Regulatory Test - Final Recommendation Report

Emerging Distribution Network Limitations in the South Gladstone Area

15 July 2014

Ergon Energy Corporation Limited

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EXECUTIVE SUMMARY

Ergon Energy Corporation Limited (Ergon Energy) is responsible (under its Distribution Authority) for electricity supply to the Gladstone South area in Central Queensland. We have identified emerging limitations in the electricity distribution network supplying the South Gladstone area. The loads on Ergon Energy's Gladstone South 132/66/11kV Zone Substation and 11kV network in the South Gladstone area have progressively increased such that augmentation is required if reliable supply is to be maintained.

The study area is presently supplied by the Gladstone South 132/66/11kV substation. This substation is supplied from Gladstone South T152 Bulk Supply via the 11kV tertiary windings on Powerlink's transformers. The N-1 rating of Gladstone South Substation is 10.9 MVA.

Additionally, there are very significant fault level issues with the existing arrangement, necessitating operating with the Gladstone South Zone Substation 11kV bus tie circuit breaker open and a further two 66kV circuit breakers in the Gladstone network also open. Loading and fault level issues also necessitated installation of a third temporary transformer in the Gladstone South Zone Substation yard, requiring disconnection of one of the 66kV feeders (now supplied radially from the far end). This transformer directly supplies one of the Gladstone South Zone Substation 11kV feeders by bypassing the bus, effectively creating three section open bus, making restoration after a fault on the distribution network much more difficult. The multiple open points within the 66kV network also results in significant risk of large outages across the greater Gladstone supply area.

The load on Gladstone South Zone Substation is already in excess of its N-1 substation capacity and without the additional temporary transformer would already be in excess of N. As such, any transformer contingency may result in customer load shedding.

Ergon Energy published a Request for Information relating to this emerging network constraint on 18 December 2013, and a Consultation Paper and Draft Recommendation on 19 March 2014. Five submissions were received by the closing date of 19 February 2014.

The evaluation process has considered all five external submissions, in conjunction with Ergon Energy's internally identified distribution network option. Three feasible solutions have been identified:

Option 1: Installation of two new 20 MVA 66/11kV transformers and a new switchboard at the Gladstone South Zone Substation by 2015

Option 2: Installation of a single new 20 MVA 66/11kV transformer and a new switchboard at the Gladstone South Zone Substation by 2015

Option 3: Installation of two new 20 MVA 66/11kV 20 MVA high impedance 11/11kV regulators and a new switchboard at the Gladstone South Zone Substation by 2015

In accordance with the requirements of the National Electricity Rules, this is now a Final Report where Ergon Energy provides both economic and technical information about possible solutions, and the solution decided on, being Option 1, to install two new 20 MVA 66/11kV transformers and a new switchboard at the Gladstone South Zone Substation by 2015.

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1. INTRODUCTION

Ergon Energy has identified emerging limitations in the electricity distribution network supplying the South Gladstone Area in Central Queensland.

When a distribution network service provider proposes to establish a new large distribution network asset to address such limitations, it is required under the National Electricity Rules (NER)[1] clause 5.6.2(f) to consult with affected Registered Participants, AEMO and Interested Parties on possible options to address the limitations. These options may include but are not limited to demand side options, generation options, and market network service provider options.

Under clause 5.6.2(g) of the NER the consultation must include an economic cost effectiveness analysis of possible options to identify options that satisfy the Australian Energy Regulator's (AER) Regulatory Test, while meeting the technical requirements of Schedule 5.1[2] of the NER.

The Final Report is based on:

- The assessment that a reliable power supply is not able to be maintained in the South Gladstone Area.
- The Request for Information consultation undertaken by Ergon Energy to identify potential solutions to address the emerging distribution network limitations; and
- An analysis of feasible options in accordance with the AER's Regulatory Test.

Updated information will be provided on our web site:

https://www.ergon.com.au/community--and--our-network/network-infrastructure/regulatory-test-consultations

For further information and inquiries please submit to the email address above.

[1] Version 53. The current version of the NER does not contain Regulatory Test obligations. Rather, this has been replaced with an obligation to perform a Regulatory Investment Test – Distribution from 1 January 2014. Transitional arrangements are prescribed in 11.50.5 of the NER. As such, all references to clause 5.6.2 of the NER relate to Version 53 and not the most recent version.
[2] Refer above. All references to Schedule 5.1 of the NER relate to Version 53 and not the most recent version.

2. BACKGROUND & REASONS AUGMENTATION IS REQUIRED

2.1. Background

If technical limits of the distribution system will be exceeded and the rectification options are likely to exceed $10M, Ergon Energy is required under the NER[3] to notify Registered Participants,[4] AEMO and Interested Parties[5] within the time required for corrective action and meet the following regulatory requirements:

- Consult with Registered Participants, AEMO and Interested Parties regarding possible solutions that may include local generation, demand side management and market network service provider options[6].
- Demonstrate proper consideration of various scenarios, including reasonable forecasts of electricity demand, efficient operating costs, avoidable costs, costs of ancillary services and the ability of alternative options to satisfy emerging network limitations under these scenarios.
- Ensure the recommended solution meets reliability requirements while minimising the present value of costs when compared to alternative solutions[7].

Ergon Energy is responsible for electricity supply to the South Gladstone area (under its Distribution Authority) and has identified emerging limitations in the electricity distribution network supplying it. Augmentation to the electricity distribution network supplying this area is required if reliable supply is to be restored.

2.2. Purpose of this "Final Report"

The purpose of this Final Report is to:

- Provide information about the existing distribution network in the South Gladstone area.
- Provide information about emerging distribution network limitations and the expected time by which action must be taken to maintain the reliability of the distribution system.
- Provide information about options identified and considered.
- Explain the process (including approach and assumptions) and the AER's Regulatory Test used to evaluate alternative solutions, including distribution options.
- Report the solution that Ergon Energy has decided on.

[3] Clause 5.6.2(f)
[4] As defined in the NER
[5] As defined in the NER
[6] NER clause 5.6.2(f)
[7] In accordance with the AER's Regulatory Test Version 3, November 2007

3. EXISTING SUPPLY SYSTEM TO THE SOUTH GLADSTONE AREA

3.1. Geographic Region

The geographic region covered by this Final Report is broadly described as the South Gladstone area as shown on the map below.

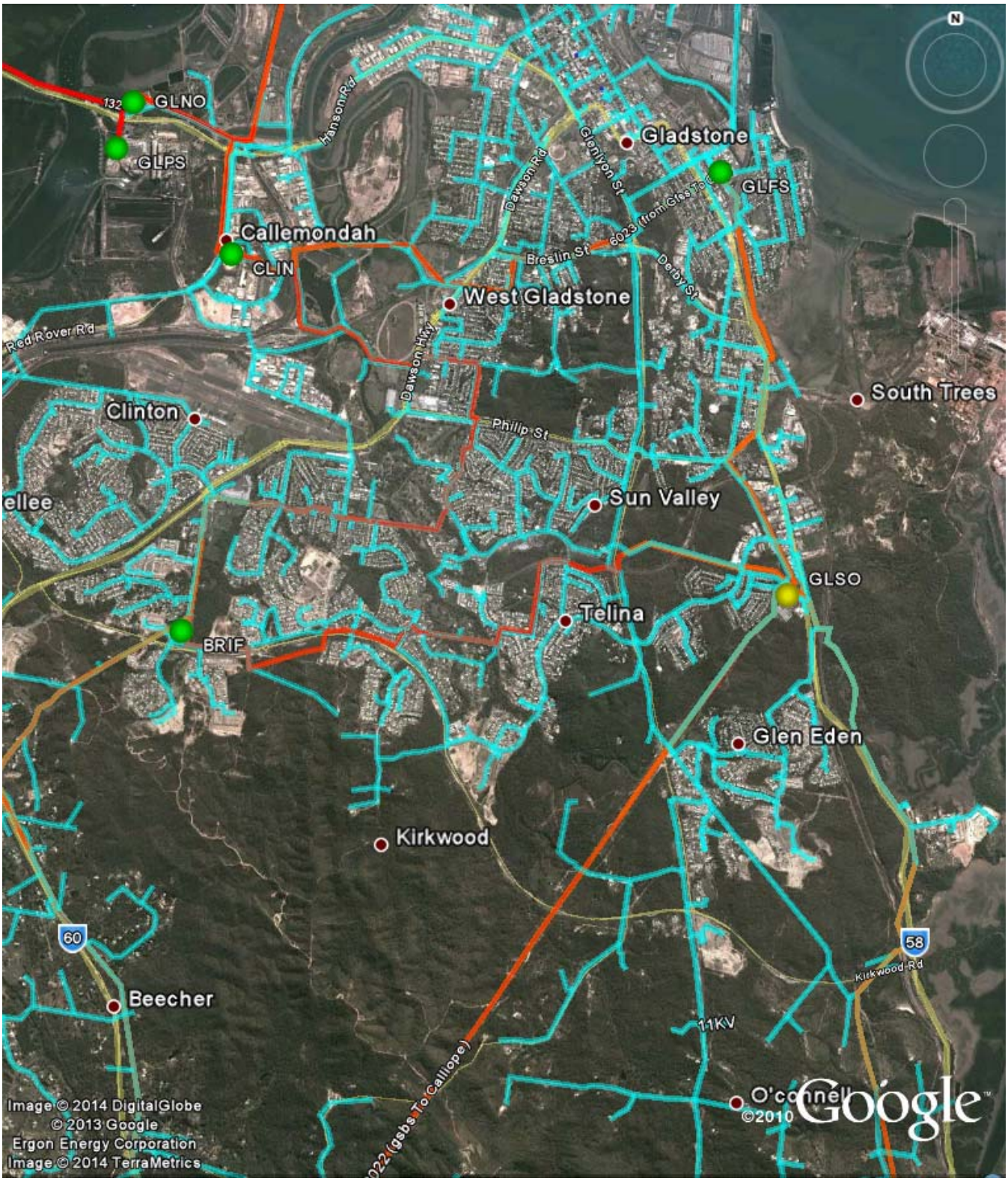

Figure 1 - South Gladstone Supply Area

3.2. Existing Supply System

Gladstone South Zone Substation has two 132/66/11kV transformers feeding two 11kV regulators (built 1971) and a temporary 66/11kV "Nomad" transformer, which supply a total of five distribution feeders. Each of the 132/11kV bays is limited to 9.6MVA during normal operation or 10.9MVA under contingency, giving the 132/11kV system an N rating of 19.8MVA.

The existing 11kV switchboard, constructed between 1964 and 1971 has an unusual arrangement, being dual rated:

"A" bus: rated at 800A (15.2MVA), with 3 x feeder and 1 x transformer circuit breakers

"B" bus: rated at 1200A (22.9MVA), with 1 x feeder circuit and 1 x transformer circuit breakers

Bus Tie: rated at 800A (15.2MVA)

Currently one of the breakers on the "A" bus is disconnected, with the feeder being supplied entirely by the temporary "Nomad" transformer (reducing loading on that side of the board). Also, in order to provide additional feeder capacity and better balance the loads on the switchboard, the single feeder circuit breaker on the "B" bus has been doubled up to a (new) fifth feeder, with individual feeder protection being provided by external Automatic Circuit Reclosers (ACRs).

3.2.1 11kV Fault Levels

Gladstone South

11kV	Normal (11kV bus tie open)	Maximum (11kV bus tie closed)
3 phase (kA)	22.45	34.71
L-G (kA)	5.85	11.12

Table 1 - 11kV Fault Levels

There are very significant fault level issues with the existing nine 11kV breakers (switchboard and transformer) all being rated at only 18.2kA, well below the 22.45kA fault level (even with the bus operated "normally open"). Under this condition a low impedance fault at 11kV would represent a risk of a catastrophic failure of the circuit breaker and switchboard, along with a risk to the Powerlink 132/66/11 transformers. It also creates an extreme safety issue for any personnel in the vicinity of 11kV assets in the substation.

In order to bring the fault level down below the rating of the circuit breakers two 66kV circuit breakers (one at Gladstone South Zone Substation and one at the nearby Gladstone Friend St Zone Substation) must also remain "normally open". Further, to provide a connection point for the temporary Nomad transformer, a further 66kV feeder (6021 Beecher) has been disconnected.

This arrangement heavily compromises subtransmission network security within the greater Gladstone supply area, resulting in significant risk of large outages across the Gladstone supply area.

Furthermore, the arrangement of the 11kV supply at Gladstone South Zone Substation effectively creates a three section bus, all of which must be operated separately (i.e. with ties between the sections left "normally open") and cannot be paralleled at any time. This makes restoration of supply following a fault significantly more difficult, particularly if the fault was to occur on one of the bus sections.

4. EMERGING NETWORK LIMITATIONS

4.1. Limitations of the Existing Network

The load on Gladstone South Zone Substation reached 20.44MVA during summer 2013/14 (noting that it was an unusually hot summer and this figure has not been temperature corrected) and is forecast to grow at 3.35% per annum for the next five years, and at 2.86% per annum for the subsequent five years[8].

Gladstone South Zone Substation	Maximum Annual Demand (MVA)									
	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Actual Load	15.9	17.1	17.6	20.4[9]						
Forecast Load				18.8	19.4	20.1	20.7	21.3	22.0	22.6

Table 2 - Gladstone South Zone Substation Load History & Forecast

It is clear from the table that the current load far exceeds the "N-1" capacity of the substation and is likely to exceed the "N" capacity by the coming summer (2014/15)[10].

4.2. Application of Regulatory Test vs. Aged Asset and Fault Level Issues

It should be noted that the need for corrective action at Gladstone South Zone Substation is driven by a combination of network capacity and non-capacity driven issues. In these cases it is often difficult to separate the cost components associated with each, particularly since "like for like" replacement of aged assets is either not possible or would require purchase of specially designed and manufactured (rather than "off the shelf") items of plant at a significant premium.

As the cost of undertaking appropriate corrective action was likely to be above $10M, Ergon Energy considers it prudent to err on the side of openness and transparency and undertake this Regulatory Test (including Public Consultation). Any corrective solution needs to address all network limitations, though a combination of network and/or non-network components would be acceptable if it represents the lowest Net Present Cost.

4.3. Timeframes for Taking Corrective Action

In order to ensure that security of supply to customers in the South Gladstone area complies with Ergon Energy's planning and security criteria, corrective action should be completed before summer 2014/15.

4.4. Known Future Network and Generation Development

Ergon Energy published the "Final Report" for the "Proposed Establishment of a new 66/11kV substation in Southern Gladstone"[11] which recommended development of a new Zone Substation at the "Briffney" site, approximately 5.5km West of Gladstone South Zone Substation. This new substation will provide capacity in the rapidly developing South-West Gladstone area and provide some capacity relief throughout the Gladstone 11kV distribution network. It cannot, however address fault level or aged asset issues at Gladstone South Zone Substation, or 66kV network security issues across the greater Gladstone supply area. Nor will it provide sufficient capacity into the medium and long term to keep loads at Gladstone South Zone Substation to manageable levels without extensive augmentation of the distribution network.

[8] The forecast was updated after preparation of Request For Information (RFI) document. The latest forecast is used here.
[9] Not temperature corrected
[10] Note that the capacity supplied by the emergency "nomad" transformer is not included here as this arrangement is temporary only and is not designed to represent a permanent solution.
[11] https://www.ergon.com.au/__data/assets/pdf_file/0019/113167/South-Gladstone-Final-Report.pdf

5. OPTIONS CONSIDERED

5.1. Consultation Summary

During the normal planning process, Ergon Energy identified that action would be required to address anticipated distribution network limitations related to supply to the South Gladstone area and to deal with fault and aged asset issues at Gladstone South Zone Substation.

On 18 December 2013 Ergon Energy released a Request for Information providing details of the emerging network limitations in the South Gladstone area. That paper sought information from Registered Participants, AEMO and Interested Parties regarding potential solutions to address the anticipated limitations.

Ergon Energy received five external submissions by 19 February 2014, being the closing date for submissions to the Request for Information paper.

The five external submissions and Ergon Energy's internally defined distribution network solution have been evaluated.

5.2. Non-Network Options Identified

All five external submissions that were received through the RFI process were identified as non-network options. A summary of the received submissions is presented below:

- Two options comprised modular diesel generation solutions
- One option comprised a single turbine solution
- One option comprised a curtailment/battery/diesel hybrid generation solution.
- One option comprised a concentrated solar power/battery/diesel hybrid generation solution

None of these options have been assessed as feasible as they all fail to address the fault level and aged asset drivers at Gladstone South Zone Substation.

5.3. Distribution Options Identified

In addition to the consultation process to identify possible non-network solutions, Ergon Energy carried out studies to determine the most appropriate distribution network solution. It was considered that a "do nothing" approach was unacceptable.

Three distribution (network) options were identified:

Option 1: Installation of two new 20 MVA 66/11kV transformers and a new switchboard at the Gladstone South Zone Substation by 2015.

Option 2: Installation of single new 20MVA 66/11kV transformer, and a new switchboard at the Gladstone South Zone Substation by 2015 and replace the 11kV regulators with 20MVA high impedance units 8 years later.

Option 3: Installation of two new 20 MVA 66/11kV 20 MVA high impedance 11/11kV regulators and a new switchboard at the Gladstone South Zone Substation by 2015.

5.4. Hybrid Network and Non-Network Options Identified

No hybrid solutions (a combination of network and non-network components) were assessed as feasible for the following reasons:

- All non-network options are generation options, and as such will increase network fault levels.
- While it is possible to install smaller (say 10MVA) transformers in each network option identified above (which will address the fault level issues) the cost saving of this alternative is very small compared to the cost of adding non-network (generation) components and does not represent a reasonable option (that is, it would be very much more expensive in NPV terms).

6. FEASIBLE SOLUTIONS

This section provides an overview of the feasible solutions identified. An NPV analysis is presented in Section 7.

Solution Description	Capital Cost
Ergon Energy Internal Option 1– New 2 x 20MVA 66/11kV transformers and 11kV switchboard	$21M
Ergon Energy Internal Option 2– New 20MVA 66/11kV transformer and 11kV switchboard now Replace 11kV regulators with 20MVA units in year 8	$26M
Ergon Energy Internal Option 3– New 2 x 20MVA 11/11kV regulators and 11kV switchboard	$24M

Table 3 - Capital Cost Comparison of Feasible Options (Inc. Overheads)

7. FINANCIAL ANALYSIS & RESULTS

7.1. Format and Inputs to Analysis

7.1.1 Regulatory Test Requirements

The requirements for the comparison of options to address an identified network limitation are contained in the Regulatory Test (version 3, November 2007) prescribed by the AER.

The Regulatory Test requires that, for reliability augmentations, the recommended option be the one that **"minimises the costs of meeting those requirements, compared with alternative option/s in a majority of reasonable scenarios"**. To satisfy the Regulatory Test, the proposed augmentation must achieve the lowest cost in the majority of (but not necessarily all) credible scenarios.

The Regulatory Test contains guidelines for the methodology to be used to identify the lowest cost option. Information to be considered includes construction, operating and maintenance costs and the costs of complying with existing and anticipated laws and regulations. The Regulatory Test specifically excludes indirect costs and costs that cannot be measured in terms of financial transactions in the electricity market.

7.1.2 Inputs to Analysis

A solution to address the future supply requirements for the South Gladstone area as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the NER and the requirements of the *Queensland Electricity Act 1994*.

According to the AER's Regulatory Test, this means that the costs of all options must be compared, and the least cost solution is considered to satisfy the Regulatory Test. The results of this evaluation, carried out using a discounted cash flow model to determine the present value costs of the various options, are shown in section 7.2.

The cost to implement the network augmentations outlined in Section 6 has been estimated by Ergon Energy. Sensitivity studies have been carried out using variations in capital cost estimates of plus or minus 20%. The operating and maintenance costs of new network infrastructure have been derived as a fixed proportion of capital cost. As a result, a variation in capital costs would be equivalent to separately varying the operating and maintenance cost.

The financial analysis considers all foreseeable cost impacts of the proposed network augmentations to market participants as defined by the regulatory process.

7.2. Financial Analysis

The economic analysis undertaken considered the present value of cost of alternative options over a 20 year period.

7.2.1 Present Value Analysis

Financial analysis was carried out to calculate and compare the Net Present Value (NPV) of the costs of each option under the range of assumed scenarios.

A 20 year analysis period was selected as an appropriate period for financial analysis. A discount rate of 9.99% was selected as a relevant commercial discount rate.

The Base Case (Scenario A) was developed to represent the most likely market scenario.

Market scenarios B to H were formulated to test the robustness of the analysis to variations in load forecast, capital costs and the discount rate. As required by the Regulatory Test, the lower boundary of the sensitivity testing was the regulated cost of capital.

Under the Regulatory Test, it is the ranking of options which is important, rather than the actual present value results. This is because the Regulatory Test requires the recommended option to have the lowest present value cost compared with alternative projects.

The following table is a summary of the economic analysis. It shows the present value cost of each alternative and identifies the best ranked option, for the range of scenarios considered.

The summary shows that **Ergon Energy's Internal Option 1 has the lowest Net Present Value under all scenarios.**

7.2.2 Summary of Economic Analysis

Commercial Outcomes - Without Ergon Overheads (In $ Mn)	Do Nothing	Option 1	Option 2	Option 3
Present Cost of Capex	$ -	-$ 8.06	-$ 8.39	-$ 9.16
Present Cost of Opex	$ -	$ -	-$ 0.33	-$ 0.13
Present Value of Benefits	$ -	$ 1.20	$ 1.54	$ 1.67
NPV	**$ -**	*-$ 6.86*	*-$ 7.18*	*-$ 7.62*
Rankings	N/A	1	2	3
IRR	N/A	N/A	N/A	N/A
Discounted Payback	0.00	0.00	0.00	0.00
Profitability Index	#DIV/0!	0.15	0.18	0.18

Figure 2 - Summary of Economic Analysis (Excl. Overheads)

Sensitivity Analysis on the Options Excluding Overheads	Sensitivity Factor	Do Nothing	Option 1	Option 2	Option 3
Scenario - BASE CASE		N/A	-$ 6.86	-$ 7.18	-$ 7.62
		N/A	1	2	3
Scenario - Escalation Opex -High	5%	N/A	-$ 6.86	-$ 7.20	-$ 7.63
		N/A	1	2	3
Scenario - Escalation Opex -Low	3%	N/A	-$ 6.86	-$ 7.19	-$ 7.63
		N/A	1	2	3
Scenario - Discount Rate - High	12%	N/A	-$ 7.08	-$ 7.30	-$ 7.75
		N/A	1	2	3
Scenario - Discount Rate - Low [REG]	9.67%	N/A	-$ 6.81	-$ 7.15	-$ 7.58
		N/A	1	2	3
Scenario - Increased Capital costs	50%	N/A	-$ 10.89	-$ 11.38	-$ 12.20
		N/A	1	2	3
Scenario - Decreased Capital costs	-1%	N/A	-$ 6.78	-$ 7.10	-$ 7.53
		N/A	1	2	3
Scenario - Commercial Benefits Decrease	-1%	N/A	-$ 6.87	-$ 7.20	-$ 7.64
		N/A	1	2	3

Figure 3 - Sensitivity Analysis (Excl. Overheads)

7.3. Discussion of Results

The following conclusions have been drawn from the analysis presented in this report:

- There is no acceptable 'do nothing' option. If the emerging network constraints are not addressed by 2015, Ergon Energy will not be able to maintain acceptable reliability of supply in the South Gladstone area.

- The local generation options, either internally supplied or those proposed by the respondents to the Request for Information could not address the fault level or aged asset issues. When combined with a smaller network option, all represented a very significantly higher cost option and as such were not considered feasible.

- The economic analysis carried out indicates that Ergon Energy's internal solution, which is to install two new 66/11kV transformers and a new 11kV switchboard, has the lowest net present cost.

- Sensitivity testing showed that the analysis is robust to variations in capital costs, discount rate and growth rate.

- As Ergon Energy's internal option is the lowest cost option in all scenarios, it is considered to satisfy the AER's Regulatory Test.

8. FINAL REPORT & DECISION

Based on the conclusions drawn from the analysis in Section 7 above, **it is Ergon Energy's decision to proceed with Option 1 to install two new 20 MVA 66/11kV transformers and a new switchboard at the Gladstone South Zone Substation** at a cost of $21M with commissioning to be scheduled for November 2015.

Ergon Energy now intends to take immediate steps to implement the solution decided on to ensure system reliability is maintained.