BOMBAY OTAHUHU REGIONAL MAJOR CAPEX PROJECT

ATTACHMENT C: OPTIONS AND COSTING REPORT

Transpower New Zealand Limited

May 2020

Keeping the energy flowing




TRANSPOWER

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.

Glossary

Capex IM	Transpower Capital Expenditure Input Methodology Determination, New Zealand Commerce Commission[1].
Code	Electricity Industry Participation Code 2010.
Connection Asset	A grid asset that connects a customer to the interconnected transmission network.
Connection Charge	The sum of the annual asset, maintenance, operating and (injection for generation customers) cost components for a connection asset over that pricing year. The charge recovers part of Transpower's AC revenue.
Exempt Major Capex	The amount of the major capex allowance (MCA) to which the major capex incentive rate does not apply.
EDGS	Electricity Demand and Generation Scenarios.
GEIP	Good electricity industry practice.
GIP	Grid injection point.
Grid Reliability Standards	The Grid Reliability Standards (GRS) are a set of standards against which the reliability performance of the existing grid (or future developments to it) can be assessed.
GXP	Grid exit point.
Interconnection Charge	Recovers the remainder of Transpower's AC revenue and is based on a customer's contribution to Regional Coincident Peak Demand (RCPD).
Investment Test	The Capex Input defines the 'Investment Test' (IT), being the detailed economic assessment required for Major Capex Projects.
Long-list consultation	Transpower's consultation document entitled Bombay to Otahuhu Regional Study Investigation Long List Consultation December 2018.
Major Capex Incentive Rate	Major Capex Incentive Rate means 15% or an alternative rate specified by the Commission in respect of an approved major capex project.
MBIE	Ministry of Business, Innovation and Employment.
MCA	Major Capex Allowance, as defined by the Capex IM, being the maximum amount Transpower can recover from customers to deliver the grid outputs in relation to this project
MCP	Major Capex Proposal, as defined by the Capex IM.
MW	Megawatt, one million watts, being the power conveyed by a current of one ampère through the difference of potential of one volt.
MWh	Megawatt hour of electrical energy.
N-1	A security standard that ensures with all facilities in service Transpower's transmission system remains in a satisfactory state following a single fault (e.g. a circuit outage).
P50	Expected peak demand forecast. P50 is the 50th percentile of the peak demand forecast probability distribution.

[1] See https://comcom.govt.nz/regulated-industries/input-methodologies/transpower-ims

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	Also, P50 means the estimated aggregate project costs where the probability of the actual project cost being lower than that estimated is 50%
Present Value	Future costs discounted to a present value using a discount rate specified in the CapexIM.
Prudent forecast	Prudent peak demand forecast. P90 is the 90th percentile of our peak demand forecast for the first seven years, then grows at the same rate as the expected for all remaining years in the analysis period.
RFI	Request for information.
RFP	Request for proposal.
Short-list consultation	Transpower's consultation document entitled Bombay to Otahuhu Regional Study Investigation Short-list Consultation December 2019.
SDDP	Stochastic dual dynamic programming – a market dispatch model used to determine the optimal dispatch of hydro, thermal and other renewable generation.
SRMC	Short run marginal cost
TPM	Transmission Pricing Methodology, defined in Schedule 12.4 of the Code.
Transpower	Transpower New Zealand Limited, owner and operator of New Zealand's high-voltage electricity network (the national grid).

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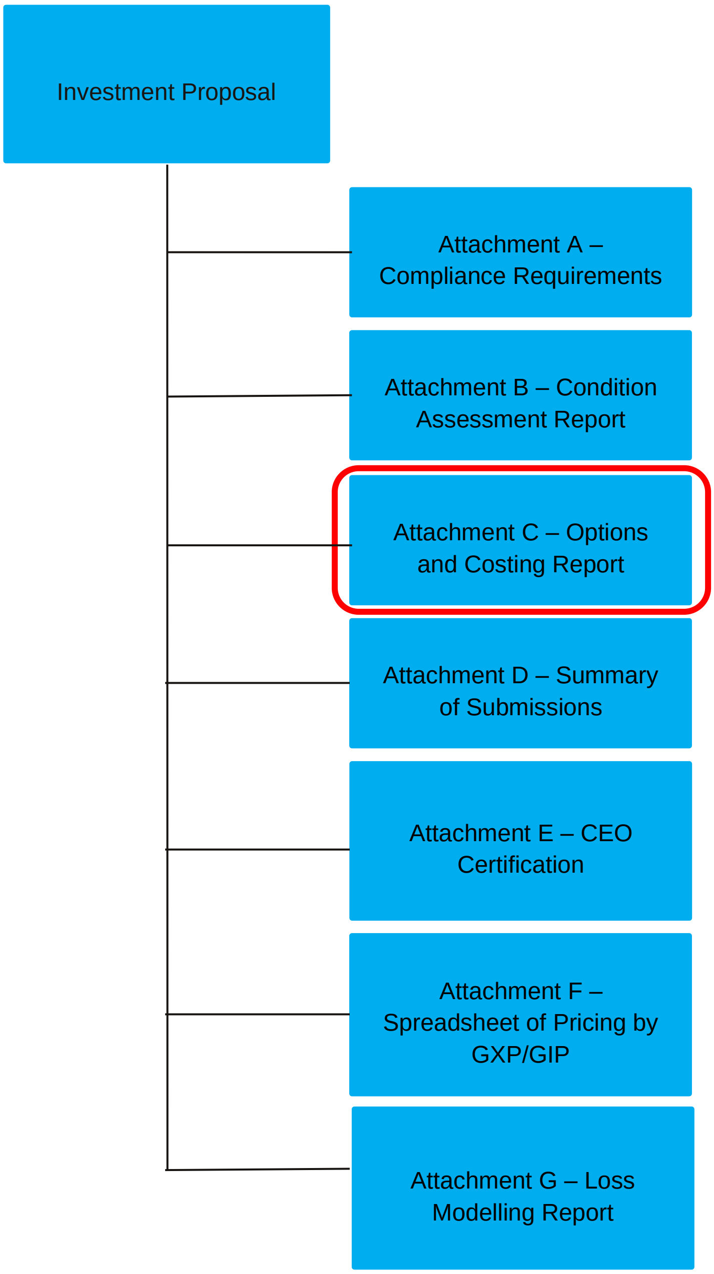
1 Introduction

This attachment provides an overview of our assessment of options and costs for the Bombay Otahuhu Regional Major Capex Proposal application.

This document explains how we have applied the Investment Test specified in the Commerce Commission's *Transpower Capital Expenditure Input Methodology Determination 2012* (Capex IM) and our assessment of the cost and revenue impact of the preferred option. It is one of the supporting attachments to our main report ('Bombay Otahuhu Regional Major Capex Proposal') and should be read in conjunction with our main Investment Proposal.



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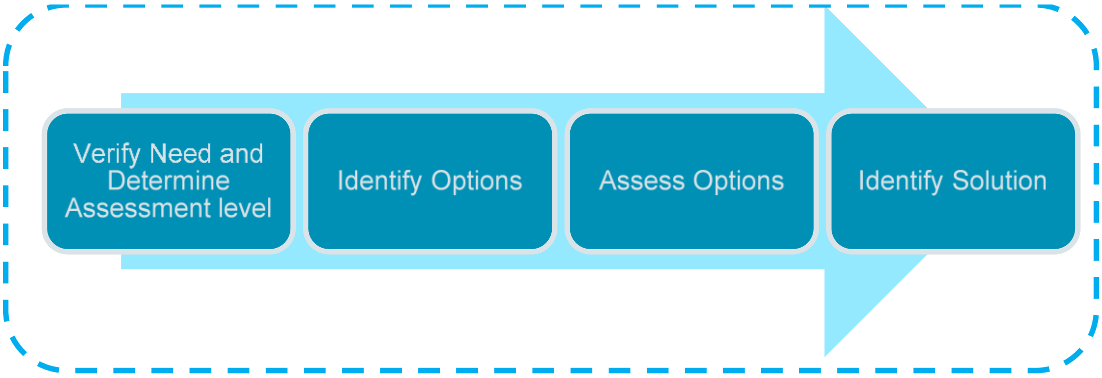
2 Option assessment approach

To assess options, we have used our internal Option Assessment Approach. This involves four key stages of investigation designed to systematically identify the best option, as illustrated in Figure 1 below.

Figure 1: Option Assessment Approach stages



Verify Need and Determine Assessment level – This step focuses on confirming the need for the project and determining an appropriate level of assessment given its complexity and cost.

Identify Options – This step involves defining a long-list of potential solutions to the identified need, and then reducing this to a short-list for further analysis.

Assess Options – This step analyses the short-listed options and quantifies costs, benefits, and unquantified benefits.

Identify Solution – This step involves identifying our preferred option, based on our analysis.

The *Verify Need* determination for this investigation is outlined in the main report and Attachment B – Condition Assessment Report. The need relates to forecast demand growth and addressing asset condition in the Bombay-Otahuhu region of the North Island.

We summarise the remaining steps in turn below.

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3 Identify options

Following verification of the need we developed a long-list of components to address the issues which make up the need. It contained a wide range of possible components which individually contribute in meeting that need. It included both transmission and non-transmission solutions (NTSs) and our preferred option consists of a series of components. For this reason, we refer to the long-list as a long-list of components, rather than the usual terminology of a long-list of options.

Components in the long-list fall into three broad categories.

- Non-transmission solutions;
- Transmission solutions – new assets;
- Transmission solutions – existing assets: maintain, upgrade, enhance, or modify.

We consulted on our draft long list of components in December 2018. Most submitters agreed with our draft long-list of components, but we did receive some additional detail on components to consider in the Long-list[2].

We subsequently incorporated feedback from this consultation to further refine our long-list of components. We also issued a Request For Proposal (RFP) for non-transmission solutions (NTS), because of the potential for NTS to economically defer or replace the investment requirement.

The long-list of component options was reduced to a short-list using our short-listing criteria. The short-list of component options was then used to compile a long-list of investment options, representing different development plans comprising the components. Each investment option addresses all of the issues and meets the identified need.

2 Refer to the long-list and short-list submissions and responses available here.

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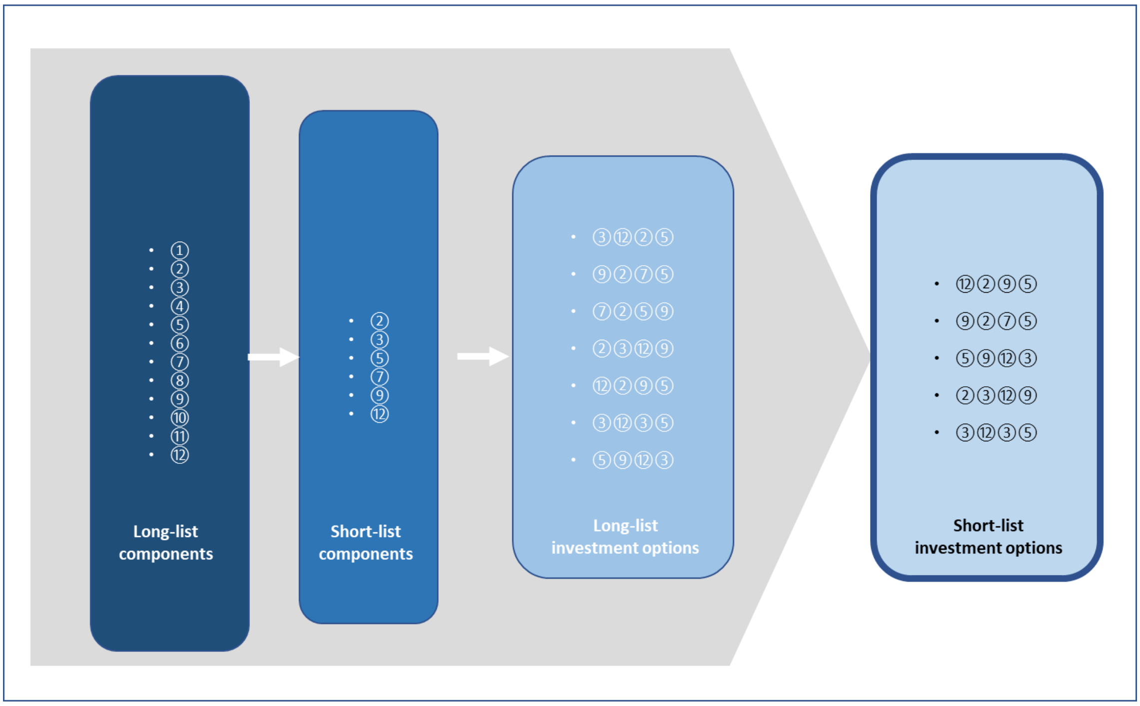

Figure 1 Derivation of short-list of development options (numbered components illustrative only)

By comparing the expected cost of the long-list of investment options, we reduced the investment options to a short-list, to which the Investment Test has been applied. The derivation of the short-list of investment options is illustrated in Figure 1. The numbered options included in the boxes in Figure 1 are for example only.

3.1 Reducing our long-list of components to a short-list

In order to reduce our final long-list of components to a short-list, we applied the following assessment criteria:

1. Fit for purpose
    - The design will meet current and forecast energy demand
    - The component meets the need of the investigation
2. Technically feasible
    - Complexity of component
    - Reliability, availability and maintainability of the component
    - Future flexibility – fits with long term strategy for the Grid
    - Ideally the design can be staged and / or have flexibility to preserve options for future changes
3. Practical to implement
    - It must be possible to implement the solution by the required dates

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- Implementation risks, including potential delays due to property and environmental issues.

4. Good electricity industry practice (GEIP)
   - Consistency with good international practice
   - Safety and environmental protections
   - Accounts for relative size, duty, age and technological status
   - Technology risks

5. System security (additional benefit resulting from an economic investment)
   - Improved system security
   - System operator benefits (controllability)
   - Dynamic benefits (modulation features and improved system stability)

6. Indicative cost
   - Whether a component will clearly be more expensive than another component with similar or greater benefits

The outcome is shown in Table 1, which indicates which of our long-list of components were taken forward to our short-list of components.

Table 1: Long list to short-list of components

Long-list consultation reference	Long-list component	Short-list?	Comments
A1	Do nothing	✗	This component is rejected due to safety and reliability of supply reasons.
Non-transmission solutions			
B1	Post-contingency automatic load shedding scheme (SPS)	✓	This component is included in our short-list of components.
B2	Load Shifting	✗	This component is rejected because the load shifting quantity is not viable on the scale required.
B3/B4	New lines/cables at the distribution level	✗	This component is rejected due to the high capital cost required due to the additional sub-transmission network investment and the effect of significant additional load on any adjacent substation and the subsequent reduction in security.
B5	Demand Side Response (DSR) - pre-contingency	✓	This component (including pre-fault load cap via demand side participation) is included as a potential low cost means of meeting part of the need.

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Long-list consultation reference	Long-list component	Short-list?	Comments
B6	New distributed generation	✗	This component was considered as a potential low cost means of meeting part of the need but has been rejected as no proponents were received during our consultation for non-transmission solutions.
B7	Battery storage	✓	This component was included as proponents of batteries provided information to us as part of our RFP for NTS.
B8	Generation Redispatch	✗	This component was excluded as it is insufficient to cover the risks required to meet the needs for this investigation.
New	Diesel peaking plant	✗	Our RFP for NTS provided us details on diesel peaking generation to consider in our long-list. This component has been rejected on non-practicability as we believe consent would not be obtainable to store the large volumes of diesel required for this to be implemented at the Wiri site.
Transmission solutions – new assets			
C1	Deviate the 220kV OTA-WKM B line (using underground cables) into Wiri. Rebuild Wiri at 220 kV	✗	Rejected based on high capital costs to implement.
C2	Tee two 220 kV cable circuits from the HLY-OTA A line into Wiri	✗	Rejected based on high capital costs to implement.
C3	New 220 kV switching station and 220 kV feeders to Wiri	✗	Rejected based on high capital costs to implement.
C4	New 220/33 kV 'Wiri' GXP	✗	Rejected based on high capital costs to implement.
C5/C6	New 220/110 kV transformers at the existing Drury switching station site	✓	Transformers at the existing Drury switching station creating a new GXP is included in the short-list
C7/C8	220 kV connection(s) at the existing Bombay site by installing 220/110kV transformer(s)	✓	New 220kV transformer(s) at Bombay are included in the short-list.
C9	New 220 kV Brownhill–Wiri–Otahuhu cable circuit.	✗	Rejected based on high capital costs to implement.

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Long-list consultation reference	Long-list component	Short-list?	Comments
C10/C11	Bombay-Wiri underground cable circuit(s)	✗	Rejected based on high capital costs to implement.
C12/C13	New Otahuhu–Wiri underground cable circuit(s)	✗	Rejected based on high capital costs to implement.
C14	New Mangere–Wiri underground cable circuit(s)	✗	Rejected based on high capital costs to implement.
C15	New Takanini–Wiri underground cable circuit(s)	✗	Rejected based on high capital costs to implement.
C16	New Bombay-Otahuhu 110kV transmission line	✗	Rejected based on high capital costs to implement.
New	New 110/33kV GXP at Wiri Jerry Green Street	✓	This component was identified following the long-list consultation and has been included in the short-list.
Transmission solutions – existing assets: maintain, upgrade, enhance, or modify.			
D1	Bombay-Wiri reconductored with same or modern equivalent conductor	✓	Reconductoring of Bombay- Wiri with similar capacity is included in our short-list.
D2	Retain the Bombay-Hamilton line and undertake the required tower maintenance	✓	This component is included in our short-list.
D3	Reconductor the Bombay-Meremere section of the Arapuni-Bombay line with same or modern equivalent conductor	✓	This component is included in our short-list.
D4	Otahuhu-Wiri reconductored with HTLS or another high-capacity conductor	✓	Reconductoring of Otahuhu-Wiri with increased capacity is included in our short-list.
D5	Bombay-Wiri reconductored with HTLS or another high-capacity conductor	✓	Reconductoring of Bombay-Wiri with increased capacity is included in our short-list

3.2 Developing investment options

3.2.1 Developing a short-list of investment options

Using the short-listed components as building blocks, a long-list of investment options was developed. Each investment option is a forward development plan which overall, ensures the (Bombay regional) need is met.

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Each investment option's indicative capital cost was determined, and the present value of the cost stream calculated. We have used these indicative capital costs to remove the most expensive investment options and form our short-list of investment options.

We included three different NTS components - post-contingency automatic load shedding using an SPS, batteries and demand response. For presentation purposes we have included these three variants of NTS in the lowest cost investment option (Option 1.2). We have used this approach as the relative cost difference between the different NTS components are likely to be similar when used on other investment options.

Our long-list of investment options, their indicative cost and whether they are short-listed[3] or not, is shown in Table 2.

We then apply the Investment Test to the short-list of investment options.

We consulted on our short-list of investment options and preferred solution in December 2019.

[3] Long-list to short-list of investment options was undertaken using 'indicative cost' short-listing criteria.

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Table 2 Long-list and short-listing of investment options

Long-list Investment option	Components included option	PV Investment cost (2019$M)	Short-list?
1.1	• Reconductor Otahuhu-Wiri line section (similar capacity) • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Wiri and/or Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines	55.6	✓
1.2 NTS option a	• Reconductor Otahuhu-Wiri line section (similar capacity) Install post-contingency automatic load shedding at Wiri • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation	37.0	✓
1.2 NTS option b	• Reconductor Otahuhu-Wiri line section (similar capacity) • Procure demand response from customers connected to Wiri • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation	*refer use of non-transmission solutions in long-list of investment options below*	✗
1.2 NTS option c	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install batteries to manage peaks at Wiri • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation	*refer use of non-transmission solutions in long-list of investment options below*	✗
1.3	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Wiri • Install 2 x 220/110 kV transformers at existing Drury switching station	53.0	✓

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Long-list Investment option	Components included option	PV Investment cost (2019$M)	Short-list?
	• Reconductor Bombay-Drury line section and connect at Drury (increased capacity) Dismantle Drury-Wiri line section. • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation		
1.4	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Wiri • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Wiri line section (increased capacity) • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	95.9	✕
2.1	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install underground cable between Otahuhu and Wiri • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines	90.4	✕
2.2	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install underground cable between Otahuhu and Wiri • Install 2 x 220/110 kV transformers at Bombay (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	71.5	✕
2.3	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install underground cable between Otahuhu and Wiri • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section (increased capacity) • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	87.6	✕

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Long-list Investment option	Components included option	PV Investment cost (2019$M)	Short-list?
3.1	• Reconductor Otahuhu-Wiri line section (increased capacity) • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines	56.5	✓
3.2	• Reconductor Otahuhu-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation	37.6	✓
3.3	• Reconductor Otahuhu-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section (increased capacity) • Dismantle Drury-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation	53.7	✓
4.1	• Install 2 x underground cables between Otahuhu and Wiri • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines	98.2	✗
4.2	• Install 2 x underground cables between Otahuhu and Wiri • Install 2 x 220/110 kV transformers at Bombay (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	79.3	✗
4.3	• Install 2 x underground cables between Otahuhu and Wiri • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section (increased capacity) • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	95.4	✗

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Long-list Investment option	Components included option	PV Investment cost (2019$M)	Short-list?
5.1	• Reconductor Bombay-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at Bombay (new Bombay 220kV connection) • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	78.6	✕
5.2	• Reconductor Bombay-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at existing Drury switching station • Connect Bombay-Wiri line to Drury. • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	86.5	✕
6.1	• Decommission Wiri GXP and build a new GXP at Jerry Green St • Reconductor Otahuhu-Bombay A line (similar capacity) • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines	153.9	✕
6.2	• Decommission Wiri GXP and build a new GXP at Jerry Green St • Install 2 x 220/110 kV transformers at Bombay (new Bombay 220kV connection) • Dismantle Bombay-Wiri-Otahuhu line • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	129.2	✕
6.3	• Decommission Wiri GXP and build a new GXP at Jerry Green St • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section (increased capacity) • Dismantle Bombay-Wiri-Otahuhu line • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines and install bussing at Hamilton substation	150.1	✕

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Use of non-transmission solutions in long-list of investment options

In order to evaluate the economics of non-transmission solutions (NTS), we have evaluated Option 1.2 (being the cheapest option on a present value basis and that option in which NTS would most likely be economic) using three different approaches at Wiri. We evaluated Option 1.2:

a. using a Special Protection Scheme (SPS). The cost of the SPS itself plus the expected unserved energy valued at VoLL was included in the overall costs

b. using demand response where expected electricity demand growth was replaced by demand response.

c. using a battery solution where expected electricity demand growth was met using batteries installed in 1 MW increments as required (and charging overnight)

Of these three options a) is by far the most economic and is included as our approach in all options. The present value of the costs of options b) and c) are at least $20 million more expensive. We have not published the economic results because the costs used in our analysis were provided confidentially. We will provide this information confidentially to the Commerce Commission.

3.2.2 Short-list of investment options

This section summarises our short-list of investment options.

Table 3 – Short list of investment options

Long-list Investment option	Short-list option	Short-list components included in option
1.1	**Option 1** Base Case	• Reconductor Otahuhu-Wiri line section (similar capacity) • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Wiri and/or Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines
1.2 (post-contingency automatic load shedding)	**Option 2**	• Reconductor Otahuhu-Wiri line section (similar capacity) Install post-contingency automatic load shedding at Wiri • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation

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Long-list Investment option	Short-list option	Short-list components included in option
1.3	**Option 3**	• Reconductor Otahuhu-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Wiri • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section and connect at Drury (increased capacity) Dismantle Drury-Wiri line section. • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation
3.1	**Option 4**	• Reconductor Otahuhu-Wiri line section (increased capacity) • Reconductor Bombay-Wiri line section (similar capacity) • Install post-contingency automatic load shedding at Bombay • Maintain Hamilton-Meremere B and Meremere-Takanini A lines • Maintain Bombay-Meremere A and Hamilton-Meremere A lines
3.2	**Option 5**	• Reconductor Otahuhu-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Dismantle Bombay-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation
3.3	**Option 6**	• Reconductor Otahuhu-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at existing Drury switching station • Reconductor Bombay-Drury line section (increased capacity) • Dismantle Drury-Wiri line section • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation
New	**Option 7**	• Reconductor Otahuhu-Wiri line section (increased capacity) • Install 2 x 220/110 kV transformers at Bombay and connect to Otahuhu-Huntly 220kV line (new Bombay 220kV connection) • Reconductor Bombay-Wiri line section (similar capacity) • Dismantle Hamilton-Meremere B and Meremere-Takanini A lines • Dismantle Bombay-Meremere A and Hamilton-Meremere A lines • Install a new bus at Hamilton substation

Option 1 maintains the status quo in terms of transmission line capacity by reconductoring the existing Bombay-Wiri-Otahuhu transmission line with the same capacity conductor as exists now, and is included as our Base Case. The existing capacity of assets in the region is maintained into the future and Special Protection Schemes (SPS) are installed as required to enable the load to exceed n-1 transmission limits. This option utilises the full capacity of our assets, but incurs the highest level of expected unserved energy.

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Option 2 includes supplying Wiri from Otahuhu by reconductoring the existing transmission line with the same capacity conductor as exists now. The Bombay-Wiri section of the Bombay-Otahuhu line is removed. Future load growth at Wiri is met by installing a SPS to manage load post a contingency, allowing load to exceed the n-1 transmission limit. Bombay is supplied via two new 220/110 kV transformers connected to the adjacent Otahuhu-Huntly line.

Option 3 is similar to Option 2, but with the two new 220/110kV transformers being installed at the Drury switching station rather than at Bombay. The Bombay-Drury section of the Bombay-Wiri line is reconductored with higher capacity conductor to supply Bombay, and the Drury-Wiri section of that line is removed.

Option 4 is similar to Option 1 (the Base Case) except that the Otahuhu-Wiri transmission line is reconductored with a higher capacity conductor than exists now. This reduces the expected cost of unserved energy, with a SPS not required at Wiri, and only required at Bombay under a high load growth scenario.

Option 5 is similar to Option 2, except that the Otahuhu-Wiri transmission line is reconductored with a higher capacity conductor than exists now and consequently no SPS is required to meet future load growth.

Option 6 is similar to Option 5, except that the two 220/110kV transformers are installed at the Drury switching station rather than at Bombay. The Bombay-Drury section of the Bombay-Wiri line is reconductored with higher capacity conductor to supply Bombay, and the Drury-Wiri section of that line is removed.

Option 7 is similar to Option 2, reconductoring the Otahuhu-Wiri section of the Bombay-Otahuhu line with like-for-like conductor and installing two 220/110 kV transformers at Bombay. This option retains the option of supplying Wiri from Bombay, should there be a double-circuit outage event (such as a tower failure) between Otahuhu and Wiri.

3.2.3 Modelled projects

Under the Capex IM each option is considered in the context of a longer-term grid development plan which may comprise ‘modelled projects’. The modelled projects are future new assets or changes to existing assets that are not part of the option proposed, but could affect the options and the choice of the preferred option.

Our short-list of investment options considers options that would enable some 110kV transmission lines between Otahuhu and Hamilton to be dismantled in the future. If these transmission lines were dismantled, some bussing at the Hamilton substation would also be required.

We have treated the dismantling of these lines, and the bussing at the Hamilton substation, as if they were modelled projects for the purposes of applying the Investment Test for some

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investment options[4]. They are important to our economic analysis because although there is a cost to dismantling these lines, we would also save considerable future maintenance costs. An indicative schedule of when these lines would be dismantled is provided in Table 4

Table 4: Indicative dismantling schedule

Component	Dismantle complete
Dismantling Bombay-Wiri section of Bombay-Otahuhu A 110kV transmission line	2025
Dismantling Bombay-Meremere A 110kV transmission line.	2026
Dismantling Hamilton-Meremere A 110kV transmission line.	2028
Dismantling Meremere-Takanini A 110kV transmission line	2032
Dismantling Hamilton-Meremere B 110kV transmission line	2032

[4] The definition of "modelled project" in the Capex IM does not include the dismantling of existing assets. Under the definition, the assets comprising the modelled project have to be likely to exist. In this case the situation is that certain assets are likely not to exist.

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4 Assess options

Our options analysis quantifies costs and benefits where possible, but as per the Capex IM[5], we treat some costs and benefits as unquantified. This is where we cannot calculate an expected value with sufficient certainty due to the extent of uncertainties in underlying assumptions, or where the cost of calculating its quantum is likely to be disproportionately large relative to the quantum. Sections 4.1, 4.2 and 4.3 describe our quantified costs and benefits and section 4.4 describes our unquantified benefits.

We have quantified the following costs and benefits for each option.

- Capital Costs
- Operating and maintenance costs
- Dismantling costs, where existing lines are dismantled
- Avoided future expenditure (where assets are dismantled)
- Unserved energy costs, assessed where special protection schemes are used
- Overall dispatch cost differences (as the configuration of the grid differs between options)

We also consider the following unquantified benefits for each option:

- Capacity
- Operational
- Community

4.1 Quantified analysis

4.1.1 Key parameters

The Investment Test is a cost-benefit analysis and as such, several parameters need to be defined. The parameters we have used are consistent with those defined in the Capex IM, as described in our long-list and short-list consultation and as supported by submissions.

4.1.1.1 Discount rate

We have applied a discount rate of 7% per annum (real, pre-tax). Our sensitivity analysis uses discount rates of 4% and 10%.

[5] See Schedule D, Clause D1(2)(b) of the CapexIM here.

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4.1.1.2 Value of lost load

When calculating the economic cost of an unplanned interruption to electricity supply in the Bombay region we have used a Value of Lost Load (VoLL) of $26,400/MWh for Bombay and $27,800/MWh for Wiri (along with sensitivities at $13,000/MWh and $39,000/MWh. These values are based on our 2018 value of lost demand study[6]. We have used these values as we consider them a better representation of VoLL at these GXPs. We note that our sensitivity range fully covers the default VoLL of $20,000/MWh described in the Capex IM.

4.1.1.3 Calculation period

The Capex IM specifies that we should use a calculation period of 20 years from the commissioning date of the last asset associated with the proposal. In this MCP, the last expected asset is expected to be commissioned in 2024 (our Stage 2 grid outputs). We have calculated costs and benefits over a 32-year calculation period from 2019-2050, as proposed in both our long-list and short-list consultations. This was in order to capture the costs and benefits over the useful life of the proposed investments. The dispatch benefits in particular, are significant and a 32-year calculation period better reflects their long-term value. We consider this an appropriate trade-off between assessing benefits over the economic life of the investment and over-weighting future benefits with their inherent uncertainty.

4.1.1.4 Demand forecasts and market development scenarios

Forecasting electricity demand is inherently difficult, and we are facing more future uncertainties in the longer term given the potential for electrification and investment in distributed energy resources.

Our peak demand forecasts are updated annually as information is received, including actual peak demand observations, and details of expected demand growth from distribution companies and directly connected electricity consumers.

As required by the Capex IM, our analysis for this investigation has regard to the Ministry of Business, Innovation and Employment's (MBIE) Electricity Demand and Generation Scenarios (EDGS), as published in July 2019, being:

- *Reference*: Current trends continue
- *Growth*: Accelerated economic growth
- *Global:* International economic changes
- *Environmental:* Sustainable transition
- *Disruptive:* Improved technologies are developed

[6] Our 2018 VoLL report can be found here.

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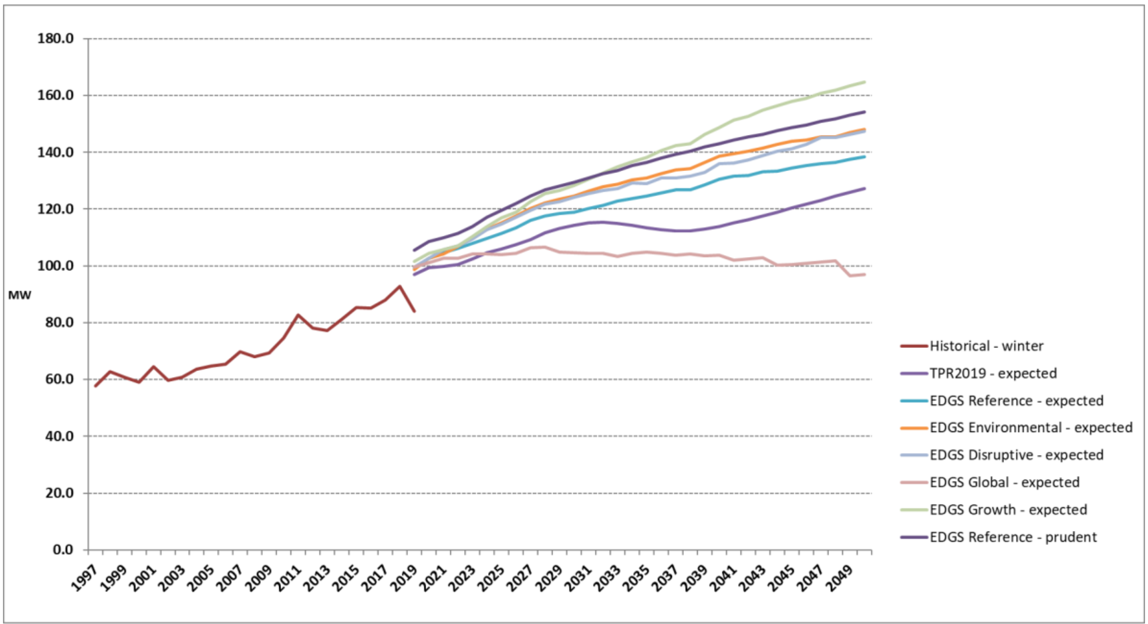
The EDGS were published after our long-list consultation in 2018 and we have also updated our own internal demand forecasts. These updates reflect actual demand observations and new information received since 2018. Our latest 2019 peak demand forecasts (which include bottom-up assumptions of uptake in emerging technologies from the Ministry of Business, Innovation and Employment's (MBIE) latest EDGS published in July 2019[7]) are included on Figures 2 and 3 below, for reference, but we have used the EDGS scenarios in our analysis. for determining the need date of components and in our calculation of unserved energy benefits and dispatch cost benefits.

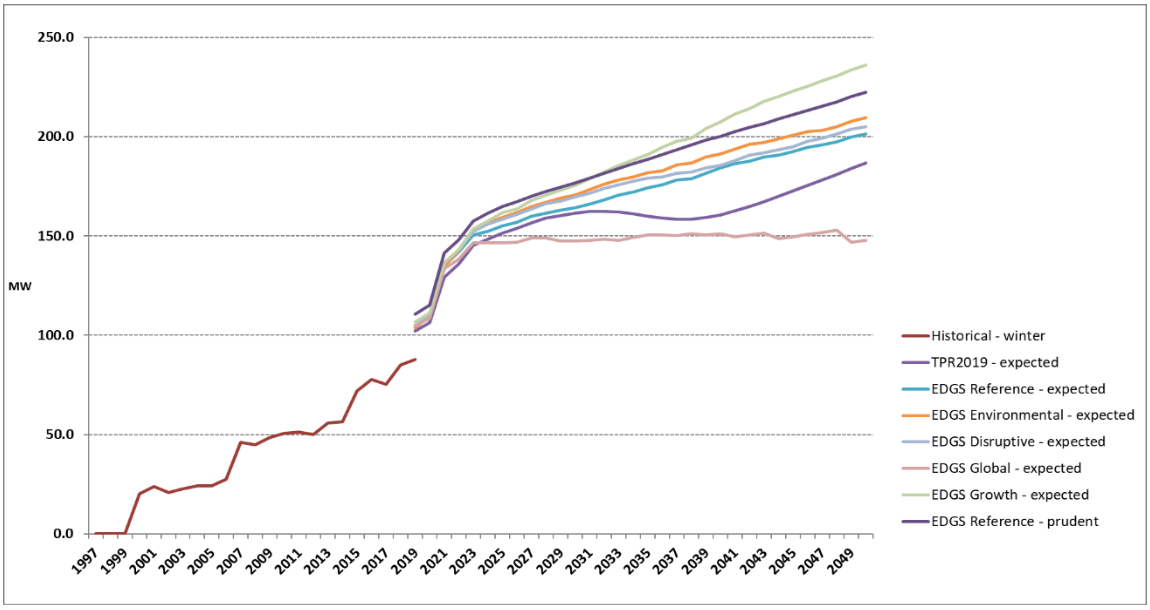
The scenarios have received equal weighting in our analysis. We have used the expected version of these forecasts to determine the benefits in our analysis (e.g. dispatch costs and unserved energy) and the prudent version to determine need dates. The prudent forecast is based on peak winter evening usage to ensure with a 90% probability (P90) that demand will fall within this level.

Figure 2: Distribution of Wiri peak demand forecasts (2019)



7 MBIE's Electricity Demand and Generation Scenarios are published here.

Figure 3: Distribution of Bombay peak demand forecasts (2019)



4.2 Capital costs and O&M expenditure

This section presents the capital, refurbishing, operating and dismantling costs for each of the short-list options.

The capital costs are estimated to be -20/+30% for the Bombay works and -50/+100% for all other costs. All cost estimates are P50 estimates consistent with the requirements of the Capex IM.

Some of the options on our short-list of investment options reflect dismantling existing 110kV transmission lines, whilst other do not. Where existing lines are dismantled, we avoid the future expenditure required on those lines to maintain them. In Option 1, our Base Case, we refurbish all existing 110kV lines. In all other short-listed options, except Option 4, we dismantle the Bombay to Wiri section of the Bombay-Otahuhu A line and lines south of Bombay, a total of approximately 186km of lines.

Our refurbishing, operating, maintenance and dismantling cost estimates which are based on expert judgement and historical data from similar equipment and dismantling cost estimates, are estimated to be -50/+100%.

Table 5 summarises these costs as their present value in $2019 million.

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Table 5: Capital cost of option components (present value $2019 million)

Option	Capital cost	Refurbish cost, lines south of Bombay	Dismantling Cost	Operating Costs
Option 1 Base Case	33.6	22.0	0.0	4.7
Option 2	37.0	0.0	6.4	0.7
Option 3	53.0	0.0	5.5	0.9
Option 4	34.5	22.0	0.0	4.7
Option 5	37.6	0.0	6.4	0.7
Option 6	53.7	0.0	5.5	0.9
Option 7	56.9	0.0	3.4	1.3

4.2.1 Unserved energy costs

We have estimated unserved energy costs for each of the demand forecasts shown in Figure 4 and Figure 5 and assuming the scenarios have equal probability and have averaged the results to give an expected unserved energy cost.

Table 6 shows the result of the unserved energy analysis.

Table 6: Present value unserved energy costs

Option	**Expected unserved energy costs (present value 2019 $m)**
Option 1 Base Case	0.5
Option 2	1.6
Option 3	1.6
Option 4	0.3
Option 5	0.0
Option 6	0.0
Option 7	0.0

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4.2.1 Dispatch cost differences

Given that some of the options contain relatively significant transmission configuration changes, we have determined the dispatch cost differences for three different grid configurations in the Bombay region of the grid as shown in

Table 7.

Table 7 Transmission configurations modelled to determine transmission loss cost differences

Configuration	Description
Like for like replacement of existing lines	Retain existing lines, with like for like replacements
Upgrade Otahuhu-Wiri line	Upgrade conductor on Otahuhu-Wiri section of line and reconductor other lines like-for-like
Upgrade Otahuhu-Wiri line and connect Bombay to 220kV	Upgrade conductor on Otahuhu-Wiri section of line, connect Bombay to the nearby Huntly-Otahuhu line and dismantle existing 110kV lines between Wiri and Hamilton

Initially, model runs were carried out enforcing n-1 contingency constraints. This led to significant deficits for the first two configuration, but not for the third. This also constrained Karapiro generation and additional thermal generation costs were incurred.

If either of those options were implemented, we would install special protection schemes to minimise the effect of the constraints, so in our dispatch modelling the n-1 constraints were relaxed.

The dispatch cost differences were valued at the North Island short run marginal cost of generation, for the corresponding load block, month and inflow sequence. The cost difference represents the total cost difference as a result of transmission loss savings and displacing expensive thermal generation.

A summary of the dispatch cost differences, assessed over the analysis period, and relative to the like-for-like replacement of existing lines configuration, are shown in Table 8.

Table 8 Dispatch cost differences (2019 $m)

Discount rate	Like-for-like	Upgrade OTA-WIR only	Upgrade OTA-WIR and BOB
4%	0	-2.1	-30.7
7%	0	-1.4	-22.0
10%	0	-1.0	-16.4

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This set of configurations does not reflect every short-list investment option exactly. The loss cost difference used in our analysis has been determined on a “benefit of the doubt” basis, whereby we have assigned one of the three loss costs shown above in a manner which only benefits each option where we do not have a representative loss cost difference. The inaccuracies of this simplification are conservative and are not considered material.

The full Dispatch Cost Modelling report is found in Attachment G.

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4.3 Application of the Investment Test

This section presents the net benefit of each option in present value (2019) dollars, relative to the Base Case.

Table 9 summarises the results of our quantified assessments of options.

Table 9: Net benefit test – (present value 2019 $m)

		Option 1 Base Case	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Capital cost	**A**	33.6	37.0	53.0	34.5	37.6	53.7	56.9
Refurbishing cost, lines south of Bombay	**B**	22.0	0.0	0.0	22.0	0.0	0.0	0.0
Operating and maintenance costs	**C**	4.7	0.7	0.9	4.7	0.7	0.9	1.3
Dismantling cost	**D**	0.0	6.4	5.5	0.0	6.4	5.5	3.4
Dispatch cost difference[8]	**E**	0.0	22.0	22.0	1.4	22.0	22.0	22.0
Estimated unserved energy costs[9]	**F**	0.5	1.6	1.6	0.3	0.0	0.0	0.0
Total cost	**A+B-C+D+E+F**	60.8	23.8	39.1	60.1	22.8	38.1	39.6
Net Benefit (relative to Base Case)		**0.0**	**37.1**	**21.8**	**0.7**	**38.0**	**22.7**	**21.2**

Option 1 maintains the status quo in terms of transmission capacity and is included as our Base Case. The existing capacity of assets in the region is maintained into the future and Special Protection Schemes are installed as required when n-1 limits are breached. This option utilises the full capacity of our assets, but incurs expected unserved energy.

8 Dispatch cost difference is the present value of dispatch costs (the variable fuel costs of generation) as modelled across the different options.

9 Estimated unserved energy costs are the present value of the economic cost of an interruption to electricity supply.

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Options 2 – 7 mostly involve installing larger assets to ensure electricity demand growth is met with minimum unserved energy. Unserved energy is high in Options 2 and 3 because Wiri is served by a double-circuit spur line that has an n-1 capacity which is lower than the projected Wiri peak load.

Our Investment Test analysis shows that Option 5 has the highest net benefit compared to the Base Case, with the net benefit of Option 2 being similar. The Investment Test recognises the inherent uncertainty in inputs to the cost-benefit analysis and outlines that where the difference in net benefit is 10% or less of the aggregate project cost of the investment option to which the preferred investment is compared, the options are considered “similar” and unquantified benefits may be taken into account in order to identify a preferred option.

In this case, the difference between Options 2 and 5 meet the criteria for those two options to be considered similar, so we have also considered unquantified benefits to determine our preferred option.

Option 2 includes supplying Wiri from Otahuhu by reconductoring the existing transmission line with the same capacity conductor as exists now. Future load growth at Wiri is met by accessing the full capacity of the transmission line and using a Special Protection Scheme (SPS) to manage unserved energy post a contingency.

Option 5 is the same, except that the Otahuhu-Wiri transmission line is reconductored with a higher capacity conductor than exists now and a SPS is not required to meet future load growth.

4.3.1 Sensitivity analysis

We have varied the magnitude of key variables and assumptions by an amount reflecting their uncertainty to determine the sensitivity of our quantified results.

Table 10 shows our sensitivity analysis of the net benefit to key economic variables and modelling assumptions. The option with the highest net benefit and options within 10% of this option are coloured in green.

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Table 10: Sensitivity analysis (net-benefit, 2019 $m)

	Option 1 Base Case	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**
Base Case	0.0	**37.1**	21.8	0.7	**38.0**	22.7	21.2
Discount rate 4%	0.0	**50.1**	33.2	1.4	**52.3**	35.4	33.6
Discount rate 10%	0.0	**26.9**	13.1	0.3	**27.2**	13.4	12.1
Upper range capital costs	0.0	**45.2**	22.2	0.3	**45.8**	22.9	20.6
Lower range capital costs	0.0	**29.0**	21.3	1.2	**30.2**	22.6	21.9
High Bombay regional demand	0.0	**37.1**	21.8	0.7	**38.0**	22.7	21.2
Low Bombay regional demand	0.0	**37.1**	21.8	0.7	**38.0**	22.7	21.2
+50% VoLL	0.0	**36.5**	21.2	0.8	**38.3**	23.0	21.5
-50% VoLL	0.0	**37.6**	22.3	0.6	**37.8**	22.5	21.0
Dispatch cost 20 yrs	0.0	**34.5**	19.2	0.5	**35.5**	20.2	18.7
+50% Dispatch cost	0.0	**59.0**	43.7	2.1	**60.0**	44.7	43.2
-50% Dispatch cost	0.0	**26.1**	10.8	0.0	**27.0**	11.7	10.2

The sensitivity analysis shows Options 2 and 5 have the highest net benefit under every sensitivity variation and are similar as defined in the Capex IM.

Therefore, we consider Option 2 and Option 5 robustly pass the Investment Test and that these two options can robustly be called similar.

4.4 Unquantified benefits analysis

We have also considered unquantified costs and benefits and these are particularly relevant for Options 2 and 5, which are similar.

The Capex IM specifies that costs and benefits can be considered unquantified when they are not possible to quantify with a satisfactory level of accuracy, or when the investigation resource required to obtain a satisfactory level of accuracy is large relative to the size of the cost/benefit.

We have considered the following unquantified costs and benefits

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Electricity market benefits:

- **Capacity benefits**: options that provide greater transmission capacity for supply to Wiri and/or Bombay have more potential to be robust to future demand growth. As discussed, future electricity demand is uncertain due to the uncertainty of electrification and uptake of distributed energy resources. Higher capacity options could avoid the need for further investment if demand growth is higher than forecast.
- **Operational benefits**: options that provide greater transmission capacity may support a longer window of time during the year to take planned transmission or generation outages and may have other operational benefits such as managing high voltages during low load periods.

Non-electricity market benefits:

- **Community benefit:** options that benefit the community through the removal of existing transmission lines.

Table 11 evaluates the unquantified benefits identified above for each above using -, ✓, ✓✓, or ✓✓✓ where more ticks represents greater benefit.

Table 11: Unquantified assessment of benefits

	Option 1 Base Case	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**
Capacity benefits	-	✓	✓	✓	✓✓	✓✓	✓✓
Operational benefits	-	✓	✓	-	✓✓	✓✓	✓✓
Community benefit	-	✓✓	✓✓	-	✓✓	✓✓	✓
Unquantified benefits ranking	**5**	**3=**	**3=**	**4**	**1=**	**1=**	**2**

The unquantified capacity benefits support options that provide a higher level of transfer capability into the Bombay-Otahuhu region. Option 5 has significantly higher capacity and operational benefits than Option 2 as it provides greater transfer capability into the Bombay region without relying on load shedding through an SPS as well as the removal of existing transmission lines.

5 Identify solution

5.1 Preferred solution

Our Investment Test analysis assessed Options 2 and 5 as having the highest net benefit and being similar in terms of the Capex IM.

Our sensitivity analysis confirms that Options 2 and 5 have the highest net benefit over all sensitivity scenarios and that the two options are similar over all sensitivity scenarios.

Options 2 and 5 only differ at Wiri, as described in section 4.3.

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When considering unquantified benefits, we consider that Option 5 has significantly higher capacity and operational benefits than Option 2.

In our view, there are advantages from the higher level of service provided to electricity consumers by Option 5. Option 5 has extra flexibility to deal with higher than expected load growth and extra flexibility in terms of maintaining the line when compared with Option 2.

Table 12: Quantitative and qualitative ranking of investment options

	Option 1 Base Case	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**
Net-benefit	0.0	37.1	21.8	0.7	38.0	22.7	21.2
Unquantified benefits ranking	**5**	**3=**	**3=**	**4**	**1=**	**1=**	**2**
Overall ranking	**7**	**2**	**5**	**6**	**1**	**3**	**4**

Therefore, we conclude that Option 5 is the preferred option and it forms the basis of this investment proposal to the Commerce Commission to meet the need to ensure ongoing reliability of electricity supply to the Bombay-Otahuhu region.

6 Proposal cost and major capex allowance

Transpower is seeking approval from the Commission to recover the full costs associated with the proposed investment.

In this section we outline our calculation of the major capex allowance and the cost for the proposed investment, covering our estimates of capital expenditure and our approach to estimating those costs.

6.1 Approach to estimating capex

We use TEES (Transpower's Enterprise Estimating System) to estimate the cost of all capex projects. TEES provides:

- instant access to the best available, up-to-date information for all users;
- the ability to apply cost escalation (commodity input prices and exchange rates);
- consistency of costing across many parts of the business;
- a costing system which is easily updated based on lessons learnt;
- high quality and detailed spend forecasting capability (spend curves which determine where spend will occur over the project duration); and
- links to and interfaces with key cost forecast information to Transpower's financial management system (FMIS).

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TEES produces cost estimates for a project based on the historical rates from past projects or known current rates. For this project, we have used TEES to produce estimates for the volumetric and enabling works scope items (e.g. cables, foundations, excavation).

We have then added costs to this base estimate, including:

- environmental and property cost
- changes in the cost of foreign exchange and key commodities such as external labour, copper, steel, and aluminium
- a risk adjustment – to account for cost uncertainty not represented in our lower and upper bound estimates.

Our estimated capex and proposed major capex allowance represent P50 estimates – i.e. the probability of the actual cost being higher or lower than our estimate is the same (i.e. 50%).

To derive P50 estimates for all capex categories other than the risk adjustment, we have estimated for each cost category a lower bound, an upper bound and a most likely (or mode) outcome and assumed that all possible capex outcomes would follow a triangular distribution.

To derive a P50 estimate for the risk adjustment, we have assigned probabilities of occurrence to each identified risk item and ran a simulation to determine the overall risk adjustment distribution and to ultimately identify the P50 estimate.

We note that our estimated project cost is expressed in 2020 dollars (it is ‘real 2020’). To derive a nominal major capex allowance, we have added to it inflation cost and interest during construction (IDC).

The MCA is higher than the costs in earlier sections because it includes interest during construction, investigation costs, and inflation.

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6.2 Capex breakdown

In Table 13 we describe the high-level cost categories used in this application.

Table 13: Cost category descriptions

Investigation	Investigation costs are costs related to the identification of our preferred solution and the development of this MCP proposal. This also includes consenting and designation costs.
Overheads **Consultants and contractors**	Overhead costs are the Transpower staff and contractor overhead related costs to deliver this project, and some contractor overheads such as insurance, project management, health and safety plans.
Design	Design costs are the costs for detailed design and the technical investigations and studies required to implement the preferred solution. This category includes consultant support, e.g. environmental, noise, and commissioning consultants.
Civil works	Civil works are the costs to build foundations and other associated costs for the transformers to be installed and commissioned. The costs also include associated civil costs for this project such as oil containment, security fencing, earthworks, underground services and drainage.
Primary plant works	Primary plant works are the costs of transformer supply and installation as well as associated equipment such as circuit breakers and bus modifications.
Cable works	Cable works are the costs of supplying and installing underground cable including the required trenching of the cable.
Protection works	Protection works are the costs to supply and install protection schemes related to this project.
Secondary works	Secondary works include the design, install and commissioning of SCADA and communication devices.
Transmission lines works	Transmission lines work cost categories capture all costs associated with the installation of a tee connection to Bombay into the Otahuhu-Huntly A transmission line. This includes material costs such as conductors, earthwires, towers poles and foundations, insulators and hardware. These cost categories capture all other major costs, construction costs such as stringing costs (the labour and associated tools and machinery hire),
Miscellaneous works	Miscellaneous works include associated project costs not covered elsewhere including environmental costs and stakeholder engagement.
Additional Risk adjustment	In addition to our lower and upper bound estimates, we have itemised all foreseeable risks that may affect the cost of the project.

6.3 Capex estimate

Our estimated capex are represented in Table 14.

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Table 14: Major capex proposal capex estimate (excl. IDC and inflation)

Capex, $000, P50	Total project Real $2020
Investigations for Bombay	2,400
Investigations for preparatory works Otahuhu-Wiri reconductoring	1,090
Transpower overheads	1,340
Consultants and contractors	3,261
Other	381
New 220/110kv Transformer at Bombay substation	
Design	1,045
Other	292
Civil works	2,524
Primary Plant works	8,997
Cable works	2,556
Protection works	997
Secondary works	353
Miscellaneous works	1,833
Additional Risk adjustment	2,900
Transmission line (tee connection)	
Design	234
Other	112
Foundations	231
Towers	288
Poles	405
Insulator sets	451
Conductor and stringing	196
Miscellaneous works	379
Additional Risk adjustment	450
Capex - total risk adjusted	**32,714**

6.4 Major capex allowance

A summary of our derivation of our draft major capex allowance calculation, including financing costs, and inflation is shown in Table 15 with an annual break down.

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We consider this amount to be our P50 estimate of the costs of the project – that there is equal chance that the project could be delivered for more or could be delivered for less. As with any project, and consistent with the incentive regime, we will attempt to deliver this project as efficiently as possible.

Table 15 Derivation of Major Capex Allowance and annual allocation

Major Capex Allowance, $000, P50	**Total project**							
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Total**
Capex - total risk adjusted (real 2020)		400	800	1,018	6,785	13,537	10,173	**32,714**
Inflation				2	132	500	586	**1,219**
Capex - total risk adjusted (nominal)		**400**	**800**	**1,020**	**6,917**	**14,037**	**10,759**	**33,933**
Interest during construction (IDC)		7	51	93	168	608	1,086	**2,013**
Major Capex Allowance		**407**	**851**	**1,113**	**7,086**	**14,645**	**11,845**	**35,946**

$10.8 million of the proposed major capex allowance of $36.0 million has already been approved by the Commerce Commission as base capex in RCP3. However, to ensure Transpower does not over-recover its capital expenditure associated with this major project, any RCP3 revenues coming from the already approved base capex will wash-up and be returned through prices in RCP4. To ensure the correct treatment when calculating incentive benefits under the base capex incentive mechanism, Transpower will remove the already approved amount from the base capex allowance consistent with the treatment prescribed in the CapexIM (through the use of the g term in Schedule B, Division 1).

6.5 Project requirements and project management approach to achieve proposed major capex project outputs

The requirements to complete the installation of a new 220/110kV transformer at Bombay and to connect it to the Otahuhu-Huntly A transmission line are outlined at a high level as follows. The site is owned by Transpower hence there is no property acquisition required.

- Outline plans (i.e. the site requires an amendment to the designation under the RMA to include a line connection into the designated area of the site)
- Regional Council resource consents (if required)
- Civil works for the platform construction
- Structural works including equipment support structures and foundations
- Electrical site works
- Supply and installation of protection relays, auxiliary relays, cabinets/panels and circuits as well as underground cables and transformers,
- Station services

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- Communication and HMI works
- A realignment of the 220kV Otahuhu-Huntly A transmission line involving the installation of a new transmission tower and several poles to enable a bus connection.

The requirements to complete the preparatory works for the Otahuhu-Wiri reconductoring are outlined as follows:

- Scope the investigation works necessary
- Tender the works according to Transpower's procurement policies
- Award the works
- Receive and review the outcome, being a SSR+ report

The proposed major capex project will be implemented and managed using Transpower's standard project delivery procedures including governance oversight, planning, scheduling, contract management, cost management, risk management, technical review and performance reporting. Transpower has appropriate processes in place and will deploy suitably experienced management and technical resources to monitor cost performance against budget, project milestones against required dates and scope and quality of deliverables with the objective of delivering the projects to budget, on time and to the required quality standards.

Factors that may affect Transpower's ability to achieve the major capex project outputs that are proposed include:

- *Failure to secure required designations and consents for the project.* This is largely outside Transpower's control. Transpower has significant experience in council and RMA applications. To partially mitigate this risk, we have commenced this process in advance of this proposal being approved to allow for any delays.
- *Unforeseen changes to electricity market operations limiting our ability to secure the required system outages.* This is largely outside Transpower's control, but we consider it highly unlikely to impact on this project as we plan and forecast outage requirements to the market in advance.

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