TRANSPOWER

Upper South Island Upgrade Stage 1: Major Capex Proposal

Attachment 3: Short list of investment options

August 2025

Purpose

This attachment is part of our Upper South Island Upgrade Stage 1 Major Capex Proposal (**MCP**). Its purpose is to outline our approach to developing options to assess, detailing how we applied our short-listing criteria to the initial long list of components. We then systematically combined these components to derive a final short list of investment options, each designed to provide a technically feasible solution that meets the regional needs of the Upper South Island (**USI**).

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1 Options assessment

1.1 Developing a short list of investment options

Our long list of components, and an assessment of whether each was considered further, is set out in Section 2. The proposed investment is expected to be a combination of various components, likely introduced in a sequenced manner. Therefore, we have referred to the long list as a long list of components.

By selecting and combining these individual components, we created some initial development plans designed to meet the USI needs through to at least 2050. These initial development plans, along with an assessment of whether each was considered further, are detailed in Section 3.

In Section 4 we refine this into our short list of investment options. Each short-listed option represents a forward-looking development plan, where the components within each option collectively form a technically feasible solution to meet the regional needs of the USI.

The Investment Test is then applied to these short-listed investment options. The three investment options included in the short list are shown in Table 1, with our proposed investment being Option 2.

Table 1: Components within each short-listed investment option

Option #	Short-list of investment options[1]
1	Orari switching station path • *Potential NTS* (A1-5) • Orari switching station (C8) • Thermal up-rate Roxburgh–Islington A line from Norwood to Orari (B1) • A total of 100 Mvar shunt capacitor banks at Orari 220 kV (C2) • Automatic over-voltage shunt capacitor and shunt reactor switching scheme (C7) • 150 Mvar STATCOM at Ashburton 220 kV (C1) • Thermal up-rate Christchurch–Twizel A line from Opihi to Twizel (B1) • New duplex Islington–Twizel line (C9)
2	Rangitata and Orari switching stations path • *Potential NTS* (A1-5) • Orari and Rangitata switching stations (C8) • Thermal up-rate Roxburgh–Islington A line from Norwood to Rangitata, and Rangitata to Orari (B1) • A total of 150 Mvar (2 x 75) shunt capacitor banks at Orari 220 kV (C2) • Thermal up-rate Christchurch–Twizel A line from Opihi to Twizel (B1) • 150 Mvar STATCOM at Ashburton 220 kV (C1) • Automatic over-voltage shunt capacitor and shunt reactor switching scheme (C7) • Thermal up-rate Benmore–Islington A line from Rangitata to Tekapo B (B1) • A total of 100 Mvar shunt capacitor banks at Ashburton 220 kV (C2) • Thermal upgrade Christchurch–Twizel A line from Ashburton to Orari (B1) • 150 Mvar STATCOM at Orari 220 kV (C1)
3	STATCOM path • *Potential NTS* (A1-5) • 150 Mvar STATCOM at Ashburton 220 kV (C1) • Thermal up-rate Christchurch–Twizel A line between Opihi and Twizel (B1) • Thermal upgrade Roxburgh–Islington A line between Livingstone and Norwood (B1) • New duplex Islington–Twizel line (C9) • 150 Mvar STATCOM at Ashburton 220 kV (C1)

1.2 Short-listing criteria

Our long list of option components was evaluated using high-level screening criteria, including indicative cost. These criteria were used to eliminate option components that were not appropriate for consideration in the initial development plans and subsequent short list. We then applied the Investment Test to the short list. The outcome of applying the shortlisting criteria is reflected in Table 3. The screening criteria are:

1. Fit for purpose
   - The design will meet current and forecast energy demand.
   - The extent to which the option resolves the relevant issue.

2. Technically feasible
   - Complexity of solution.
   - Reliability, availability and maintainability of the solution.
   - Future flexibility – fit with long term strategy for the grid.
   - Ideally the design can be staged and/or has flexibility to preserve options for future changes.

3. Practical to implement
   - It must be possible to implement the solution by the required dates.
   - Implementation risks, including the likelihood of obtaining any necessary outages and potential delays due to property, social and environmental issues, are manageable.

4. Good electricity industry practice (GEIP)
   - Ensures safety.
   - Consistent with good international practice.
   - Accounts for relative size, duty, age and technological status.
   - Technology risks.

5. Provides system security
   - Improves resilience of the power system.
   - Has benefits for system operation (e.g., controllability).
   - Improves voltage stability (e.g., has modulation features or improves system stability).

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

[1] The references in brackets next to each component refer to our long-list of components (Table 2)

2 Long list of option components

Table 2 provides an overview of the long list components that were considered as potentially playing a role in addressing the grid issues anticipated in the USI. These components are essentially the building blocks, while an investment or development plan represents a specific set of these components, commissioned sequentially as required over the 20-year planning period to address the investment need.

In August 2023 we consulted on this long list to support the needs of the USI.2 Orion NZ suggested[3] the inclusion of additional components not included in our initial draft, such as re-insulation to 400 kV and dynamic asset ratings. Based on this feedback, we added these additional components to the list. These new components are identified in green text in Table 2 below.

The list comprises a mix of transmission, operational, generation and demand response solutions. Table 2 provides a brief description of each component, indicating whether it progressed to the short-list stage. For components that were not selected for further consideration, a brief justification is included.

Key feedback from our long list consultation noted:

- Strong support for the necessity of investing in the USI to ensure a reliable electricity supply.
- Emphasis on the potential for load management and non-transmission solutions (**NTS**) to influence investment timing, and a request that these factors be considered.
- Suggestions for additional components to be included in our long list for consideration.

This feedback was incorporated into the long list prior to applying our short-listing criteria.

Table 3 provides a summary of all the components that were advanced to the short-list stage.

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3 Upper South Island Long-list: Summary of Submissions

Table 2: Long-list of components

Component	Type	Sub-type	Details	Considered further during the short-list stage
Non-Transmission Options				
A1	Generation	New generation	We could enter into a Grid Support Contract (**GSC**) with either an existing or new generator in the USI. This contract would allow us to leverage the generation capacity to provide voltage support in the event of a fault on our network and reduce the loading on our transmission lines.	X New generation has the potential to defer transmission investment. Some new generation in the USI has been proposed, however limited new generation is committed. The impact of new market generation will be considered in the economic analysis in our scenarios.
A2	Generation	Existing generation grid support contract		X There is an increasing demand in the region and limited significant generation in the region to support this demand.
A3	Generation	Diesel generation		✓ Could be considered as part of a NTS. Refer to section 2.1.
A4	Load control	USI Load Manager	Load Control via the existing USI Load Manager (via USI EDBs) could reduce peak load in the region.	X The USI Load Manager has been demonstrated to successfully manage load in the region and this has been assumed to continue in our demand forecasts.

Component	Type	Sub-type	Details	Considered further during the short-list stage
A5	Load control	Demand response	Demand response may play a role in deferring transmission investment and/or managing delivery risks associated with major projects. We could explore the possibility of entering into a Grid Support Contract (GSC) with a party to procure suitable demand-side services to defer transmission investments should such an option be available.	✓ Refer to section 2.1. Other than the existing USI Load Manager, no significant demand response is currently in operation.
A6	Generation	Batteries	Battery solutions could be beneficial in deferring transmission investments and managing delivery risks associated with significant projects. We could explore the possibility of entering into a Grid Support Contract (GSC) with one or more parties to provide battery storage and support in the USI region.	✓ Could be considered as part of a NTS. Refer to section 2.1.
A7	NTS	Third party voltage support	Third party connections that contain voltage support capability (other than batteries).	X We are not aware of any third-party voltage support options (other than batteries).

Component	Type	Sub-type	Details	Considered further during the short-list stage
A8	NTS	Management of power factor by distribution companies	Capacitor banks that are installed in the distribution network, or other inverter-type loads connected to the USI distribution networks can help manage voltage stability.	X We are not aware of any options available to do this in practice and could be difficult and impractical to manage operationally.
Transmission option: Upgrade existing assets: maintain, upgrade, enhance, modify				
B1	Line upgrade	Thermally up-rating AC transmission circuits from the Waitaki Valley through to Christchurch and other areas where required	Thermally up-rating existing transmission lines to a higher thermal rating to increase the thermal capacity of the constrained circuit can help address the thermal needs in the region. *18-30+ months delivery after planning investigation (i.e., design complete, property rights and consents secured)*	✓ Short-listing the following line upgrades: • Thermal upgrade Norwood–Rangitata to 90°C • Thermal upgrade Orari–Rangitata to 100°C • Thermal upgrade Opihi–Twizel to 90°C • Thermal upgrade Livingstone–Norwood to 90°C • Thermal upgrade Ashburton–Orari to 90°C

Component	Type	Sub-type	Details	Considered further during the short-list stage
B2	Line upgrade	Reconductor / duplex one or more of the four existing transmission circuits	Duplex/upgrade Benmore–Islington A or Christchurch to Twizel A lines. Including their potential upgrade to 400kV. *18-30+ months delivery after planning investigation (i.e., design complete, property rights and consents secured)*	*X* All 220 kV lines supplying the USI region are already duplex. Further upgrades to 400 kV would involve transformers to change voltage and very expensive upgrades to the lines/ new transmission lines to accommodate the higher voltages.
B3	Substation upgrade	Enhance existing protection to improve fault clearance and dynamic voltage performance	Reducing fault clearance times may delay investment need date. *18 to 30 + months delivery for each line after planning investigation*	*X* This provides minimal improvement to dynamic performance and does not help with thermal and static requirements of the need.
B4	Substation upgrade	A seventh bus section at Islington 220 kV bus	Having additional bus sections further reduces the risk of multiple component outages. *~24 months*	*X* Because of the existing circuit configuration, there is limited benefit from additional bus sections.

Component	Type	Sub-type	Details	Considered further during the short-list stage
B5	Lines upgrades	Use of realistic dynamic asset ratings	Changing the asset ratings can potentially increase the limits and provide more flexibility. *~24 months*	*X* Small changes to the asset ratings may assist in the short-term but will not change overall long-term need for investment. While we do apply variable line ratings on many circuits, we do not have the ability to apply dynamic ratings, and do not consider them to be a prudent response to long-term capacity limits. NB. The use of thermal up-rating to permanently increase the limits is short-listed.
Transmission option: New transmission assets				
C1	Voltage support	Dynamic reactive devices	SVC, STATCOM or synchronous condenser, installed in the USI region. *3 – 7 years (depending on the preferred technology)*	✓ We can increase power transfer limits into the USI by installing additional dynamic reactive support in the region. Additional dynamic reactive support would act to lessen the size of voltage disturbances caused by faults. Dynamic reactive support is modelled using STATCOMs to represent the necessary dynamic response. STATCOMs serve as building blocks that provide dynamic support to increase the dynamic voltage stability limit.

Component	Type	Sub-type	Details	Considered further during the short-list stage
C2	Voltage support	Shunt capacitor banks	Static voltage support in the USI region. *3 – 5 years*	✓ As load continues to grow, additional static reactive support will be necessary to keep pre-contingent voltages within acceptable levels and ensure adequate reactive reserves for dynamic plant. This support helps prevent slow voltage collapse by maintaining voltage levels. Additionally, it can be switched in after a fault to aid in dynamic response and provide static support once voltage stabilises.
C3	Voltage support	Series capacitors	Series capacitors on one line between Waitaki Valley and Christchurch. *3 – 5 years*	*X* Limited benefit available due to lack of spare thermal capacity on the existing lines.
C4	Voltage support	Phase shifting transformer (**PST**) or Quad booters	PST or Quad boosters on one line between Waitaki Valley and Christchurch. *3 – 5 years*	*X* A PST or Quad Boosters will help control the share of loading on a particular circuit to assist with thermal capacity. However, load sharing between the circuits is not a significant problem in this case.
C5	Voltage support	Rebalance line power flow using series reactors	Achieve balanced loading across the four circuits (three lines) between Waitaki and Christchurch. *3 – 5 years*	*X* Limited thermal capacity benefit as the circuit loading is already reasonably even. This component offers no voltage benefit.

Component	Type	Sub-type	Details	Considered further during the short-list stage
C6	Voltage support	Rebalance line power flow using impedance reduction technology	Achieve balanced loading across the four circuits (three lines) between Waitaki and Christchurch. *2 – 3 years*	*X* Will provide some voltage benefit but limited thermal capacity benefit as loading is reasonably even already.
C7	Voltage support	Automatic over–voltage shunt capacitor and shunt reactor switching Scheme	A protection-based automation system to control over–voltage. It aims to reduce reactive power needs at a lower cost.	✓ Working alongside dynamic devices to reduce reactive power needs at a lower cost. Such a scheme does not replace the need for dynamic reactive devices.
C8	Bussing circuits	New switching station(s) near Orari	Switching station is a type of substation that ties together two or more circuits, allowing flexibility in managing the flow of electricity and enhancing the reliability of the system by providing alternative paths for the current in case of a circuit failure. *2 – 3 years*	✓ Create new switching station/s near where the existing 220 kV circuits between the Waitaki Valley and Christchurch converge near Geraldine (Rangitata and/or Orari). This enables the four 220 kV circuits between Christchurch and Waitaki Valley to be connected at about their mid-point. The advantage of this approach is that it reduces the effect of an outage in a 'long' single circuit, as the switching stations would allow the remaining 'half circuit' to continue to provide power to the load after a circuit failure. Increases the voltage stability transfer limit by reducing the impact of single line outages. It also provides a possible new supply point that may defer future capacity increases at other GXPs, and/or supply new electrification load. This is also a possible location for future reactive support, e.g., capacitors, SVCs and STATCOMs.

Component	Type	Sub-type	Details	Considered further during the short-list stage
C9	New transmission line	New AC transmission line from the Waitaki Valley to Christchurch (or elsewhere as required)	A new transmission line from the Waitaki Valley, to improve voltage stability and thermal limits. *42-54+ months delivery after planning investigation (i.e., design complete, property rights and consents secured)*	✓ A new transmission line would improve the voltage stability of the USI and improve thermal capacity. Adding an additional parallel 220 kV line in the USI decreases the electrical length of transmission circuits, thereby improving system stability. Shortlisting: • New Islington–Twizel line (single circuit, duplex Sulfur AAAC 75°C)
C10	New HVDC terminal station	North Canterbury HVDC tap-off	Supply some Christchurch load via the existing HVDC line to improve voltage stability limits.	*X* While a HVDC tap-off would increase the voltage stability transfer limit, this would be very expensive, requiring the construction of an additional HVDC converter station and associated transmission lines. It would also need to be integrated with the existing HVDC controls and protection systems and would use converter and line capacity that is already essential for the existing HVDC system.

Table 3: Summary of short-listed components

Option	Components
A1-5	**Non-transmission solutions** • To be considered closer to the need date
B1	**Line upgrades** • Thermal upgrade Norwood–Rangitata to 90°C • Thermal upgrade Orari–Rangitata to 100°C • Thermal upgrade Opihi–Twizel to 90°C • Thermal upgrade Livingstone–Norwood to 90°C • Thermal upgrade Ashburton–Orari to 90°C
C1	**Dynamic Reactive Devices** • +/- 150 Mvar STATCOM @ Ashburton 220 kV • +/- 150 Mvar STATCOM @ Orari 220 kV
C2	**Shunt capacitor banks** • A total of 100 Mvar shunt capacitor @ Orari 220 kV • A total of 150 Mvar shunt capacitor @ Orari 220 kV • A total of 100 Mvar shunt capacitor @ Ashburton 220 kV
C7	**Automatic over-voltage shunt capacitor and shunt reactor switching scheme** • Automatic over-voltage shunt capacitor and shunt reactor switching scheme
C8	**Switching station(s)** • Orari switching station • Rangitata switching station
C9	**New transmission lines** • New Islington–Twizel line (single circuit, duplex Sulfur AAAC 75°C)

2.1 Non-transmission solutions

During the USI long-list consultation we included a request for information (**RFI**) to explore NTS as a potential alternative to meet the identified need.[4]

Consequently, in March 2024 we issued a follow-up RFI (RFP Stage 1) to more clearly outline the issues and information requirements.[5] The purpose of this additional request was to gather detailed information on available NTS options, including their capacity and indicative costs, to aid in our short-listing process. Based on the information sought, if an NTS component was short-listed and identified as part of our preferred investment option, we planned to incorporate it into our MCP and seek to contract for it.

However, market responses indicated that the available NTS capacity was limited and pricing was uncertain. As a result, we decided not to proceed at that time.

Since then, Transpower has worked closely with the Commerce Commission to develop an approach that allows us to fund economic NTS solutions that provide a net benefit by deferring transmission investments – using the financial value of up to 12 months of deferred transmission capital expenditure. This is covered further in Attachment 8.

3 Approach to creating development plans

Individual short-listed components alone are not sufficient to provide a complete solution; therefore, multiple components must be combined to meet the investment need. We have combined these short-listed components into the initial development plans presented in Table 4. Each development plan is designed to address the voltage stability and thermal capacity constraints in the USI through to at least 2050, collectively forming a technically feasible solution to meet the region's investment need.

Table 4 summarises a succession of need dates, with the first occurring in 2028 based on the prudent demand forecast. This date could potentially be deferred by implementing a NTS. Some development plans include components that are scheduled for later implementation, and some incorporate a new line between Waitaki and Islington at a certain stage of the development plan.

From this list of initial development plans, we applied our short-listing criteria to derive a short list of development plans which were considered further as our final short list of investment options.

Two of the initial development plans, the Rangitata switching station-only (Option 1b), and the new duplex Islington–Twizel line (Option 4), were not short-listed for further consideration.

The Rangitata switching station-only option was not advanced as it is more expensive than the Orari switching station-only option. It also involves the need for earlier capital investment in costly components.

Similarly, the option to construct a new duplex Islington–Twizel line was not advanced. While this option shares similarities with the components in the STATCOM path, it features the immediate construction of a new transmission line by 2028. The timeline required for consenting,

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constructing, and commissioning such a line is impractical within this timeframe. Additionally, the immediate construction of a new transmission line significantly increases costs, making this option considerably more expensive than alternatives.

Table 4 details whether each development plan has been short-listed.

Table 4: Initial development plans of short-listed components

Option	Development plans			High-level cost of full development plan (2028 – 2050) PV, 2024$	Short- listed?
	2028-30	*2031-34*	*2035+*		
1a	**Orari switching station** -Thermal up-rate Roxburgh–Islington A line from Norwood to Orari 90°C - A total of 100 Mvar shunt capacitor banks at Orari 220 kV - Automatic over-voltage shunt capacitor and shunt reactor switching scheme - 150 Mvar STATCOM at Ashburton 220 kV	-Thermal up-rate Christchurch–Twizel A line from Opihi to Twizel 90°C -New duplex Islington–Twizel line		$600M-700M	✓
1b	**Rangitata switching station** -Thermal up-rate Roxburgh–Islington A line from Islington to Norwood, and Norwood to Rangitata 90°C -Thermal up-rate Christchurch–Twizel A line from Opihi to Twizel 90°C - A total of 150 Mvar shunt capacitor banks at Rangitata 220 kV - Automatic over-voltage shunt capacitor and shunt reactor switching scheme -150 Mvar STATCOM at Ashburton 220 kV	-New duplex Islington–Twizel line		$600M-700M	*X* *This option is similar to the Orari switching station option (1a), but more expensive and involves the construction of a new transmission line earlier than the Orari only option.*

Option	Development plans			High-level cost of full development plan (2028 – 2050) PV, 2024$	Short- listed?
	2028-30	*2031-34*	*2035+*		
2	**Orari and Rangitata switching stations** -Thermal up-rate Roxburgh–Islington A line from Norwood to Rangitata 90°C, and Rangitata to Orari 100°C - A total of 150 Mvar shunt capacitor banks at Orari 220 kV -Automatic over-voltage shunt capacitor and shunt reactor switching scheme	-Thermal up-rate Christchurch–Twizel A line from Opihi to Twizel **90°C** -150 Mvar STATCOM at Ashburton 220 kV	-Thermal up-rate Benmore–Islington A line from Rangitata to Tekapo B -A total of 100 Mvar shunt capacitor banks at Ashburton 220 kV -Thermal upgrade Christchurch–Twizel A line from Ashburton to Orari -150 Mvar STATCOM at Orari 220 kV	$200M-300M	✓
3	**STATCOM path** -150 Mvar STATCOM at Ashburton 220 kV -Thermal upgrade of Christchurch–Twizel A line between Opihi and Twizel **90°C** -Thermal upgrade of Roxburgh–Islington A line between Livingstone and Norwood **90°C**	-New duplex Islington–Twizel line	-150 Mvar STATCOM at Ashburton 220 kV	$700M-800M	✓
4	**New duplex Islington–Twizel line** -New Islington–Twizel line	-150 Mvar STATCOM at Ashburton 220 kV	-150 Mvar STATCOM at Ashburton 220 kV	$700M-800M	X

Option	Development plans			High-level cost of full development plan (2028 – 2050) PV, 2024$	Short- listed?
	2028-30	*2031-34*	*2035+*		
			-Thermal upgrade of Christchurch–Twizel A line between Opihi and Twizel 90°C -Thermal upgrade of Roxburgh–Islington A line between Livingstone and Norwood 90°C		*This option is similar to the STATCOM path option (3) but excluded on practical grounds as not possible to implement by 2028 and is more expensive than other options.*

4 Short list of investment options

In section 3 we outlined the process of deriving a short list of development plans, which now form our final short list of investment options. The following sections provide a detailed overview of the three short-listed options and their respective development paths over the analysis period.

We received positive feedback regarding the appropriateness of these options during our Short-list Consultation in December 2024, and a follow-up consultation in April 2025.

Two of the short-listed options involve the construction of switching stations at existing Transpower-owned properties where multiple transmission lines converge. Figure 4 provides a simplified map showing the locations of the Orari and Rangitata sites where the switching stations could be constructed, and their proximity to key regional features.

Our short list includes a range of options that explore different investment paths to meet the investment need, using specific approaches across the near and medium terms. These options include optimising existing assets (such as switching stations connecting existing lines and tactical upgrades of transmission lines), constructing new transmission lines and integrating static and dynamic voltage support technologies (such as STATCOMs and capacitor banks). Based on the shortlisting criteria presented in Section 1.2, we believe that these options represent an appropriate balance of number and technology to address the identified investment need. All short-listed options could potentially be deferred using NTS, which could delay the capital investment in transmission components (see section 2.1).

The subsections below provide a detailed breakdown of each short-listed option.

4.1 Option 1 – Orari switching station

Option 1 begins with the construction of a switching station near Orari, which will connect three of the four Christchurch–Waitaki Valley circuits together, half-way between the Waitaki Valley and Christchurch. Following this, the Roxburgh–Islington A line from Norwood to Orari will be thermally up-rated by 2028.[6]

To maintain voltage stability, shunt capacitor banks will be installed at the Orari site by 2029. By 2030, a STATCOM will be required to further support voltage stability. In 2031, a thermal upgrade of the Opihi–Twizel circuit sections will be necessary to accommodate increasing demand.

Finally, by 2034, a new 220 kV line will be needed to address further voltage and thermal capacity issues in the region. This will involve replacing the single circuit Islington–Tekapo B–Twizel line with a new double circuit line. Once the new line is completed, no further investment will be required within the analysis period.

6 This effectively divides the circuits into the following sections: Norwood–Orari–1, Livingstone–Orari–1, Ashburton–Orari–1, Ashburton–Orari–2, Orari–Timaru–Twizel–1 and Orari–Timaru–Twizel–2.

Table 5 outlines the commissioning timeline for the components of Option 1. These are presented graphically in Figure 1.

Table 5: Option 1: Orari switching station path

Year	Constraint	Item built
2028	Thermal capacity Static voltage stability	Build new switching station near Orari
2028	Thermal capacity	Thermal up-rating of Norwood–Orari circuit to 90°C
2029	Static voltage stability	A total of 100 Mvar shunt capacitor banks at Orari 220 kV
2029	Dynamic voltage stability	Automatic over-voltage shunt capacitor and shunt reactor switching scheme
2030	Dynamic and static voltage stability	150 Mvar STATCOM at Ashburton 220 kV
2031	Thermal capacity	Thermal upgrade of Opihi to Twizel to 90°C
2034	Thermal capacity Dynamic and static voltage stability	Replacing the single circuit Islington–Tekapo B–Twizel line with a new double circuit line on the same route.

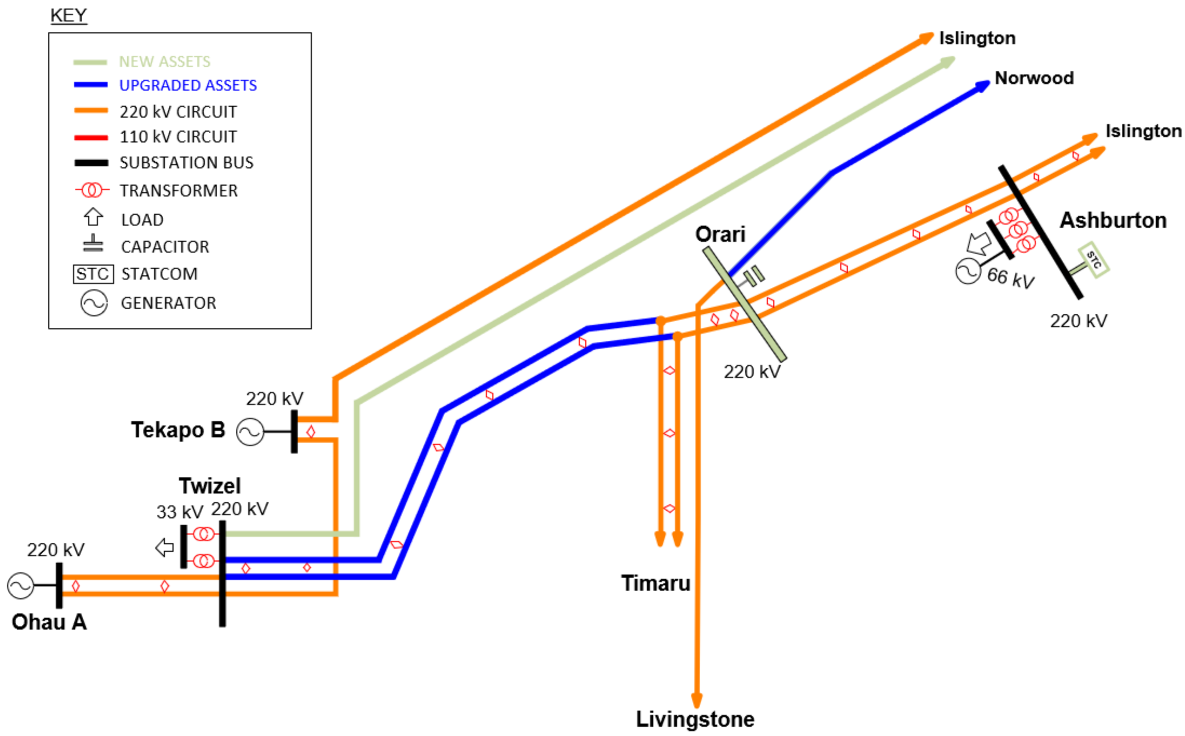

Figure 1: Diagram of Option 1, Orari development path

4.2 Option 2 - Orari and Rangitata switching stations

Option 2 involves the construction of two switching stations near Orari and Rangitata in 2028, providing flexibility to undertake cost-effective investments through targeted thermal upgrades. These switching stations will connect the four Christchurch–Waitaki Valley circuits together, half-way between the Waitaki Valley and Christchurch.[7] Additionally, the circuit section from Norwood to the Rangitata site, as well as the section connecting the Rangitata and Orari switching stations will be thermally upgraded.

After our consultation, we increased the thermal upgrade of the Orari-Rangitata circuit from 90°C to 100°C. This will provide 50% additional increase in capacity (90°C gives an additional 256 Amps, 100°C gives an additional 381 Amps), costing around $1.3M more (to resolve eight additional ground clearance violations). Even though 90°C is sufficient for the anticipated load increase (until 2035), the relatively small cost increment along with removing the need to upgrade the circuit in 2035 makes 100°C preferable. This is still the case even if Fonterra decides to fully convert Clandeboye to biomass (as Clandeboye is located south of the Orari-Rangitata circuit).

The tactical thermal upgrade to 100°C can be achieved without reconductoring by the following measures:

7 This effectively divides the circuits into the following sections: Rangitata–Tekapo B–1, Islington–Rangitata–1, Norwood–Rangitata–1, Orari–Rangitata–1, Livingstone–Orari–1, Ashburton–Orari–1, Ashburton–Orari–2, Orari–Timaru–Twizel–1 and Orari–Timaru–Twizel–2.

- Increasing conductor tensions
- Converting suspension towers into a strain or floating strain configuration
- Increasing tower heights e.g., parallel body extensions
- Attachment point modification
- Insulator replacements.

To maintain voltage stability, shunt capacitor banks will be installed at Orari by 2030. By 2033, thermal upgrades for the Opihi–Twizel circuit sections will be required, and a STATCOM will be necessary to ensure dynamic voltage stability.

By 2035, to address thermal capacity constraints, the Rangitata–Tekapo B–1 and Ashburton–Orari–1 and 2 circuits will undergo a thermal upgrade. Additional shunt capacitor banks will also be installed for voltage stability.

The construction of the two switching stations removes the need for investment in the new long-distance transmission lines required in the other options. Instead, the installation of a STATCOM in 2033 will be required. Further upgrades are also required further into the future.

Table 6 outlines the components of Option 2 and their commissioning timeline, while Figure 2 visually represents this information.

Table 6: Option 2: Orari and Rangitata switching stations path

Year	Constraint	Item built
2028	Thermal capacity Static voltage stability	Build two new switching stations near Orari and Rangitata[8]
2028	Thermal capacity	Thermal upgrade of the Norwood–Rangitata circuit to 90°C[9]
2030	Thermal capacity	Thermal upgrade of the Orari–Rangitata circuit to 100°C
2030	Static voltage stability	150 Mvar shunt capacitor banks at Orari 220 kV
2031	Dynamic voltage stability	Automatic over-voltage shunt capacitor and shunt capacitor switching scheme[10]
2033	Thermal capacity	Thermal upgrade of Opihi–Twizel circuit sections to 90°C

8 We expect commissioning of the two switching stations to be delayed to 2029 due to longer lead times.

9 We expect the TTU of Norwood–Rangitata circuit may finish as late as 2030 due to discussions with landowners to ensure under clearance requirements are met (including existing under clearance violations as discussed in Attachment 5).

10 We plan to install this by 2030 so it can be carried it out at the same time as an RCP4 protection replacement work for delivery efficiency.

Year	Constraint	Item built
2033	Dynamic voltage stability	150 Mvar STATCOM at Ashburton 220 kV
2035	Thermal capacity	Thermal upgrade of Rangitata–Tekapo B–1 to 90°C
2035	Voltage stability	100 Mvar of shunt capacitor at Ashburton 220 kV
2035	Thermal capacity	Thermal upgrade Ashburton–Orari–1 and 2 to 90°C
2046	Dynamic and static voltage stability	150 Mvar STATCOM at Orari 220 kV

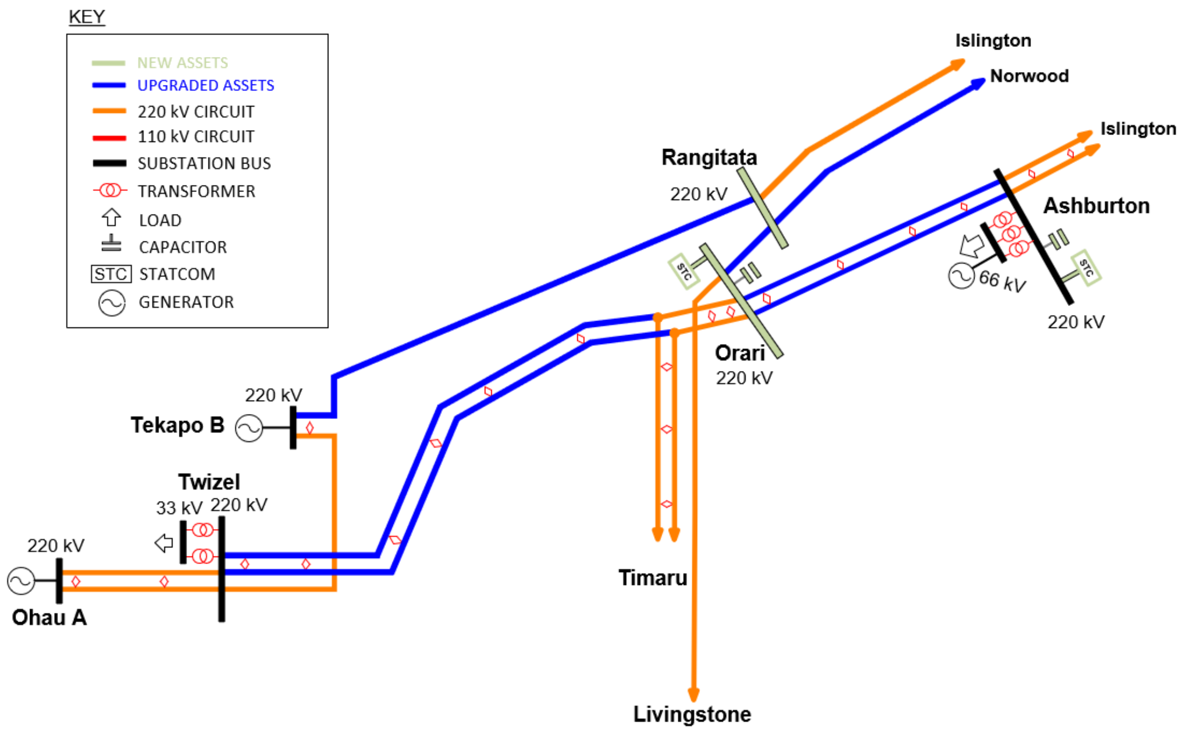

Figure 2: Diagram of Option 2, Orari and Rangitata development path

Since our consultation, we have done some further analysis on the impact of ~300 MW installed solar capacity in the USI on our development plan. We ran a sensitivity assuming a 15% solar contribution to our peak summer demand and no solar contribution to peak demand in winter. In this case the thermal upgrade of the Orari–Rangitata circuit to 100°C and shunt capacitors at Orari can be shifted from 2030 to 2031.This sensitivity has not changed our base case due to the uncertainty of this generation as discussed in Attachment 2.

4.3 Option 3 – STATCOM path

Option 3 is centred on the installation of a STATCOM in 2028 to address both static and dynamic voltage instabilities. In addition to the STATCOM, thermal upgrades for the Opihi–Twizel circuit will be implemented in 2028, followed by a thermal upgrade to the Livingstone–Norwood circuit in 2029.

Without the installation of switching stations, a new transmission line will be necessary by 2031 to address both voltage and thermal capacity constraints. This new line will effectively defer the need for additional investment until 2048, at which point a second STATCOM will be required for voltage stability.

Table 7 details the components of Option 3, including their commissioning timelines, while Figure 3 provides a graphical representation of this information.

Table 7: Option 3: STATCOM path

Year	Constraint	Item built
2028	Dynamic and static voltage stability	150 Mvar STATCOM at Ashburton 220 kV
2028	Thermal capacity	Thermal upgrade Opihi–Twizel–1 and 2 to 90°C
2029	Thermal capacity	Thermal upgrade Livingstone–Norwood–1 to 90°C
2031	Thermal capacity Static voltage stability	Replacing the single circuit Islington–Tekapo B–Twizel line with a new double circuit line on the same route.
2048	Dynamic and static voltage stability	150 Mvar STATCOM at Ashburton 220 kV

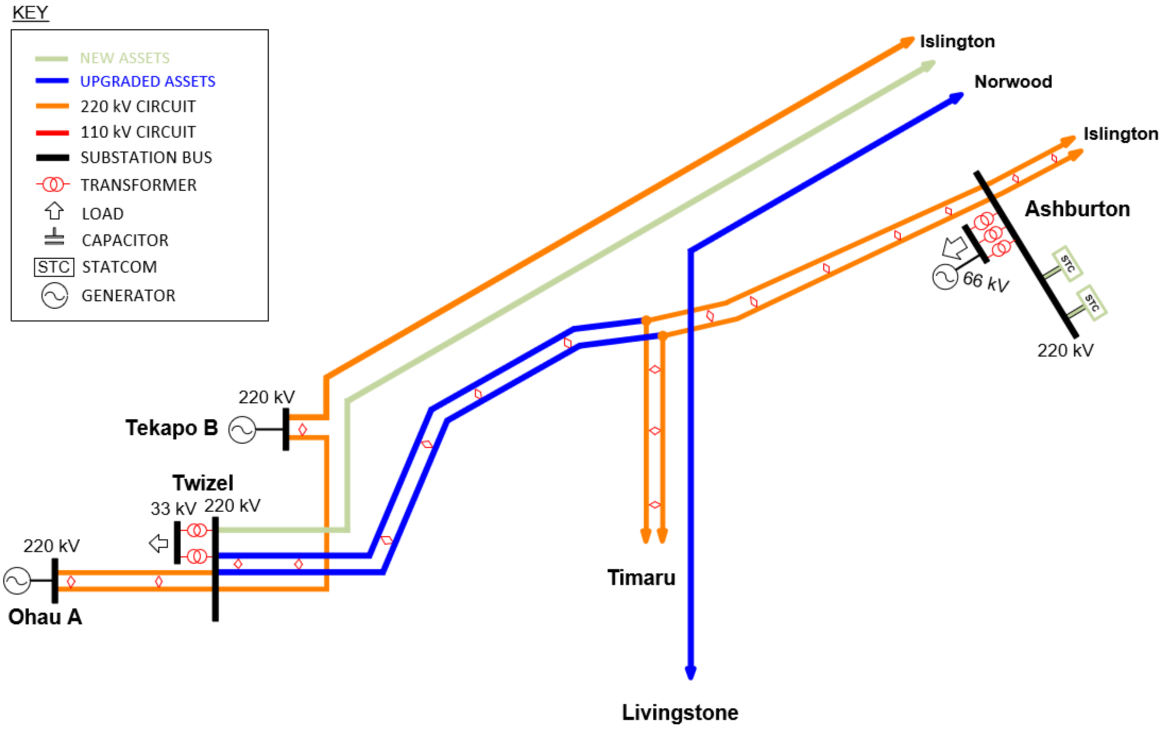

Figure 3: Diagram of Option 3, STATCOM development path

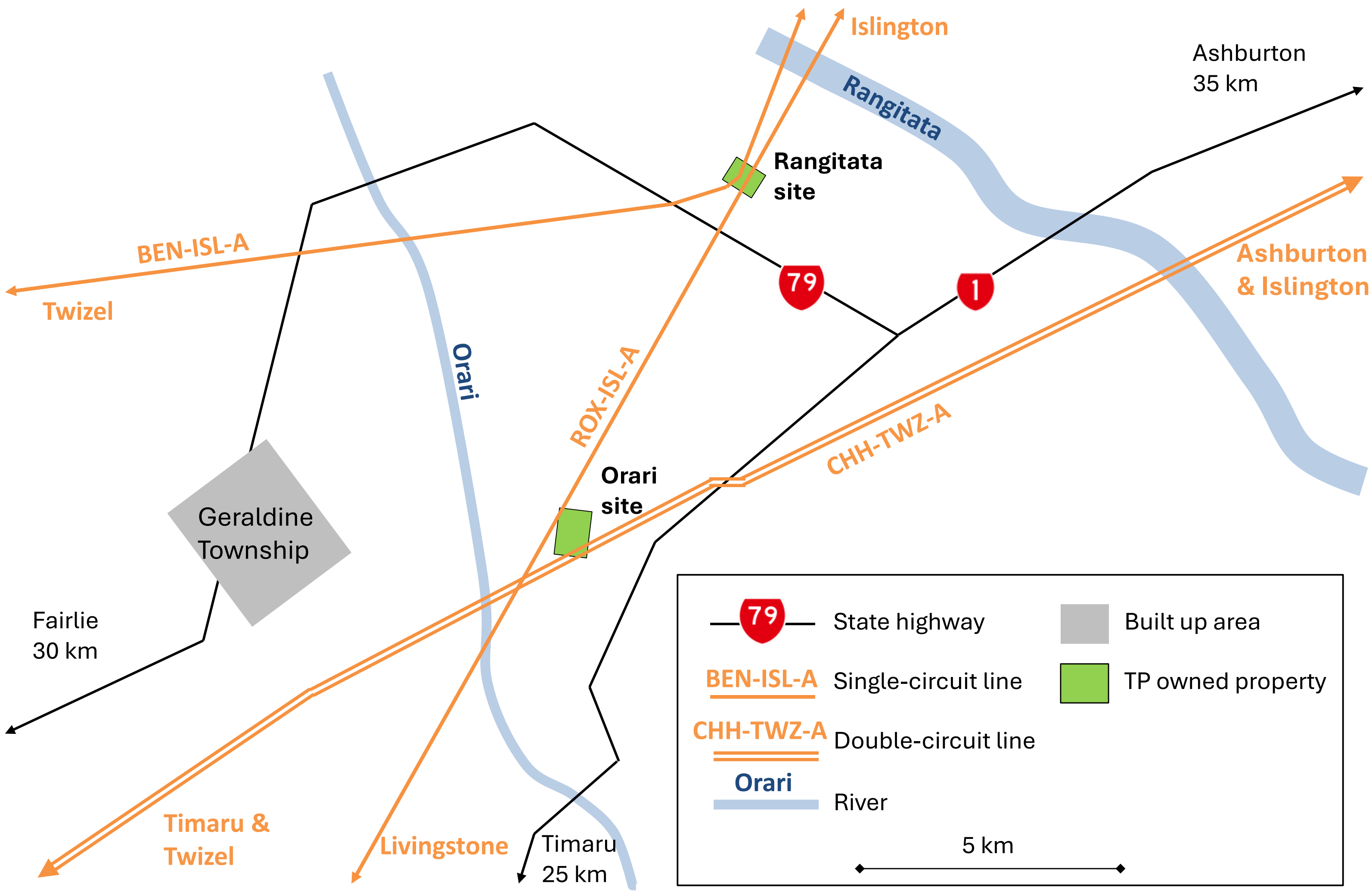

Figure 4: Simplified map showing location of Orari and Rangitata switching stations in proximity to other features

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