2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack - PUBLIC

CP.02463
Dysart Transformer Replacement

Delivering better value

ID&TS – Reset 2017/18-2021/22 Project Proposal for CP.02463 T035 Dysart No. 1 & 2 Transformer Replacement

Document Approval		
	Name	Position
Prepared by		Project Manager
Reviewed by		Manager Projects
Approved by		Group Manager Infrastructure Delivery

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1. Executive Summary

T035 Dysart Substation was originally established in 1973 to supply the growing mining development in the Central Queensland region and Ergon Energy regional distribution network. T035 Dysart substation has two 132/66/22kV transformers both being rated at 52.5/70MVA (Tx1 & Tx2).

Tx1 & Tx2 were installed in 1973 as a part of the substation development. Both units are approaching 42 years of age and are displaying issues typical of transformers of this age.

A recent condition assessment in February 2015 has highlighted a number of issues with the units, and recommends action to be taken within 5 years.

The objective of this project is to replace the transformer 1 and transformer 2 units with new 100MVA units by October 2019.

2. Project Definition

2.1 Project Scope

Briefly, the project consists of replacing both existing 70MVA 132/66/22kV transformers at T035 Dysart with new 132/66/22kV 100MVA transformers. In order to achieve the required bay ratings for the new transformers the transformer bays will also need to be replaced as part of the scope of work.

Decommission, remove and dispose of the recovered transformer 1, transformer 2 and associated bays.

2.1.1 Transmission Line Works

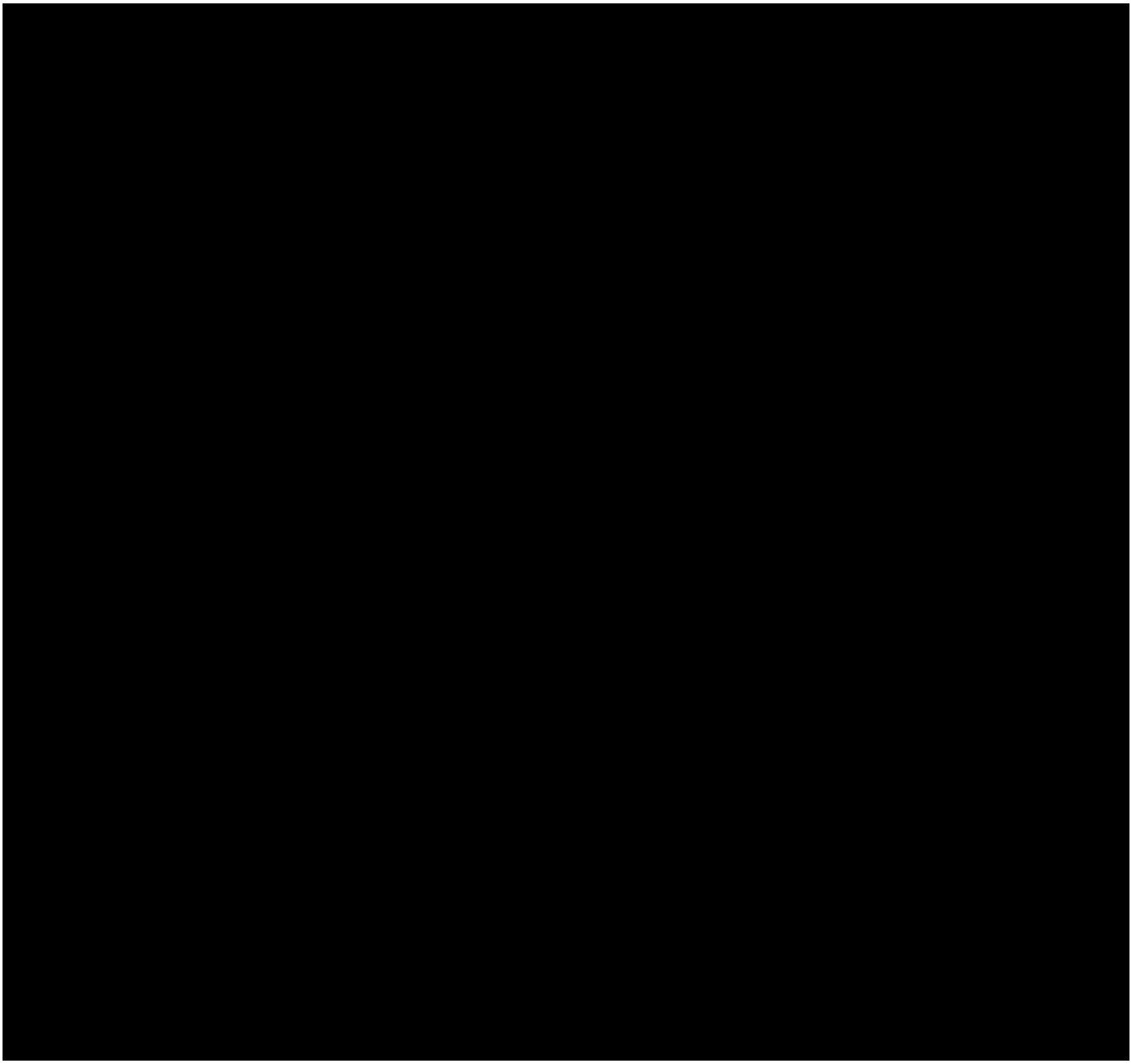
N/A.

2.1.2 T035 Dysart Substation Works

Design, procure, install and commission two 132/66/22kV transformers, including all necessary civil works:

- Procure, supply and install two 60/80/100MVA 132/66/22kV transformers, with on load tap changer and cooling facilities;
- Replace transformer foundations;
- Modify transformer oil separation tank to allow for increased transformer oil quantity on site;
- Replace existing T1 132/66/22kV transformer with a new 60/80/100MVA transformer;
- Replace existing T2 132/66/22kV transformer with a new 60/80/100MVA transformer;
- Reconnect local supply to new T2 transformer and commission;
- Upgrade 132kV strung bus connections;

- Upgrade the 66kV TF surge arrestors;
- Upgrade the associated TF bay plant equipment to achieve load rating compatible with new transformer ratings (2 x TF bays). A review of the existing bay plant ratings has confirmed that the transformer bays do need to be replaced to achieve the required bay rating for the new transformers;
- Decommission old Transformer 1 & Transformer 2 units, recover and dispose of decommissioned transformer units;
- Modify protection, automation and communication systems to accommodate the new transformers;



2.2 Major Scope Assumptions

The following assumptions and issues are important to consider during the implementation of this project:

- It has been assumed that the new transformer pads and associated bays can be replaced within the existing substation fence boundary and no allowance has been made for extending the substation platform;
- It has been assumed that the Ergon 22kV assets can be relocated by Ergon prior to the commencement of site works. It is assumed that all cost associated with this work will be Ergon costs;
- Plant and equipment identified as suitable to be recovered for use as spares or returned to stores will be packaged and transported to an appropriate storage location, with a suitable allowance for the cost included in the estimate;
- Detailed outage plans are not required to be submitted as part of this reset proposal;
- Ergon Energy also operates both 66kV and 22kV plant located on the site, with shared access arrangements; and
- It has been assumed that the new transformers will require noise walls. A detailed noise study will be required to confirm this.

2.3 Scope Exclusions

- No allowance has been made in this estimate for the removal/relocation of the Ergon 22kV assets.
- No allowance has been made in this estimate for the replacement of the existing station services transformers.

3. Project Execution

3.1 Project Dependencies & Interactions

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
	Ergon relocation of 22kV assets	May 2018	Ergon 22kV assets need to be relocated to allow the construction of the new transformer pads adjacent the existing TF locations.
Co-requisite Projects			
CP.01666	Dysart Substation Rebuild	Oct 2019	There will be cost savings that could be realised by combining CP.01666 and CP.02463 into a single project.
Other Related Projects			

3.2 Site Specific Issues

Ground conditions: No identified concerns.

Location: Remote location adjacent to Dysart in a rural area with no major environmental or cultural heritage issues. As the site is in North Queensland the wet season period of December to March should be avoided.

Resource availability: It is anticipated that the Maintenance Service Provider (MSP) (Ergon) and specialist transformer contractor resources would be utilised for this project.

Existing infrastructure: Dysart Substation is a well-developed site. No expansion of the existing site infrastructure is required for this project.

3.3 Project Delivery Strategy

Design: It is anticipated that Powerlink design resources would be utilised for this project

Construction: It is anticipated that Substation Panel Agreement (SPA) contractor and specialised transformer contractor resources would be utilised for this project.

Test and Commissioning: It is anticipated that the Maintenance Service Provider (MSP) and specialist transformer contractor resources would be utilised for this project.

Project Delivery Strategy Matrix		
Design	Earthworks Design	Powerlink
	Civil Design	Powerlink
	Electrical Design (Primary)	Powerlink
	Electrical Design (Secondary) – Protection	Powerlink
	Electrical Design (Secondary) – Automation	Powerlink
	Transmission Line Design	N/A
	Telecommunication Design	Powerlink
Procurement	Transformer Procurement	Powerlink
Construction	Earthworks Construction	SPA Contractor
	Civil Construction	SPA Contractor
	Electrical Construction / Installation	SPA Contractor
	Transmission Line Construction	N/A
Testing	Substation Testing – FAT	Ergon Energy
	Substation Testing – SAT	Ergon Energy
	Substation Testing – Cut-Over	Ergon Energy
	Telecommunication Testing	Ergon Energy

3.4 Proposed Sequence of Works

3.4.1 Project Schedule

To meet the required commissioning date of October 2019 full project approval will be required by 1st August 2017.

High Level Schedule

- Ergon Notification : Oct 2016
- Project Approval : 1st August 2017
- Transformer Procurement : August 2017
- Design Complete : March 2018
- SPA Construct contract awarded : May 2018
- Staged bay construction : June 2018 – August 2019
- Staged bay test/commissioning : August 2018 – Sept 2019
- Final decommissioning/Tidy up : October 2019
- Project Completion : 31st October 2019

3.4.2 Project Staging

Major project stages of the project are considered to be:

Stage	Description/Tasks
1	Relocate Ergon 22kV infrastructure (Ergon work).
2	Construct new Transformer 1 132kV pad and bay offset from existing TF 1 bay. Construct new Transformer 2 132kV pad and bay offset from existing TF bay. Install new transformers. Note: Outage advice has indicated that outages will not be available for in-situ replacement. Due to this the new Transformer bays have been positioned offset from the existing Transformer bays.
3	Test and Commission new Transformer 1 and associated bay in new location including bus mods.
4	Test and Commission new Transformer 2 and associated bay in new location including bus mods..

Note: Additional stages may be required following detailed planning.
Note: An alternative location for TF1 would be the future TF3 location as shown in the substation Ultimate General Arrangement however this would require an extension of the 132kV yard. This would have additional cost implications however it would provide an alternative option if there were issues relocating the Ergon 22kV assets.

3.4.3 Network Impacts and Outage Planning

There are significant outage constraints at this site. Preliminary outage advice from Network Operations has indicated that long duration outages (or outages with a long return to service time) will not be available due to load/security of supply impacts on mine customers, rail customers and Ergon load. It is recommended that TF1 and TF2 are not rebuilt in their current location as the required outages are unlikely to be granted and/or there would be very significant contingency plan cost associated with them.

In order to overcome the outage constraints the construction staging has been developed based on the new transformer pads and bays being constructed adjacent the existing bays. Once the new pads and bays are constructed the transformers can be cutover one at a time into their new locations. This will result in significantly reduced outage durations.

3.5 Project Health & Safety

The implications of relevant workplace health & safety legislation in delivering the proposed solution have been considered in preparing this estimate. In particular, this estimate includes an allowance for any specific safety related activities required in the delivery phase of the project.

3.6 Project Environmental Management

No specific environmental management implications for the delivery of this project have been identified.

4. Project Risk Management

The risks have only been investigated at a high level and a detailed risk analysis will be required during the project proposal phase. Details of the risk that have been included can be found in the risk section of the estimate.

It is assumed that Ergon will relocate the 22kV assets prior to site work commencing for CP.02463. Any delay to the 22kV asset relocation is likely to have a significant impact on the project. No cost have been included in the estimate for this risk. It is recommended that Powerlink get formal agreement from Ergon to relocate the assets as early as possible to help minimise this risk.

5. Project Estimate

5.1 Estimate Summary

Quote Summary (version 2)

The quotation at current base level and escalated for completion by 31/10/19 at 2.5% per year plus labour rate revisions, for CP.02463 T035 Dysart No.1 & 2 Transformer Replacement is as follows:

CP.02463 Quotation in $ AUD	Base Levels	Escalated to Compln.	Comment (Costs @ Base Levels)
Dysart Substation	8,661,993	9,371,439	Replace existing 2x 52.5/70MVA 132/66/22kV transformers with 2x new 132/66/22kV 60/80/100MVA transformers, include 2x transformer bays. Modification to existing oil separation tank. Replace existing 2x transformer foundation.
Project Management	[redacted]	[redacted]	
Qleave			
Other Costs			
TOTAL QUOTE (EXCL RISKS AND OFFSETS)	**9,049,567**	**9,789,631**	
Offsets Estimate	**0**	**0**	
TOTAL QUOTE (INCL OFFSETS)	**9,049,567**	**9,789,631**	
Risk Estimate	**500,000**	**500,000**	[redacted]
TOTAL QUOTE (INCL RISKS AND OFFSETS)	**9,549,567**	**10,289,631**	

NOTE: A link to the estimate detail can be found in the table in Section 6 References.

5.2 Asset Disposal Table

The current net book value of assets to be disposed of as a result of this project are set out in the table below.

CP.02463 Asset Disposal Table. Values current at 30th June 2016

Functional Loc.	Description	Asset	Subnumber	Book val.	% Disposal	Disposal Value	Currency
T035-T01-1TRF	1 TRANSFORMER	105866	0	120,743.45	100%	$ 120,743.45	AUD
T035-T02-2TRF	2 TRANSFORMER	105867	0	120,743.45	100%	$ 120,743.45	AUD
T035-D01-442-	132kV 2 TRANSF BAY	105846	0	101,594.38	100%	$ 101,594.38	AUD
T035-D03-441-	132kV 1 TRANSF BAY	105849	0	51,747.05	100%	$ 51,747.05	AUD
T035-SSS-441-	132kV 1 TRANSF BAY	105850	0	10,984.54	100%	$ 10,984.54	AUD
T035-SSS-442-	132kV 2 TRANSF BAY	105847	0	22,069.47	100%	$ 22,069.47	AUD
					Total	$ 427,882.34	AUD

6. References

Document name and hyperlink (as entered into Objective)	Version	Date
Project Scope Report	1.0	July 2015
Estimate Detail	3.0	Jan 2016
CP.02463 Dysart Sub Rebuild Proposed TF Bay Locations	1.0	July 2015

T035 Dysart Transformer T1 & T2 Condition Assessment

Report requested by:	[redacted]	**Requested Completion Date:**	01/10/2014
Report Prepared by:	[redacted]	**Date of site visit:**	13/03/2014
AUTHOR/S:	[redacted]		
Report Approved by:	[redacted]	**Report Approval Date:**	
Report Reviewed by:	[redacted]	**Review Date:**	11/02/2015
Issue Approved by:	[redacted]	**Issue Date:**	11/02/2015

Date	Version	Objective ID	Nature of Change	Author	Authorisation
03/11/2010	1.0	A947424	Full Review	[redacted]	[redacted]
11/02/2015	2.0	A1885630*	Full Review	[redacted]	[redacted]

** - This report was developed using Dysart Substation Condition Assessment report dated 11/02/2015.*

IMPORTANT: - This condition assessment report provides an overview of the condition of power transformer/s (excluding internal transformer inspections) and high level indications of their residual reliable service life. As it is a snapshot in time and subject to the accuracy of the assessment methodology and ongoing in-service operating environment, the comments in this report are valid for 3 years from the date of the site visit stated above.

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1. SUMMARY

T035 Dysart substation transformers T1 and T2 are 41 year old General Electric design and in line with the requirements of AM-POL-0056, a condition assessment has been performed towards “end of life” including an on-site visual assessment combined with a desktop analysis of historical oil and insulation test data, maintenance history and through fault data history where available.

Although power transformer condition is monitored closely, the exact point of power transformer failure cannot be accurately predicted. As the consequences associated with catastrophic power transformer failure in electricity transmission are very high in terms of the financial costs, and potential loss of supply, impact on safety of personnel and public and on the environment (fire, gasses, oil disposal, etc.), the asset management strategy employed is to plan and execute replacement before the actual failure occurs.

This is done by assessing the condition of major transformer components and estimating their end of life as well as that of the overall transformer. As the transformer systems and components deteriorate their probabilities of failure increase leading to an increased risk cost and decreased transformer availability. While component repair or replacement may be possible, in many cases they would provide very little or no benefit with regards to the transformer probability of failure. Typically repairs would have to be performed on a number of power transformer components, whilst the major internal components (insulation, core and mechanical enforcement of internal components) cannot be repaired.

As such, no attempt has been made in this report to cover any detailed economic analysis of the viability of rectifying any highlighted issues associated with these transformers. The report provides a condition assessment of the “key” parameters for these transformers and what may need to be actioned if the transformers are to remain operational for a further 5 years and beyond.

A summary of the findings is shown in Table 1. Note that the assessment has revealed that Transformer T2 is in a marginally better condition than T1 and was exposed to a smaller number of through faults. Its cellulose age may not be truly reflected in the 2 –Furfurals measurement as the oil was processed.

Transformers T1 and T2 have assessed “as-is” residual life expectancies of 3 to 5 years and 5 to 10 years, respectively due to their overall condition. Their reliable life is limited by their mechanical integrity which if tested by through fault of significant magnitude or duration is very likely to fail.
If these two transformers are to be kept for longer than 3 years, as a minimum a new set of bushings (estimate $200,000 plus Contractor charges for installing) would need to be installed.

TABLE 1

Summary of Estimated Residual Life of Transformer T1 & T2 "Key" Components

Parameter	Estimated Residual Life		Further Comments
	T1	T2	
Anti-corrosion system	3 to 5 years for main tank. 2 to 3 years for cooler bank	5 to10 years for main tank. 3 to 5 years for radiators	Significant corrosion on some parts and clear indication of its progression as some oil leaks result from corrosion.
Winding paper life	10 to 15 years	15 to 20 years	T1 Calculated Av age = 19 years Wdg Hot spot age = 24 years T2 Calculated Av age = 17 years Wdg Hot spot age = 22 years
Winding mechanical stability	Cannot be assessed accurately, but is considered to be 1 to 3 years due to design and high exposure to through faults.	Cannot be assessed accurately, but is considered to be 3 to 5 years due to design and high exposure to through faults which is significantly lower than for T1.	Old clamping structure design, decreased DPv & moisture exchange plus a high number of through faults predominantly caused by voltage regulators connected to transformer tertiary.
External HV & LV bushings	HV and LV bushings need replacement. These are all original Micafil bushings manufactured in 1973.	HV and LV bushings need replacement. These are all original Micafil bushings manufactured in 1973.	All bushings have exceeded their predicted design life. Some have small oil leaks from top cap.
Insulating Oil	3 to 5 years	5 to10 years	Assuming similar in-service operating conditions for the future.
Radiators	2 to 3 years for cooler bank	3 to 5 years for cooler bank	Oval tube / bottom header interface corrosion issues. Some cooling fans may need replacement.
Repairs to leaking gaskets.	Required now.	3 to 5 years	Many gasket leaks.
Overall residual life.	**3 to 5 years**	**5 to 10 years**	**Residual life will reduce if subjected to through fault of significant magnitude.**

Planning Statement – Dysart Transformer Assessment

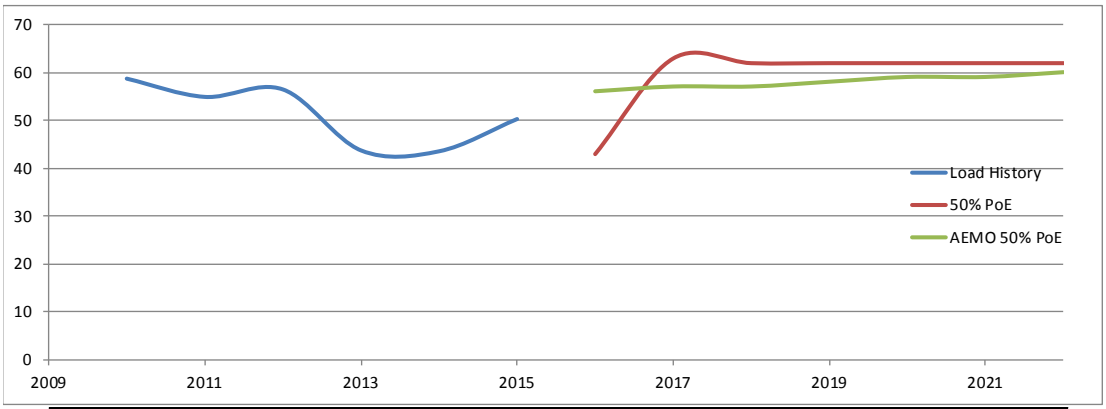
Recommendation: *It is recommended that transformers 1T and 2T be replaced with two transformers at end of life.*

Purpose: The purpose of this paper is to determine the transformation capacity forecast for the Dysart substation.

Background: Dysart Substation was established in the 1970's to support the load growth associated with the expansion of coal mining in the Northern Bowen Basin. At establishment, 2 x 70MVA 132/66kV transformers were installed with 22kV tertiaries to provide supply to the township. The ratings of the transformers are shown below

Transformer Ratings (MVA)	1T	2T
Normal Cyclic	80	80
Emergency Cyclic	89	89
2hr Short Term	91	91

The historic and forecast loadings for T035 Dysart are shown in Figure 1.



	Load History						50% PoE Forecast						
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
MVA	59	55	56	44	44	50	43	63	62	62	62	62	62
AEMO MVA							56	57	57	58	59	59	60

Figure 1: Historic and Forecast loads for T035 Dysart

Latest condition information indicates that 1T and 2T are approaching their end of life, and it is proposed that they be removed from service within the next 10 years.

Due to the nature of the loads at T035 Dysart, being predominantly mining load, significant fluctuations in load occur and the instantaneous load can be up to 50% higer than the 30 minute average, as shown in Figure 2: Load variance at T035 Dysart. This should be taken into account when choosing appropriate rated transformers.

The following Options were considered to address the EOL of transformers 1T and 2T at Dysart.

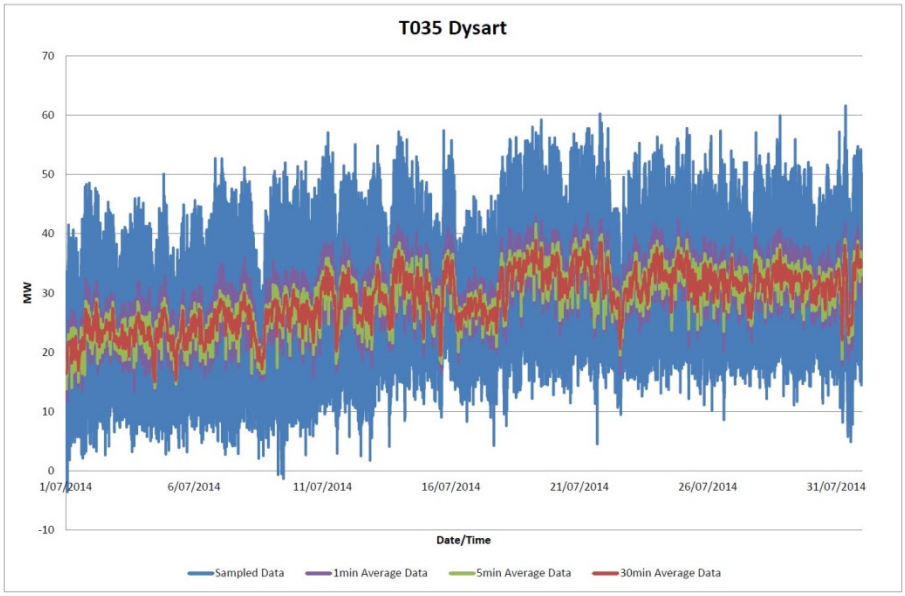


Figure 2: Load variance at T035 Dysart

Option: Replace T1 and T2 with two transformers

Under this option the 2 x 70MVA transformers would be replaced with 2 new (minimum 100MVA) 132/66kV transformers.

This option provides adequate N-1 capacity and ensures that Powerlink's reliability obligations under its Transmission Authority are met.

The use of lower rated transformers and network support could be considered if it were to be cost effective.

***Recommendation**: This option is recommended on the basis that it meets reliability obligations and represents the most economic and efficient investment decision.*

Option: Replace T1 and T2 with one transformer

Under this option it would be proposed to replace the 2 x 70MVA transformers with a single (minimum 100MVA rated) transformer.

This option would not meet Powerlink's obligations under its Transmission Authority, as more than 50MW of load would be at risk for the loss of the single remaining transformer (the minimum load at Dysart in 2014 was 10MW, and it would take less than 1 day to breach the 600MWh cap).

This option, combined with network support, could be considered, however network support would need to be online to ensure that more than 50MW was not shed for the contingency.

This option does not provide adequate N-1 capacity and does not meet Powerlink's reliability obligations under its Transmission Authority.

***Recommendation**: This option should not be considered further on the basis that it does not meet Powerlink's reliability obligations.*

22kV supply

Ergon currently take 22kV tertiary supply from the tertiary of both transformers, however it has been agreed that where Powerlink was replacing transformers that Ergon would provide an alternate supply where economic to do so.

Powerlink's current 132/66kV transformer specification has an 11kV tertiary supply, however Dysart has a local 22kV supply. There are a number of options detailed below that can be considered for the replacement of the tertiary.

Option: Specify 132/66/22kV transformers

Specify and install 132/66/22kV transformers, with the existing 22kV regulators replaced at the end of their life.

Recommendation: *This option does not comply with Powerlink policy, however would minimise switchgear requirements.*

Option: 66/22kV transformers

Procure and install 2 x 66/22kv transformers, as well as new 66kV bays, with the ageing 22kV regulators recovered..

Recommendation: *This option would likely have a high upfront cost due to the additional transformers and switchgear requirements.*

Option 132/66/11kV transformers with 11/22kV transformers

Install 132/66/11kV transformers (to current specification), and install 11/22kV transformers, with the ageing 22kV regulators recovered.

Recommendation: *This option does not comply with the policy, and would likely have a high upfront cost due to the additional transformers required.*

Option: 66/22kV transformer with backup from 22kV tertiary

Procure and install 1 x 66/22kv transformer with 1 new 66kV bay. Backup would be via a 22kV tertiary connection, which would be operated normally open. One of the 22kV regulators would be recovered, and a second 66/22kV transformer to replace the other 22kV regulator at the end of its life.

Recommendation: *This option would provide a balanced outcome for cost and risk.*