash flow beyond the horizon will have a diminishing impact.

It is important to note that different discount rates are used for the annuitisation of lump sum costs and discounting:

- The WACC is used as the discount rate for annuitising lump sum costs as it reflects the cost of capital required to finance the transmission developments.
- A uniform discount rate is used by Transpower to discount all costs and benefits associated with a NDP to determine the present value of the costs and benefits.

5.7. Step 5: Evaluate net electricity market benefits

This step determines the net electricity market benefits for each NDP under each scenario. Net electricity market benefits are explained and illustrated in the box below.

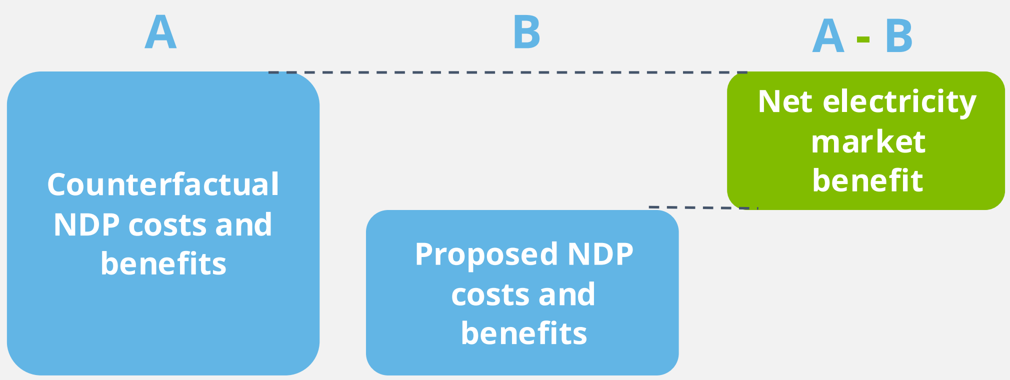
[14] WACC is not specified in this methodology paper, as the applicable WACC may vary by asset type. Asset-specific WACC values will therefore be provided by Transpower as an input.

Total system costs and net electricity market benefits

Total system costs refer to the total electricity market costs expected to be incurred under a given scenario for a given NDP. These costs include, for example, capital costs of projects, fuel costs and competition effects (i.e., economic welfare lost as a result of competition effects).

The NEMB, or net electricity market benefit, of a NDP is the reduction in total system costs relative to the counterfactual NDP. That is, an estimate of how the expansion and upgrade options in an NDP lowers total system costs.

Figure 6: Calculation of net electricity market benefits



Source: Deloitte Access Economics based on AEMO

Under a given scenario, the net electricity market benefit (NEMB) of an NDP is calculated as the difference between the discounted total system costs of the counterfactual and the discounted total system costs of the NDP. The NEMB is therefore the expected decrease in discounted total system costs, relative to the counterfactual, under that scenario.

This process is undertaken for each NDP under each scenario, providing an estimate of the expected NEMB and providing a basis to compare and evaluate NDPs across scenarios.

5.8. Step 6: Rank the Network Development Plans

The next step of the CBA is to rank the NDPs based on the estimated NEMB under each scenario. Two different approaches are used to rank NDPs:

1) Maximising NEMB, which ranks NDPs from highest to lowest net electricity market benefits, taking into account all scenarios
2) Minimising 'Least-Worst Weighted Regrets' (LWWR), which ranks NDPs from least to most regret, taking into account all scenarios

This CBA methodology employs both approaches to ensure alignment to the guiding principles and assess the robustness of benefits. NDPs are ranked under both approaches under each scenario. An overall assessment is also made, based on weighted average NEMB and scenario likelihood.

Maximising net electricity market benefits
The first evaluation approach ranks NDPs from highest NEMB to lowest NEMB.

For each scenario, the NEMB is calculated for each NDP. The calculated NEMB across all scenarios for a given NDP is then weighted based on the probabilities assigned to each scenario and summed. This gives a weighted-average NEMB for each NDP, accounting for uncertainty about the future context in which New Zealand's transmission network will exist.

Scenario weighting

Scenario weighting assigns relative likelihoods to the different future scenarios for Aotearoa's electricity system. This is done so that each NDP can be evaluated on its expected performance across all plausible futures. By weighting scenario-specific net electricity market benefits, comparison of options can be made on a consistent, probabilistic basis, ensuring that the preferred path reflects both expected outcomes and underlying uncertainty rather than relying on any single scenario

The NDP with the highest weighted-average NEMB should be selected as the preferred according to the maximising NEMB criterion.

Table 2: Numerical example of maximising NEMB

Net electricity market benefit	Scenario A	Scenario B	Scenario C	Weighted NEMB ($m)	Rank
Scenario Weighting	*50%*	*40%*	*10%*		
NDP 1	340	200	120	262	1
NDP 2	310	200	180	253	2
NDP 3	200	160	300	194	3

Source: Deloitte Access Economics

In the example above, NDP 1 delivers weighted-average NEMB of $262m, which is greater than that of NDP 2 or NDP 3. Under the maximising NEMB criterion, NDP 1 would be selected as the preferred NDP.

Minimising Least-Worst Weighted Regrets

While the first approach focuses simply on identifying the NDP which maximises NEMB across all scenarios, the second approach focuses on the concept of regret. Regret arises when over- or under-investment occurs relative to how the future ultimately unfolds.[15]

Regret

In the context of this CBA methodology, regrets are associated with investment decisions that are later shown to be in excess of, or in short of, future consumer needs. In this context there are two types of regret:

1. Over-investment regret: Future benefits from infrastructure investment are not realised as conditions change and do not require or make efficient use of these assets resulting in consumer regret from over-investment.
2. Under-investment regret: Future changes occur faster than anticipated and an asset is required sooner than what is possible creating additional costs, and therefore, consumers regret not investing earlier.

While risks occur from both under and over-investment, under-investment often poses greater risk due to potential impacts on system reliability. To account for this, the methodology recommended in this report includes applying both 'Maximising Net Benefits' and 'Least-Worst Weighted Regrets' approaches to inform the determination of the Blueprint.

Mathematically, regret is calculated as the difference in NEMB between an individual NDP and the 'best' NDP (highest NEMB) for each scenario. Regret measures the NEMB lost in a scenario by choosing a NDP that is not optimal in that scenario. The larger the difference in NEMB, the larger the regret if that scenario eventuates. If a NDP is optimal in a given scenario, the regret of that NDP in that scenario will be zero.

Weighted regret is calculated by multiplying regret for each NDP under each scenario by the weighting assigned to that scenario. Worst weighted regret for a given NDP is the maximum weighted regret across all scenarios.

NDPs are then ranked from *lowest* worst weighted regret to *highest*. Under the LWWR criterion, the NDP with the lowest worst weighted regret should be selected as the preferred NDP.

[15] For further discussion on LWWR, see AEMO "ISP Methodology" (June 2025) <https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2024/2026-isp-methodology/isp-methodology-june-2025.pdf> at pg. 89-90

Table 3: Numerical example of minimising LWWR

Weighted regret	Scenario A	Scenario B	Scenario C	Worst weighted regret ($m)	Rank
Weighting	*50%*	*40%*	*10%*		
NDP with highest NEMB	*NDP 1 = 340*	*NDP 1 & 2 = 200*	*NDP 3 =300*		
NDP 1	(340 - 340) x 50% = 0	(200 – 200) x 40% = 0	(300 – 120) x 10% = 18	18	2
NDP 2	(340 – 310) x 50% = 15	(200 – 200) x 40% = 0	(300 – 180) x 10% = 12	15	1
NDP 3	(340 – 200) x 50% = 70	(200 – 160) x 40% = 16	(300 – 300) x 10% = 0	70	3

Source: Deloitte Access Economics

The above example calculates weighted regret for each NDP using the NEMB figures in Table 2. Under this example, NDP 2 delivers the least-worst weighted regret of $15m under Scenario A. Under the minimising LWWR criterion, NDP 2 should be selected as the preferred NDP.

CBA outputs

The ultimate outputs of the CBA are the NEMBs and regrets under of each NDP under each scenario, as well as the NDP rankings under the criteria of maximising NEMB and minimising LWWR.

5.9. Step 7: Select the Blueprint

The final step of the CBA is to select the Future Grid Blueprint by considering the outputs of the CBA and other considerations.

The CBA assessment produces a ranking of NDPs based on two key criteria, maximising NEMB and minimising LWWR. These assessments are used to inform the Future Grid Blueprint. While selection should be guided by the CBA outputs, judgement should be used in interpreting the outputs, considering optionality and sensitivities when selecting the Blueprint.

Net electricity market benefits versus minimising 'Least-Worst Weighted Regrets'

In the perfect case, both the maximising NEMB and minimising LWWR criterion will select the same NDP. In this case, that NDP both provides the highest expected NEMB, weighted by scenario uncertainties, and minimises the risk of regret from over or under-investing.

It is important to note that both the maximising NEMB and minimising LWWR rankings are calculated based off NEMBs. Divergence in rankings occurs because maximising NEMB is an *expected-value* measure of NEMB, while LWWR is a *risk-exposure* measure of NEMB.

A key consideration is therefore the risk-return trade-off. This requires assessing the scenarios which are driving high NEMBs and which scenarios are driving high levels of regret and considering risk-appetite to these scenarios.

This occurs in the examples set out in Table 2 and Table 3 above, where NDP 1 maximises expected NEMB, but NDP 2 minimises LWWR. Selecting the Blueprint should be done with consideration to the risk-appetite to Scenario C (where NDP 1 experiences high regret) eventuating.

5.10. Incorporation of optionality and flexibility

Optionality refers to the ability to augment an existing NDP, for example by shifting commissioning dates of specific options or building in preparatory works to reduce lead times for other options.

For the most part, optionality can be treated as an iterative consideration made during the modelling of NDPs. This would result in alternative NDPs with slightly different characteristics. This could be, for example, because during modelling runs it is identified that a particular new transmission asset is not properly utilised until later in the time period, and therefore could be delayed with minimal impact and potentially higher overall net benefits to the system.

Flexibility

As electricity system investments have considerable lead times and are subject to significant uncertainty around future market conditions, flexibility adds value to the Blueprint.

To minimise the risk of over or under-investment, any projects considered for the Blueprint should account for future developments in generation, network, and storage, as well as evolving consumer needs over the life of the asset. In this case, projects that are more capable at adapting to different future market conditions are inherently more valuable. Projects selected for delivery as part of a Future Grid refresh should demonstrate that investing now delivers benefits greater than if the decision were to be delayed. This requires trading off deciding to invest now (which may come with a risk of regret) against delaying the decision.

Flexibility can be built into the Blueprint through optionality, such as staging project size or timing, deploying non-network solutions to address immediate needs, undertaking early works to enable faster future delivery and applying decision rules to confirm ongoing need.

5.11. Sensitivity testing

Another consideration is sensitivity testing of scenario assumptions. This can be particularly useful in assessing the drivers of regret and why this may cause diverging rankings when maximising NEMB. Sensitivity testing could be undertaken to consider, for example, how a change in fuel price assumptions under a given scenario impacts the benefits and regret associated with an NDP.

Robustness

A guiding principle of this analysis is that the Blueprint is robust to changes in key assumptions. As conditions of New Zealand's future energy demands are inherently uncertain the Blueprint is tested under a range of scenarios. The use of scenario analysis tests the benefits of alternative development options to consumers across a range of future conditions. While scenarios address some of the uncertainty, within each scenario there are differing inputs and assumptions that need to be tested. In this case, sensitivity analysis can add robustness to this analysis as it tests whether the ranking of NDPs changes with a change in one (or more, if appropriate) of the inputs and/or input assumptions.

6. Considerations beyond the CBA

The chosen Future Grid Blueprint will have broader economic impacts on New Zealand's economy, that are important to consider when applying judgement and selecting the Blueprint.

6.1. Wider economic impacts

While the CBA quantifies changes in high level electricity system costs, these are not equivalent to broader economic impacts and outcomes for New Zealand. To better understand the broader interactions between transmission upgrades and the economy, additional modelling, outside of the CBA for the electricity system, could be undertaken. One option is Computable General Equilibrium (CGE) modelling to compare how the New Zealand economy changes under a given NDP relative to the counterfactual NDP. For example, this would trace how total system costs flow through to electricity prices, and how improved electricity affordability impacts businesses and households. A general equilibrium framework may be suited to this analysis due to its ability to capture how changes in one part of the economy flows through to other parts.

The outputs of this could include, for example, the impact of the Future Grid Blueprint on macroeconomic variables such as GDP, exports, consumption, investment, wages and output by industry.

6.2. Socioeconomic and environmental impacts

Other wider impacts could include costs and benefits arising from social outcomes and environmental impacts. Depending on data availability, future work could look to monetise some of these impacts and include them in assessing other costs and benefits associated with transmission network design.

7. Finalising the Blueprint

The Blueprint should be selected based on the CBA outputs and other considerations. Where maximising NEMB and minimising LWWR reveal different rankings, judgement should be applied in interpreting these. While the CBA provides valuable insight, it should be considered alongside other strategic and qualitative considerations when finalising the Blueprint.

7.1. Determining the Future Grid Blueprint

The outputs of the CBA do not determine the decision of the Future Grid Blueprint by Transpower. Instead, the CBA methodology provides a structured basis for decision making under uncertainty by clearly setting out the trade-offs between different NDP options.

Elements of the CBA can help inform decision making in the following ways:

- The net market benefits approach identifies the option that maximises overall economic efficiency across the electricity system while also evaluating the performance of options across a range of plausible future scenarios. This scenario assessment helps account for uncertainty by testing how outcomes vary under different future conditions.

- Through the least-worst weighted regrets approach the CBA assesses the downside risk by identifying options that minimise maximum regret across scenarios.

- By considering both the net market benefits and the least worst weighted regrets approaches, the CBA supports the assessment of trade-offs between maximising overall economic efficiency and maintaining robustness to uncertainty. This combined approach also informs the selection of development pathways and timing by identifying options that maintain flexibility and enable adaptation over time. Overall, the combination of these two conceptual approaches provides a transparent and consistent framework for comparing options and supporting decision-making.

While the CBA methodology is a robust approach to analyse the benefits and cost from the various technical and economic modelling, there are other considerations that might be relevant to deciding the Blueprint that might not be accounted for. For example, the CBA methodology is subject to an analysis time horizon, and it is recognised that some longer-term impacts may not be fully captured quantitatively.

The future is also inherently uncertain. Therefore, applying an independent, fact-based approach—coupled with expert judgement to account for factors that cannot be readily quantified—is critical in determining the Future Grid Blueprint that will best serve Aotearoa New Zealand and maximise long-term benefits.

8. List of tables and figures

List of Tables

List of Figures

9. Glossary

Acronym or term	Description
AEMO	Australian Energy Market Operator
Blueprint or Future Grid Blueprint	Refers to the Future Grid Blueprint Development Plan, the NDP selected as the preferred NDP.
CBA	Cost Benefit Assessment
CGE	Computable General Equilibrium
Counterfactual	A NDP which consists of the existing network plus all committed projects. The counterfactual provides a basis against which to evaluate NDPs.
DAE	Deloitte Access Economics
ENTSO-e	European Network of Transmission System Operators for Electricity
Future Grid	Refers to Transpower's *Te Kanapu: Future Grid Blueprint for Aotearoa* work programme.
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
LWWR	Least-Worst Weighted Regrets, an approach to assessing NDPs based on regret.
Market Cost	The gross (total) electricity market costs expected under a given scenario for a given NDP.
NDP	Network Development Plan, defined as a set of network expansion options and commissioning dates for each option.
NEMB	Net electricity market Benefits, defined as the reduction in total system costs between an NDP and the counterfactual under a given scenario.
Ofgem	Office of Gas and Electricity Markets
Regret	The extent to which an investment is in excess of, or short of, actual future needs.
Unconstrained Network NDP	A fictitious NDP where there are no transmission constraints in the network.
WACC	Weighted Average Cost of Capital

10. Use, limitations and disclaimer

10.1. Restrictions and limitations

This report is commissioned by and in accordance with the scope agreed with our addressee client Transpower. This report is based on the specific facts and circumstances relevant to our addressee client. Our report is intended to inform Transpower's approach to evaluating alternative transmission development pathways and determining the Future Grid Blueprint Development Plan.

Deloitte, its partners, principals, employees, and agents make no statements or representations whatsoever concerning this report, and the reader acknowledges that it may not rely on any such statements or representations made or information contained within this report.