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AUSNET ELECTRICITY SERVICES

AUGEX DEFERRAL REVIEW FOR CLYDE NORTH AND DOREEN ZONE SUBSTATIONS

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Augex deferral review for Clyde North and Doreen zone substations

AusNet Electricity Services

WSP
Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

REV	DATE	DETAILS
A	1 May 2019	Initial draft
B	9 May 2019	Final
C	28 May 2019	Final – incorporating Customer Forum comments

	NAME	DATE	SIGNATURE
Prepared by:	Michael Van Doornik		
Reviewed by:	David Downing		
Approved by:	Michael Van Doornik	28 May 2019	

TABLE OF CONTENTS

EXECUTIVE SUMMARY

AusNet Services engaged WSP to undertake an independent review of the augmentation deferral options for projects at Clyde North and Doreen Zone Substations. The scope of the review was to assess the reasonableness of the method, data sources and assumptions used to determine the costs and benefits of the deferral options in the context of AusNet Services' proposed network solution. Review of the demand forecasts was excluded from WSPs scope of work.

As part of the review, WSP addressed information and areas of the analysis where the Customer Forum and Australian Energy Regulator (AER) had requested further information.

Clyde North Zone Substation

AusNet had identified that the current demand at Clyde North Zone Substation (CLN ZSS) exceeds the N-1 rating[1] of the zone substation and that there is insufficient capacity on the 22 kV network for permanent load transfers. Additionally, demand is forecast to continue increasing such that it will exceed the N rating[2] of CLN ZSS in 2024.

AusNet completed technical and economic assessment of eight options, including network and non-network options, to determine which options would resolve the need in the most economic manner. The preferred solution was identified to be the installation of a third transformer and switchboard at CLN ZSS, to be completed for the 2024/25 summer period (in service by November 2024).

To undertake the review, WSP developed a set of criteria based on common industry practice, the RIT-D and associated guidelines published by the AER. WSP also addressed specific questions raised by the Customer Forum and AER:

- impact of residential solar PV and battery installation
- potential for commercial and industrial customer demand management to defer the need
- potential for network reconfiguration to defer the need
- constraints necessitating augmentation are appropriate
- all reasonable options have been considered, including non-network and other deferral options

WSP found that:

- the root cause of the network issue/constraint was correctly identified
- a full suite of options that would address the network need were identified
- the level of analysis and assumptions made were appropriate for the value and credibility of each option

WSP considers that there is no reason to believe that the evidence provided, assumptions made and approach to modelling are unreasonable.

WSP notes that while the model and analysis followed an appropriate methodology and was free from material error, the construction of the model could be improved, with respect to useability and transparency, for future project assessments.

Doreen Zone Substation

The Doreen Zone Substation (DRN ZSS) augmentation project was initially identified by AusNet based on the current demand at DRN ZSS exceeding the N-1 capacity of the substation and the demand forecast which indicated that the demand would exceed the N rating of DRN ZSS towards the end of 2021-25 regulatory period. However, a revised

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1 The N-1 rating, also referred to as the firm capacity, is the rating of the substation with one of the major plant out of service. In this case, it refers to the power transformers.

2 The N rating is the substation capacity will all plant in service.

demand forecast indicates that the zone substation N rating will not be exceeded until 2028 and AusNet has also implemented load transfers to further reduce the load on the zone substation and defer any expenditure.

The independent review of the DRN ZSS augmentation project has not been undertaken as, based on the revised demand forecasts and inclusion of the load transfer, economic modelling indicates that mitigation of the service level risk at DRN would not be economic until the middle of the following (2026-30) regulatory period.

1 PROJECT BACKGROUND

1.1 PURPOSE

AusNet Services required an independent review of the augmentation deferral options for projects at Clyde North and Doreen Zone Substations. The review was to:

- Establish the reasonableness of the method, data sources and assumptions used to determine the costs and benefits of the deferral options in the context of AusNet Services' proposed network solution
- Suggest improvements or modifications if/where appropriate
- Provide a written report documenting the analysis and results of the independent review.

1.2 SCOPE OF THE REVIEW

The scope of the review was set out by AusNet Services to be:

- Review AusNet Services proposed definition of deferral options.
- Organise and undertake a meeting with the Customer Forum to outline and discuss the consultant's approach to conducting the review.
- Meetings/teleconferences with AusNet Services to discuss the analysis undertaken by AusNet Services of the deferral options and improvements to the analysis.
- AusNet Services documentation of deferral options will then be provided to the Customer forum for initial feedback. The reviewer will then be asked to produce:
  - Draft report. AusNet Services will have an opportunity to review the draft report and provide comments
  - Final report. The report will be provided to AusNet Services for handover to the Customer Forum. The report should include details of the assessors' qualifications and experience relating to economic and technical assessment of augmentation projects.

1.3 STRUCTURE OF REPORT

This report assesses the projects against the criteria established and agreed to with the Customer Forum, as well as additional information requests by the Customer Forum in its Interim Engagement Report[3] and guidance from the AER[4]. The report follows the following structure:

- Clyde North Zone Substation
  - Customer forum information request
  - AER information request
  - General project review criteria
- Doreen Zone Substation

[3] AusNet Services draft proposal and the Customer Forum's Interim Engagement Report, Australian Energy Regulator

[4] Guidance note - AusNet's draft proposal, Australian Energy Regulator

2 CLYDE NORTH ZONE SUBSTATION

AusNet identified that current demand at Clyde North Zone Substation (CLN ZSS) exceeds the N-1 capacity of the zone substation and that there is insufficient capacity on the 22 kV network for permanent load transfers. Additionally, demand is forecast to continue increasing such that it will exceed the N rating of CLN ZSS in 2024.

In the analysis, AusNet considers the cyclic rating of the transformers, meaning that the capacity is based on the thermal loading of the transformers and can only be maintained for defined periods of time (normally a few hours) and then requires time to cool down to avoid damaging the transformers.

The preferred solution to resolve this issue is to install a third transformer to be completed for the 2024/25 summer period (in service by November 2024). The Customer Forum and AER requested additional information and independent review of the network constraint, options identification and analysis, and the modelling and assumptions used to identify the preferred option.

The specific information requests from the Customer Forum and AER are discussed in sections 2.1 and 2.2, respectively. The findings from the independent review of the network constraint, options identification and analysis, and the modelling and assumptions are set out in section 2.3.

2.1 CUSTOMER FORUM INFORMATION REQUEST

While the Customer Forum recognised the need for the augmentation project, they requested confirmation that the service level risk would not be reduced by any of the following three factors to the extent that deferral of the proposed network project would be economic:

- the impact of residential solar PV and battery installation
- commercial and industrial customer demand management
- network reconfiguration

This section considers the concerns initially raised by the Customer Forum, the additional analysis undertaken by AusNet and WSP's opinion on the reasonableness of AusNet's assessment and whether or not the three items listed above could result in a material change to the timing of the network constraint.

2.1.1 RESIDENTIAL SOLAR AND BATTERY INSTALLATION

The Customer Forum requested confirmation that the accelerating rate of take up of solar PV and battery storage will not impact the need for augmentation at CLN ZSS.

SOLAR PV

AusNet provided additional information to the customer forum that demonstrated the difference in network demand caused by solar PV. The information demonstrated that due to the time of day where the peak occurs, there is low generating from solar PV to offset the high demand, hence the peak is not materially affected.

The Customer Forum stated it is satisfied that the accelerating rate of residential solar PV will not moderate demand as the peak demand and peak solar PV generation times do not coincide[5]. Hence, WSP only assessed how the impact of residential battery storage had been considered.

[5] AusNet Services draft proposal and the Customer Forum's Interim Engagement Report, Australian Energy Regulator

RESIDENTIAL BATTERIES

The question of whether batteries will affect the forecast demand needs to be considered in two parts as discussed in the sections below.

Has the demand forecast already accounted for increasing rates of battery penetration?

Ausnet Services' confirmed that the maximum demand forecasts include the current level of battery penetration as a negative load. Battery penetration beyond the historical base level had not been considered in developing the maximum demand forecasts. While an increased uptake of battery penetration was not considered in developing the maximum demand forecasts, consistent with AEMO's forecast level of battery penetration uptake, any unaccounted battery penetration is not expected to have a material impact on residential demand levels in the 2021-25 period.

How much battery capacity must be installed on the network to enable deferral of the capacity constraint.

AusNet is aware of approximately 3.8MW of residential batteries currently installed across their entire distribution network. There are currently 16 known customers with a residential battery installation, totalling less than 100kW of battery capacity, in the CLN supply area.

To be a viable option to address the capacity constraint, the installed capacity in the CLN supply area would need to increase to 4MW of controllable and/or responsive battery support during maximum demand periods to enable network augmentation deferral by one year. This is a significant increase and is close to the capacity that is currently installed across AusNet's entire network. Although the maximum demand forecasts do not consider the impact of future battery uptake levels, AusNet has separately forecast the number of residential battery installations within its network. In the CLN supply area the number of residential battery installations is forecast to reach 547 by 2024, suggesting the average residential battery installation would need to exceed 7kW and have a 100% capacity available to support the network at maximum demand times to defer the proposed network augmentation.

AusNet identified that a battery bank installation proposed by a market proponent and identified in the Distribution Annual Planning Report to be installed by December 2020[6] is not going to proceed.

WSP recognises there is uncertainty in the forecast of residential batteries as the technology is just becoming economic for residential use. There are limited historical rates of uptake to use as a basis for forecasting future uptake. However, we consider it unlikely that there would be sufficient uptake during the next five years to enable deferral of the network constraint.

AusNet included the use of batteries as a non-network solution option. The approach to modelling and assumptions applied did not appear unreasonable. The model found that expected net economic benefit of installing a new transformer (preferred option) was greater than the use of residential batteries given uncertainty in capacity and probability and value of unserved energy.

FINDING

WSP notes that the use of batteries as a non-network solution was included as an option and appropriately modelled with assumptions, including cost, availability and capacity, that do not appear unreasonable.

2.1.2 COMMERCIAL AND INDUSTRIAL DEMAND MANAGEMENT

The Customer Forum requested confirmation that increased demand management, particularly from large commercial and industrial customers, will not result in deferral of the need for augmentation at Clyde North.

ADDITIONAL ASSESSMENT UNDERTAKEN BY AUSNET

AusNet provided evidence that commercial and industrial customer demand management would not provide sufficient load reduction to enable deferral of the need for network augmentation. The evidence provided was:

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[6] AusNet Services, Distribution Annual Planning Report, 2019, page 28

- There are approximately 460 commercial and industrial customers (1.5% of all customers supplied by CLN ZSS) of which 65 are identified as large customers with the Critical Peak Day tariffs in their connection agreements. The maximum demand of these large customers is approximately 7 MW. The historical take up rate of demand management by commercial and industrial customers supplied by CN ZSS through the CPD tariff mechanism has been approximately 9%, which is reasonable compared to the network average response of 7% to 12%, and resulted in a maximum demand reduction of 1.2 MW.
- An additional 1.86 MW reduction has been achieved through four customers by using Network Support Contracts.
- Economic assessment by AusNet based on the historical costs of the CPD tariffs demonstrates that while demand management could result in a degree of deferral with sufficient uptake, the preferred option of installing a third transformer and switchboard has a larger net benefit to customers.

The evidence provided shows that there has been limited up take of demand management in the past even with existing financial incentives. The uptake would need to increase by 4 MW to defer the capacity constraint by one year and 11.7 MW (more than the existing large customer demand) to enable deferral by 2 years.

Since the CPD tariffs provide demand reduction at the discretion of the customer, currently 1.2 MW, this cannot be relied upon when assessing augmentation deferral options. For demand management to be reliable and enable deferral of augmentation for one year it would require an additional 5.2 MW to be contracted on Network Support Contracts (or similar) so that the demand management is at the direction of AusNet. Given past uptake, this does not appear to be a reasonable assumption.

FINDING

WSP considers that, given the evidence provided regarding historical rate and cost of demand management participation and analysis undertaken by AusNet, while demand management has a net economic benefit it is unlikely it will enable deferral of the proposed network augmentation.

WSP considers that there is no reason to believe that the evidence provided, assumptions made including cost and likely uptake, and approach to modelling are unreasonable.

2.1.3 NETWORK RECONFIGURATION

The Customer Forum requested confirmation that the need for augmentation at Clyde North could not be addressed through network reconfiguration.

ADDITIONAL ASSESSMENT UNDERTAKEN BY AUSNET

AusNet provided evidence that the capacity at the 22kV level of the network is also reaching its capacity and while there is ability for emergency load transfers, there is no capacity for permanent load transfers. This was demonstrated through the demand forecast per feeder compared to the feeder rating. The evidence provided was:

- Demonstration that the CLN ZSS feeders are forecast to be close to, or exceeding, their rating by 2024. Shown below as percentage of the feeder rating.

FEEDER	CLN11	CLN12	CLN13	CLN14	CLN21	CLN22	CLN23
2024	52%	90%	124%	98%	95%	87%	137%

- Adjacent feeders that have connections to the CLN feeders are also forecast to be close to, or exceeding, their rating by 2024. Shown below as percentage of the feeder rating.

FEEDER	BWN12	CRE23	CRE32	CRE33	HPK11	HPK14	HPK22	OFR21
2024	111%	69%	80%	93%	100%	83%	97%	108%

- The total emergency transfer capacity is forecast to reduce by approximately 1.3 MVA per year due to load growth at the adjacent zone substations reducing the capacity available on the interconnecting feeders.

The Distribution Annual Planning report identifies the potential installation of a new feeder (CLN24) to reduce the loading on CLN23. While this will reduce the load on CLN23 to approximately 70% if shared equally, CLN13, CLN14 and CLN21 are still forecast to be greater than 95% of their capacity. Additionally, while the addition of CLN24 will assist with managing the load on the distribution network, it does not address the zone substation capacity issue as the load is still supplied by CLN.

There are no new feeders committed to be installed at adjacent zone substations that would have interconnections with CLN ZSS to enable load transfers[7].

This demonstrates that permanent network reconfiguration is not a technically credible solution to resolve the underlying need identified by AusNet which includes capacity constraints on both the distribution feeders and the zone substation transformation capacity.

FINDING

WSP considers that, based on the evidence provided, there is insufficient capacity on the 22 kV network to enable permanent load transfers as a credible option to resolve or defer the identified need.

2.2 AER GUIDANCE NOTE

In the AER's guidance note, it identified three lines of questions that they would need to consider to assess the appropriate timing of augex projects. These are whether:

- Demand forecasts were reasonable
- Constraints necessitating augmentation are appropriate
- All reasonable options have been considered, including non-network and other deferral options

Under each of the three lines of questioning, the AER listed a number of points they would specifically consider to make their assessment. This section assesses how each of these items has been considered by AusNet.

2.2.1 DEMAND FORECASTS

Assessment of the demand forecast methodology is out of scope of WSPs review. WSP acknowledges that the demand forecasting methodology is currently being reviewed by an alternative external consultant. WSP's conclusions presented in this report are subject to the alternative consultants' review.

2.2.2 NETWORK CONSTRAINTS CONSIDERED

THE RISK, TIMING AND PROBABILITY OF AN OUTAGE RESULTING FROM THE CONSTRAINT

AusNet has assessed the probability of an asset failure resulting in loss of supply to customers as well as the loss of supply as a result of exceeding the N rating of the zone substation:

- The probability of failure was based on the asset health score. Both the failure rate and health score were extracted from AusNet's asset data system and modelled to increase over time, using the asset's condition based age as a proxy for deterioration in condition.
- Where the outage is due to the capacity being exceeded (no asset failure, just demand exceeding cyclic rating) the probability of unserved energy was weighted at ~99%[8].

[7] The potential feeder works at Cranbourne Zone Substation identified in the DAPR (CRE24) would only off load CRE31 and will not have interconnection to any Clyde North Zone Substation feeders.

[8] The low probability of failure of these transformers means 99% probability of being in the N state with less than a 1% probability of being in an N-1 or N-2 state.

- When calculating the probabilities of transformer failure, AusNet did not properly allocate the probability of failure between N-1 and N-2 scenarios. However, the calculation of the probabilities matches the assumptions applied for outage duration. The net effect is the correct calculation of the value of energy at risk, but loss of transparency (incorrect allocation to the scenario) in which the energy at risk is incurred. Refer to Appendix B for further explanation.

The probabilities of failure were used to weight the amount of energy not supplied under each scenario. The approach and assumptions used to calculate the expected energy unserved is described below.

THE VOLUME OF LOAD THAT IS POTENTIALLY AT RISK EACH YEAR

The volume of energy at risk was calculated using the load duration curves for the substation and included the cases of asset failure and demand exceeding substation capacity.

The unserved energy is weighted by:

- the probability of an event occurring
- the probability of the event resulting in an outage, and
- the expected time to repair the asset/restore supply.

This approach is consistent with industry practice when assessing capacity constraints at zone substations.

WSP notes that the cost of expected energy at risk has only been calculated for failure of transformers and bus outages. The cost of expected energy at risk has not been considered for the individual feeders which are shown to also be close to their rated capacity. Including the assessment of energy at risk of the individual feeders will increase the benefits of the preferred option and may result in an earlier timing of the project.

THE LIKELY DURATION OF ANY OUTAGE

The likely outage duration was based on the asset type:

- Where the outage is due to the zone substation capacity being exceeded (an N scenario) and no asset failure occurs, the full duration of the event was included.
- Failure of a single transformer (N-1) was assumed to result in a 141 day outage.
- Failure of two transformers (N-2) was assumed to result in an 86 day outage of both transformers until the first transformer is returned to service (or replaced) plus an additional 141 days for the restoration of the second transformer.
- Failure of assets other than the transformers were assumed to result in a 2-hour outage.

These durations account for available spare transformers, and do not appear unreasonable based on AusNet's planned approach to address each event.

WHETHER ROTATIONAL LOAD SHEDDING HAD BEEN CONSIDERED

This was not specifically discussed in the report or model.

WSP considers that even if there is rotational load shedding, while the impact for each individual customer may be reduced, the net economic loss would still be incurred as calculated by the total energy unserved.

The approach applied by AusNet is consistent with common industry practice.

HOW CYCLIC AND THERMAL LOAD CONSIDERATIONS HAD BEEN FACTORED IN

AusNet has undertaken the analysis based on the cyclic rating of the transformers. The cyclic rating of the CLN ZSS transformers were specifically calculated based on their attributes and the load profile to which they have historically been subjected. This is has resulted in a cyclic capacity of 43.5 MVA per transformer when their nameplate ratings are 20/33 MVA. This calculation has been based on the thermal inertia of the transformers under their normal loading during summer conditions.

WSP considers that this approach will maximise the deferral of the augmentation requirement, hence minimising the cost impact to customers.

WHETHER THE RIGHT VCR HAS BEEN USED

AusNet used the VCR as published by AEMO in 2014, adjusted to March 2018 dollars for four customer sectors: Residential, Agricultural, Commercial, and Industrial. The average value for CLN ZSS was then determined based on weighting the value of each customer sector by the annual energy consumption of the customers supplied by CLN.

This is a common industry practice and is an appropriate methodology.

WSP notes that the values were adjusted to March 2018 dollars, but the analysis undertaken is in 2019 dollars. The latest data from the ABS is December 2018 which has an increase of 1.3%. The impact is that the model slightly understates the benefits to the project. However, it does not have a material impact on the selection of the preferred option or identified timing.

FINDINGS

WSP notes that while the net calculation of energy at risk under the N-1 and N-2 scenarios is correct, the energy at risk is not allocated to the appropriate N-1 or N-2 outage scenario due to the calculation of the probabilities. While the net calculation is correct, transparency of the assessment model could be improved.

There is a slight understatement of benefits due to the CPI adjustment being based on old CPI data (March 2018) and not considering the energy at risk at the individual feeder level.

For each of the scenarios considered, AusNet has appropriately calculated each of the aspects that contribute to the network constraints, being failure of an asset or demand exceeding the zone substation capacity, and has appropriately calculated the consequences.

WSP considers that there is no reason to believe that the evidence provided, assumptions made and approach to modelling are unreasonable.

2.2.3 OPTIONS CONSIDERED

THE BASE CASE IS REASONABLE

The base case has used appropriate assumptions and has considered the impact of different failure modes. The network constraint (transformer and feeder capacity) has been clearly defined. The assessment of the base case (used as the benefit for assessed options) has considered the probability weighted cost impacts of:

- safety
- environmental damage
- energy at risk
- asset replacement cost
- secondary damage cost (explosive failure)

WSP notes that while safety, environment, secondary plant damage and replacement costs have been included for all assets, the cost of expected energy at risk has only been calculated for failure of transformers and bus outages. The cost of expected energy at risk has not been considered for the individual feeders. This means that the outcome is likely to be understating the benefits attributed to the preferred option.

THE USE OF PROBABILISTIC RISK ANALYSIS IS APPROPRIATE AND CONSISTENT

AusNet has used a common industry approach to the application of probabilistic risk analysis and has applied it consistently across all options.

THE TIME VALUE OF DEFERRAL OPTIONS IS APPROPRIATELY CONSIDERED

Options 2, 3 and 4 focus on non-network solutions to resolve or defer the need to augment the network. Option 5 considers network reconfiguration (feeder level outside of the zone substation) to resolve or defer the need to augment the network.

The deferral benefits of these options are considered by comparing the year in which the net benefits become positive to identify the timing of each option and the net present value of each option to identify which maximises the economic benefits. This approach appropriately considers the benefits to identify the timing and preferred option.

THE COSTS FOR DEMAND MANAGEMENT AND NON-NETWORK OPTIONS ARE REASONABLE AND APPROPRIATELY CONSIDERED

The costs for demand management and non-network solutions are based on historical actual costs and are therefore considered reasonable.

The costs for battery network support were estimated and based on historical actual demand management costs with a multiplying factor to account for the higher fee due to the additional level of controllability assumed for these devices compared to demand reduction network support.

The costs for embedded generation were based on historical actual costs to hire and install portable diesel generator units, and historical fuel costs to operate these generators.

THE SENSITIVITY ANALYSIS THAT HAS BEEN UNDERTAKEN IS REASONABLE AND APPROPRIATE.

Sensitivity analysis has been undertaken for the following variables:

- probability of asset failure
- demand
- value of customer reliability
- capital cost of each option
- value of statistical life
- discount rate

The selection of upper and lower bounds do not appear to be unreasonable, however, reason/justification for the selection of those bounds was not provided.

FINDING

WSP considers that AusNet has appropriately defined the base case and identified an appropriate set of options, including non-network options, and used the economic analysis to determine the preferred project based on highest NPV and the optimal timing of the project.

2.3 GENERAL PROJECT REVIEW CRITERIA

WSP developed assessment criteria based on the Regulatory Investment Test for Distribution (RIT-D) requirements and the guidelines[9] recently released by the AER in order to undertake a general assessment of the investment case proposed by AusNet.

The analysis is presented in Appendix A.

WSP found that:

- the root cause of the network issue/constraint was correctly identified
- a full suite of options that would address the network need were identified
- the level of analysis and assumptions made were appropriate for the value and credibility of each option

WSP notes that while the model and analysis followed an appropriate methodology and was free from material error, the construction of the model could be improved, with respect to useability and transparency, for future project assessments.

[9] Application guidelines, Regulatory investment test for distribution, AER, December 2018

3 DOREEN ZONE SUBSTATION

The Doreen Zone Substation (DRN ZSS) augmentation project was initially identified by AusNet based on the current demand at DRN ZSS exceeding the N-1 capacity of the substation and the demand forecast which indicated that the demand would exceed the N rating of DRN ZSS towards the end of 2021-25 regulatory period. The preferred solution identified to resolve the capacity constraint was to install a third transformer.

A revised demand forecast indicates that the zone substation N rating will not be exceeded until 2028 and AusNet has also implemented load transfers to further reduce the load on the zone substation.

The Customer Forum and AER requested additional information and independent review of the network constraint, options identification and analysis, and the modelling and assumptions used to identify the preferred option. The specific information requests from the Customer Forum and AER are set out in AusNet Services draft proposal and the Customer Forum's Interim Engagement Report[10].

However, due to the revised demand forecast and load transfer, AusNet found that economic modelling indicates that mitigation of the service level risk at DRN would not be economic until the middle of the following (2026-30) regulatory period. Hence, the independent review of the DRN ZSS augmentation project was removed from the scope of WSP's review.

[10] AusNet Services draft proposal and the Customer Forum's Interim Engagement Report, Australian Energy Regulator

4 INFORMATION REVIEWED

The following information was reviewed and considered in the assessment of the projects.

Table 4.1 Information reviewed for project assessment

ITEM	DOCUMENT FILENAME
1	AMS 20-316 Planning Report Clyde North (CLN) Zone Substation Service Level Constraints (11-04-2019).docx
2	CLN - TOR - Milestone2_Rev0.11.docx
3	CLN - TOR - Milestone2_Rev0.7.docx
4	CLN_V3.0_Economic_Model-Master_Template_05-03-19.xlsm
5	CLN_V3.2_Economic_Model-Master_Template_17-03-19.xlsm
6	CLN_V3.4_Economic_Model-Master_Template_22-03-19.xlsm
7	CLN_V3.5_Economic_Model-Master_Template_22-03-19.xlsm
8	CLN_V4.0_Economic_Model-Master_Template_22-03-19.xlsm
9	CLN_V4.0_Economic_Model-Hybrid Option_06-05-19
10	DRN_V3.5_Economic_Model-Master_Template_22-03-19.xlsm
11	Guidance note - AusNet's draft proposal.pdf
12	Repex and augex further info Nov 18.pdf
13	Distribution Annual Planning Report, 2019-2023

5 QUALIFICATION OF THE ASSESSORS

WSP assembled a team that is highly experienced in developing and reviewing project justifications from both a technical and economic perspective. Our team has a good understanding of the RIT-D framework and has been involved in developing RIT-Ds for transformer replacements.

The qualifications, capabilities, and experience of the team members undertaking a verification of the cost-benefit analysis of options on other assignments is set out below.

MICHAEL VAN DOORNIK, LEAD REVIEWER

15 YEARS EXPERIENCE

Master of Applied Finance, University of Melbourne

Bachelor of Electrical Engineering (Hons), Monash University

Bachelor of Science, Monash University

Chartered Professional Engineer, MIEAust

Michael is a management consultant with over 15 years' experience working for both private and government owned organisations with a focus in the regulated electricity industry. He has significant industry experience in strategic asset management, financial modelling and data analysis, risk management, audit of non-financial information, developing business cases and engineering. He has worked with all levels of management and has worked throughout Australia, New Zealand and Central and South East Asia.

Recent relevant projects:

- Review of Ausgrid's Ensuring reliability requirements in the Sydney CBD RIT-D, (2018), AER. Undertook an initial review of the Draft Project Assessment Report for the AER and then a more detailed review in response to a submission from stakeholders. This review assessed the project against the requirements of the RIT-D and matters in the submission made by the stakeholder.
- Business case development, (2018), Power and Water Corporation. Developed models and business cases to assess and justify the replacement of network assets, including zone substation transformers as part of Power and Water Corporations' regulatory reset submission.

DAVID DOWNING, QUALITY ASSURANCE

36 YEARS EXPERIENCE

Bachelor of Science (Engineering), Imperial College of Science and Technology, University of London

David has wide-ranging experience and expertise in both technical and commercial aspects of project development, construction and operation. From an initial background in large rotating electrical machinery design and manufacture, he has incrementally increased his technical expertise to develop a working knowledge of all types of equipment required in the power generation, transmission and distribution industries, and several process industries.

Recent relevant projects:

- Static Frequency Converter Electrification Review (2017-18), Brisbane, Queensland Rail, Consultant. Review of QR's cost-benefit analysis and other documentation that supports the business's electrification strategy to replace conventional transformer fed traction feeder (sub)stations with static frequency converter-fed feeder stations.
- Logistical and cost modelling of a liquefied CO_2 road transportation solution (2016-17), Queensland, CTSCO – updated the 2014 logistical and whole-of-life cost modelling and reporting for a study into the available options for the road transportation of up to 60,000 tonnes per annum liquefied CO_2 from a post-combustion carbon capture plant to a possible underground injection site. Logistical modelling used Interdynamics's Planimate® software and cost modelling used a spreadsheet-based Monte-Carlo method to introduce randomisation into both analyses and produce cost estimates within client's required tolerances.

6 LIMITATIONS

In preparing this report, WSP has relied upon documents, data, reports and other information provided by AusNet. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this report are based in whole or part on the information, those conclusions are contingent upon the accuracy and completeness of the information provided. WSP will not be liable in relation to incorrect conclusions should any information be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP. The assessment and conclusions are indicative of the situation at the time of preparing the report. Within the limitations imposed by the scope of services and the assessment of the data, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable consultants under similar circumstances. No other warranty, expressed or implied, is made.

APPENDIX A

DETAILED PROJECT REVIEW – CLYDE NORTH ZSS

IDENTIFIED PROJECT NEED

IDENTIFIED NEED – CLAUSE 5.17.4(J)(1) TO (2)		
RIT-D proponents should express an identified need as the achievement of an objective.		
Information/analysis required	**Finding**	**Comment**
Has the need/driver for augmentation been stated as an objective, not a means to meet an objective?	**Achieved**	Demand exceeding capacity of the existing substation at the N-1 rating and forecast to exceed the N rating between 2021 and 2025. Also, insufficient capacity at the feeder level expected in the same timeframe.
Has sufficient evidence of the need for augmentation been provided in the document?	**Achieved**	Review of the demand forecast is out of scope for WSP. It is being reviewed by an alternative consultant. Evidence has been supplied supporting the demand forecast v substation capacity, feeder loadings and their forecast growth compared to capacity, current uptake and penetration of existing demand management initiatives.
Is sufficient information provided to understand the technical justification?	**Achieved**	
Are the data sources from a reliable source and sufficiently recent?	**Achieved**	
Are the assumptions and inputs used appropriate?	**Achieved**	
How is the timing of the need identified? Is this based on common industry practice?	**Achieved**	Common industry practice followed for determining the need and timing. Review of the demand forecast is out of scope for WSP. It is being reviewed by an alternative consultant. Should the demand forecast change

		materially following the review, then WSPs findings will need to be reviewed in light of the revised forecast. ,
In determining the timing, is the total service cost (probability weighted cost of risk, safety, opex etc) considered and assessed appropriately?	**NA**	Discussed and assessed jointly in the table below under the section title Analysis of identified options.

OPTIONS IDENTIFICATION

IDENTIFICATOIN OF OPTIONS – CLAUSES 15.15.2(C)(1) TO (4) 5.17.4 (B) TO (D) AND (J)(3) TO (4)		
[the draft report must include] a description of each credible option assessed In applying the RIT-D, the RIT-D proponent must consider, in relation to a RIT-D project other than those described in clause 5.17.3(a)(1)-(6) [excluded projects], all options that could reasonably be classified as credible options, without bias to: 1) Energy source; 2) Technology; 3) Ownership; and 4) Whether it is a network option or non-network option.		
Information/analysis required	**Finding**	**Comment**
Was a complete set of **network** options identified?	**Achieved**	Further information about an option comprising Network and Non-Network options was requested by WSP and provided by AusNet, including information regarding additional options as needed. Additional options identified by WSP: – Asset retirement was not considered, but is not a credible solution to the need identified.

		– Building a new substation as a long term strategic approach to demand management for the area. We note this is likely to be significantly more expensive than the preferred option. – Upgrade the distribution voltage to increase capacity of each feeder. We note this is likely to be significantly more expensive than the preferred option. – Install new transformer and upgrade feeders (CLN and adjacent substations) to resolve the limiting feeder section causing the constraint. – Extension of Switchboards at adjacent ZSS's to enable transfer of load to defer the need for augmentation at CLN. The options identified by WSP were discussed with AusNet and identified to not be economic or aligned to AusNet long-term strategy.
Was a complete set of **non-network** options identified?	**Achieved**	Large customer demand management was considered. Residential customer demand management was not considered. The feasibility of implementing this in the required timeframe and achieving the required demand reduction (>10% reduction for up to 5 hours over the hot period of the day and evenings) should be investigated by AusNet. Based on past experience with RIT-D's WSP considers it is unlikely this would be credible option, but the analysis should be presented. It is also noted that the cost of residential demand management typically exceeds that of large customer demand management, and is therefore expected to be less economically feasible than the demand management option presented. AusNet provided additional information and analysis regarding a Hybrid Option (an option comprising Network and Non-Network options). The analysis demonstrated that the preferred option remained as option 6 with the highest NPV.

What network or non-network options did WSP identify in addition to those considered?	**NA**	As in the two rows above.
Do the identified options address the identified need?	**Achieved**	

ECONOMIC AND TECHNICAL ANALYSIS OF OPTIONS

DEFINING THE BASE CASE (BENEFITS ATTRIBUTED TO MITIGATION OPTIONS)

ANALYSIS OF THE BASE CASE – RIT-D GUIDELINES SECTION 3..3		
What is the technical justification for augmentation		
Information/analysis required	**Finding**	**Comment**
Has BAU (i.e. no augmentation) been used as the base case?	**Achieved**	
Have reasonable and appropriate service costs been included for the assessment of the base case? AER definition: Total **service cost**: total operational and maintenance costs plus the probability weighted risk (safety, environment, energy) costs	**Achieved**	
Have appropriate inputs been applied – probability of the constraint occurring, economic cost per MWh etc	**Achieved**	

Have these been based on reputable sources (NTNDP, ISP, AEMO etc)		
Have appropriate economic scenario's been developed and assessed to provide certainty of the timing and of the constraint occurring? Are the scenarios reasonable?	**NA**	Discussed and assessed jointly in the table below under the section title Analysis of identified options.

COSTS AND BENEFITS OF OPTIONS

COSTS, BENEFITS AND OTHER INPUTS – CLAUSES 5.17.4(J)(5) TO (8)		
[the draft report must include] where a Distribution Network Service Provider has quantified market benefits in accordance with clause 5.17.1(d), a quantification of each applicable market benefit for each credible option; **Notes:** clause 5.17.1(d) states that the RIT-D proponent may quantify any market benefit it considers may be material or may alter the selection of the preferred option.		
Information/analysis required	**Finding**	**Comment**
Have all relevant costs and benefits been considered (capex, opex, market costs and benefits)? Are any overly optimistic/conservative?	**Achieved**	
What methodologies are used in quantifying each cost, benefit and metric (discount rate etc)?	**Achieved**	The methodology used for the options assessment is consistent with common industry practice. Use of capacity constraints, load duration curve, probability of failure and VCR to determine the economic cost of not doing anything and using this as the benefits attributed to the options assessed.

Are the inputs and assumptions in the model reasonable, justified and applied consistently across options?	**Achieved**	
Does evidence of past performance support the assumptions?	**Mostly achieved**	There are no historical trends of asset performance provided. Historical load data is provided as load duration curves and an average daily load profile. All demand data is forecast, but we note AusNet uses historical information in the demand forecasting methodology. As the need for the project is based on the substation capacity and not on historical asset performance, the past performance information is not material in this case as 73% of the benefit is due to the demand exceeding the substation capacity.
Are demand forecasts reasonable, what are the data sources, are data sources current and from reliable source?	**NA**	Out of WSP scope

ANALYSIS OF IDENTIFIED OPTIONS

ANALYSIS OF IDENTIFIED OPTIONS – CLAUSES 5.17.4(J)(5) TO (8)		
[the draft report must include] the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results **Notes:** clause 5.17.1(c)(4) also covers the analysis required by a RIT-D. It states the requirement to consider potential voluntary load curtailment, economic cost of loss of supply, cost impact due to capex, opex and timing, ability for generation to take up load, additional option value gained or forgone by the selection of an option, consideration of electrical losses and other market benefits.		
Information/analysis required	**Finding**	**Comment**
Modelling		

Is the modelling approach suitable for each of the network and non-network options assessed?.	**Achieved**	
Has the model been built correctly (free from error in formulas)?	**Mostly achieved**	While the model is correctly calculating the analysis in this case, WSP identified a number of aspects that are not good practice and could result in errors: — assumptions are not explained or justified within the model — mix of hard coded numbers with numbers generated by formulae. Creates risk of error when model inputs or calculations are changed — formulae reference ranges that extend past populated tables and include blank cells. Creates risk of error if values entered into the blank cells without realising they are part of a formula. — inconsistent formatting making it more difficult to review — forcing cells to be blank rather than zero, making it more difficult to review — very long nested formulae (lookups, offset, if statements) which increase chance of error in formulae and difficulty in debugging and reviewing — Additional data is contained in the model that is not used and add complexity to the model.
Have correct financial/economic principles been followed?	**Achieved**	Notwithstanding the issues identified above, in general, appropriate financial and economic principals have been followed when constructing the model. Error in allocation of risk, as described in Appendix B
How has timing of the options been assessed? Ie, when annualised capital costs/project costs are exceeded by the do nothing cost	**Achieved**	

Has the model appropriately considered and implemented: - network redundancies, - probabilities of plant failure, - coincident probability of plant failure to result in USE.	**Achieved**	Benefit of reduced feeder loading – and therefore reduced energy at risk – not considered on an individual feeder basis and therefore is likely to understate the benefits attributed to Option 6. However, this will not change the selection of Option 6 as the preferred option.
Real options		
Has real option value been considered – retaining flexibility in the network: - larger capacity if small incremental cost and high probability of needing it, or - scalable/modular design to minimise costs.	**Achieved**	

SENSITIVITY AND SCENARIO ANALYSIS

SENSITIVITY AND SCENARIO ANALYSIS
5.17.1(c)(1) [the RIT-D must] be based on a cost benefit analysis that must include assessment of reasonable scenarios of future supply and demand **Clarification from Guidelines:** we consider a reasonable scenario as a set of variables or parameters that the RIT-D proponent does not expect to change across each of the relevant credible options. For example, the following variables should be independent of the credible options and considered as components of each reasonable scenario: – levels of economic growth and the associated level of base electricity demand – level of population growth and the associated level of base electricity demand – unit capital and operating costs of generation plant – value of any environmental penalties – value of unserved energy. In a particular analysis, it may be appropriate to assess the benefits of a credible option across high, medium and low demand reasonable scenarios. To the extent that a demand side option leads to lower peak demand under each of these reasonable scenarios, RIT-D proponents should account for this in the states of the world associated

with that option under each of those reasonable scenarios. This ensures that RIT-D proponents transparently calculate the benefits of the demand side option separately in high, medium and low demand scenarios.		
Information/analysis required	**Finding**	**Comment**
Has sensitivity analysis been undertaken?	**Achieved**	
To which variables (assumptions, inputs) is the model most sensitive? How has this been tested?	**Achieved**	Key variables were assessed in the sensitivity analysis
How sensitive is the preferred option to changes in assumptions (e.g. the value of USE or probabilities)? Would this make DM or NNO preferred or result in a delay to the need of the augmentation??	**Achieved**	Preferred option is not sensitive to the tested variable. It remains the preferred option in all cases. The proposed timing of the project is 2025 in all but 3 cases. In two cases, the timing is brought forward to 2024 and in one case it is delayed to 2026. In the model, the years are based on the summer. So, 2025 means the summer of 2024/25. To meet this timing, the augmentation needs to be completed in Nov 2024 to be ready for the summer period.
Has the above been adequately addressed?	**Achieved**	
Have relevant parts of the ISP and current NEM transformations been considered?	**NA**	
Are parameters used in the scenario analysis internally consistent and consistent across options?	**Achieved**	
Have the scenarios been appropriately probability weighted to determine the expected scenario/NPV?	**Achieved**	

DETERMINATION OF THE PREFERRED OPTION

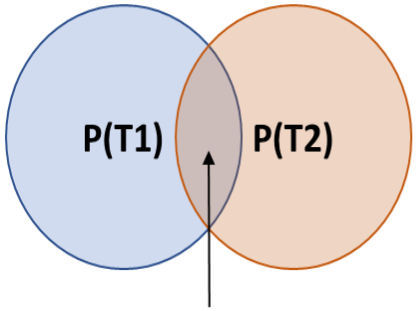
PREFERRED OPTION		
Clearly stated why the selected option is the preferred (optimal) option in comparison to other options: - technical feasibility - economic assessment - deliverability - ongoing network risk - providing real options/flexibility for the future		
Information/analysis required	**Finding**	**Comment**
Does the analysis support the selection of the preferred option?	**Achieved**	
Have the economic/technical scenarios been considered appropriately in selecting the preferred option?	**Achieved**	

GENERAL

GENERAL		
Be applied in a predictable, transparent and consistent manner – clause 5.17.1(c)(3)		
Information/analysis required	**Finding**	**Comment**
Has the analysis been applied in a predictable, transparent and consistent manner – clause 5.17.1(c)(3)	**Achieved**	A complex model has been used, but can be followed through and the assessment and financial/economic/technical principles have been applied correctly.
Does the assessment consider the full project, not in parts as per 5.17.3(e)	**Achieved**	
For all options, has the level of analysis been appropriate for to the scale and likely impact of each of the credible options being considered?	**Achieved**	

APPENDIX B

TRANFORMER FAILURE PROBABILITIES



P(T1 and T2) = P(T1) x P(T2)

Probabilities

Scenario	AusNet	Corrected
N-1	P(T1) + P(T2)	P(T1) + P(T2) – [P(T1) x P(T2)]
N-2	P(T1) x P(T2)	P(T1) x P(T2)

Assumes independence of the two transformers

Calculation of energy at risk

Scenario	AusNet	Corrected
N-1	[P(T1) + P(T2)] x USE(1 TF) x MTTR1	[P(T1) + P(T2) – [P(T1) x P(T2)]] x USE (1 TF) x MTTR1
N-2	P(T1) x P(T2) x USE(2 TF) x MTTR2	[P(T1) x P(T2) x USE(2 TF) x MTTR2] + [P(T1) x P(T2) x USE(1 TF) x MTTR1]

Where: USE is the Unserved Energy and the brackets indicate for the outage of 1 or 2 transformers; and, MTTR1 is the outage duration to restore supply from a N-1 situation and MTTR2 is the duration to restore supply from a N-2 situation to a N-2 situation

The table shows that while the allocation of the energy at risk to the N-1 or N-2 differs for the two approaches to calculating probability of failure, the sum of the two approach results in the same amount.