

Powerco CPP – Portfolio Overview Document

Portfolio Name	Putaruru GXP
Expenditure Class	Capex
Expenditure Category	Growth & Security
As at Date	12 June 2017

Expenditure Forecast ^{1,2}	Pre CPP	FY19	FY20	FY21	FY22	FY23	Post CPP	CPP Period Total	Project Total
Pre-Internal Cost Capitalisation and Efficiency Adjustments ³ (2016 Constant NZ\$(M))	\$0.6	\$0.3	\$4.9	\$7.8	\$7.8	\$0.0	\$0.0	\$20.8	\$21.5
Post-Internal Cost Capitalisation and Efficiency Adjustments (2016 Constant NZ\$(M))	\$0.7	\$0.3	\$5.3	\$8.5	\$8.1	\$0.0	\$0.0	\$22.2	\$22.9

Description

Project Need Overview	The security of supply to Transpower’s Hinuera GXP is constrained by the single transmission circuit and the supply transformers are loaded beyond firm capacity. Consequently, all of Powerco’s downstream network is at risk from a fault on Transpower’s equipment. The sub-transmission network to Putaruru is constrained due to the lengthy single circuit supplying the Putaruru substation from Hinuera.
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Solution

Project Solution Overview	A new 110/33kV GXP substation is to be established at Putaruru to provide an alternate supply to the area and increase capacity, restoring security of supply levels. The new GXP will be located at the existing Putaruru substation and be supplied via a single 110kV cable circuit from Arapuni hydro station.
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¹ Forecast expenditure is based on Powerco’s financial year (i.e. FY18 is for the period April 2017 through March 2018). Expenditures do not consider general price level changes over time (i.e. are in real or constant terms).

² Only includes Growth & Security Expenditure. Some projects discuss and rely on the replacement of assets that are at “end of life”. However, the replacement cost for these assets is accounted for in the Replacement Expenditure category.

³ All other forecast expenditure / cost estimates in this POD are pre-internal cost capitalisation and efficiency adjustments, consistent with this forecast.

Need Identification	
Background	<p>The zone substations within Powerco’s Waikato Area are supplied via a 33kV network out of the Hinuera, Piako and Waihou GXPs as shown in Figure 1 and Figure 4. The network is characterised by long single circuit 33kV lines. The Hinuera network supplies a number of industrial consumers which include Fonterra (Waharoa), Fonterra (Tirau), Open Country Cheese (Waharoa), Buttermilk (Putaruru), Icepak (Waharoa), Kiwi Lumber (Putaruru) and Pacific Pine (Putaruru). Over the last decade the Hinuera GXP has experienced steady growth. A significant portion of the load relates to the dairy industry, which means that the electrical demand is spring/summer peaking.</p>
Underlying Drivers and Investment Triggers	<p>The Hinuera area has a number of network constraints as follows:</p> <ul style="list-style-type: none"> • Transpower’s Hinuera GXP is supplied via a ≈23km long, single circuit, 110 kV overhead line from the Karapiro power station. The peak demand on the Hinuera GXP is ≈45MW. The existing transmission network would not meet the requirements of Powerco’s Security-of-Supply Standard, which would require a (N-1), no break (a security class of AAA⁴). • The Hinuera GXP’s supply transformers have exceeded their (N-1) capacity. Again, this would not meet the requirements of Powerco’s Security-of-Supply Standard. • Maintenance on the Hinuera 110/33kV GXP and incoming 110kV line is becoming increasingly difficult due to the inability to supply consumer load (via the 33kV link to the north to the Piako GXP). During maintenance activities many of the consumers experience a planned outage which disrupts their businesses. The backup supply is not only a network capacity issue but also a delivery voltage issue due to the long 33kV lines (particularly supplying load at Tirau and Putaruru). The South Waikato District Council has expressed concern over the security of supply to Putaruru and Tirau on a number of occasions.
Timing	<p>Powerco has a preliminary design for the Putaruru 110/33kV substation and has begun investigations of the potential line/cable routes from Arapuni to Putaruru. Powerco is planning to commission the new Putaruru 110/33kV substation and associated line/cable before the winter of 2022.</p>

⁴ AAA – Supply is uninterrupted in the event of the outage of one major element of the sub-transmission network. Load can be transferred to other substations without interruption by switching on the network if necessary to avoid exceeding ratings (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).

Demand Forecast | Waikato Area

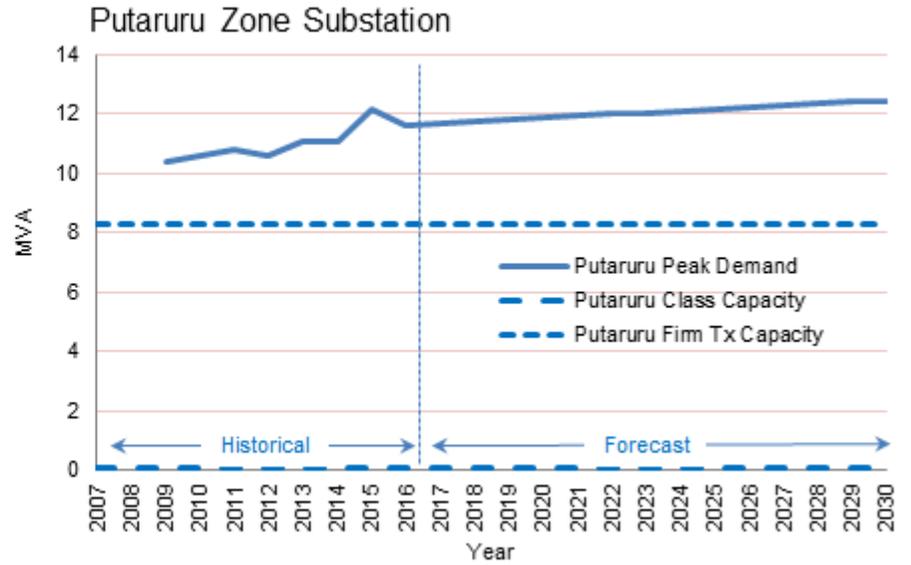
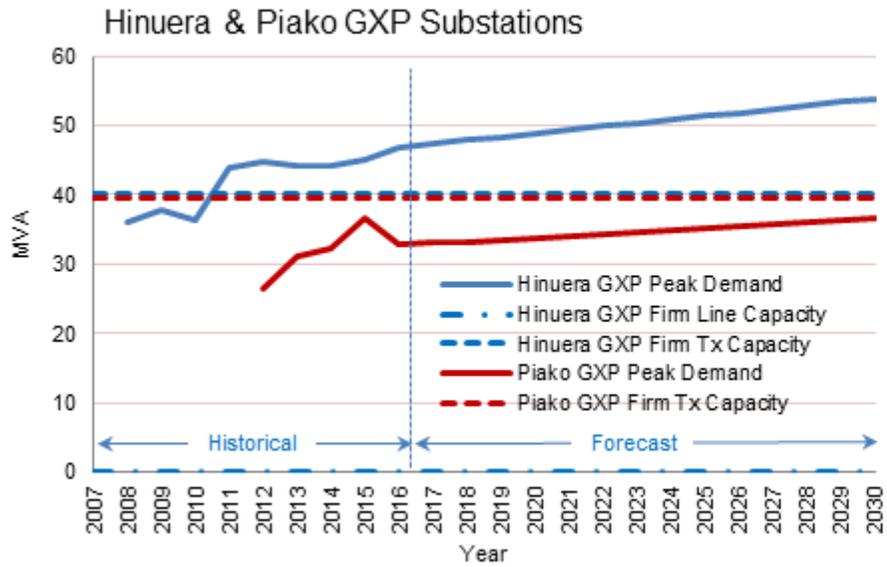
HINUERA AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Browne St	10.6	1.2%	9.9	10.0	10.1	10.3	10.4	11.0	11.6
Lake Rd	0.0	0.4%	5.9	6.0	6.0	6.0	6.0	6.1	6.3
Putaruru	0.0	0.5%	11.6	11.7	11.7	11.8	11.9	12.2	12.4
Tirau	0.0	0.5%	9.5	9.5	9.6	9.6	9.7	9.9	10.1
Tower Rd	0.0	1.5%	9.8	9.9	10.1	10.2	10.4	11.1	11.8
Waharoa	0.0	2.0%	7.8	8.0	8.1	8.3	8.4	9.2	10.0
Walton	0.0	0.1%	5.9	5.9	5.9	5.9	5.9	6.0	6.0

PIAKO AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Farmer Rd	0.0	0.2%	5.9	6.0	6.0	6.0	6.0	6.1	6.1
Inghams	3.6	0.0%	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Morrinsville	0.0	0.5%	10.7	10.8	10.8	10.9	10.9	11.2	11.4
Piako	15.2	1.0%	15.0	15.2	15.3	15.5	15.6	16.3	17.0
Tatua	1.2	0.0%	4.5	4.5	4.5	4.5	4.5	4.5	4.5

WAIKATO AREA GXPS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	TX FIRM CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Hinuera GXP	40.0	1.1%	46.9	47.4	47.9	48.4	48.9	51.4	53.9
Piako GXP	40.0	0.8%	32.7	33.0	33.3	33.6	33.8	35.2	36.6

Notes:

1. Class capacity is similar to Firm Capacity and represents the capacity that can be delivered following the first outage of any major equipment. Unlike Firm Capacity it considers the long term deliverable capacity in the context of switching and network reconfiguration (11kV & 33kV) post-fault conditions.
2. All maximum demand values are in MVA.
3. Purple shaded cells indicate that the substation’s Class Capacity has been exceeded and network enhancements should be considered.
4. The Piako GXP is equipped with two transformer units (40MVA & 60 MVA). The 40MVA is only temporary, and will be upgraded to 60MVA shortly.
5. The Hinuera GXP is equipped with 1 x 30MVA and 1 x 50MVA transformer units. N-1 capacity is 37/40MVA summer /winter.
6. The Piako GXP was commissioned in ≈2013.



Options Analysis | Long List of Project Options | High Level Assessment

<p>Assessment Process</p>	<p>A wide range of potential options are available for the resolution of electrical network constraints. However, depending on local conditions many of the options can be impractical or too expensive. On this basis a two tier Options Analysis process is followed. In the first instance all potential options are considered against a set of high level criteria. Those options that are identified as having significant challenges and not favourable are not considered further.</p> <p>A significant issue that Powerco often faces is the reality of trying to secure landowner easements. For this reason the costs associated with easements/consents are often difficult to estimate and the consenting/land-acquisition stage of a project can take a significant period. Given this fact Powerco assesses the risk / likelihood of securing development rights for individual projects (within a realistic timeframe) during the high level assessment stage.</p>
<p>Long List of Options</p>	<p>The following table contains a list of the high level project options that are potentially available to resolve the electrical supply issues within the Hinuera area. The four non-network options (Nos. 1, 2, 3 & 4) are not shortlisted on the following basis:</p> <ul style="list-style-type: none"> • Fossil fuelled generation (i.e. diesel or gas) is technically viable but not shortlisted due to the cost and environmental/consenting challenges. • No viable renewable generation options that would provide the required security of supply have been identified. • Fuel switching and demand side response (DSR) are considered to be deferral strategies. Their viability is not considered to be certain given the growth rates that the Hinuera area has experienced and the fact that the network security levels are already well exceeded. • Energy storage is potentially viable but the costs are expected to be significant. For example, an emerging technology that could be employed is storage batteries installed in domestic premises. In the context of Hinuera, more than 30MW (peak demand) of storage would be required with a capital cost of potentially exceeding \$90M⁵ for two hours' supply. An additional factor is that the current application of battery storage technology to power networks is very limited in New Zealand and the existing security risk is too great to allow deferral until trials and standards could be established. <p>Eight viable potential options to reinforce the existing network via the construction of additional lines/cables/equipment were identified. The options include:</p> <ul style="list-style-type: none"> • New 33kV circuits from Arapuni into the region (No. 5). • A new 110kV circuit to a new GXP at Putaruru (No. 6 & 7). • A new 110kV circuit to the existing Hinuera GXP (No. 8 & 9). • The supply of a new GXP at Putaruru via a 110kV circuit from the existing Transpower owned Tarukenga-Kinleith 110kV line (Options 10, 11 & 12). <p>The large distances involved with reinforcing the Hinuera GXP, coupled with the high construction costs, meant that the Hinuera GXP</p>

⁵ The installed costs of domestic battery storage systems are expected to be >NZ\$1,500/kWh, or >NZ\$3,000 /kW (vendors indicate equipment costs of ≈US\$3.5k for a 4kW/7kWh system, but that is a factory gate price).

reinforcement options (No. 8 & 9) were not shortlisted. The Tarukenga-Kinleith 110kV line supply options (Options 10, 11 & 12) were initially considered to be very cost effective. However, the upstream transmission upgrade costs were found to be significant and these options are thus not shortlisted.

The shortlisted options (Options 5, 6 & 7) all involve the installation of a network link between Arapuni and Putaruru. All three options are proven to be well insulated against wider grid conditions such as the 110 kV topology (system split/closed), generation availability in the upper North Island, South Waikato and Bay of Plenty regions, and load growth in the region [supporting document 16].

Note that the following related projects area also planned for the Waikato Area:

- A 33kV circuit from the Putaruru substation to the Tirau substation.
- A 33kV circuit from the Kereone substation to Walton substation.
- A 33kV switchboard at the Walton substation.
- A 33kV switchboard at the Hinuera GXP.

The descriptions and costs associated with these projects are not included in this PoD and are considered elsewhere (i.e. described in other PoDs).

Long List of Options | High Level Assessment

Hinuera Area		Long list of projects and high level assessment				Assessment Criteria				
PROJECT FOCUS	No.	PROJECT	Safety	Fit	Feasible	Practical	GEIP	Security	Cost	Short-list
Non-network:	1	Embedded Generation (DG) including peak lopping generation	✓	✗	✓	✗	✓	✓	✗	✗
	2	Fuel switching to reduce electrical demand	✓	✓	✗	✗	✓	✗	✗	✗
	3	Demand Side Response (DSR)	✓	✓	✗	✗	✓	✗	✗	✗
	4	Energy Storage	✓	✗	✓	✗	✓	✗	✗	✗
Network Reinforcement	5	New GXP at Arapuni. 2 x 800mm ² feeders Arapuni to Putaruru. 1 x 33kV, 800mm ² cable feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV Switchboard at Walton.	✓	✓	✓	✓	✓	✓	✓	✓
	6	New GXP at Putaruru. 1 x 110kV 400mm ² , cable from Arapuni. 1 x 33kV, 800mm ² cable feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV Switchboard at Walton.	✓	✓	✓	✓	✓	✓	✓	✓
	7	New GXP at Putaruru. 1 x 110kV Overhead line in road reserve / private land from Arapuni. 1 x 800mm ² feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV Switchboard at Walton.	✓	✓	✓	✓	✓	✓	✓	✓
	8	110kV Overhead line in road reserve / private land from Arapuni to Hinuera. 1 x 33kV, 630mm ² cable feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV Switchboard at Walton.	✓	✓	✓	✗	✓	✓	✗	✗
	9	110kV Overhead line from Karapiro to Hinuera. 1 x 33kV, 630mm ² feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV Switchboard at Walton.	✓	✓	✓	✗	✓	✓	✗	✗
	10	New GXP at Putaruru, 1 x 110kV cable from a new switching station on the Arapuni-Kinleith (ARI-KIN) #2 circuit. 1 x 800mm ² feeder Putaruru to Tirau. 1 x 33kV, 630mm ² cable feeder Kerone to Walton. 33kV	✓	✓	✓	✓	✓	✗	✗	✗
	11	Identical to No. 10, with the inclusion of the upgrade Transpower's existing Tarukenga-Kinleith 110kV line (2 circuits).	✓	✓	✓	✓	✓	✓	✗	✗
	12	Identical to No. 10, with the installation of reactors on Transpower's existing Tarukenga-Kinleith 110kV line (2 circuits).	✓	✓	✓	✓	✓	✓	✗	✗

Key:

- Safety Health and Safety: Any significant implications in terms of Safety or Health - new products or compounds or practices, or requires difficult live line access etc.
- Fit Fit for Purpose: Does the option address the need appropriately and does it fit with other developments in the vicinity.
- Feasible Technically Feasible: Consider the complexity, future adaptability, and whether it aligns with company standards, strategies and policies.
- Practicality Practical to Implement: Are there potential environmental or property issues which may be insurmountable. Can it be achieved in the required time frame.
- GEIP Good Electricity Industry Practice (GEIP): Good practice (technically and environmentally) and in terms of AM practice (capacity, age, technological)
- Security Security and Reliability: Does the option provide adequate levels of security and appropriate reliability considering the demand, load type and future growth.
- Cost Some options will intuitively be known to be far more expensive than other options, and this may preclude them.



Transmission Options Analysis | Short List of Options

Option	Cost (NZ\$M)	Description
<p>Option 5:</p> <p><i>New 110/33kV GXP at Arapuni. 33kV Ccts to Putaruru Refer to Figure 2 & Figure 5.</i></p> <p><i>(Note 1)</i></p>	<p>\$24.5M</p> <p>(Note 2)</p>	<p>This option involves the construction of a new 110/33kV substation at the Arapuni power station. The options available for connection onto the existing 110kV busbar include (i) a new 110kV bay on the north/south end of the bus or (ii) the use of the existing ex-Arapuni-Pakuranga 110kV bay. The former option (new 110kV bay) is considered to be the most cost effective. An existing 40MVA, 110/33kV transformer (owned by Powerco) at the Piako GXP would be shifted to the new 110/33kV substation.</p> <p>Powerco would install a ≈17km, double circuit, 800mm² underground 33kV cable (2 x40MVA) from the new GXP to the existing Putaruru 33/11kV zone substation site. A new indoor 33kV switchboard would be installed at the Putaruru substation to accommodate the incoming cables and rationalise the existing outdoor 33kV switchyard.</p> <p>The 33kV cables to Putaruru would be in road reserve. There would be some challenges traversing across the Waikato River (from the Arapuni switchyard). The most practical options are considered to be via overhead line or 33kV cable across a low level access bridge near the powerhouse.</p> <p>Due to voltage constraint backfeeding up to Tower Road in future, reactive compensation is required.</p>
<p>Option 6:</p> <p><i>New 110/33kV GXP at Putaruru. 110kV OH line Arapuni to Putaruru Refer to Figure 3 & Figure 6.</i></p> <p><i>(Note 1)</i></p>	<p>\$21.3M</p> <p>(Note 2)</p>	<p>For this option a new 110/33kV substation would be installed at the existing Powerco Putaruru Substation. The substation would be equipped with an existing 40MVA, 110/33kV transformer (owned by Powerco) that would be shifted from the Piako GXP. A new indoor 33kV switchboard would be installed at the Putaruru substation to rationalise the existing outdoor 33kV switchyard.</p> <p>The substation would be supplied via a new ≈17km, 60MVA, 110kV line that would be constructed from the Arapuni substation to Putaruru. The 110kV bus structure at Arapuni would need to be extended (to the south of the existing power station switchyard) to accommodate a new 110kV switchgear line bay.</p> <p>The new 110kV line would need to cross the Waikato River due to the fact that the power station switchyard is to the east of the Waikato River and a route would need to be established through/past the Arapuni township. The challenges associated with securing the consents/easements in order to construct an overhead 110kV line are expected to be significant, particularly given the route crosses the route of the recently constructed 400kV overhead line (which received significant public opposition). In particular, a ≈2km section of the route that crosses the Arapuni dam and through the Arapuni township may have to be installed underground. However, Option 6 assumes the entire route is of overhead construction and includes significant easement/consenting costs.</p>



<p>Option 7:</p> <p><i>New 110/33kV GXP at Putaruru. 110kV UG Cable Arapuni to Putaruru Refer to Figure 3 & Figure 6.</i></p> <p><i>(Note 1 & 3)</i></p>	<p>\$21.5M</p> <p>(Note 2)</p>	<p>This option is identical to Option 6 with the exception that the 110kV overhead line is replaced with a ≈17km, 60MVA, 110kV, underground cable. The construction of an 110kV underground cable is expected to receive relatively little public opposition.</p>
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Note 1: All three short listed network reinforcement options assume that the following “linked projects” will proceed:

- A 33kV circuit from the Putaruru substation to the Tirau substation.
- A 33kV circuit from the Kereone substation to Walton substation.
- A 33kV switchboard at the Walton substation.
- A 33kV switchboard at the Hinuera GXP.

Note 2: The costs indicated do not include the costs associate with the projects outlined in Note 1. The costs include a 40 MVA 110/33kV transformer budgeted at \$1.4M.

Note 3: Figure 3 & Figure 6 indicate an overhead line. An underground cable is expected to take a similar route.



Option Analysis | Advantages vs Disadvantages

The following sections summarise the advantages/disadvantages associated with the short listed options. The intention being to also capture project risks and inter-dependencies.

Option	Advantages	Disadvantages
<p>Option 5:</p> <p><i>New 110/33kV GXP at Arapuni. 33kV Ccts to Putaruru</i> Refer to Figure 2 & Figure 5.</p>	<ul style="list-style-type: none"> • Property and consenting risks are low. The installation of underground 33kV cable is a permitted activity and there is sufficient space in the existing Arapuni substation. • The timeline to complete the project would be relatively short and it would deliver significant benefit to the existing consumer base. • Delivers 2 x 33kV cables into the Hinuera area via an independent 110kV GXP (i.e. diversity of supply). • Delivers (N-1) security to Putaruru zone substation and improved security for Tirau substation for 33kV faults. 	<ul style="list-style-type: none"> • In the event of damage/failure the underground cables would take a relatively long time to repair. However, this is balanced by the fact that the existing Hinuera GXP and associated 33kV lines provide backup. • Reactive compensation required at Tower Rd substation to provide voltage support.
<p>Option 6:</p> <p><i>New 110/33kV GXP at Putaruru. 110kV OH line Arapuni to Putaruru</i> Refer to Figure 3 & Figure 6.</p>	<ul style="list-style-type: none"> • The 110kV supply from the Arapuni power station would be reliable and robust (relatively high fault level). • An existing substation site (Putaruru zone sub) would be reconfigured (using existing land) to accommodate the 110/33kV substation. An additional site is not required. • Delivers a second independent 110kV supply into the Hinuera area (i.e. diversity of supply). • Delivers (N-1) security to the Putaruru zone substation and improved security to the Tirau substation during 33kV faults. • Relatively low construction costs. • The repair of an overhead 110kV line is relatively simple. 	<ul style="list-style-type: none"> • The property rights and consents to build an overhead 110kV line are expected to take a significant period to acquire (>5 years). Powerco expect significant landowner opposition to this project and compulsory acquisition is expected to be required in order to proceed with the project. • High easement/consenting costs. • Significant challenges are expected in order to cross the Waikato River. • Overhead lines tend to have lower reliability and attract higher maintenance costs (i.e. vegetation management, insulator repair etc.)



<p>Option 7:</p> <p><i>New 110/33kV GXP at Putaruru. 110kV UG Cable Arapuni to Putaruru Refer to Figure 3 & Figure 6.</i></p>	<ul style="list-style-type: none"> • The 110kV supply from the Arapuni power station would be reliable and robust (relatively high fault level). • An existing substation site (Putaruru zone sub) would be reconfigured (using existing land) to accommodate the 110/33kV substation. An additional site is not required. • Delivers a second independent 110kV supply into the Hinuera area (i.e. diversity of supply). • Delivers (N-1) security to the Putaruru zone substation and improved security to the Tirau substation during 33kV faults. • Underground cables tend to have higher reliability (than overhead lines) as they are unlikely to be affected by wind, lightning, trees, animals etc. • Relatively low easement/consenting costs. 	<ul style="list-style-type: none"> • Relatively high construction costs. • Underground 110kV cables are a proven technology, but they do have a different risk profile to overhead lines. In the event of a cable failure the repair times would be relatively long and Powerco would need to maintain the relevant cable jointing skills (and cable spares).
<p>Shared Features</p>	<ul style="list-style-type: none"> • Utilise known technology and proven designs. • Consultation with consumers has confirmed support for the project. 	<ul style="list-style-type: none"> • All options take supply from the grid via Arapuni. • Does not provide the Hinuera network (N-1) with a no break supply.

<p>Recommendation</p>	
<p>Preferred Option</p>	<p>The preferred project is Option 7 involving a new Putaruru GXP that is supplied via a single circuit, 60MVA, 110kV underground cable from the Arapuni Substation.</p>
<p>Reasons for choosing Option</p>	<p>Option 5 is expected to be the highest cost, whilst the costs associated with Option 7 and Option 6 are likely to be relatively similar. Option 6 (involving the construction of an overhead 110kV line) is expected to receive public opposition and thus have a longer lead time.</p> <p>Given the above facts Option 7 is Powerco’s preferred option and it will:</p> <ul style="list-style-type: none"> • Deliver additional diversity of supply into the Hinuera area, which is a significant factor. • Provide backfeed to the Putaruru substation during outages on the Hinuera-Putaruru single 33kV circuit. • Provide backfeed to the Hinuera GXP during outages on the Karapiro-Hinuera single 110kV circuit.



Option 7 | Detailed Costs⁶

Item	Description	Actual Cost	Projected Cost
A	Preliminary Works		
A.1	Cable Route Selection and Design	-	\$500,000
A.2	Waikato River Crossing and Design (inc. negotiations with Mercury & local council)		\$430,000
B	Substation Costs		
B.1	Putaruru 110/33kV substation (inc 110/33 transformer cost @\$1.4M)	-	\$4,800,000
B.2	Arapuni 110kV line bay		\$1,150,000
C	Line and Cable Costs		
C.1	≈17km, 110kV, Underground Cable	-	\$13,946,333
C.2	Waikato River Crossing Construction		\$645,000
E	Committed/Historical Costs (A+B+C+D)	\$0	
F	Future Projected Costs (A+B+C+D)		\$21,471,333
G	Anticipated Final Cost (E+F)		\$21,471,333

⁶ Excludes Powerco’s internal/overhead costs (referred to as AMG).



Project or Action	Start Year ¹	End Year ¹	NZ \$'000 ¹	Details / Comments
Project costs to date	-	FY15	\$0	Costs that have already occurred.
Cable Route Selection & Design	FY17	FY19	\$500	Selection of cable route. Preliminary and detailed design.
Waikato River Crossing design & negotiations	FY17	FY19	\$430	Selection of route. Consultation with Mercury & local council. Preliminary and detailed design.
Single circuit 110kV cable (Arapuni to Putaruru)	FY20	FY22	\$13,946	≈17km, 400mm ² AL XLPE underground cable to be installed within road reserve from Arapuni substation to Powerco's existing 33/11kV zone substation.
Waikato River Crossing Construction	FY20	FY22	\$645	Construction of structure across the Waikato to accommodate 110kV cables
110/33kV substation at Putaruru	FY21	FY22	\$4,800	Reconstruction of the existing Putaruru zone substation to include a 40MVA, 110/33kV transformer coupled with a new 33kV indoor switchroom. Includes \$1.4M for new 110/33 transformer
Arapuni substation 110kV works	FY21	FY22	\$1,150	Construction of another 110kV line bay on the existing 110kV busbar.
Total Project Costs →	-	FY22	\$21,471	Only Growth & Security Expenditure.

Supporting Documents and Models

<p><i>Planning documents Standards Policies Reviews and Consultant reports Concept Designs Estimates</i></p>	<ol style="list-style-type: none"> 1. Putaruru GXP – Options Analysis Report & Hinuera GXP Security Improvement Economic Evaluation Analysis dated October 2016. 2. Putaruru Transmission Project – Public Consultation 3. Putaruru Grid Reliability Standard (GRS) Assessment, Transpower document dated December 2013. 4. Putaruru_GRS Review, dated December 2013 5. Putaruru Connection Options. Transpower document, dated 26th October 2012 6. Putaruru GRS Review, dated February 2014 7. Putaruru Project Plan Presentation, dated October 2014 8. Hinuera to Tirau Additional 33kV Circuit, board memo dated 16th November 2013. 9. Putaruru – Hinuera: 110kV and 33kV Options High Level Response dated 1st August 2016. 10. Powerco’s Demand Forecast. 11. Powerco’s 2013 Asset Management Plan (AMP). 12. Transpower’s Annual Planning Summary (APS). 13. “310S001 Security-of-Supply Classifications – Zone Substations”, Powerco Standard. 14. “393S041 Zone Substation Transformer Ratings”, Powerco Standard. 15. “393S035 Electrical Network Conductor Rating Standard”, Powerco Standard. 16. Transpower-Powerco Joint Report – Hinuera Reinforcement Review, dated 28 October 2016.
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Notes/Assumptions

<p><i>Generic Assumptions in relation to Options Costs</i></p>	<ul style="list-style-type: none"> • Costs are expressed in 2016 (real) dollars. • Powerco’s capital costs fall within the Growth and Security workstream and Quality of Supply expenditure categories only. • The capital costs only include Powerco’s capital expenditure (not Transpower or other parties). • The costs include all costs associated with the proposed projects (or alternate options) regardless of whether those costs fall within the CPP period or not, although they do not include any sunk costs (assets commissioned already).
<p><i>Specific Assumptions in Relation to Options Costs</i></p>	<ul style="list-style-type: none"> • Cost estimation for the options has initially been achieved via a desktop study using Powerco’s standard building block unit costs. The costs have then been refined by further investigations. • Property and consenting costs are usually a high risk area involving considerable uncertainty. Proposed underground cables are installed where possible in road reserve.

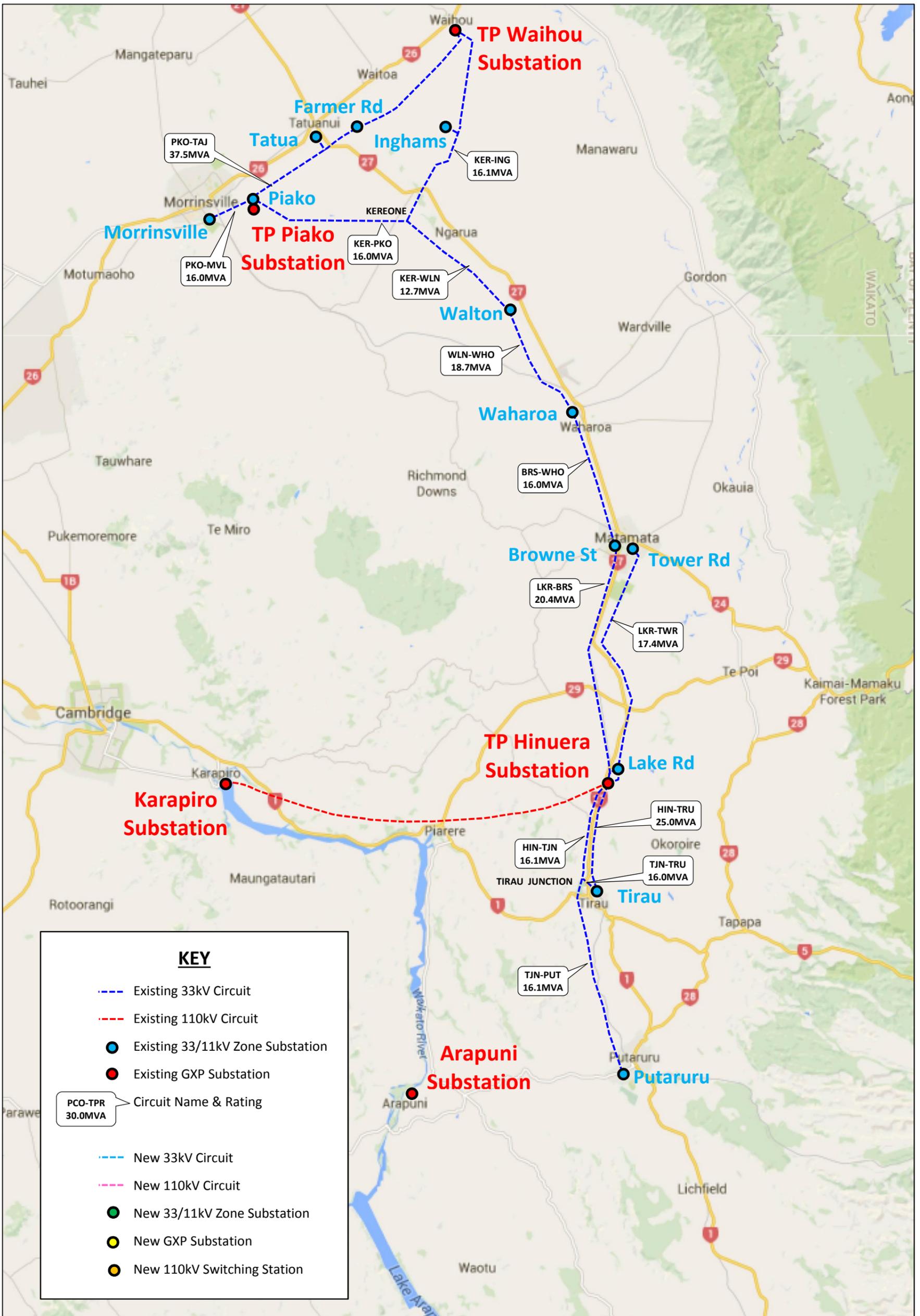


Figure 1 Existing Hinuera & Piako GXP Sub-transmission Networks: Geographic Diagram

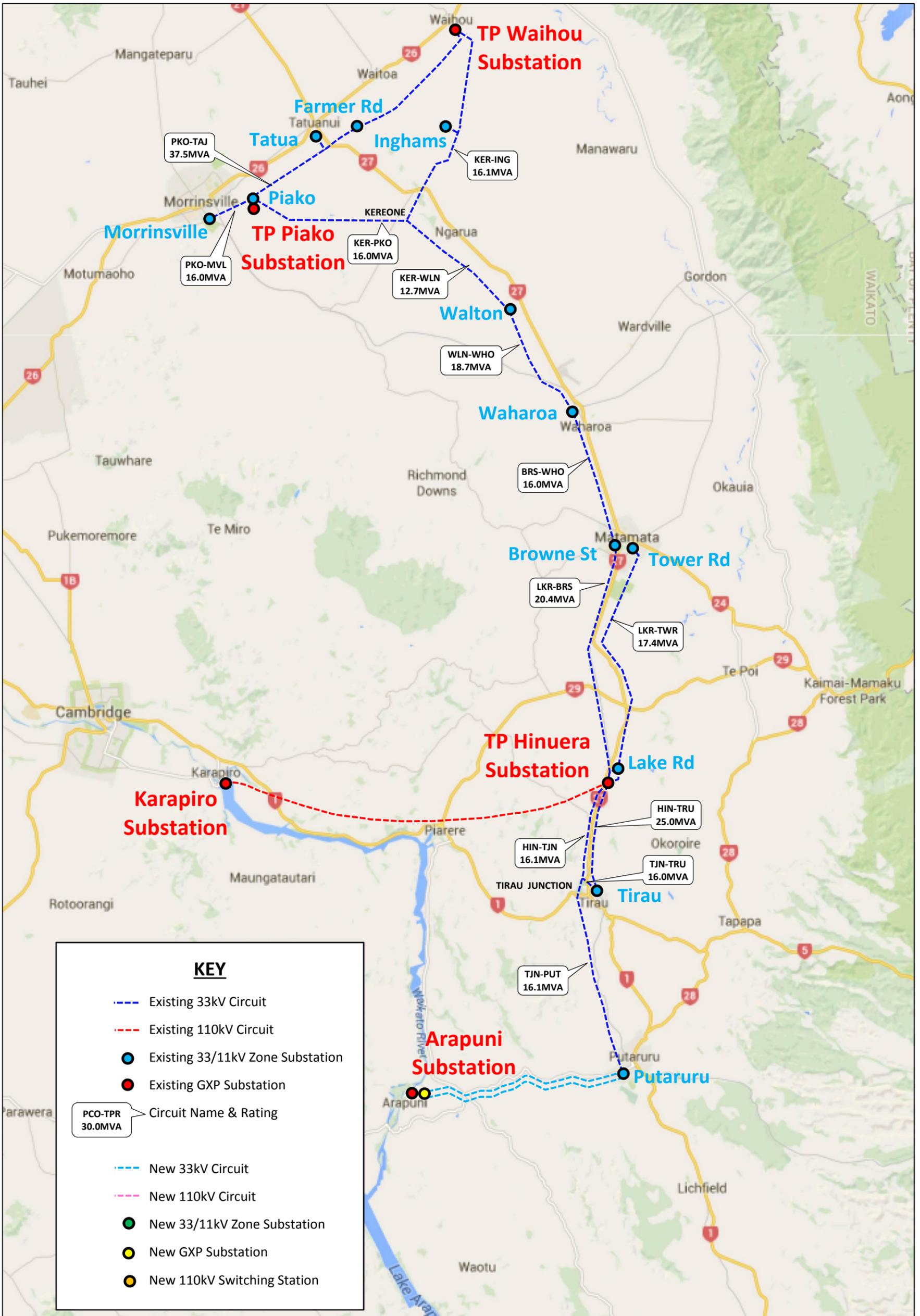


Figure 2 Option 5: New Arapuni GXP with 2 x 33kV Cables to Putaruru: Geographic Diagram

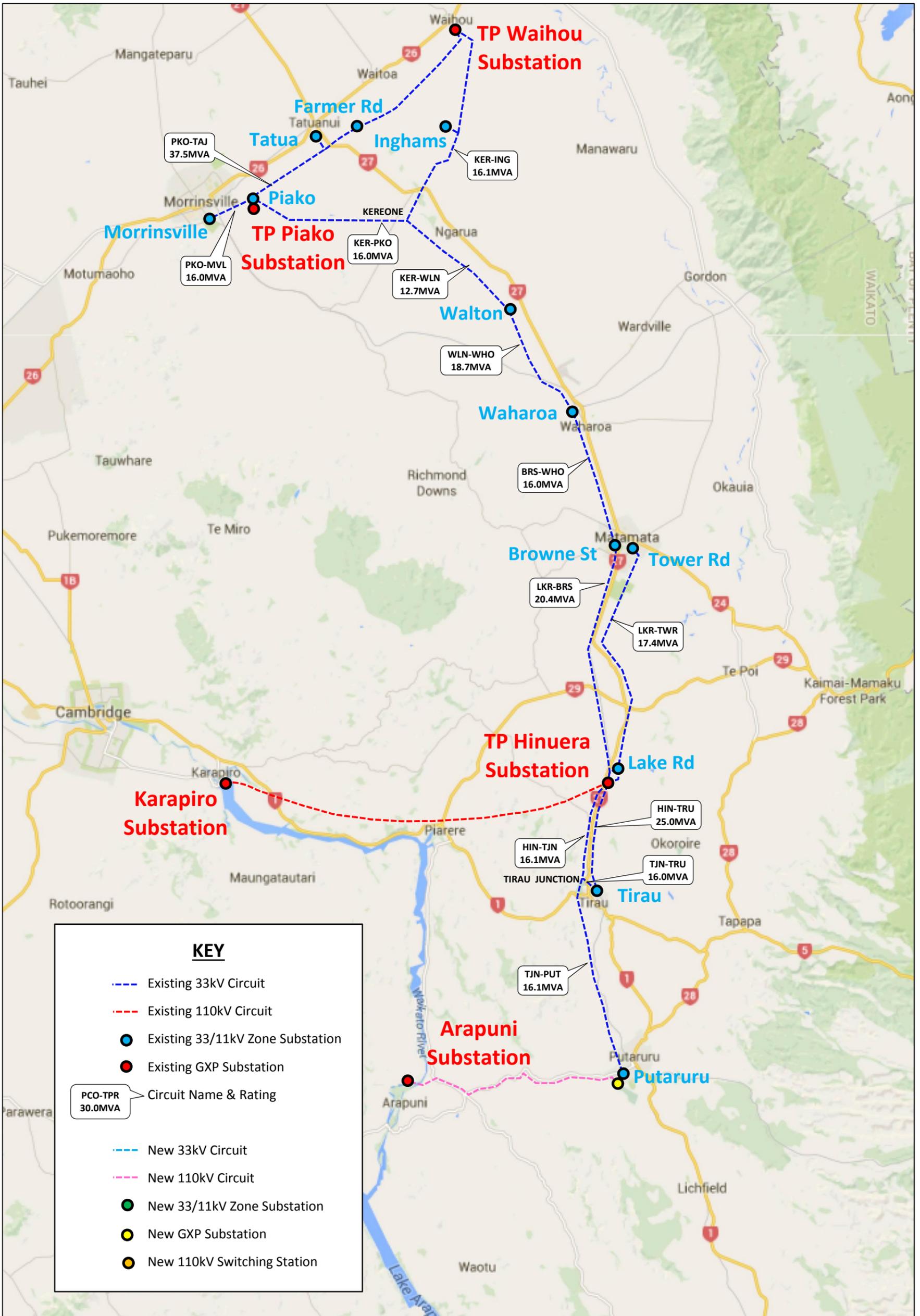


Figure 3 Option 6/7: New Putaruru GXP – Arapuni 110kV Connection: Geographic Diagram

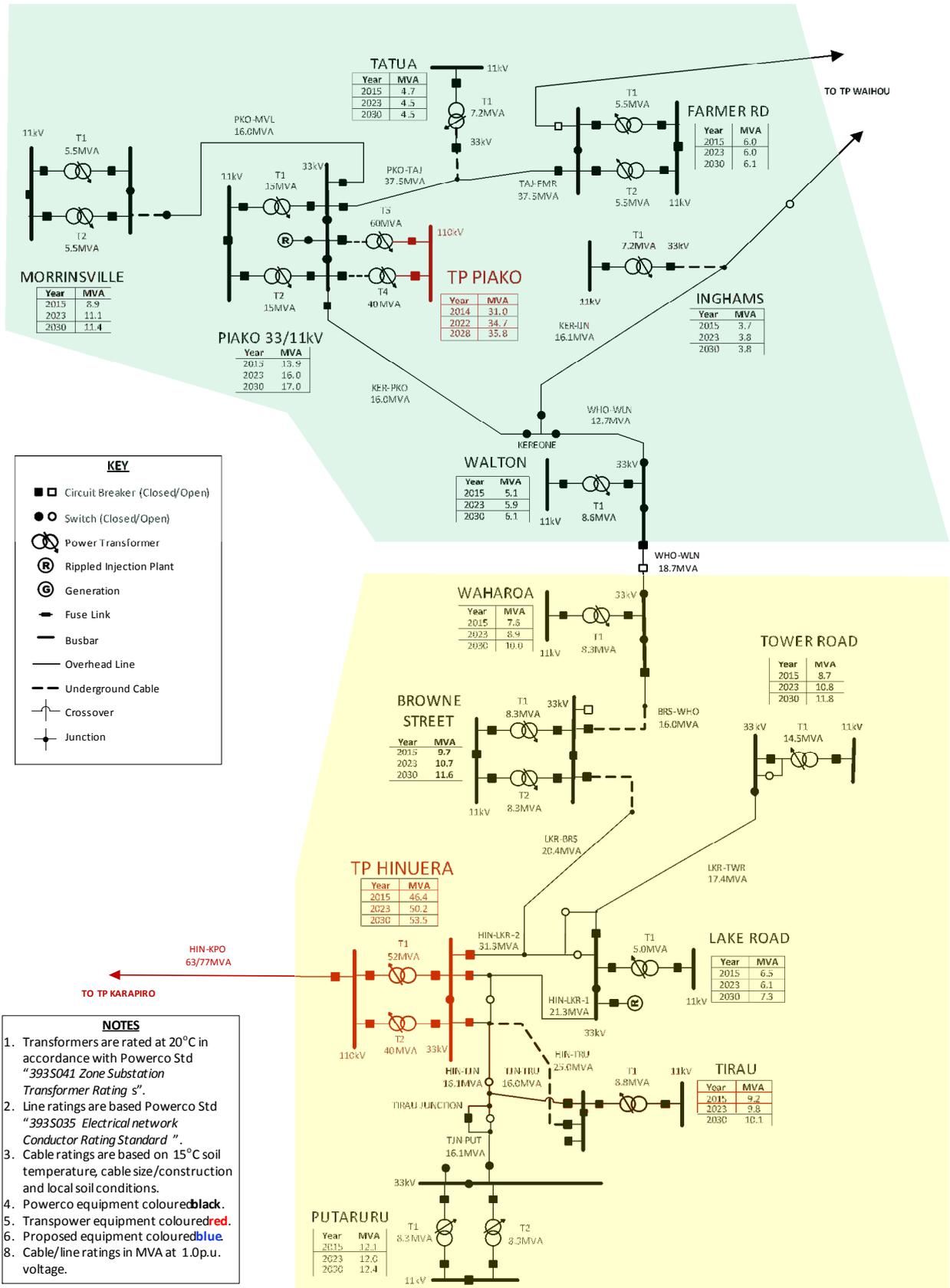


Figure 4 Existing Hinuera & Piako GXP Subtransmission Networks: One-Line Diagram

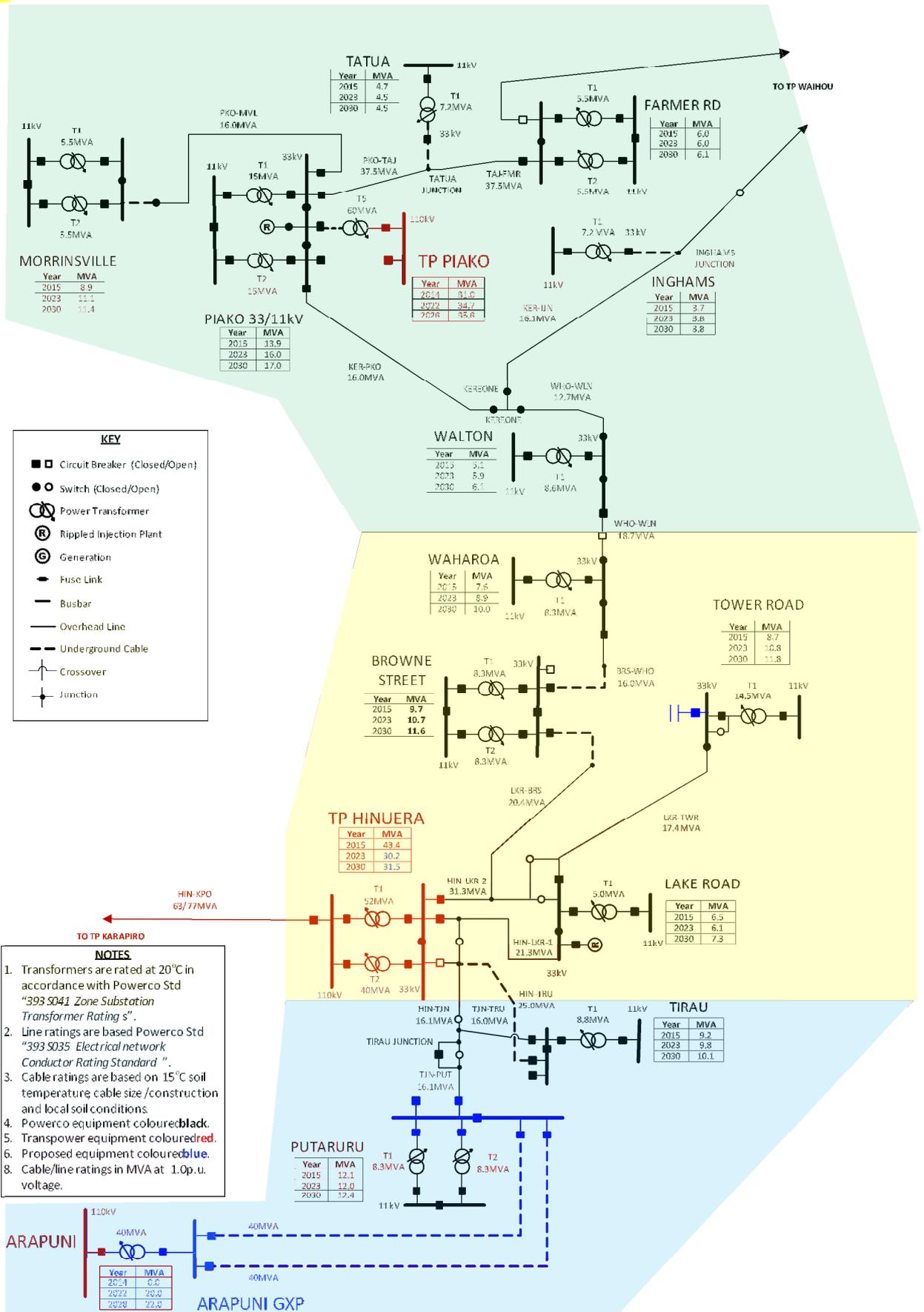


Figure 5 Option 5: New Arapuni GXP with 2 x 33kV Cables to Putaruru: One-Line Diagram

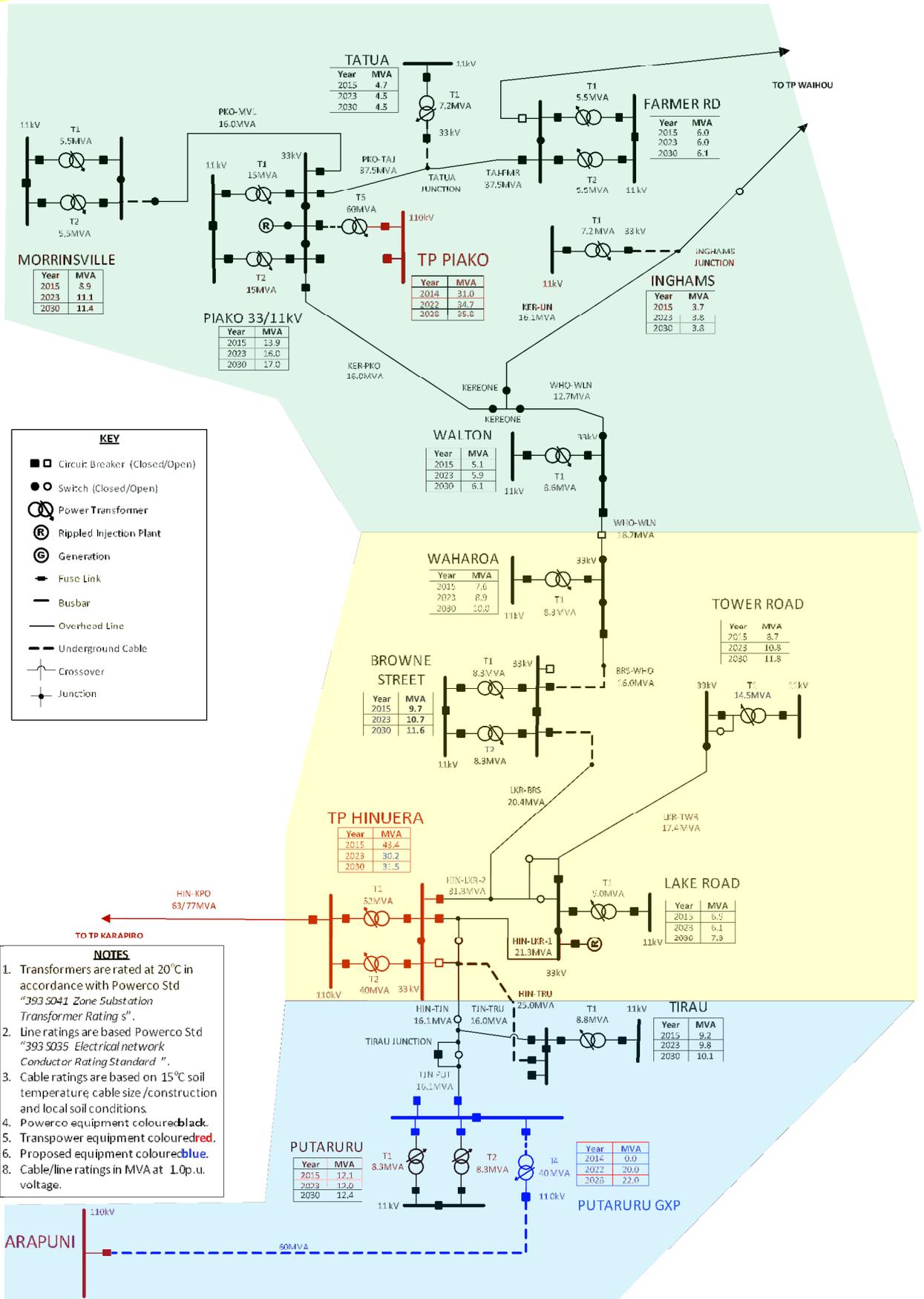


Figure 6 Option 6/7: New Putaruru GXP – Arapuni 110kV Connection: One-Line Diagram