

LOWER SOUTH ISLAND RELIABILITY INVESTIGATION

LONG LIST – SHORT LIST – DEVELOPMENT PLANS

Transpower New Zealand Limited

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Keeping the energy flowing



TRANSPOWER



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1 Purpose of this document

The purpose of this document is to:

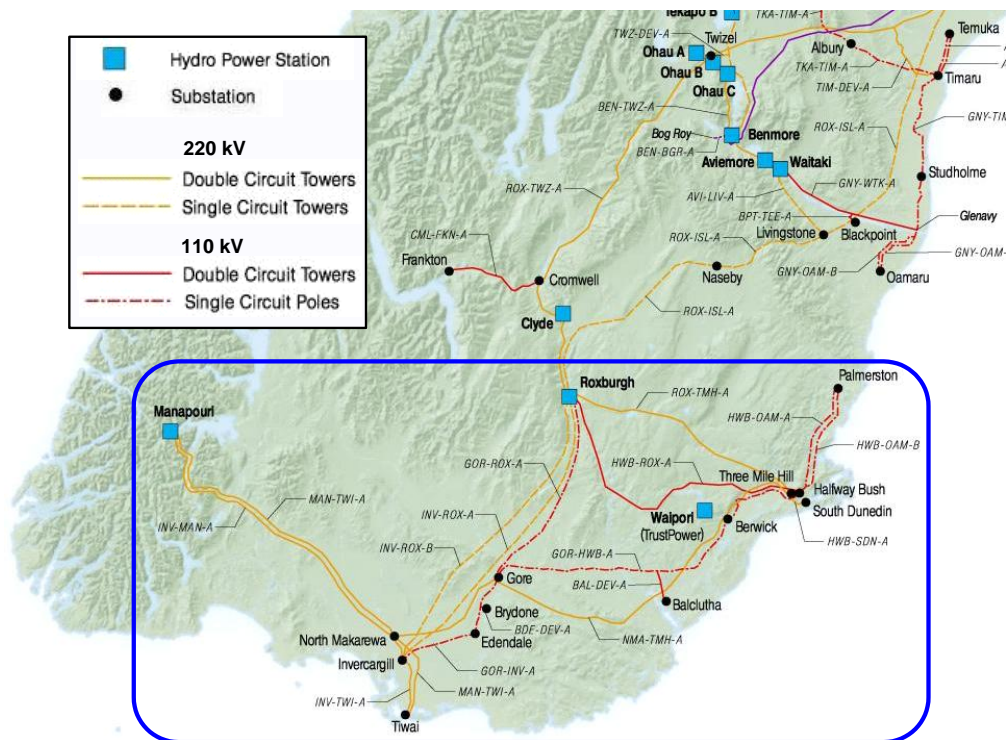
- explain the long listing to short list process for the LSI Reliability Investigation
- outline the short listed options for the investigation
- explain the development plans for each of these options.

It is for information only, although any response you have to the information will be received and considered.

2 Background

The Southland regional network area of interest is shown in the diagram below. It consists of 220 kV and 110 kV circuits with interconnecting transformers located at Halfway Bush, Roxburgh and Invercargill, two main power stations (Manapouri and Roxburgh) and smaller stations at Waipori and White Hill.

Figure 1-2-1: Lower South Island area under investigation



The investigation was initiated for the following reasons:

1. Reinforcement of supply for the Otago/Southland region by managing dry-year risk due to predominantly hydro-generation in the region (ie low or no Manapouri generation). Broadly, this covers supplying the whole region (ie transport electricity south) when Manapouri generation is low (greater 220 kV capacity). There are also two wind farms planned that could inject 440 MW into the 220 kV line between North Makarewa and Three Mile Hill. The active and reactive power is currently provided by Meridian under the

Tiwai Point Connection Contract (TPCC) but which expires in 2012, including to meet the Grid Reliability Standards (GRS) for the Aluminium smelter at Tiwai Point

2. Reinforce the 110 kV network so as to supply greater 110 kV load (mainly Gore/Brydone/Edendale) due to increasing demand. The region is likely to experience significant growth in the dairy sector, including on-farm demand and growth at the Edendale dairy factory.
3. Maintain the GRS on the 220 kV and 110 kV networks to meet both organic load growth and anticipated step-changes in load growth (mainly in summer peak), noting that the Electricity Governance Rules (EGRs) dictate a different GRS for the 220 kV network from that of the 110 kV network

An array of options exist to address the needs of both the 110 kV and 220 kV networks.

As part of the investigation process an initial long list of alternatives was presented to stakeholders in December 2008. It was developed further and made available for stakeholder review in March 2009. Submissions from stakeholders on this draft long list were then incorporated to develop the long list as shown in Section 3.

A standard set of high-level screening criteria has been developed to discard those options that are not appropriate for Transpower to consider in the short list. The criteria is explained in Section 3.2 and applied in Section 3.3. The final short list is provided in Section 3.4 and the resulting development plans for the short-listed options are detailed in Section 4.

The next stage of the process is to apply the Grid Investment Test to the short-listed options in order to determine the preferred solution.

2.1.2 The 220 kV network

Line Asset	Length (km)	Capacity (MVA)	Conductor	Details
Halfway Bush–South Dunedin A	12	333/370	Zebra ACSR simplex	Double cct steel tower & pole
Invercargill–Manapouri A	144	311/379	Goat ACSR simplex Pheasant ACSR simplex	Double cct steel tower
Invercargill–Roxburgh A	132	347/382	Zebra ACSR simplex	Single cct steel tower
Invercargill–Roxburgh B	130	347/382	Zebra ACSR simplex	Single cct steel tower
Invercargill–Tiwai A	25	385/455	Goat ACSR duplex Chukar ACSR simplex	Double cct steel tower
Manapouri–Tiwai A	169	311/379	Goat ACSR simplex Pheasant ACSR simplex	Double cct steel tower
North Makarewa–Three Mile Hill A	198	347/382	Zebra ACSR simplex	Double cct steel tower
Roxburgh–Three Mile Hill A	101	385/469	Zebra ACSR duplex Chukar ACSR simplex	Double cct steel tower

2.2 The need

Tiwai Aluminium Smelter

The Tiwai load (Aluminium smelter) is the largest load in Southland – it accounts for approximately 60% of the regional load. The Tiwai load is estimated to be around 639 MW (peak) in 2012. In the year 2012 the total demand (ADMD) south of Roxburgh (including the Tiwai load) would be around 1060 MW in summer and 1073 MW in winter.

Until 2012, the Tiwai load is supported by Manapouri generation (owned by Meridian Energy) under the Tiwai Point Connection Contract (TPCC) (and supplementary agreements) which guarantees that Meridian will supply a minimum active and reactive power in the Southland area. The TPCC is due to expire in 2012. The terms of any possible future agreement are not known.

Load growth

Significant load growth is anticipated in Southland. As with previous Grid Upgrade Plans, Transpower is using a slightly modified version¹ of the regional load forecast dated June 2009 from Covec Ltd. This forecast is higher than that in the 2008 Statement of Opportunities and shows:

- the prudent peak regional demand at 1034 MW for winter 2010 and 1019 MW for summer 2010
- the growth rate from 2010 to 2011 is projected to be around 3% per annum for both winter and summer, dropping to around 2% per annum for both winter and summer to 2012
- beyond 2012 the expected annual average load growth is projected to be lower again at around 1%

¹ Following consultation with PowerNet, the prudent forecast for Gore, both summer peak and winter peak, has been held to the 2009 value for 2010 and 2011 and delayed for 2 years thereafter.

- Tiwai Grid Exit point with an annual peak demand in 2010 of 619 MW.

Generation and 110 kV network

Generation in the region is dominated by the power stations at Manapouri (750 MW), and Roxburgh (200 MW on 220 kV and 120 MW on 110 kV). By 2012, and under a prudent peak demand forecast, forecast generation patterns create a range of constraints on the 110 kV network between Palmerston, Roxburgh and Invercargill. The 110 kV network capacities also limit the amount of power that can be transferred on the 220 kV circuits. In addition, the end of the active and reactive power supplied by Meridian under the TPCC will place more reliance on transmission through Roxburgh.

Roxburgh output is constrained by the connection to the 110 kV network. In situations where Southland demand is low, it is not possible to run both Clyde and Roxburgh at high output levels because constraints occur on either of the following:

- Edendale–Invercargill 110 kV line
- Gore–Roxburgh 110 kV line
- Roxburgh 220 / 110 kV Interconnecting transformer
- Low voltage constraints: Balclutha, Gore, Halfway Bush area

Consequently transmission reinforcement is necessary to meet Grid Reliability Standards if the region's load growth exceeds its generation development as the existing capacity of the 110 kV transmission is insufficient to meet the prudent demand forecast. In addition, there may be economic benefit from reinforcing the network to enable the export of generation from the region at times of high (potential) generation. This aspect will be included in our evaluation.

3 Long List

The long list describes the widest range of possible options for meeting the need, including options that reduce the size of the need. Options other than transmission are called transmission alternatives or non-transmission options. Transmission alternatives/non-transmission options include demand management (demand side) and additional generation on the downstream side of the constraint (supply side).

Options have been grouped broadly as follows:

- Transmission alternatives: supply side and demand side
- Transmission: optimising existing assets
- Transmission: creating new assets

Through its Request for Information (RFI), Transpower was able to ascertain whether there are transmission alternatives/non-transmission options that meet the need. The Request for Information was part of a Consultation Document published April 2009². Seven submissions were received³.

² Lower South Island (Southland - Coastal Otago 110 kV Network) Reliability Investigation Assumptions, Approach and Options Consultation Document http://www.gridnewzealand.co.nz/f2026,12347089/12347089_lsi-reliability-consultation.pdf.

³ Aurora Ltd (submitted by Delta Utility Services), Contact Energy Ltd, Dongwha Patinna NZ Ltd Fonterra Ltd, Meridian Energy Ltd, Powernet Ltd, Rio Tinto Alcan Ltd.

Transpower's transmission alternative is to offer a *Grid Support Contract* to create investment option value. Option value refers to the additional (investment) value realised by information not presently known but that when known in a future period (a year or so) would alter the investment decision made.

3.1 Investment Base Case

The Rules define the term Base Case as being the reasonable future state of the electricity system without the proposed investment or any alternative project. The Base Case therefore, is the counterfactual against which the investment proposal is compared

For a reliability investment, Transpower interprets this, and in particular the word "reasonable", as meaning that the Base Case must ensure that existing load continues to be met, ie, "do nothing" is not a reasonable Base Case for a reliability investment, as it might be for an economic investment.

Transpower considers that a reasonable Base Case for this investigation is to deploy an inter-trip or SPS with Manapouri and/or Tiwai and, when required, split of the 110 kV network between Gore and Brydone (ie disconnect the Gore–Brydone circuit when the 110 kV network constrains north-south flow on the parallel 220 kV circuits). The splitting of the 110 kV network only needs to occur at times of peak load or following a contingent event. See Development plans 0A and 0B in section 4 below.

3.2 Criteria for selection of Short List

A set of high level screening criteria has been developed to eliminate those options that are not appropriate for Transpower to consider in the short list. The criteria were compiled with reference to:

- the definition of "alternative projects" under the Rules and
- the Grid Upgrade Investigation and Review Policy (GUIRP)

Broader issues (eg social, environmental or cultural factors) will be considered in the processes of identifying a preferred investment proposal and its alternative projects.

Any option that does not meet one or more of the criteria is removed from further investigation. The overall assessment is indicated by a ✘ or ✔.

✘ Not included in short list

✔ Investigated further / on short list

The short-listed criteria are:

A. Fit for purpose

- The design will assist meeting future energy demand growth
- The extent to which the option resolves the relevant issue.

B. Technical feasibility

- Complexity of option
- Reliability, availability and maintainability of the option
 - Is this proven technology (ie used commercially, internationally and/or with available data on performance, and expected life cycle)?
 - Does Transpower have experience with the technology?
 - Is there a low level of risk associated with implementing this technology (such as ongoing maintenance requirements and availability of after sales support and spare parts)?
- Future flexibility - Grid Development Strategy
 - To what extent does the option open up or foreclose future development options?
 - Could the investment be stranded under certain conditions?

C. Practicability of implementing the option

- It must be possible to implement the solution by the required dates (probability of proceeding)
 - How long will it take to implement this option? Consideration includes:
 - Property acquisition time
 - Likelihood of gaining required environmental approvals
 - Equipment lead time
 - Time taken to build
 - Implementation risks, including potential delays due to property and environmental issues
 - Are there technical issues with access or available space for the works?
 - Implementation risks eg Are outage constraints on the existing system going to impact on this option?
- The availability of proponent for or potential counterparty to a transmission alternative

D. Good electricity industry practice (GEIP)⁴

- Ensure safety
- Consistent with good international practice
- Minimise or mitigate environmental impacts
- Accounts for relative size, duty, age and technological status
- Manage technology risks

⁴ refer Part A of the Electricity Governance Rules.

- E. System security (additional benefit resulting from an economic investment)
 - Improved system security
 - System Operator benefits (controllability)
 - Does the option provide operational flexibility?
- F. Indicative cost
 - Whether an option will clearly be more expensive than another option with similar or greater benefits
 - The cost estimates, if used, are high level.

3.3 Long list options

3.3.1 Transmission alternatives

a) Grid Support Contract with Generator

The only generation of a size suitable for such a contract is Manapouri. Owner Meridian Energy stated in its submission⁵:

“The Southland/Otago peak is only 250 MW above minimum demand. A grid support requirement any more than 250 MW implies that the grid support is being required to meet base load demand. Unfortunately because of the variable inflows, Manapouri is not well suited to providing base load support and any grid support contract would need to have an energy limit of 4.3 GWh per day to ensure that we could reliability meet the energy requirements of the grid support.”

However, a contract that would only be deployed in a dry year situation may be possible.

✓ Investigated further / on short list

b) Potential New Generation Investments

No new hydro generation developments of sufficient capacity have been committed in the region. The wind generation signalled is not considered suitable for the need since its output cannot be guaranteed, and while some thermal plant proposals exist, none are at a sufficiently advanced stage of development to provide certainty of generation capabilities.

✗ Not included in short list

c) Demand Side Management

To be viable, peak demand would need to be restricted to present levels, compensating any future demand growth via demand management techniques.

Due to the size of the demand-side management required and no proposals from parties to provide demand reduction, we conclude this is not viable for this particular need.

✗ Not included in short list

⁵ http://www.gridnewzealand.co.nz/f2026,13855129/13855129_Meridian_submissioncomplete.pdf.

d) Fuel Switching

Demand reduction potential from switching from electricity to gas.

Due to the scale of fuel switching required this is not viable. One submitter pointed out fuel switching would cause an increase in operating costs for them.

✘ Not included in short list

e) Co-ordinated Energy Efficiency Measures

Demand reductions may be achieved through the promotion and installation of energy efficient heating, motors and appliances. This would require co-ordinated action from a number of third parties, all having decided that it was the right investment for them at this time.

Due to the scale of the demand reduction required, this action set is not viable for this particular need.

✘ Not included in short list

f) Special Protection Scheme – small irrigation and industrial

On the 110 kV non-core grid, irrigation loads and some industrial processing may be suitable for consideration as part of SPS schemes to curtail demand during outages on the transmission system. No proponents for such were forthcoming. The use of an SPS to shed load following a contingent event (outage) is considered a short-term solution only.

✘ Not included in short list

g) Special Protection Scheme - specific large loads

The large load in the LSI that could be a candidate for an SPS scheme is the Tiwai Point aluminium smelter.

Rio Tinto is not interested in offering a permanent SPS at Tiwai as a substitute for transmission investment⁶. An SPS in present use at Tiwai Point is only offered by Rio Tinto as a stop-gap until a transmission solution is put in place. Transpower and Rio Tinto are discussing whether an SPS that was only needed during dry periods would be possible.

✓ Included in short list

h) Pre-contingency load shedding

This option would mean shedding load in advance of a contingency; economically other options are generally better.

✘ Not included in short list

i) Post-contingency load-shedding (110 kV network-wide)

A 110 kV network-wide SPS centred at Gore which will allow pre-contingency splits to be implemented, following a contingent event some load would not be supplied.

✓ Included in short list

⁶ http://www.gridnewzealand.co.nz/f2026,13855201/13855201_RioTinto_Submission.pdf

3.3.2 Options that optimise existing assets

Economically responsible consideration of transmission options means seeking to better utilise existing assets (with or without reconfiguring the network) before deploying new assets.

j) Thermal upgrade

Thermal upgrade relates to techniques that allow more power flow through a transmission line: for example, increase line tension, dig-out land underneath, increase tower height. Some lines in the region have already been thermally upgraded to the extent possible without major (uneconomic) tower rebuilding. Others have copper conductors which are not suitable for operating at a higher temperature.

Two circuits were identified as suitable for thermal upgrade:

- Gore–Roxburgh A (110 kV), (eg wolf 75° , 92/101MVA (summer/winter))
- Roxburgh–Three Mile Hill 1 & 2 (220 kV) (eg upgrading of the Chukar or duplex Zebra sections of the line)

No other lines in the Otago/Southland region are considered candidates for thermal upgrading as they have either been thermally upgraded already, or extensive rebuilding is needed to attain the necessary clearances and structures for the upgraded lines.

This option meets all the criteria including technical practicality and the cost is likely to be similar to other options yielding similar or greater benefits.

✓ Included in short list

k) Series Reactors

Series reactors limit power flow in circuits. Power flow could be limited to below their circuit ratings in circuits such as Gore–Roxburgh 110 kV and Invercargill–Roxburgh 220 kV.

This option is considered unsuitable because it would not manage constraints under all operating conditions and the reactive power losses in the transmission system increase significantly, creating further voltage regulation and stability issues in the region.

✗ Not included in short list

l) Series Capacitors

Series capacitors allow increased power flow through under-utilised circuits. They might be useful on the North Makarewa–Three Mile Hill and/or Three Mile Hill–Roxburgh 220 kV circuits - either would divert power away from the constrained Invercargill–Roxburgh 220 kV circuits. The use of series capacitors is more effective on the North Makarewa–Three Mile Hill circuit because the circuit is longer.

✓ Included in short list

m) Phase Shifting Transformers (PSTs)

Phase shifting transformers (PSTs) regulate the power flow in a circuit by controlling the transformer taps. Some of the 110 kV circuit constraints in the region could be managed in this way eg Invercargill–Edendale–Brydone–Gore 110 kV circuits or Invercargill–Roxburgh 220 kV circuits. This option has the

disadvantage that, compared to series capacitors, reactive power losses in the transmission system will increase leading to needing additional investment in reactive power support devices.

✓ Included in short list (noting the disadvantage described)

n) Re-conductor existing lines

The existing conductors are replaced with a higher capacity conductor, or another line (s) is added. Lines considered are:

- Gore–Roxburgh 110 kV A, (eg simplex⁷ nobelium at 75°, 135/148 MVA)
- Brydone–Edendale 110 kV, (eg simplex nobelium at 75°, 135/148 MVA)
- Edendale–Invercargill 110 kV, (eg simplex nobelium at 75°, 135/148 MVA)
- Balclutha–Berwick 110 kV A, (eg simplex nobelium at 75°, 135/148 MVA)
- Gore–Halfway Bush 110 kV A, (eg simplex nobelium at 75°, 135/148 MVA)
- Invercargill–Roxburgh 220 kV A and B, (eg simplex falcon, 710/780 MVA)

✓ Included in short list

o) Conversion of existing transmission lines to higher voltage

Lines operated at a higher voltage can carry more power; however, none of the existing 110 kV lines in the LSI region can be physically converted to 220 kV. A voltage increase would, in effect, be a new line option.

✗ Not included in short list

p) Adding additional circuits to existing towers

Double circuit towers that carry single circuit lines could have the second line added, thereby increasing power flow. However, none of the double circuit towers in the region are only strung on one side. Therefore conversion to double circuit would be a new line option.

✗ Not included in short list

q) Reconfigure the 110 kV network – splits with auto changeover

The 110 kV network in the Southland region is not part of the Core Grid as defined under the EGRs. Therefore, providing a level of supply reliability needs to be justified on economic merit.

Overloading of some 110 kV transmission circuits under some operating conditions with all assets in service as well as under some system contingencies can be managed by splitting of the circuits. However, this will reduce the level of reliability provided to some GXPs.

✓ Included in short list

r) Post-contingency use of Special Protection Schemes to reconfigure the network (with auto-changeover if required)

Overloading of some 110 kV transmission circuits in the region can be managed post-contingency by reconfiguring the network (this includes splitting the circuits). Post-contingency measures allow the normal flow to exceed the usual (n-1) reliability limits. Reconfiguration of the network will reduce the through flow in the network over the constrained lines and will divert power flow

⁷ Simplex = single line; duplex = two lines

to circuits with spare capacity. Some splitting schemes will require change - over of the load at GXPs from one part of the network to another part, and may be carried out automatically or manually.

✓ Included in short list

3.3.3 Options that create new assets

New assets can be created with appropriate capacity to meet projected demand. New assets include lines and transformers.

s) New 220 kV circuit from Gore to Roxburgh.

- Gore–Roxburgh, (eg simplex sulphur, 293MVA)
- Gore–Roxburgh, (eg duplex sulphur, 586MVA)

Note: the transmission capacity to Invercargill can also be increased by connecting the Gore 220 kV bus to North Makarewa–Three Mile Hill line (option u below).

✓ Included in short list

t) New single circuit 220 kV line from Roxburgh to Invercargill

This option and the one above provide similar benefits, but this option is more expensive (as the line is longer).

✗ Not included in short list

u) A new 220 kV bus at Gore with a short length of new 220 kV line to connect to the North Makara to the Three Mile Bush 220 kV line

- Gore to North Makarewa–Three Mile Hill A, 220 kV,(eg simplex zebra at 75° , 382/347 MVA)
- Gore 220 kV bus

✓ Included in short list

v) A new single or double circuit 110 kV line from Gore to Roxburgh, in addition to, or replacing, the existing line

✓ Included in short list

w) A new single or double circuit 110 kV line from Invercargill to Gore, in addition to, or replacing, the existing line

- Gore–Brydone, Brydone–Edendale and/or Edendale–Invercargill, (eg wolf at 75°, 92/101MVA)

Cost is higher than thermal upgrade or reconductor options.

✗ Not included in short list

x) A new double circuit 110 kV line from Brydone to Gore, remove Edendale– Invercargill and Gore –Edendale lines

(Eg Simplex Nobelium, 135/148MVA)

Expensive in relation to other new lines

✗ Not included in short list.

y) A new 220/110 kV interconnecting transformer at Gore with a short length of new 220 kV line to connect to the North Makara A to Three Mile Hill 220 kV line

- Gore ICT, 220/110 kV at new Gore220 kV bus, (eg 150MVA)
- Gore to North Makarewa–Three Mile Hill A, 220 kV, (eg simplex zebra at 75°, 382/347 MVA)
- Gore 220 kV bus

✓ Included in short list

z) A new 220/110 kV interconnecting transformer at Balclutha with a short length of new 220 kV line to connect to the North Makarewa–Three Mile Hill 220 kV line

- Balclutha ICT, 220/110 kV ICT, (eg 150MVA)
- Balclutha to North Makarewa–Three Mile Hill A, 220 kV, (eg simplex zebra at 75°, 382/347 MVA)

While this option would reduce the loading on the Halfway Bush–Berwick–Balclutha 110 kV circuits, it does not reduce the overloading issues on Gore–Roxburgh 110 kV or Invercargill–Edendale–Gore 110 kV circuits.

✗ Not included in short list

aa) A replacement or additional 220/110 kV interconnecting transformer at specific locations

- Roxburgh T10 new ICT, (eg 150MVA)
- Invercargill T1 new ICT, (eg 150MVA)
- Halfway Bush T4 new ICT, (eg 150MVA)

✓ Included in short list

bb) For option y (220 kV bus at Gore), the Gore load could be shifted off the 110 kV network to the 220 network

- Gore, 220/33 kV at new Gore220 kV bus

✓ Included in short list

cc) Replace the existing Halfway Bush 110/33 kV supply transformer banks (and possibly 220/33 kV supply transformer bank) with further 220/33 kV supply capacity

This option does not reduce circuit loading into GOR.

✗ Not included in short list

dd) Utilise existing, or build new, HVDC transmission lines

This option involves converting an existing AC transmission line to HVDC, or constructing a new HVDC transmission link (including converter stations).

✗ Not included in short list

ee) Use shunt capacitors at Balclutha to provide reactive support

eg 22 Mvar

✓ Included in short list

ff) Use shunt capacitors at North Makarewa to provide reactive support

eg 22 Mvar

✓ Included in short list

gg) Static Var Compensators (SVCs)

SVCs address dynamic voltage issues but the problem here is more slowly varying reactive support.

✗ Not included in short list

3.4 Summary of Long List to Short List

Transmission alternatives

	Long list	Shortlisted
A	Grid Support Contract with Generator	✓
B	Potential New Generation Investments	✗
C	Demand Side Management	✗
D	Fuel Switching	✗
E	Co-ordinated Energy Efficiency Measures	✗
F	Special Protection Scheme – small irrigation and industrial	✗
G	Special Protection Scheme – specific large loads	✓
H	Pre-contingency load shedding (involuntary from perspective of demand)	✗
I	Post – contingency load-shedding (involuntary from perspective of demand)	✓

Options that optimise existing transmission assets

	Long list	Shortlisted
J	Thermal upgrade	✓
K	Series Reactors	✗
L	Series Capacitors	✓
M	Phase Shifting Transformers (PSTs)	✓
N	Re-conductor existing lines	✓
O	Conversion of existing transmission lines to higher voltage	✗
P	Adding additional circuits to existing towers	✗
Q	Reconfigure the 110 kV network – splits with auto changeover	✓
R	Post-contingency use of Special Protection Schemes to reconfigure the network (with auto-changeover if required)	✓

Options that create new Transmission assets

	Long list	Shortlisted
S	New 220 kV circuit from Gore to Roxburgh	✓
T	New single circuit 220 kV line from Roxburgh to Invercargill	✗
U	A new 220 kV bus at Gore with a short length of new 220 kV line to connect to the North Makara to the Three Mile Bush 220 kV line	✓
V	A new single or double circuit 110 kV line from Gore to Roxburgh, in addition to, or replacing, the existing line	✓
W	A new single or double circuit 110 kV line from Invercargill to Gore, in addition to, or replacing, the existing line	✗
X	A new double circuit 110 kV line from Brydone to Gore, remove Edendale– Invercargill and Gore –Edendale lines	✗
Y	A new 220/110 kV interconnecting transformer at Gore with a short length of new 220 kV line to connect to the North Makara A to Three Mile Hill 220 kV line. Alternatively the transformer could be at a new substation near the line, with a new 110 kV line to the Gore substation.	✓
Z	A new 220/110 kV interconnecting transformer at Balclutha with a short length of new 220 kV line to connect to the North Makarewa–Three Mile Hill 220 kV line	✗
Aa	A replacement or additional 220/110 kV interconnecting transformer at specific locations	✓
Bb	For the option of a 220 kV bus at Gore, the Gore load could be shifted off the 110 kV network to the 220 network	✓
Cc	Replace the existing Halfway Bush 110/33 kV supply transformer banks (and possibly 220/33 kV supply transformer bank) with further 220/33 kV supply capacity	✗
Dd	Utilise existing, or build new, HVDC transmission lines	✗
Ee	Use shunt capacitors at Balclutha to provide reactive support	✓
Ff	Use shunt capacitors at North Makarewa to provide reactive support	✓
Gg	Static Var Compensators (SVCs)	✗

4 Development plans from short list

The Development plans are constructed from a combination of the viable (component) options remaining on the short list. Each development plan is a way to meet either an 'n' or 'n-1' security level, thus there are two groups of plans:

1. plans that deliver **n-1 security** on the 220 kV and **n-1 security** 110 kV networks
2. plans that deliver **n-1 security** on the 220 kV network and **n security** on the 110 kV (note maintenance outages are not factored in). Since the GRS on the 110 kV network is described as a probabilistic standard the plans to deliver must be shown to be economic (evaluated using the Grid Investment Test).

The Grid Investment Test is **not** being applied to every development plan. Instead, development plans will be additionally informed by asset cost estimates and consideration of the plan's potential environmental effects and landowners/community impacts. Development plans that clearly cost more than others for the realisation of similar benefits – for example, achieving the same security level – would not be progressed to a full GIT application. The remaining plans become the 'proposed investment and alternative projects' required by the GIT methodology⁸ and will be submitted to the regulator.

Development plans with a high score for environmental and community impacts would not be eliminated on that basis alone. Rather this will identify the need to consider avoiding, remedying or mitigating these environmental effects (pursuant to the Resource Management Act).

The Development plans are described for works in the short-term only (2010 to 2015). Costs are not shown. The plans have been based on Covec's prudent peak load forecast, details of which are included in Appendix A.

DEVELOPMENT PLANS AT A GLANCE (more detail follows):

- **DP Option 0** (A or B) – base case with no 220kV upgrade (110kV = n-security OR n-1)
- **DP Option 1** (A or B) – 2 x 50% series comp on 2 x NMA-TMH circuits
- **DP Option 2** (A or B) – 2 x PST on 2 x INV-ROX circuits
- **DP Option 3** – reconductor all 110kV
- **DP Option 4** (A or B) – new 220kV ROX to GOR line connecting to NMA-TMH line at Gore
- **DP Option 5** – same as 1 but with 2 x GOR ICTs
- **DP Option 6** – 2 x 220/33kV supply transformers at GOR
- **DP Option 7** – 1 x 70% series compensation on 1 NMA-TMH circuit

"A" Options decouple 110 kV network from ROX-INV bulk transfer making two separate 110 kV sub-networks : one HWB-ROX, one GOR-INV

"B" Options have no major 110 kV additions

⁸ EGRs Part F Section III Schedule F4.

4.1 220 kV and 110 kV to n-1 security

Development Plan	Outline – short term between now and 2015	Environmental and community impact
0A – BASE CASE Reliance on Tiwai and Manapouri for increased transfer	<ul style="list-style-type: none"> • Intertrip or SPS on Tiwai and/or Manapouri • Install a 220/110 kV interconnecting transformer and associated switchgear at Gore • 220 kV single circuit line to Gore (a T off from North Makarewa–Three Mile Hill line near Gore) • Install two 110 kV bus sections (tie-breaker normally open) at Gore to enable reconfiguration of 110 kV grid connected to Gore during contingencies (automatic switching of bus sections): • Section 1: Gore–Roxburgh circuit, and Balclutha–Gore circuit • Section 2: Gore- ICT, Gore supply transformers and Brydone–Gore circuit • Install 33 kV shunt capacitors at Balclutha • Install 3rd 110/33 kV supply transformer at Gore • Install 33 kV shunt capacitors at Gore 	2
1A - Series Capacitors on North Makarewa–Three Mile Hill 220 kV	<ul style="list-style-type: none"> • Series capacitors on North Makarewa–Three Mile Hill 220 kV circuits (50% compensation) • Install a 220/110 kV interconnecting transformer and associated switchgear at Gore • 220 kV single circuit line to Gore (a T off from North Makarewa–Three Mile Hill line near Gore) • Install two 110 kV bus sections (tie-breaker normally open) at Gore to enable reconfiguration of 110 kV grid connected to Gore during contingencies (automatic switching of bus sections): • Section 1: Gore–Roxburgh circuit, and Balclutha–Gore circuit • Section 2: Gore- ICT, Gore supply transformers and Brydone–Gore circuit • Install 33 kV shunt capacitors at Balclutha • Install 3rd 110/33 kV supply transformer at Gore • Install 33 kV shunt capacitors at Gore 	2
2A Phase-shifting transformers on Invercargill–Roxburgh 220 kV	<ul style="list-style-type: none"> • Install a 220/110 kV interconnecting transformer and associated switchgear at Gore • 220 kV single circuit line to Gore (a T off from North Makarewa–Three Mile Hill line near Gore) • Install two 110 kV bus sections (tie-breaker normally open) at Gore to enable reconfiguration of 110 kV grid connected to Gore during contingencies (automatic switching of bus sections) • Section 1: Gore–Roxburgh circuit, and Balclutha–Gore circuit • Section 2: Gore- ICT, Gore supply transformers and Brydone–Gore circuit • Install 33 kV shunt capacitors at Balclutha • Phase shifting transformers on Invercargill–Roxburgh 	2

	220 kV circuits <ul style="list-style-type: none"> • Install 3rd 110/33 kV supply transformer at Gore • Install 33 kV shunt capacitors at Gore 	
3 Re-conductor 110 kV network	<ul style="list-style-type: none"> • Re-conductor the Gore–Roxburgh, Brydone–Gore, Brydone–Edendale and Edendale–Invercargill 110 kV lines • New 110 kV ring-bus at Gore • Roxburgh 220/110 kV Interconnecting transformer replacement • Invercargill 220/110 kV Interconnecting transformer replacement • Inter-tripping scheme for Brydone–Gore 110 kV circuit • Special protection scheme to reconfigure Gore 110 kV bus and split Gore GXP load • Shunt capacitors at Balclutha, Gore and Edendale • Phase shifting transformer on Gore–Roxburgh 110 kV circuit • 3rd 110/33 kV Gore supply transformer 	2
4A - New 220 kV line Gore – Roxburgh	<ul style="list-style-type: none"> • New 220 kV single circuit line from Roxburgh to Gore • Install a 220/110 kV interconnecting transformer and associated switchgear at Gore • 220 kV single circuit line to Gore (a T off from North Makarewa–Three Mile Hill line near Gore) • Install two 110 kV bus sections (tie-breaker normally open) at Gore to enable reconfiguration of 110 kV grid connected to Gore during contingencies (automatic switching of bus sections) • Section 1: Gore–Roxburgh circuit, and Balclutha–Gore circuit • Section 2: Gore ICT, Gore supply transformers and Brydone–Gore circuit • Install 33 kV shunt capacitors at Balclutha • Install two new 110/33 kV supply transformer at Gore • Install new 110/33 kV supply transformer at Gore • Install two new 110/33 kV supply transformers at Edendale 	3
5 Two interconnecting transformers at Gore	<ul style="list-style-type: none"> • Series capacitors on North Makarewa–Three Mile Hill 220 kV circuits (50% compensation) • Install two 220 /110 kV interconnecting transformers and associated switchgear at Gore • 220 kV double circuit line to Gore (2 x T offs from North Makarewa–Three Mile Hill line near Gore) • Connect Gore–Roxburgh 110 kV circuit to Balclutha–Gore 110 kV circuit at or near Gore. (Note: connection of these circuits with Gore bus is not required). • Install 33 kV shunt capacitors at Balclutha 	3
6 Transfer Gore GXP load to 220 kV network	<ul style="list-style-type: none"> • Two 220/33 kV supply transformers at Gore (located close to North Makarewa–Three Mile Hill 220 kV lines at Gore) • Required 33 kV lines from new 220/33 kV supply transformers to the existing Gore GXP • Series capacitors on North Makarewa–Three Mile Hill 	1

	<p>220 kV lines</p> <ul style="list-style-type: none"> • Shunt capacitors at Balclutha • Inter-tripping schemes for Brydone–Gore 110 kV line 	
<p>7</p> <p>Single series capacitor on North Makarewa – Three Mile Hill 220 kV</p>	<ul style="list-style-type: none"> • Install two 220/110 kV interconnecting transformers and associated switchgear at Gore • 220 kV double circuit line to Gore (2 x spur lines from North Makarewa–Three Mile Hill line near Gore) • 220 kV switching station adjacent to North Makarewa–Three Mile Hill line near Gore • Series capacitor on North Makarewa–Three Mile Hill 220 kV one of the circuits (70% compensation) • Install 33 kV shunt capacitors at Balclutha • Install 3rd 110/33 kV supply transformer at Gore (1) 	2

4.2 Development Plans: 220 kV at *n-1* security and 110 kV to *n*

Purpose: to meet increased demand at Gore GXP and reduce overloading on 110 kV system and Roxburgh – Invercargill 220 kV circuits following contingent events.

Development Plan	Outline – short term between now and 2015	Environmental and community impact
<p>0b – BASE CASE</p> <p>Reliance on Tiwai and Manapouri for increased transfer.</p>	<ul style="list-style-type: none"> • Intertrip or SPS on Tiwai or Manapouri • Sectionalize the Gore 110 kV bus into three sections (Initially two sections and Balclutha–Gore 110 kV lines open at Gore). The assets connected to each section are as follows: <ul style="list-style-type: none"> • Section 1: Gore–Roxburgh circuit, and the existing supply transformers T2 & T3 • Section 2: Brydone–Gore and a new supply transformer T4 • Section 3: Balclutha–Gore circuit and a new supply transformer T5 (needed in 2019) • Replace the interconnecting transformer at Roxburgh and associated switchgear at Roxburgh • Install 33 kV shunt capacitors at Gore (Section 1) 	1
<p>1b</p> <p>Series Capacitors on North Makarewa – Three Mile Hill 220 kV</p>	<ul style="list-style-type: none"> • Series capacitors on North Makarewa–Three Mile Hill 220 kV circuits (50% compensation) • Sectionalize the Gore 110 kV bus into three sections (Initially two sections and Balclutha–Gore 110 kV lines open at Gore). The assets connected to each section are as follows: <ul style="list-style-type: none"> • Section 1: Gore–Roxburgh circuit, and the existing supply transformers T2 & T3 • Section 2: Brydone–Gore and a new supply transformer T4 • Section 3: Balclutha–Gore circuit and a new supply transformer T5 (needed in 2019) • Replace the interconnecting transformer at Roxburgh and associated switchgear at Roxburgh • Install 33 kV shunt capacitors at Gore (Section 1) 	1

<p>2B</p> <p>Phase-shifting transformers on Invercargill–Roxburgh 220 kV</p>	<ul style="list-style-type: none"> • Phase shifting transformer on Invercargill–Roxburgh 220 kV circuits • New 110 kV bus sections at Gore enabling Gore GXP load is fed from Roxburgh and Balclutha. Brydone and Edendale GXPs are fed from Invercargill radially • (Gore Section 1: Gore–Roxburgh and T2 & T3, Gore Section 2: Balclutha–Gore and T4, Section 3: Brydone–Gore open at Gore) • Shunt capacitors at Gore and Balclutha • New 110/33 kV supply transformers at Gore 	<p>1</p>
<p>4B</p> <p>New 220 kV line Gore – Roxburgh (Tee off North Makarewa – Three Mile Hill)</p> <p>TO DO</p>	<ul style="list-style-type: none"> • Sectionalize the Gore 110 kV bus into three sections (Initially two sections and Brydone–Gore 110 kV line open at Gore). The assets connected to each section are as follows: • Section 1: Gore–Roxburgh circuit, and the existing supply transformers T2 & T3 • Section 2: Balclutha–Gore and a new supply transformer T4 • Section 3: Brydone–Gore circuit and a new supply transformer T5 (needed in 2020) • Install 33 kV shunt capacitors at Gore (Section 1) • Install 33 kV shunt capacitors at Gore (Section 2) • Install 33 kV shunt capacitors at Balclutha • New 220 kV single circuit line from Roxburgh to Gore (T–off to North Makarewa–Three Mile Hill line near Gore) 	<p>1</p>

*Description of community / environmental impact	Level
<p>The development plan will require Transpower to undertake extensive physical works on non-Transpower land, creating local disruption to landowners and/or the community. The development is likely to take an extensive period of time and/or occur at staged intervals.</p> <p>Any development plan that includes a new line or substation build is likely to create significant (albeit notified and managed) disruption.</p>	<p>3</p>
<p>The development plan will require Transpower to undertake physical works on non-Transpower land, and/or may cause limited disruption to landowner or community activity.</p>	<p>2</p>
<p>The development plan requires Transpower to undertake physical works on its own land; with minimal (although possibly not zero) impact on landowner/community activity.</p>	<p>1</p>