Powerco CPP – Portfolio Overview Document

Portfolio Name	Inglewood 6.6kV to 11kV conversion
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))*	$0.0	$2.1	$2.7	$0.7	$0.0	$0.0	$0.0	$5.5	$5.5
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$0.0	$2.3	$2.9	$0.8	$0.0	$0.0	$0.0	$5.9	$5.9

Description

Project need overview	Inglewood substation operates at 6.6kV. This lower distribution voltage results in compatibility issues with the surrounding area and the distribution transformers are not standard items on Powerco's network. Voltage at the end of some of the distribution feeders is below acceptable limits. The substation itself is loaded beyond firm capacity and backup from surrounding areas is limited due to the variation in distribution voltage.

Preferred Solution

Project solution Overview	The proposed solution is to convert Inglewood substation to 11kV. This involves replacing the remaining 6.6kV/415V distribution transformers with dual ratio units then converting everything to 11kV.

Need Identification

[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.

Background	Inglewood Zone Substation supplies power to Inglewood township and the surrounding rural area at 6.6 kV. There are 2,515 ICPs supplied by this substation and its present demand is 5.3MVA. Its present distribution network is constructed to operate at 11kV. Presently, there are two 33/11kV-6.6kV, 5MVA transformers, but only one transformer operates at a time due to the lack of 33kV CBs on the two incoming 33kV lines. One supply is from Huirangi and other from Stratford GXP. There is a routine project planned to install a 5-panel indoor 33kV Switchboard in FY 2018. Inglewood Substation supplies six 6.6kV distribution feeders – Mountain Rd, Kaimata, Rata St, Eliot St, Bristol Rd and Brooks St. Inglewood township is mostly supplied from Rata St, Eliot St and Brooks St feeders. Over the last 10 years Powerco has been installing dual voltage ratio, 11kV-6.6/0.415kV transformers whenever a new or an old transformer is being replaced. However, the progress is slow and it would take decades to replace all transformers by natural attrition.
Underlying Drivers and Investment Triggers	The following constraints/issues exist in this area: • 6.6kV feeders draw more current (1.67 times) than an 11kV feeder to supply the same load and affects voltage quality and thermal capacity • Mountain Rd feeder during peak demand period experiences voltage quality around 1.2% below the acceptable limit (95%) at several far end sections of lines. Refer Figure 1. • Other feeders are close to voltage limits and will require upgrading and/or voltage regulators in the near future. • Adjacent backup supply from most of the nearby substations is at 11kV, therefore incompatible with the Inglewood supply. • Dual voltage distribution transformers carry a 25% cost premium over our standard transformers.
Timing	The project is timed to occur around 2019.

Demand Forecast | Inglewood Substation

INGLEWOOD SUBSTATION			FORECAST DEMAND 98th percentile [A]						
FEEDER	ICP COUNT	GROWTH	2016	2017	2018	2019	2020	2025	2030
Mountain Rd	450	1.9%	98	100	101	103	105	114	123
Kaimata	236	0.6%	53	53	53	54	54	56	57
Rata St	706	0.9%	102	103	104	104	105	110	114
Elliot St	169	1.0%	35	36	36	36	37	39	40
Bristol Rd	158	1.1%	42	42	42	43	43	46	48
Brookes St	796	0.8%	111	112	113	114	114	119	123

INGLEWOOD SUBSTATION			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Inglewood	6.2	1.1%	5.4	5.4	5.5	5.6	5.6	5.9	6.2

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 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.

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

Assessment Process	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 have significant challenges and/or shortcomings. On this basis a two tier Options Analysis 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. As a result of the process a short list of viable options is identified for further analysis.
Long List of Options	The following table contains a list of the high level project options that are potentially available to resolve the issues in Inglewood. Option 1 involves maintaining the status quo and allowing the voltage and power quality to decrease over time. Adoption of this option is possible but as a prudent network operator Powerco is of the view that following this path would not be appropriate, given the supply network would not meet regulatory levels in terms of supply voltage. Option 1 is thus not short-listed. The three non-network options (Options 2, 3 and 4) are not shortlisted on the following basis: • Renewable generation sources are often not viable due to their intermittent nature and cost. Fossil fuelled generation is technically viable but not shortlisted due to cost, environmental and consenting issues. • Fuel switching and demand side response (DSR) are considered to be deferment strategies and their viability is not certain. Powerco uses a mains-borne ripple control system to control significant amounts of hot water cylinder load on its network. During peak loading periods most hot water cylinders are turned off. The demand reduction, however, is not sufficient to

	alleviate the constraints. No significant/additional winter peaking consumer loads have been identified for control. Options 5 through 7 are considered viable options and warrant further assessment. Options 6 and 7 are similar, delivering the same overall outcome, but are implemented over different project timeframes.

Long List of Options | High Level Assessment

Inglewood 6.6kV to 11kV		*Long list of projects and high level assessment*	*Assessment Criteria*						
PROJECT FOCUS	**No.**	**PROJECT**	Fit	Feasible	Practical	GEIP	Security	Cost	**Short-list**
Do Nothing	1	Allow the electrical demand & risk of consumer non-supply to increase	✗	✓	✓	✗	✗	✓	✗
Non-network:	2	Distributed Generation (DG) including peak lopping generation	✗	✓	✗	✓	✓	✗	✗
	3	Fuel switching to reduce electrical demand	✗	✗	✗	✓	✓	✗	✗
	4	Demand Side Response (DSR)	✗	✗	✗	✓	✓	✗	✗
Network Reinforcement	5	Maintain the network at 6.6kV (reconductor and voltage regulators)	✓	✓	✓	✗	✓	✓	✓
	6	Convert to 11kV over CPP period using step up transformers	✓	✓	✓	✓	✓	✓	✓
	7	Convert to 11kV over a 3 year period	✓	✓	✓	✓	✓	✓	✓

Key:

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, safety)
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.

Options Analysis | Short List of Options		
Option	**Cost[4]**	**Description**
Option 5: ***Maintain the 6.6kV supply***	$11.1M	This option involves continuing to operate the Inglewood network at 6.6kV by upgrading conductors to meet voltage and capacity demands. Over time, all the 115kms of feeders would need to be replaced.
Option 6: ***Staged conversion to 11kV over CPP period***	$7.6M	This option involves installing 6.6/11kV step up transformers midway on the feeders, converting the ends of the feeders to 11kV and progressively moving the step up transformers back toward the start of the feeder, eventually carrying out a full conversion to 11kV at the end of FY23
Option 7: ***Conversion to 11kV over a 3 year period***	$5.5M	This option involves replacing the remaining 6.6kV /400V transformers with dual winding transformers and then converting all feeders to 11kV within a three year timeframe. Changeover would be done on each feeder as a whole, beginning with the one having the worst voltage drop. Once all feeders were changed over the substation would be reconfigured to supply at 11kV in FY21.

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
Option 5:	• Upgrades can match demand increases • No need for step-up transformers	• More expensive overall. • Network remains incompatible with surrounding network • Significant outages required to implement the reconductoring.

[4] The total capital cost of each project. The costs do not consider the time value of money and do not include the economic value of other factors (i.e. network losses and consumer outage costs).

Option 6:	• Upgrades can be staged to match the demand growth	• More expensive to implement overall • Adds complexity to the network with split feeder voltages. • Involves a large amount of rework as the step up transformers are relocated • Delayed final changeover to 11kV
Option 7:	• Most efficient project • Reduces complexity • Enhances reliability and performance sooner	• For some feeders, voltage improvements may occur well ahead of when they are needed.

Preferred Option(s)	
Preferred Option	**Option 7:**
Reasons for choosing Option	Option 7 is determined to be the most economic option. It has the following benefits and advantages over the other options considered: • The lowest capital cost. • Reduces network complexity • Improves network reliability through simpler interconnection with adjacent networks. • Avoids rework

Project Name: PoD- G22 Inglewood 6.6kV to 11kV conversion

Item	Description	Actual Cost	Projected Cost
A	Conversion from 6.6kV to 11kV	-	$5,493,401
E	Committed/Historical Costs	$0	
G	Anticipated Final Cost (A+E)		$5,493,401

Implementation Plan

Project or Action	Start Year	End Year	NZ $'000	Details / Comments
Project costs to date	-	FY19	$0	A number of dual voltage distribution transformers have been installed but the costs have been treated as straight out renewal to date and so are not included in this project.
Replace distribution transformers with dual wound transformers and convert to 11kV	FY19	FY21	$5.5M	
Total Project Costs ➔	**FY19**	**FY21**	**$5.5M**	Includes Only Growth & Security Expenditure.

Supporting Documents and Models	
Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Powerco's Demand Forecast. 2. Powerco's 2016 Asset Management Plan (AMP). 3. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 4. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 5. "*393S035 Electrical network Conductor Rating Standard*", Powerco Standard.

Notes/Assumptions	
Generic Assumptions in relation to Options Costs	• Costs are expressed in 2016 (real) dollars. • The costs quoted are to construct the network and do not include economic factors (i.e. costs of non-supply) • The capital costs fall within the Growth and Security 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.
Specific Assumptions in Relation to Options Costs	• 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. Due to the urban/lifestyle-block nature of area underground cable is used and where possible installed in road reserve. • The costs in this POD may differ from those in the detailed Options Analysis document. This is because some of the costs have been further reviewed and refined to confirm the preferred solution. The refined costs have been checked against the estimates used in the Options Analysis to ensure that it does not materially impact the Option Analysis outcomes and that the preferred solution still ranks higher than alternatives.

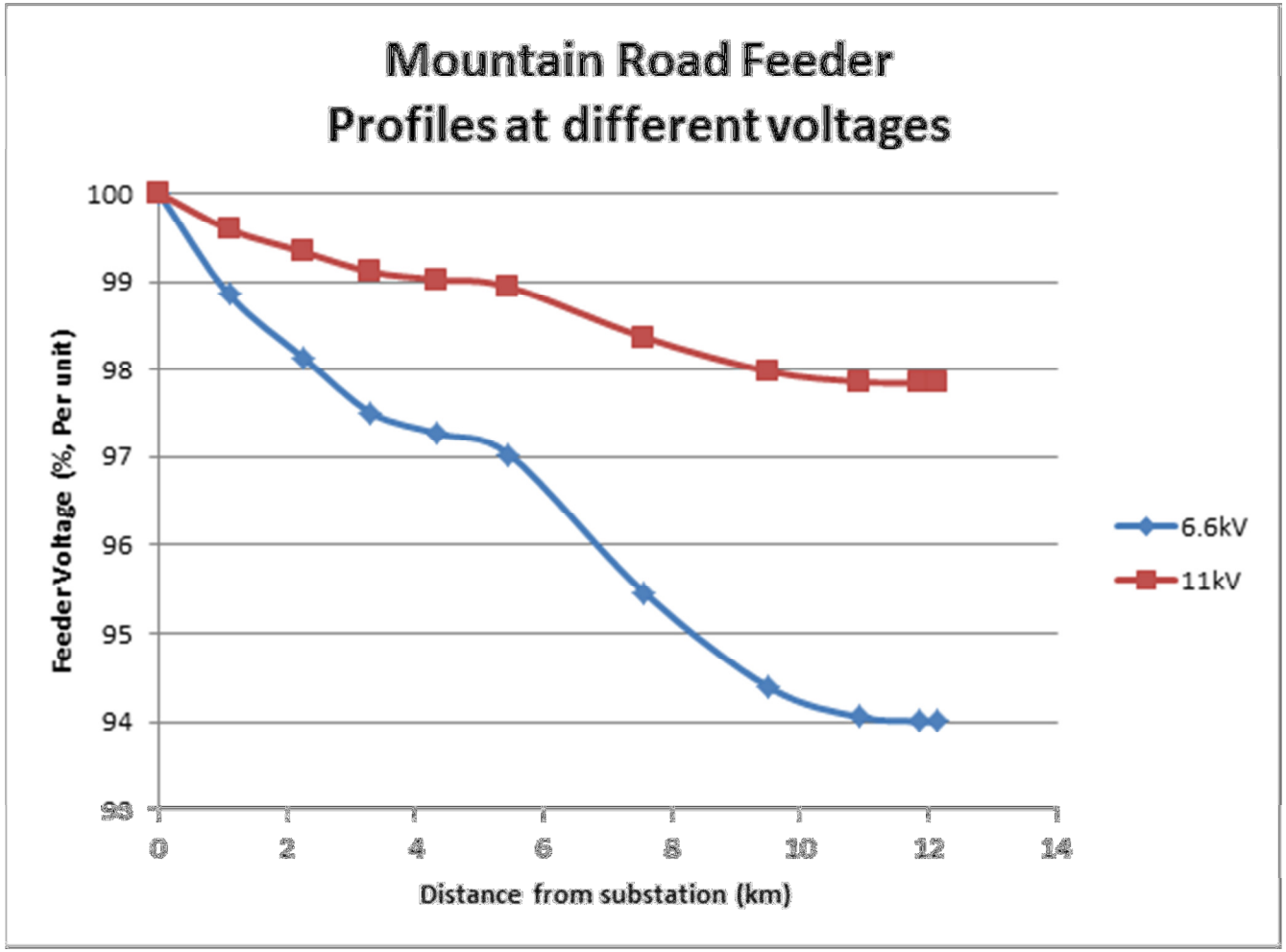

Figure 1: Mountain Road feeder voltage profile