

EYRE PENINSULA ELECTRICITY SUPPLY OPTIONS

**Regulatory Investment
Test for Transmission**

Project Assessment Draft Report

16 November 2017

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Cover picture: Electranet transmission tower at the Port Lincoln substation in South Australia

Executive Summary

This report considers the most economic long-term electricity supply solution for the Eyre Peninsula

We understand the importance of a reliable electricity transmission supply to the regional areas of South Australia such as the Eyre Peninsula, and the contribution it makes to both communities and the ongoing economic development of the wider economy.

This Regulatory Investment Test for Transmission (RIT-T)¹ has been initiated to explore electricity supply options for meeting the South Australian Electricity Transmission Code (ETC)² reliability standards for the Eyre Peninsula most efficiently in the future.

Works required to replace components of the existing transmission line in the next few years and the upcoming expiry of the existing backup generation network support arrangement at Port Lincoln provide an opportunity to investigate alternative supply options to the current ageing radial 132 kV network.

In particular, it is timely to assess whether building new higher capacity transmission lines, including over more diverse paths, may result in greater expected net benefits to customers over the long-term, given potential future developments on the Eyre Peninsula. That is, while meeting the ETC reliability standard is the basis of the identified need for this RIT-T, the potential wider market benefits from investing in a more robust network for the Eyre Peninsula means that a broader range of solutions has been considered to meet that need.

Ten variants of five credible options have been assessed, including options for future-proofing the Eyre Peninsula electricity supply

We have investigated ten variants of five broad options for supplying the Eyre Peninsula going forward, which reflect a wide variety of different network capacities and routes.

These options range from:

- maintaining equivalent capacity on the Eyre Peninsula as currently; ie, a single-circuit 132 kV line coupled with network support at Port Lincoln; through to
- upgrading the entire network to 275 kV, with two completely divergent network paths from Cultana to Port Lincoln, in order to provide greater supply reliability.

Three options have been specifically designed for staged development to provide flexibility for potential future mining and/or renewable energy developments on the Eyre Peninsula. Real options analysis was used to estimate the net market benefits associated with the 'future-proof' options, and to compare them with the other investment options.

¹ The RIT-T is the economic cost benefit test that is overseen by the Australian Energy Regulator and applies to all major network investments in the National Electricity Market.

² The Electricity Transmission Code is made by the Essential Services Commission of South Australia (ESCOSA) and specifies required reliability standards at transmission network connection points, including on the Eyre Peninsula.

Building a new transmission line to supply the Eyre Peninsula delivers the most cost effective long-term solution

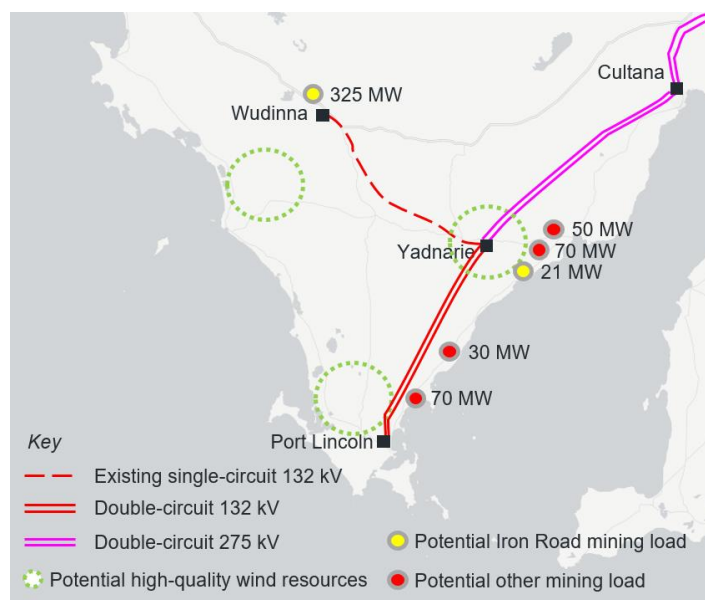
We engaged economic experts HoustonKemp to undertake the economic modelling reported in this Project Assessment Draft Report (PADR).

This assessment identifies that building a new transmission line to supply the Eyre Peninsula is the best option that simultaneously ensures reliable electricity supply to the Eyre Peninsula, consistent with the ETC reliability standards, and delivers the most efficient long-term solution; ie, delivers the greatest net market benefits to customers of the Eyre Peninsula, South Australia and the National Electricity Market.

The highest ranked preferred option (known as Option 4B)³ involves building and operating a double-circuit higher capacity 275 kV line from Cultana to Yadnarie, and a double-circuit 132 kV line from Yadnarie to Port Lincoln, as shown in Figure 1 below.

The estimated capital cost of the preferred option is \$300 million.

Figure 1 – Network configuration under Option 4B and locations of key mining and wind potential



We tested the draft conclusion under a range of alternative assumptions

The conclusion that Option 4B delivers the greatest net benefits has been found to be the case for not only a central set of key assumptions, but also for a range of alternate underlying assumptions regarding the future, as well as numerous sensitivity tests on other key modelling assumptions. Across all reasonable alternate assumptions investigated, Option 4B was consistently found to be the preferred credible option and, in all cases, was found to deliver positive net market benefits.

Even taking the additional benefits provided by the flexible ‘future proof’ options into account, Option 4B remains the preferred option under the RIT-T.

Option 4B would also remain the preferred option in the event that the Iron Road mining development becomes committed prior to the start of construction of this network option. It would also be the preferred option even if additional mining load never located on the Eyre Peninsula.

³ The preferred option is the one that delivers the greatest expected net benefits under the RIT-T economic assessment.

The benefits of most credible options investigated arise from two key impacts of those options on the wholesale electricity market – namely:

- changes in fuel consumption in the National Electricity Market (NEM) arising from different patterns of generation dispatch – in particular, reductions in gas fired generation in South Australia; and
- changes in the timing and type of generation investment – in particular, increasing the efficiency of generation investments, with increased wind farm generation on Eyre Peninsula, reduced wind farm investment in the mid-north region of South Australia, Victoria, and New South Wales, and reduced solar photovoltaic generation capacity in South Australia.

Each of these benefits are expected where credible options allow different patterns of generation dispatch and future construction (and retirement) of generators in the NEM, compared to where the existing single-circuit 132 kV line is retained.

In particular, these benefits are driven by the ability of the credible options to facilitate wind generators connecting on the Eyre Peninsula, which cannot be accommodated under the base case where replacement works are undertaken on the existing limited capacity transmission line.

Customer price impact

The estimated capital cost of the preferred option is about \$220 million more than the ‘business as usual’ base case of replacing components of the existing transmission line and establishing a new backup generation network support arrangement at Port Lincoln. However, the preferred option would remove the need for the backup network support arrangement and therefore save ongoing operating costs of about \$9 million per annum, which are paid for by electricity customers in South Australia.

The preferred option is estimated to deliver net market benefits of \$120 million over 20 years (in present value terms) and add less than \$3 to the transmission component of the annual electricity bill for the average residential customer in South Australia⁴.

We seek your feedback on this PADR and its draft finding

We welcome written submissions on the information contained in this PADR. Submissions are due on or before 19 January 2018.

Submissions are particularly sought on the credible options presented, the economic assessment undertaken (and its assumptions and methodology), as well as the draft finding that Option 4B is the preferred option involving a double circuit 275 kV between Cultana and Yadnarie and double circuit 132 kV between Yadnarie and Port Lincoln.

Submissions should be marked “Eyre Peninsula Electricity Supply Options PADR feedback” and emailed to consultation@electranet.com.au.

A Project Assessment Conclusions Report, including final options analysis, is expected to be published in April 2018.

⁴ This estimate has been determined using the Australian Energy Regulator’s Post Tax Revenue Model.

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Glossary of Terms

Term	Description
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CCP9	Consumer Challenge Sub-Panel No. 9
CEIP	Iron Road's Central Eyre Iron Project
EPLGA	Eyre Peninsula Local Government Association
ESCOSA	Essential Services Commission of South Australia
ETC	Electricity Transmission Code
FCAS	Frequency Control Ancillary Service
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NTNDP	AEMO's National Electricity Network Development Plan
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
PV (context: costs)	Present value
PV (context: generation)	Photovoltaic
RDWEP	Regional Development Australia Whyalla and Eyre Peninsula
RFT	Request for Tender
RIT-T	Regulatory Investment Test for Transmission
SACOME	South Australian Chamber of Mines and Energy
TNSP	Transmission Network Service Provider
VCR	Value of Customer Reliability
WACC	Weighted Average Cost of Capital

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Overview

This Project Assessment Draft Report (PADR) represents the second step in the application of the Regulatory Investment Test for Transmission (RIT-T)⁵ to network and network support options for ensuring reliable electricity supply to the Eyre Peninsula.

It follows the release of the Project Specification Consultation Report (PSCR) on 28 April 2017. ElectraNet received 15 submissions on the PSCR, reflecting a range of views and interests. These submissions have been taken into account in the analysis presented in this draft report.

ElectraNet notes the recent Federal Government announcements in relation to the proposed new National Energy Guarantee, comprising a Reliability Guarantee and an Emissions Guarantee. At this stage, ElectraNet does not expect that these policies will materially impact the analysis presented in this PADR.

Reliable electricity supply to the Eyre Peninsula is of the utmost importance

We understand the importance of a reliable electricity transmission supply to the regional areas of South Australia such as the Eyre Peninsula, and the contribution it makes to both communities and the ongoing economic development of the wider economy.

The identified need for this RIT-T is to explore electricity supply options for meeting Electricity Transmission Code (ETC)⁶ reliability standards at Port Lincoln most efficiently in the future⁷ – driven by the need to replace major transmission line components serving the lower Eyre Peninsula in the next few years, and the upcoming expiry of the generation network support arrangement at Port Lincoln.

The Eyre Peninsula is currently served by a radial 132 kV transmission line which runs from Cultana to Yadnarie and through to Port Lincoln.⁸ The original line to Port Lincoln was established in 1967 and our most recent assessment of the line's condition shows that there are four key sections, totalling 118 km, which need major replacement works in the next few years.

Supply to Port Lincoln is also supported by a network support agreement, which enables ElectraNet to call upon the services of three diesel fired gas turbines connected at Port Lincoln when needed. This arrangement expires in December 2018.

The 'business as usual' base case for this RIT-T, against which all other options have been assessed, is the partial reconductoring of the existing single-circuit 132 kV line and establishment of a new network support arrangement at Port Lincoln.⁹ This base case has been adopted as a 'do nothing' alternative would result in significant unserved energy to the Eyre Peninsula, which is an unacceptable and unrealistic outcome, and therefore not an appropriate basis for comparison.

⁵ The RIT-T is the economic cost benefit test that is overseen by the Australian Energy Regulator and applies to all major network investments in the National Electricity Market.

⁶ The ETC, which is made by the Essential Services Commission of South Australia (ESCOSA), specifies required reliability standards at transmission network connection points, including on the Eyre Peninsula.

⁷ The South Australian Electricity Transmission Code (ETC) reliability standards require that ElectraNet provide non-continuous "N-1" equivalent line capacity to the Port Lincoln exit point, so that backup supply for Port Lincoln is available within one hour when supply from the 132 kV line is interrupted.

⁸ A radial 132 kV line also extends from Yadnarie to Wudinna to supply the West Coast.

⁹ Option 1 is consistent with ElectraNet's submitted revenue proposal for the 2018-23 regulatory period; i.e. in its proposal, ElectraNet included approximately \$80m for replacing the line conductor in high priority sections of the 132 kV lines.

The new ETC ('TC/09') requires that the costs and benefits of maintaining the existing reliability standard are considered when it comes to major replacement decisions. ElectraNet has met this requirement by demonstrating the economic case for the 'business as usual' base, to which all other options are compared.¹⁰

Relationship between the recent ESCOSA review and this PADR

Supply interruptions in South Australia towards the end of 2016 highlighted the vulnerability of electricity supply in areas like the Eyre Peninsula to severe weather, particularly where they are served by a radial network. Following these events, the Essential Services Commission of South Australia (ESCOSA) undertook an inquiry into the reliability and quality of electricity supply on the Eyre Peninsula. ESCOSA's final report was published on 27 October 2017.

A number of parties raised the distribution level options identified in the ESCOSA reports as reflecting relatively low-cost solutions to improving reliability outcomes for consumers in the region. However, it is important to recognise that the transmission options being explored as part of this RIT-T are expected to deliver a broader range of market benefits over and above the reliability benefits highlighted in the ESCOSA report, and may displace some of the generation options proposed by SA Power Networks.

Comparing the SA Power Networks and ElectraNet options only on the basis of improvements in reliability (minutes saved) and estimated cost may give the false impression that the SA Power Networks' options should be prioritised over the transmission options. In particular, as demonstrated in this PADR, transmission options will deliver a broader range of market benefits via enabling potential future mining loads to connect to the transmission network, as well as unlocking the potential for additional wind generation.^{11,12}

In addition, the estimated cost of each of the distribution-level options excludes the reinvestment necessary to maintain reliability of supply to the Eyre Peninsula given the condition of the existing transmission assets.

This RIT-T considers the most economic long-term solution for the Eyre Peninsula

The required replacement works on the existing transmission line and the upcoming expiry of the existing network support contract provide an opportunity to investigate alternative supply options to the current radial 132 kV network.

In particular, it is timely to assess whether building new higher capacity transmission lines, including over more diverse paths, may result in greater expected net benefits over the long-term, given potential future developments on the Eyre Peninsula. That is, while meeting the ETC reliability standard is the basis of the identified need for this RIT-T, the potential wider market benefits from investing in a more robust network for the Eyre Peninsula mean that a broader range of solutions has been considered to meet that need.

¹⁰ ElectraNet has included a summary of an economic assessment of this option (Option 1) undertaken in 2016 and early 2017 as Appendix F to this PADR. While it pre-dates this RIT-T, it has been included to illustrate the rigour sitting behind the decision to include Option 1 as the 'business as usual' base case in this RIT-T and illustrates that Option 1 is expected to generate net benefits across a reasonable range of underlying assumptions.

¹¹ These benefits are captured in the RIT-T framework in terms of their impact in lowering dispatch and investment costs in the National Electricity Market (NEM).

¹² For a detailed discussion of the interaction between the distribution-level options and the transmission options considered in this PADR/RIT-T, please refer to ElectraNet's submission to the ESCOSA draft report, available at: <http://www.escosa.sa.gov.au/ArticleDocuments/1085/20170831-Inquiry-ReliabilityQualityElectricitySupplyEyrePeninsula-DraftReportSubmission-ElectraNet.pdf.aspx?Embed=Y>

The Eyre Peninsula is a natural resource rich-region of Australia, including both:

- significant untapped mineral deposits and mining potential – the region covers the mineral areas known as the Gawler Craton and the Eucla Basin, which have significant proven iron ore and other mineral deposits¹³; and
- significant untapped wind generation potential – the Eyre Peninsula is widely renowned as having very high-quality wind resources, with estimates of thousands of mega-watts of wind generation potential.¹⁴

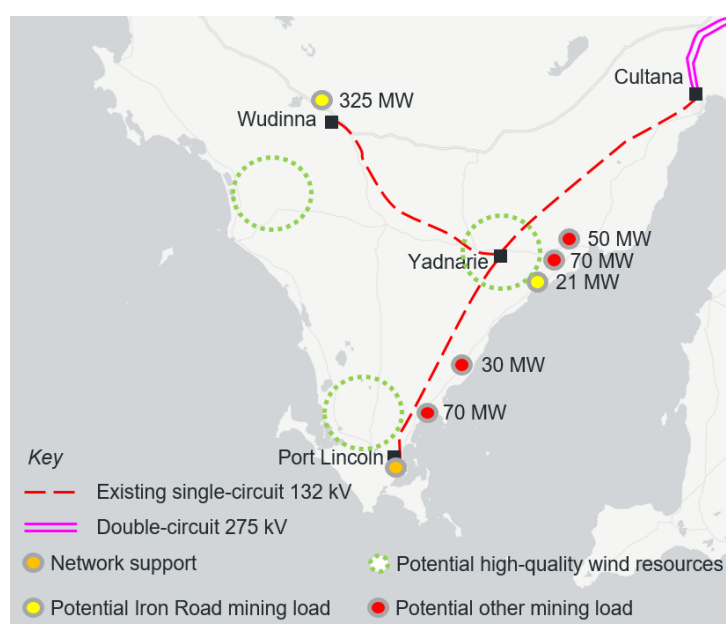
The existing transmission infrastructure has very limited spare capacity, which acts as a constraint on the amount of both mining load and wind generation that can connect.¹⁵

‘Future-proofing’ the Eyre Peninsula for potential economic developments

Potential mining and wind energy developments

The figure below presents a stylised overview of both advanced mining load proposals¹⁶ on the Eyre Peninsula as well as identified areas of high-quality wind resource.¹⁷

Figure 2 – Existing electricity supply to the Eyre Peninsula and locations of representative mining and wind potential



¹³ <http://www.minerals.statedevelopment.sa.gov.au/mining>

¹⁴ Baker and McKenzie, WorleyParsons & Macquarie Bank, Green Grid – Unlocking Renewable Energy Resources in South Australia, 2010, p. 25.

¹⁵ As an example, the two existing wind farms on the peninsula are at times constrained due to network limitations – this occurred for up to 24 per cent of the time in 2016 and up to 15 per cent of the time in 2015.

¹⁶ Specifically, it presents the location and indicative load requirements relating to the five formal connection enquiries from mining entities ElectraNet has received for the Eyre Peninsula.

¹⁷ The three areas identified were previously identified in the Green Grid report released in 2010 as zones that should be prioritised for development owing to their excellent wind resources – see Baker and McKenzie, WorleyParsons & Macquarie Bank, Green Grid – Unlocking Renewable Energy Resources in South Australia, 2010, p. 27.

While the Eyre Peninsula has strong mining and renewable generation potential, there is inherent uncertainty in relation to when these resources will be developed. In particular:

- mining developments depend on world minerals prices – prior to international iron ore (and other minerals) prices taking a downturn in recent years, five major mining developments on the Eyre Peninsula had reached a pre-feasibility stage and made formal enquiries with ElectraNet for connection to the transmission network;¹⁸ and
- renewable energy developments on the Eyre Peninsula remain driven to an extent by both Commonwealth¹⁹ and South Australian carbon emissions policies, as well as expectations about future wholesale market prices.

We note that the five potential mining developments shown above represent a subset of the total mining potential on the Eyre Peninsula and relate only to those where ElectraNet has previously received a formal connection enquiry. For example, the South Australian Government currently recognises 10 potential mining projects on the Eyre Peninsula, all of which could ultimately be developed in the future.²⁰

The prospect of increased mining activity on the Eyre Peninsula has recently re-emerged. On 3 May 2017, after release of the PSCR, the South Australian government announced two key approvals for Iron Road's Central Eyre Iron Project (CEIP), for which representative potential loads are shown in yellow in the figure above. These are 21-year leases for a mining and minerals processing operation near Warramboo, and Development Authorisation for associated infrastructure components (transmission line, port, railway, water pipeline and worker village).²¹ Iron Road's submission to the PSCR states that it expects to make a final investment decision by the end of 2017 on the CEIP, with financial close expected during 2018.²²

Many of the other submissions received on the PSCR also acknowledge both the mining load and renewable energy potential on the Eyre Peninsula.

Future proofing

If building a new transmission line is more cost effective than repairing the existing line and establishing a new network support agreement at Port Lincoln, then there are several important options to consider for the efficiency of future supply solutions on the Eyre Peninsula, including:

- build a 'minimum capacity' option now, relying on network support to minimise the required transmission investment – while this option will involve lower upfront costs, it may end up costing more over the long-term and risks suboptimal outcomes if mining and/or renewable generation, particularly wind generation, develops on the Eyre Peninsula; or

¹⁸ These loads requested to connect in the vicinity of Wudinna, Yadnarie and between Yadnarie and Port Lincoln substations – they are illustrated on Figure 3 above. The formal connection enquiries previously received by mining companies culminated in ElectraNet commencing a formal RIT-T process in February 2012, which sought to assess the most efficient long-term solution for the Eyre Peninsula. A PADR was released in January 2013 and that RIT-T was put on-hold until ElectraNet received confirmation regarding spot load increases.

¹⁹ The recent Finkel review for example made recommendations in relation to network planning to new renewable precincts, including that AEMO, supported by Transmission Network Service Providers (TNSPs) and other stakeholders, is to determine the optimal transmission network design to enable the connection of renewable resources (the 'Integrated Grid Plan') by mid-2018. This is to include identification of prospective renewable zones (which may include the Eyre Peninsula on account of the quality of the potential wind resource), and a high-level assessment of the relevant economics, to inform decisions about the order in which to develop the transmission network. See: Finkel Report, Recommendation 5.1, p.124.

²⁰ http://www.minerals.statedevelopment.sa.gov.au/mining/mineral_projects

²¹ Government of South Australia – Department of the Premier and Cabinet, *Submission to ElectraNet's revenue proposal for 2018-23*, 12 July 2017, p. 3.

²² Iron Road, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 18 July 2017, p.1.

- invest in slightly greater network capacity now to get the ‘option value’ of upgrading the network (or part of it) to 275 kV later if mining and/or wind generation develop – while this option involves a greater cost upfront, it may be more cost-effective in the long-run to accommodate future mining and/or wind generation developments; or
- build all or part of the network to 275 kV initially – this would cost more upfront, but would allow mining and wind generation to connect as soon as the new network is commissioned. However, it also carries a risk that the additional network capacity could be built before it is needed, or not needed at all.

This RIT-T seeks to identify which of these high-level options is the prudent and efficient choice to make considering the various uncertainties surrounding future activity on the Eyre Peninsula.

It is the first RIT-T in the National Electricity Market to formally estimate ‘option value’, in relation to options which, for additional upfront cost, provide the flexibility to upgrade network capacity in the future if it is efficient to do so.

Variants of five credible options have been assessed, including options that actively model and capture the ‘option value’ associated with future-proofing

ElectraNet has investigated variants of five broad options for supplying the Eyre Peninsula going forward, which reflect a wide variety of different network capacities and routes.

These options range from:

- maintaining equivalent capacity on the Eyre Peninsula as currently, ie, a single-circuit 132 kV line coupled with network support at Port Lincoln; through to
- upgrading the entire network to 275 kV, with two completely divergent network paths from Cultana to Port Lincoln, to provide greater supply resilience.

Three options have been specifically designed to be dynamic and allow the ‘option’ of upgrading the network capacity at a future date, if a certain ‘trigger’ occurs (these options are 4C, 4D and 5C, described on the next page). These triggers reflect ‘learning’ about potential future mining developments on the Eyre Peninsula as well as renewable energy policies – specifically:

- the CEIP mining project reaching committed status;
- various other mining loads reaching committed status at some point in the future (eg, due to a rebound in world minerals prices); and
- the Eyre Peninsula being designated as a priority for renewable energy development.

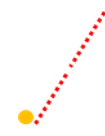





Designing three options to be flexible in response to such events makes it possible to explicitly look at the benefit of spending more upfront to give the option of upgrading to 275 kV at a lower cost later if one of these triggers occurs.

Table 1 below summarises each of the ten option variants we have assessed. Specifically, it outlines:

- the key features of each option, in terms of the network capacity and route(s);
- the estimated costs under each option, including the *additional* cost for those three options that have the option to upgrade to 275 kV at a later date if one of the above triggers occurs; and

- a high-level schematic of the network configuration under each option, including in different future ‘states of the world’ for the three flexible options that are initially operated at 132 kV but can be energised to 275 kV at a later date, if required.







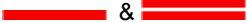



Table 1 – Summary of the ten option variants assessed

Option Overview	Estimated capital cost(s) ^{23,24}	Affected/new network ²⁵
<u>Option 1 ('base case')</u> Continue network support at Port Lincoln and reconductor the existing 132 kV single-circuit line	\$80 million As well as operating costs of about \$9 million per year for network support	
<u>Option 2</u> A double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit rated to about 300 MVA	\$220 million	
<u>Option 3</u> Two single circuit 132 kV lines routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 300 MVA	\$390 million	
<u>Option 4A</u> Double circuit 275 kV following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit rated to about 600 MVA	\$390 million	
<u>Option 4B</u> Double circuit 275 kV between Cultana and Yadnarie, each circuit rated to about 600 MVA, and double circuit 132 kV between Yadnarie and Port Lincoln, each circuit rated to about 300 MVA	\$300 million	
<u>Option 4C</u> Double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit initially rated to about 300 MVA – with the ability to be upgraded to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	\$310 million <i>Plus \$50 million if the Cultana to Yadnarie line is upgraded to 275 kV</i> <i>Or, plus \$90 million if all lines are upgraded to 275 kV</i>	

²³ Costs for all options are to be treated as indicative at this stage and are based off a preliminary design. All options have been designed, and costed, to be consistent with the relevant Australian Standards.

²⁴ All costs and benefits in this PADR are in 2017-18 dollars, unless stated otherwise.

²⁵ These schematics illustrate the affected/new network under each option. Under all options, the existing 132 kV line from Wudinna to Yadnarie remains unchanged and so is not shown in these high-level network diagrams.

Option Overview	Estimated capital cost(s) ^{23,24}	Affected/new network ²⁵
<u>Option 4D</u> Double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit initially rated to about 300 MVA – with the ability to upgrade the Cultana to Yadnarie section to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	\$270 million Plus \$50 million if the Cultana to Yadnarie line is upgraded to 275 kV	
<u>Option 5A</u> Two single circuit 275 kV lines following separated routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 600 MVA	\$610 million	
<u>Option 5B</u> Two single circuit lines between Cultana and Port Lincoln (one going via Wudinna), with the Cultana to Wudinna line built and operated at 275 kV and rated to about 600 MVA, and the rest only ever operated at 132 kV with each circuit rated to about 300 MVA	\$450 million	
<u>Option 5C</u> Two single circuit 132 kV lines following separated routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 300 MVA – with the ability to be upgraded to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	\$500 million Plus \$30 million if the Cultana to Wudinna line is upgraded to 275 kV Or, plus \$60 million if the Cultana to Wudinna line AND the Cultana to Yadnarie lines are upgraded to 275 kV Or, plus \$110m if all lines are upgraded to 275 kV	
Key:  Reconductored 132 kV  Network support at Port Lincoln  &  132 kV single-circuit & 132 kV double-circuit  &  275 kV single-circuit & 275 kV double-circuit		

Option 1 is the 'business as usual' base case against which all other options are assessed.²⁶

²⁶ Option 1 is consistent with ElectraNet's submitted revenue proposal for the 2018-23 period, which included approximately \$80 million for replacing the line conductor in high priority sections of the 132 kV lines. ElectraNet has included a summary of the precursory economic assessment of Option 1 undertaken in 2016 and early 2017 as Appendix F. While it pre-dates this RIT-T, it has been included to illustrate the rigour sitting behind the decision to include Option 1 as the 'business as usual' base case in this RIT-T and illustrates that Option 1 is expected to generate net benefits, across a reasonable range of underlying assumptions.

These options are broadly consistent with the five options presented in the PSCR, but have been expanded and amended to reflect further consideration, cost refinement and network modelling undertaken by ElectraNet. Options 4C, 4D and 5C in particular build on the double and single-circuit options presented in the PSCR to explicitly capture the option value ascribed to being able to upgrade that option to 275 kV at a later date if sufficient mining or wind developments emerge. As a consequence, the option numbering in the PADR is different to the PSCR.²⁷

The options also accommodate feedback received in submissions to the PSCR, including the investigation of 275 kV options to accommodate mining and wind generation as well as an alternative route that goes via Wudinna.

ElectraNet released a Request for Tender (RFT) on 28 September 2017 that requested financial and operating parameters from network support proponents, as was indicated in the PSCR. ElectraNet has assessed these responses to develop assumptions regarding future network support costs at Port Lincoln.

Since publication of the PSCR, ElectraNet has further refined the optimal routes for the geographically diverse single-circuit line options and concluded that one circuit should be considered to go to Port Lincoln via Wudinna for the purpose of these options. Doing so allows for reduced expected unserved energy due to providing de-radialised transmission supply to Wudinna, improved lower Eyre Peninsula supply security due to the significantly geographically diverse routes, and also better wind diversity through gaining access to wind resources south-west of Wudinna (around Elliston) and cheaper resource costs associated with connecting CEIP, if it eventuates.

A combination of both wholesale market modelling and real option value techniques has been used to evaluate the benefits of options assessed

ElectraNet engaged HoustonKemp to undertake the modelling reported in this PADR. HoustonKemp applied two separate modelling techniques in order to capture uncertainties in the analysis:

- wholesale electricity market modelling – allowing an assessment of likely future market outcomes across a range of scenarios; and
- real option valuation – to explicitly model the ‘option value’ associated with being able to make future decisions about upgrading supply to all, or part, of the Eyre Peninsula to higher capacity 275 kV if mining and/or wind development occurs.

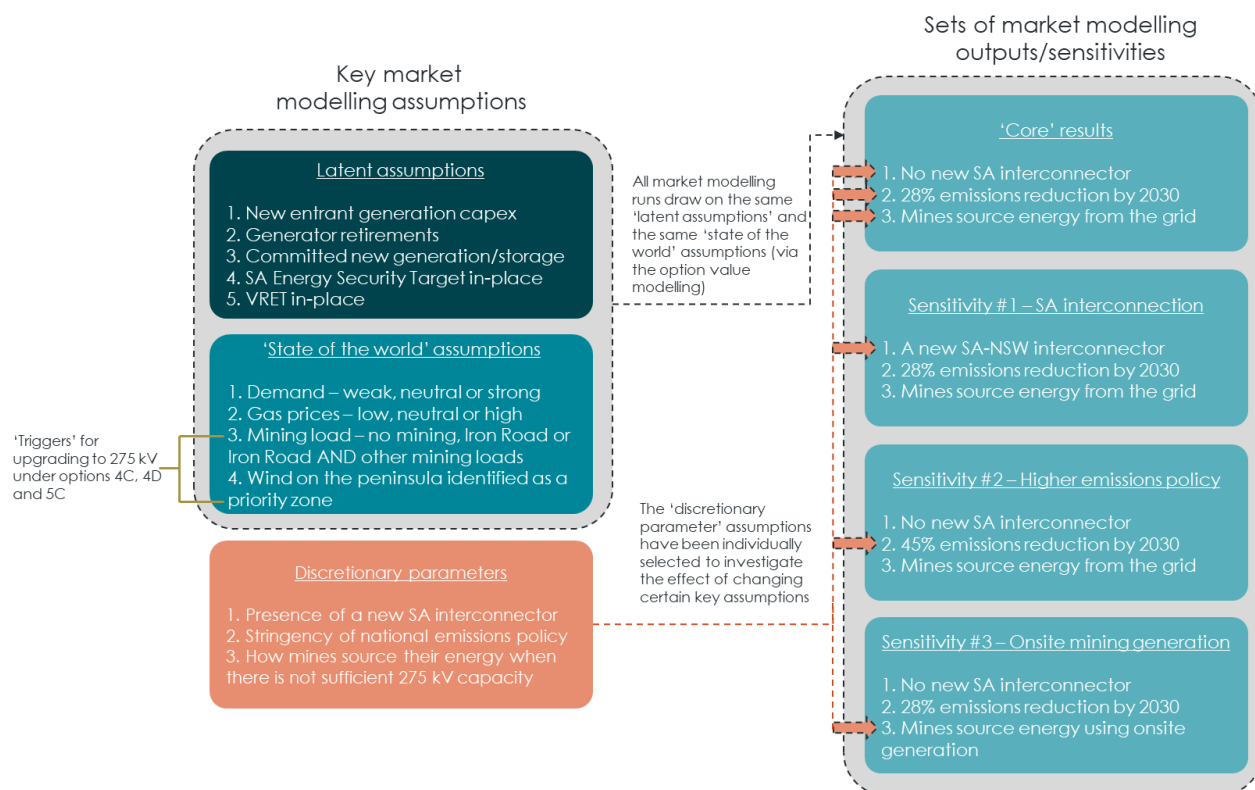
Real option valuation has allowed an investigation of whether there is sufficient benefit generated through those options that consider the potential to upgrade to 275 kV at a later date if required, ie, Options 4C, 4D and 5C. It allows us to model whether there is significant benefit associated with spending more in relation to a particular option initially in order to give the option of upgrading the network, or part of it, to 275 kV at a lower cost later on if mining load or wind generation emerges on the Eyre Peninsula.

²⁷ The PSCR included the following five broad options: Option 1 – continue network support arrangement at Port Lincoln and component replacement works on the existing 132 kV single-circuit transmission line (consistent with Option 1 in the PADR); Option 2 – Double circuit 132 kV line (consistent with Option 2 in this PADR); Option 3 – two single circuit 132 kV lines (consistent with Option 3 in this PADR, except with refined geographically diverse routes); Option 4 – double circuit 275 kV line, to be operated at 132 kV initially (consistent with Option 4C in this PADR); and Option 5 – two single circuit 275 kV lines (broadly consistent with Option 5C in this PADR, except with refined geographically diverse routes).

The combination of these modelling techniques has allowed for a more thorough assessment than traditional scenario analysis. In particular, it has allowed the modelling of a large number of possible future states of the world, reflecting different combinations of key exogenous variables.²⁸ It has also allowed a thorough testing of the sensitivity of the results to key underlying assumptions.

We have investigated the costs and market benefits of each credible option under four key sets of assumptions (one 'core' set of results and three key 'sensitivities'), as illustrated in the figure below.

Figure 3 – Overview of the market modelling undertaken



The 'state of the world' assumptions are a proxy for how key benefit drivers may unfold in the future and include both electricity demand and gas price assumptions, as well as mining load and renewable energy policy 'trigger' variables. The state of the world assumptions have a number of effects in the modelling framework – namely:

- triggering network upgrades in the options that possess option value (ie, 4C, 4D and 5C);
- increasing demand in South Australia (for cases with mining loads); and
- allowing new wind resources to locate on the Eyre Peninsula.

The following table summarises each 'state of the world' assumption and their sources.

²⁸ Including: whether, and how much, mining load develops on the Eyre Peninsula in future; whether, and how much, renewable energy may locate on the Eyre Peninsula in future years; different trajectories of key assumptions, such as electricity demand and gas prices; various national emissions policies; and whether greater interconnection is established between South Australia and the rest of the NEM.

Table 2 – Various 'state of the world' assumptions and their sources

Assumption	States of the world	Probability	Source
Electricity demand	Strong	0.33	AEMO's 2017 Electricity Statement of Opportunities ²⁹
	Neutral	0.33	
	Weak	0.33	
Gas prices ³⁰	High	0.33	ElectraNet assumption
	Neutral	0.33	AEMO's 2016 NTNDP ³¹
	Low	0.33	ElectraNet assumption
Mining load	No mining load	0.60	ElectraNet assumptions
	Iron Road mine is developed	0.20	
	Iron Road and others assumed mines are developed	0.20	
Wind on the Eyre Peninsula	Eyre Peninsula is declared a renewables precinct	0.50	ElectraNet assumptions
	No declaration	0.50	

The modelling assumes that the first auction under the Victorian Renewable Energy Auction Scheme is held in 2018 and that the auction successfully procures the full quantity of capacity contracts available; ie, 100 MW of solar photovoltaic (PV) generation and 550 MW of technologically neutral renewable generation. Recognising the uncertainty regarding future state-based renewable energy targets, the modelling does not make any assumptions regarding longer-term renewable energy targets for Victoria or other jurisdictions.

The South Australian Energy Security Target is also assumed to take effect from 2020 onwards. The target requires a specified quantity of generation to be met by generation located in South Australia that meets dispatchability and system security requirements and that utilises gas or renewable fuel sources.³²

On 17 October 2017, the Commonwealth Government released a new federal energy policy – the National Energy Guarantee.³³ The policy consists of two principal components: a reliability guarantee and an emissions guarantee, and imposes obligations on retailers to procure generation such that their load is met by a portfolio of generation that meets dispatchability, system security and emissions intensity criteria. It may be the case that the reliability guarantee is similar in nature to and could ultimately replace the South Australian Energy Security Target.

²⁹ Retrieved through the Australian Energy Market Operator's (AEMO's) Forecasting Data Portal.

³⁰ In line with the approach adopted for the South Australian Energy Transformation RIT-T, and reflecting comments received by stakeholders to that RIT-T process, a wider range of gas prices than are assumed by AEMO have been adopted. In particular, the high gas price scenario is defined as \$3.50/GJ above the neutral case and the low gas price scenario is defined as \$2.50/GJ below the neutral case – for reference the neutral case sees gas price forecasts for Torrens Island from \$7.63/GJ in 2018 to \$8.40/GJ from 2023 onwards.

³¹ National Transmission Network Development Plan

³² Draft legislation for the scheme Electricity (General) (Electricity Security Target) Variation Regulations 2017

³³ Energy Security Board, *Energy Security Board Advice on Retailer Reliability Emissions Guarantee and Affordability*, 13 October 2017.

Some uncertainty remains regarding whether the National Energy Guarantee will be accepted in its current form, the timing of the implementation of the policy and the detailed parameters within the policy. However, ElectraNet is of the view that the modelling undertaken for this PADR is consistent with this new policy. This assumes that the requirements for dispatchable generation under the reliability guarantee do not materially differ from similar requirements that are required to meet the South Australian Energy Security Target, which has been included within the modelling. In addition, the modelling captures emissions reductions in line with the COP21 Paris Agreement which the new policy is anticipated to meet.

Market benefits are driven by the ability of options to facilitate wind generation on the Eyre Peninsula

Most of the credible options investigated have benefits arising from two key impacts on the wholesale market – namely:

- changes in fuel consumption in the National Electricity Market (NEM) arising through different patterns of generation dispatch; and
- changes in the timing and type of generation investment.

Market benefits from expanding Eyre Peninsula transmission capacity are found to be primarily due to the following impacts on future dispatch and investment outcomes:³⁴

- a reduction in investment in new wind farms in the mid-north region of South Australia;
- a reduction in investment in solar PV generation in South Australia;
- a reduction in investment in wind farms in Victoria and, to a lesser extent, New South Wales; and
- a reduction in dispatch of gas fired generation in South Australia.

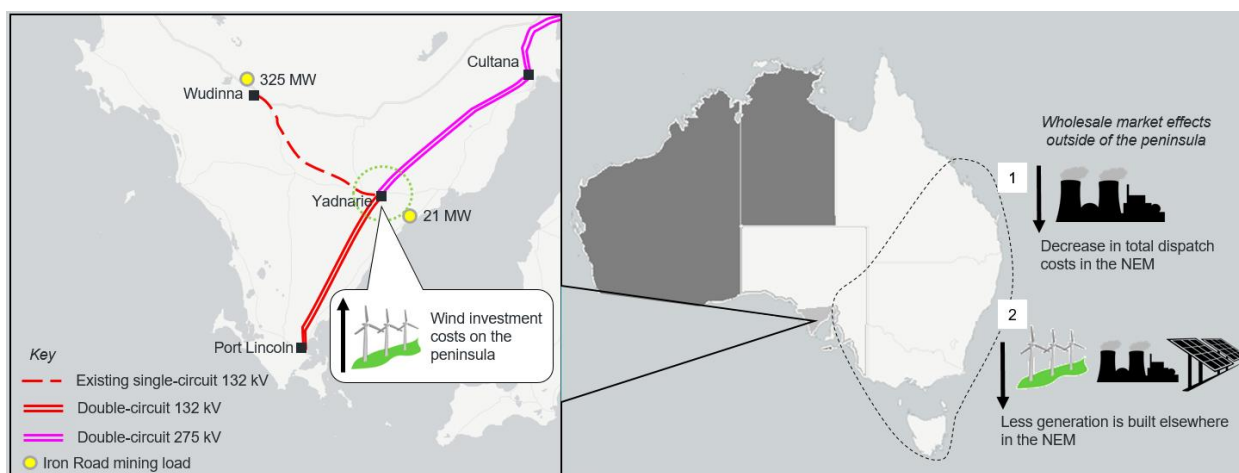
Each of these benefits are expected where credible options allow different patterns of generation dispatch and future construction (and retirement) of generators in the NEM, compared to where the existing limited capacity single-circuit 132 kV line is retained (ie, Option 1).

In particular, both categories of market benefit are driven by the ability of the options to facilitate wind generators connecting on the Eyre Peninsula, which cannot be accommodated under Option 1.

The figure below illustrates these effects, and the two market benefits above, using Option 4B and the assumed 'state of the world' where only Iron Road's CEIP locates on the Eyre Peninsula as an example. It illustrates how wind generation locating on the Eyre Peninsula results in lower total dispatch costs in the NEM as well as less generation being built overall.

³⁴ See Appendix H for a breakdown of the dispatch and investment impacts under each option and sensitivity.

Figure 4 – Summary of key wholesale market effects – using Option 4B as an example

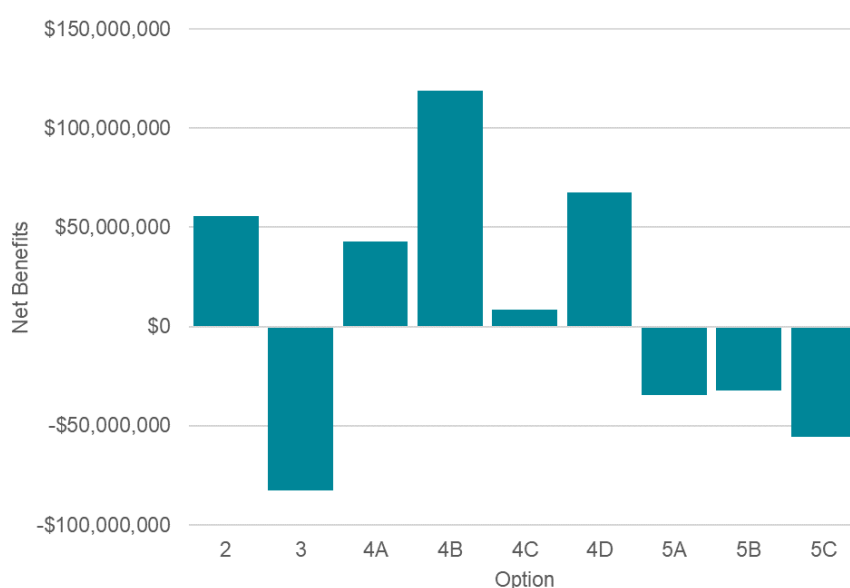


We have included the ability for wind generation to contribute towards system security, allowing new entrant wind farms to opt to be eligible for the South Australian Energy Security Target through incurring additional costs estimated to be 20 per cent of their capital and fixed and variable operating costs. This approach assumes that with these additional costs, wind generators will be eligible for participation in the scheme by meeting dispatchability and system security requirements.

Option 4B is the preferred option at this draft report stage and the cost of further ‘future-proofing’ is not found to be economically justified

Option 4B is found to have the greatest estimated net market benefits of the 10 option variants considered under the ‘core’³⁵ set of assumptions. Option 4B involves building upfront and operating a double-circuit 275 kV line from Cultana to Yadnare, and a double-circuit 132 kV line from Yadnare to Port Lincoln (that cannot be upgraded to 275 kV later).

Figure 5 – Estimated net market benefits for credible options under the ‘core’ set of assumptions, relative to Option 1 (the ‘business as usual’ base case)



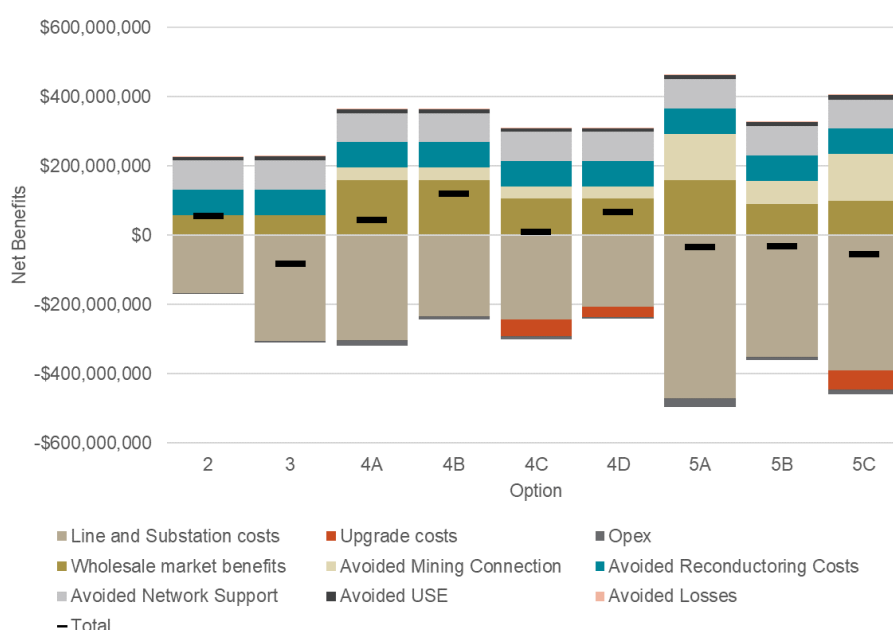
³⁵ The ‘core’ set of assumptions reflect ElectraNet’s central view regarding key underlying assumptions likely to affect the magnitude of net market benefits estimated for each option. These core assumptions have been stress-tested through various sensitivity tests to ensure the robustness of the overall results.

All the options considered provide market benefits in terms of increased reliability, and therefore decreased unserved energy, for customers on the Eyre Peninsula. However, this benefit category forms only a small proportion of the total market benefits estimated (as do benefits from changes in transmission losses).

The primary source of market benefit for all options comes from the expected impact on the wholesale electricity market by facilitating more wind generation locating on the Eyre Peninsula. In particular, avoided dispatch costs in the NEM from additional, high quality wind generation being able to locate on the Eyre Peninsula, delivers the greatest category of market benefit, particularly for options that energise all, or part, of the Eyre Peninsula to 275 kV.³⁶

Importantly, the assessment in this RIT-T is not predicated on an assumption that additional wind generation will automatically locate on the Eyre Peninsula, if the transmission lines are augmented to 275 kV. Rather, the market modelling demonstrates that additional wind generation would locate in the Eyre Peninsula when it represents the least cost solution (taking into account system security considerations), and that this is particularly the case in the high and medium demand 'states of the world'.

Figure 6 – Breakdown of estimated net market benefits for credible options under the 'core' set of assumptions, relative to Option 1 (the 'business as usual' base case)³⁷



The second largest category of benefit for all options is the avoided network support costs associated with maintaining the current required ETC reliability standard at Port Lincoln. This avoided cost is, however, substantially the same for all credible options, relative to the base case (Option 1) and so does not affect the ranking of the options, and therefore the choice of preferred option.

The above results demonstrate that avoided connection costs to mines associated with connecting to the electricity network are also a significant source of benefit for options that result in all, or part, of the Eyre Peninsula being operated at 275 kV capacity.

³⁶ These avoided fuel costs are offset slightly by increased generation investment costs in the NEM associated with this additional wind locating in the Eyre Peninsula.

³⁷ While this figure provides the breakdown of gross market benefits and costs across all options, in present value terms, it also presents the net market benefits (via the black dashed markers). For clarity, the net market benefit results shown in this figure are equal to the net market benefit figures shown in Figure 6 above.

These avoided connection costs are largest when a 275 kV line is assumed to go via Wudinna (ie, 5A, 5B and 5C) due to the main CEIP load being located near Wudinna.

Overall, Option 4B is the preferred option primarily owing to it having the equal highest market benefits among the options in combination with one of the lowest total capital and operating costs. While Option 4A has higher costs than Option 4B (due to the entire route being built and operated to 275 kV), it provides no additional market benefits. This is driven by the assumption that the additional 275 kV lines from Yadnarie to Port Lincoln do not allow any additional wind generation to connect on the Eyre Peninsula, as the capacity for additional wind connection is already utilised by additional wind generation located around Yadnarie. The 132 kV lines between Yadnarie and Port Lincoln would be capable of accepting about 500 MVA additional wind or other generation.

Relative to the options that incorporate option value and follow the existing route down the Eyre Peninsula (ie, options 4C and 4D), Option 4B has higher market benefits owing to the deferred expansion of the network under these more flexible options, and the subsequent loss in benefits from being unable to access the wind resources on the Eyre Peninsula earlier.

This effect is exaggerated by the fact that solar PV generation becomes increasingly cost effective relative to wind throughout the modelling period, and therefore, having access to the Eyre Peninsula wind resources later means the resources are less utilised, with lower quality wind resources located elsewhere in the NEM being adopted instead.

Option 4C, which has been designed as a low-cost option that allows ElectraNet the ability to upgrade to 275 kV at a later date if required, is found to have only marginally positive net market benefits. This is due largely to the fact that the upfront costs of building the line to be able to operate at 275 kV at a later date are far greater than the ultimate upgrade costs (which focus on relatively low-cost substation upgrades to transition to 275 kV).

Under the core set of assumptions, the higher capital costs associated with building lines on the geographically diverse path via Wudinna (ie, options 5A, 5B and 5C) are not offset by the additional benefits arising from reductions in unserved energy or reductions in mining connection costs.

We tested this draft conclusion under a range of alternate assumptions

We have investigated the robustness of the finding that Option 4B is the preferred option to a range of alternative assumptions regarding key future developments, including:

- assuming that there is additional interconnection commissioned between South Australia and the rest of the NEM at some stage in the future;
- assuming that there is a national renewables policy requiring 45 per cent renewables by 2030; and
- assuming that mining developments on the Eyre Peninsula elect to source their energy requirements from onsite generation where there is not sufficient 275 kV network capacity, as opposed to from the grid.

We have also undertaken a range of sensitivity tests on other key assumptions and found that the results are most sensitive to assumptions regarding gas prices going forward and the quality of the wind resource on the Eyre Peninsula.

While the level of net benefits changes substantially with the assumed gas price forecasts, in each case, Option 4B remains the preferred option and has positive net market benefits, even under low assumed gas prices.

Similarly, while the market benefits are strongly affected by the assumed capacity factor of new wind farms, Option 4B still remains the preferred option and has a positive net benefit under a lower assumed capacity factor.³⁸

While the magnitude of estimated net market benefits varied for each credible option under all other sensitivities investigated,³⁹ the results consistently show that Option 4B is the preferred option and is expected to yield strongly positive net market benefits. For example, even if additional mining load never located on the Eyre Peninsula, Option 4B would still yield the greatest net market benefits of all options assessed.

In addition, in the event of the future construction of a new interconnector between South Australia and New South Wales, the benefits arising from unlocking wind resources on the Eyre Peninsula increase, reflecting the increased ability to export wind to other regions and the relaxation of constraints on wind generation owing to system security requirements.

While there may be a particular set of severe assumptions that, once combined, result in Option 4B not being the preferred option (and possibly not being found to have positive net market benefits), it would not change the overall conclusion of this PADR.⁴⁰

Overall, ElectraNet considers that the range of underlying future possible 'states of the world' and modelling assumptions tested in this PADR reflect a reasonable approximation of the underlying potential variation in key factors.

Customer price impact

The estimated capital cost of the preferred option is about \$220 million more than the 'business as usual' base case of replacing components of the existing transmission line and establishing a new backup generation network support arrangement at Port Lincoln. However, the preferred option would remove the need for the backup network support arrangement and therefore save ongoing operating costs of about \$9 million per annum, which are paid for by electricity customers in South Australia.

The preferred option is estimated to deliver net market benefits of \$120 million over 20 years (in present value terms) and add less than \$3 to the transmission component of the annual electricity bill for the average residential customer in South Australia⁴¹.

³⁸ ElectraNet also undertook an extreme test of the sensitivity of the results to the assumed wind capacity factor and found that, assuming a capacity factor of 36.6 per cent (consistent with historical observed output of wind farms in the mid north regions of South Australia), resulted in negative expected net market benefits for all options except Option 2 (Option 4B is ranked second with marginally negative estimated net market benefits). ElectraNet considers that this is an extreme sensitivity and that there are good reasons why any new wind farms locating on the Eyre Peninsula can be expected to have higher capacity factors, including that the Eyre Peninsula is generally considered a superior wind resource to the mid north region and that any new wind farms locating on the Eyre Peninsula would utilise new turbine technologies, which typically have higher associated capacity factors than older/existing wind farms.

³⁹ The range of other general sensitivities undertaken, includes the probabilities relating to the assumed trigger variables (ie, development of mining load and designation of the Eyre Peninsula as a renewable energy zone), assumed electricity demand, assumed background future system security requirements, assumed discount rate and capital costs.

⁴⁰ In particular, the RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate market benefits.

⁴¹ This estimate has been determined using the Australian Energy Regulator's Post Tax Revenue Model.

Submissions and next steps

ElectraNet welcomes written submissions on the information contained in this PADR. Submissions are due on or before 19 January 2018.

Submissions are particularly sought on the credible options presented, the economic assessment undertaken (and its assumptions and methodology), as well as the draft finding that Option 4B is the preferred option involving a double circuit 275 kV between Cultana and Yadnarie and double circuit 132 kV between Yadnarie and Port Lincoln.

Submissions should be marked "Eyre Peninsula Electricity Supply Options PADR feedback" and emailed to consultation@electranet.com.au

Submissions will be published on the ElectraNet website. If you do not want your submission to be made publicly available, please clearly specify this in writing at the time of lodging your submission.

A Project Assessment Conclusions Report (PACR), including final options analysis, is expected to be published by April 2018.

1. Introduction

This PADR represents the second step in the application of the RIT-T to network and network support options for ensuring reliable electricity supply to the Eyre Peninsula into the future.

It follows the release of the PSCR on 28 April 2017. ElectraNet received 15 submissions from parties on the PSCR, reflecting a range of views and interests. These submissions have been considered in the analysis presented in this report.

Sections of the existing Cultana to Yadnarie and Yadnarie to Port Lincoln 132 kV transmission lines require replacing or reconductoring soon due to their age and deteriorating condition. In addition, the current network support agreement at Port Lincoln, which enables ElectraNet to call upon generation services when needed, expires in December 2018.⁴²

The required replacement works on the existing transmission line and the upcoming expiry of the existing network support contract provide an opportunity to investigate alternative supply options for the Eyre Peninsula to the current radial 132 kV network. In particular, it is timely to assess whether additional network capacities and/or more diverse paths may result in greater expected net benefits over the long-term - in particular, through enabling future mining load and/or wind generation being able to connect to the Eyre Peninsula network.

This RIT-T seeks to assess which investment option is the prudent and efficient choice to make now in light of the various future uncertainties surrounding development on the Eyre Peninsula.

1.1 Role of this report

This PADR represents the second step in the application of the RIT-T to the network and network support options for ensuring reliable electricity supply to the Eyre Peninsula going forward.

The purpose of this report is to:

- Describe the identified need which ElectraNet is seeking to address, together with the credible options that ElectraNet considers may address the identified need;
- Summarises the submissions received on the PSCR;
- Provide a quantification of costs and classes of material market benefit for each of the credible options, together with an outline of the methodologies adopted by ElectraNet in undertaking this quantification;
- Present the results of the Net Present Value (NPV) analysis for each credible option assessed, together with accompanying explanatory statements;
- Identify the credible option which satisfies the RIT-T, and which is therefore the preferred option for investment by ElectraNet; and
- allow interested parties to make submissions and provide input to the RIT-T assessment.

⁴² The South Australian ETC reliability standards require that ElectraNet provide non-continuous "N-1" equivalent line capacity to the Port Lincoln exit point, so that backup supply is available for Port Lincoln when supply from the 132 kV line is interrupted.

The next stage of this RIT-T involves publication of a PACR. The PACR will update the quantitative assessment of the net benefit to the NEM associated with different investment options in light of any submissions received on this PADR.

The entire RIT-T process is detailed in Appendix C. The next steps for this particular RIT-T assessment are discussed further below.

1.2 Submissions and next steps

ElectraNet welcomes written submissions on the information contained in this PADR. Submissions are due on or before 19 January 2018.

Submissions are particularly sought on the credible options presented, the economic assessment undertaken (and its assumptions and methodology), as well as the draft finding that Option 4B is the preferred option involving a double circuit 275 kV between Cultana and Yadnarie and double circuit 132 kV between Yadnarie and Port Lincoln.

Submissions should be marked “Eyre Peninsula Electricity Supply Options PADR feedback” and emailed to consultation@electranet.com.au

Submissions will be published on the ElectraNet website. If you do not want your submission to be made publicly available, please clearly specify this in writing at the time of lodging your submission.

A PACR, including final options analysis, is expected to be published by April 2018.

Further details in relation to this project can be obtained from:

Brad Parker
Network Planning Manager
ElectraNet Pty Ltd
+61 8 8404 7641
consultation@electranet.com.au

2. The identified need is to ensure reliable supply to the Eyre Peninsula

The identified need for this RIT-T is to explore electricity supply options for meeting ETC reliability standards at Port Lincoln most efficiently in the future – driven by the need to replace major transmission line components serving the lower Eyre Peninsula in the next few years, and the upcoming expiry of the network support arrangement at Port Lincoln.

The ETC transmission reliability standards are generally expressed in terms of the amount of ‘redundancy’ that must be built into the network to avoid supply outages. Redundancy is generally expressed in ‘N-x’ terms, where ‘x’ reflects the number of elements⁴³ that could fail on the network without electricity supply being lost. For example:

- ‘N-1’ means that electricity supply will not be disrupted if one element of the network fails; and
- ‘N-2’ means that supply will not be disrupted if two separate elements fail.

Generally, the higher the ‘x’, the more reliable the network, as it means that electricity will continue to be supplied, even with more elements of the network not operating.

The ETC specifies several different reliability standards for loads on the Eyre Peninsula, with the highest being the ETC ‘Category 3’ at Port Lincoln which essentially requires an ‘N-1’ level of reliability.⁴⁴ With the exception of Port Lincoln, ElectraNet meets the ETC reliability requirements for all of the connection points on the lower Eyre Peninsula through transmission assets alone.

For Port Lincoln, the transmission service includes a network support arrangement that allows ElectraNet to call upon local generation services, to provide equivalent transmission line and transformer capacity in accordance with the ETC requirements. Reliability standards under the ETC are generally expressed as “equivalent” line or transformer capacity standards to allow flexibility for meeting the standards by any means or a combination of means (including network and non-network options).

Overall, meeting the ETC reliability standard at Port Lincoln, and ensuring reliable electricity supply to the entire Eyre Peninsula, forms the identified need for this RIT-T. However, the need to replace sections of the current network, and the upcoming expiry of the current network support agreement, provide the opportunity for ElectraNet to also consider the most efficient investment to make now to ‘future proof’ the supply arrangements to accommodate likely future developments on the Eyre Peninsula. In particular, there is the potential for future mining and/or wind generation developments on the Eyre Peninsula.

There are several important decisions ElectraNet can make now that greatly affect the efficiency of future supply solutions. Broadly speaking, ElectraNet faces the decision to either:

- build a ‘minimum capacity’ 132 kV option now – while this option will involve lower upfront costs, it may end up costing more over the long-term (if mining and/or renewable generation, particularly wind generation, develops on the Eyre Peninsula) and risks suboptimal outcomes; or

⁴³ Elements of the transmission network include lines, transformers and other network equipment.

⁴⁴ Section 3.2.1 provides more detail on the specific reliability standards applying to loads on the Eyre Peninsula.

- invest in slightly greater network capacity now to get the 'option value' of upgrading the network (or part of it) to 275 kV at a later date if mining and/or wind generation develop – while this option involves a greater cost upfront, it may more cost-effectively accommodate mining and/or wind generation developments in the future, if they eventuate; or
- build all or part of the network to 275 kV initially – this would cost more upfront but would allow mining and wind generation to connect as soon as the new network is commissioned. However, it also carries a risk that the additional network capacity could be built before it is needed, or not needed at all.

This RIT-T assesses which of these high-level options is the prudent and efficient choice to make now considering the various uncertainties surrounding future development on the Eyre Peninsula.

3. Submissions to the Project Specification Consultation Report

ElectraNet received 15 submissions to the PSCR, representing a range of views and interests – namely:

- local Eyre Peninsula representatives and individuals;⁴⁵
- parties offering network support at Port Lincoln;⁴⁶
- customer representatives;⁴⁷ and
- wind farm developers and mining companies.⁴⁸

This section summarises the key issues raised by submitters and how they have been incorporated in the analysis in this PADR.

3.1 Interaction with the ESCOSA reliability review for the Eyre Peninsula

On 7 April 2017, ESCOSA initiated the “Inquiry into reliability and quality of electricity supply on the Eyre Peninsula” following concerns raised by Eyre Peninsula community members about the customer impacts arising from the level of reliability and quality of supply in the region.

A number of parties raised the distribution-level options identified in the ESCOSA reports as reflecting relatively low-cost solutions to improving reliability outcomes for consumers in the region.⁴⁹ ElectraNet considers that the distribution-level options may in fact offer cost effective ways to reduced expected unserved energy to customers on the Eyre Peninsula. However, these initiatives would likely need to be subject to a separate Regulatory Investment Test for Distribution.

The Consumer Challenge Sub-Panel No. 9 (CCP9) stated its support for ESCOSA’s finding that reliability issues on the Eyre Peninsula would benefit from more joint planning between ElectraNet and SA Power Networks. It recommended ElectraNet respond to the draft findings of the ESCOSA inquiry by creating opportunities for more joint planning and through resetting the timeline for the Eyre Peninsula RIT-T. CCP9 also recommend that the Australian Energy Regulator (AER) should support independent oversight of a specific joint planning and investment test project that involves ElectraNet, SA Power Networks, The Australian Energy Market Operator (AEMO), ESCOSA, consumers and proponents of network support solutions.⁵⁰

It is important to recognise that the transmission options being explored as part of this RIT-T are expected to deliver a broader range of market benefits over and above the reliability benefits highlighted in the ESCOSA report, and may displace some of the generation options proposed by SA Power Networks.

⁴⁵ District Council of the Lower Eyre Peninsula, Energy Security for SA Working Party, Regional Development Australia Whyalla and Eyre Peninsula and the Eyre Peninsula Local Government Association, Mr Fred Gerschwitz and Mr Geoff Rayson.

⁴⁶ AES Energy Storage, Aggreko/Marubeni Power Developments JV, Engie and Karpower International.

⁴⁷ Business SA, The Consumer Challenge Sub-Panel No. 9 and Mr Tim Kelly as the Nominated Conservation Council SA volunteer, serving on the ElectraNet Consumer Advisory Panel.

⁴⁸ Iron Road, Meridian Energy and The South Australian Chamber of Mines and Energy.

⁴⁹ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 5-6; Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 1; and Engie, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 5.

⁵⁰ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 3 & 9.

Comparing the SA Power Networks and ElectraNet options only on the basis of improvements in reliability (minutes saved) and estimated cost may give the false impression that the SA Power Networks' options should be prioritised over the transmission options. In particular, as demonstrated in this PADR, transmission options will deliver a broader range of market benefits via enabling potential future mining loads to connect to the transmission network, as well as unlocking the potential for additional wind generation.^{51,52}

In addition, the estimated cost of each of the distribution-level options excludes the reinvestment necessary to maintain reliability of supply to the Eyre Peninsula given the condition of the existing transmission assets.

ElectraNet considers that this logic also applies to any consideration of a micro-grid solution for the Eyre Peninsula.⁵³ In particular, while a micro-grid solution may be technically feasible, it would not capture the substantial wider market benefits that primarily network options provide and, consequently, would not satisfy the RIT-T.

3.2 Options proposed in the PSCR

The most commonly supported future network capacity supported by submitters was a 275 kV solution. A large number of submitters commented on the need for there to be a 275 kV network on the Eyre Peninsula, particular to assist with accommodating any future mining and/or wind generation. Specifically:

- the District Council of the Lower Eyre Peninsula requested that a double-circuit 275 kV line down the spine of the Eyre Peninsula be investigated in order to allow for future industry development, with acknowledgement that this line will be managed as a 132 kV line unless demand warrants instigation of the full 275 kV capacity – the council also requests that at a minimum a dual circuit 132 kV transmission line be provided to Eyre Peninsula;⁵⁴
- Business SA notes that future significant mining loads would likely require additional transmission capability beyond 132 kV;⁵⁵
- Tim Kelly, Nominated Conservation Council SA volunteer, serving on the ElectraNet Consumer Advisory Panel, considers that two geographically separated single-circuit 275 kV lines, initially operated at 132 kV, is the only option that meet the three aspects of regional transmission reliability, capacity for demand growth and capacity for generation growth of wind power;⁵⁶
- the South Australian Chamber of Mines and Energy (SACOME) considers there is a need for a reinforcement of the transmission line from 132 kV to a double circuit 275 kV to support mining and other developments in the region;⁵⁷

⁵¹ These benefits are captured in the RIT-T framework in terms of their impact in lowering dispatch and investment costs in the NEM.

⁵² For a detailed discussion of the interaction between the distribution-level options and the transmission options considered in this PADR/RIT-T, please refer to ElectraNet's submission to the ESCOSA draft report, available at: <http://www.escosa.sa.gov.au/ArticleDocuments/1085/20170831-Inquiry-ReliabilityQualityElectricitySupplyEyrePeninsula-DraftReportSubmission-ElectraNet.pdf.aspx?Embed=Y>

⁵³ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 3.

⁵⁴ District Council of the Lower Eyre Peninsula, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p.1.

⁵⁵ Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 3.

⁵⁶ Tim Kelly, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 27 July 2017, pp. 2-4.

⁵⁷ SACOME, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 24 July 2017, p. 1.

- Iron Road submitted that a 275 kV line is a vital component for the CEIP to go ahead.⁵⁸
- Regional Development Australia Whyalla and Eyre Peninsula (RDAWEP) and the Eyre Peninsula Local Government Association (EPLGA) consider that two geographically separated single-circuit 275 kV lines, initially operated at 132 kV, is the preferred option and that, at a minimum, two geographically separated single-circuit 132 kV lines should be constructed.⁵⁹

Consistent with these submissions, the assessment of options in this PADR includes options that are built at 275 kV initially, as well as options that have the capability to be operated at 275 kV but are operated at 132 kV initially.

Several parties also suggested that the assessment should consider running transmission lines from Cultana to Port Lincoln via Wudinna.⁶⁰ The attraction of such a network configuration is its ability to provide heightened supply reliability to the Eyre Peninsula and lessen the likelihood of future interruptions to suppl. As a result, ElectraNet has investigated a number of credible options that involve two geographically diverse single-circuit lines from Cultana to Port Lincoln where one goes via Yadnarie and the other goes via Wudinna (Options 5A, 5B and 5C).

CCP9 noted the importance of the option value of deferral/staging strategies and commends ElectraNet's commitment to the consideration of the option value of alternative investments as it can reduce the risk of consumers having to pay for assets that would otherwise be stranded.⁶¹

Meridian Energy submitted that simply reconductoring the existing 132 kV line and continuing with network support at Port Lincoln was undesirable. Meridian submitted that doing so may restrict further growth in the area, of both generation and load, and would provide a less robust and secure network solution. Meridian Energy consider that the nature of the support provided in Option 1, while it may technically meet reliability standards, is not truly comparable with the other options provided.⁶²

The Energy Security for SA Working Party submitted that any option that relies on the continued operation of the existing power station at Port Lincoln raises concerns as to the reliability and adequacy of ongoing maintenance and support of the existing generation equipment.⁶³ It states that the current Port Lincoln Power Station, which is currently identified as the backup power supply in case of blackout, has not successfully operated for some time and costs \$10 million annually.⁶⁴

Engie, who hold the current network support contract at Port Lincoln, were the only party to explicitly express support for the reconductoring option and seeking a new network support agreement to maintain the required reliability level at Port Lincoln. Engie state that it would be unfortunate if a decision was taken to build a costly double circuit transmission line south to Port Lincoln, only to then find that a substantial new load project seeks network connection in the northern or western part of the Eyre Peninsula.⁶⁵

⁵⁸ Iron Road, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 18 July 2017, p. 1.

⁵⁹ RDAWEP & EPLGA, *Submission in relation to Eyre Peninsula RIT-T PSCR* [via email].

⁶⁰ RDAWEP & EPLGA, *Submission in relation to Eyre Peninsula RIT-T PSCR* [via email]; and Submission of Fred Gerschwitz to the Eyre Peninsula RIT-T PSCR

⁶¹ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 3-4 & 8.

⁶² Meridian Energy, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 June 2017, p. 1.

⁶³ Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, pp. 3-5.

⁶⁴ Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, p. 2.

⁶⁵ Engie, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 4-5.

ElectraNet appreciates this position but notes that, equally, it would also be unfortunate if the network was underbuilt and new mining located on the peninsula for a higher connection cost, or wind generation on the Eyre Peninsula was constrained by the network capacity. The RIT-T, and wider network planning process, is designed to recognise, and thoroughly test, for the *expected* case considering the various uncertainties that exist – reflecting this, ElectraNet has assessed all credible options across a range of underlying future ‘states of the world’ and general modelling assumptions.

The Energy Security for SA Working Party recommend that a 500 kV network be included and assessed as part of the RIT-T, stating that 132 kV and 275 kV options are not sufficient to allow the development of the full potential of resources on the Eyre Peninsula.⁶⁶ ElectraNet does not consider at this stage that the significant cost of 500 kV network options would be justified in terms of the *additional* market benefits they can be expected to deliver over and above the 275 kV options included in this report. In particular, the cost of building a 500 kV transmission network on the peninsula has been estimated to be in the order of \$1.2 billion⁶⁷ and it is not expected that it would deliver commensurate levels of market benefit.⁶⁸

3.3 Network support at Port Lincoln

ElectraNet received submissions to the PSCR from several parties offering network support at Port Lincoln, representing a variety of generation and technology solutions.

While the details of these submissions have been requested to be kept confidential, ElectraNet has subsequently liaised with these parties regarding their proposed network support solutions and, on 28 September 2017, released a formal RFT to request financial and operating parameters from network support proponents.

The ongoing communication with network support proponents and responses to the formal RFT have greatly assisted ElectraNet to develop updated assumptions regarding future network support costs at Port Lincoln for Option 1. Further detail on the process for reviewing and assessing the various network support proposals received can be found in section 8.1. ElectraNet is grateful for the network support proposals received.

3.4 Extent of mining potential on the Eyre Peninsula

Several submitters noted the mining load potential on the Eyre Peninsula.⁶⁹

Iron Road stated that after the PSCR was released, on 3 May 2017, the Government of South Australian granted the CEIP Mining Lease and Development Approval.

⁶⁶ Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, pp. 3-5.

⁶⁷ ESCOSA, *Inquiry into the reliability and quality of electricity supply on the Eyre Peninsula*, Final Report, October 2017, p. 21.

⁶⁸ Specifically, the market modelling finds that the wind resource limits are not reached on the peninsula with the 275 kV options, even under high demand assumptions. This implies that 500 kV options would not necessarily result in more wind generation choosing to locate on the peninsula than the 275 kV options.

⁶⁹ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 3; Iron Road, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 18 July 2017, p. 1; Engie, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 3; SACOME, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 24 July 2017, p. 1; Submission of Geoff Rayson to the Eyre Peninsula RIT-T PSCR, 20 June 2017.

It further noted that the rail and port component has previously been declared a 'priority project' by Infrastructure Australia, one of only 10 projects nationwide, and the CEIP enjoys 'major project facilitation' by the Australian Government, the only South Australian project to receive this status.

Iron Road stated that it expects to make a final investment decision by the end of 2017 on the CEIP, with financial close expected during 2018, and noted that three major banks have formally expressed interest in providing debt finance for the project and discussions with these entities are advanced.⁷⁰

SACOME stated that there are several mineral projects currently active on the Eyre Peninsula and three are at a mature stage of development (including the CEIP, which is targeting a 2018-2019 date for construction and first ore by 2021-2022).⁷¹

The assessment in this RIT-T takes into account the potential for future mining development on the Eyre Peninsula, as well as the uncertainty in relation to that development. In particular, the analysis considers three future states of the world in which either no mining investment occurs, the CEIP project goes ahead, or the CEIP project and a range of other mining projects go ahead. This is discussed further in section 5.1.

If CEIP (or another project) commits to developing a mine before completion of this RIT-T process or before the start of network construction, then at that stage the uncertainty in relation to mining development would disappear. However, if CEIP is committed prior to the beginning of construction of the investment option under this RIT-T, the analysis in this RIT-T indicates that the preferred option would remain unchanged (ie, Option 4B).

3.5 Extent of wind generation potential on the Eyre Peninsula

Submitters also commented on the wind generation potential on the Eyre Peninsula.⁷²

Meridian Energy stated that, while the Eyre Peninsula is widely renowned as having the best wind resources in Australia, the failure of the current network to be able to support further generation investment at a time of major development in renewable energy imposes significant market costs that are borne by all customers. Meridian Energy stated that, while it is difficult to forecast the likelihood of additional generation or load connecting, they believe that additional investment in the network, and relief of existing constraints, will lead to additional connections of both generation and load.⁷³

The Energy Security for SA Working Party reiterated the significant electricity generation capacity on the Eyre Peninsula. In particular, they quoted the 2010 Select Committee on Wind Turbines Report undertaken by Worley Parsons and Macquarie Capital ('the Green Grid' study), which identified over 4,000 MW of easily harvested wind generation.

⁷⁰ Iron Road, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 18 July 2017, p. 1.

⁷¹ SACOME, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 24 July 2017, p. 1.

⁷² Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 3; Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 1; Meridian Energy, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 June 2017, p. 1; Engie, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 3; Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, p. 2; Submission of Geoff Rayson to the Eyre Peninsula RIT-T PSCR, 20 June 2017.

⁷³ As an example, Meridian Energy stated that, while it is currently exploring development of new large scale solar plants, they have excluded the Eyre Peninsula from such explorations due to the existing network constraints (despite it having a number of advantages for them, including an existing connection arrangement at Mt Millar. See: Meridian Energy, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 June 2017, pp. 1-2.

The Energy Security for SA Working Party also suggested that a further capacity of over 4,000 MW of solar generation available on Eyre Peninsula has been identified.⁷⁴

Tim Kelly, Nominated Conservation Council SA volunteer, serving on the ElectraNet Consumer Advisory Panel, suggested that the modelling provide for identified and plausible wind farm sites and any major solar PV array or solar thermal sites on Eyre Peninsula. He also raised the interaction between this RIT-T and the significant work previously undertaken under the Green Grid study.⁷⁵

ElectraNet considers the earlier Green Grid work to be the most thorough public consideration to-date of the renewable energy potential on the Eyre Peninsula – we have consequently drawn on it to develop a range of assumptions regarding the quantity and quality of new wind generation on the Eyre Peninsula.

While Engie also note that the Eyre Peninsula has long been recognised as an area that has significant mineral resources and exploration potential, as well as very good wind and solar potential, they consider the sparsely populated nature of the region means it is difficult to justify building significant transmission infrastructure. Engie consider that ElectraNet cannot simply build a new transmission line in anticipation of new generation or load projects emerging to take advantage of the network. Engie further note the uncertainty regarding new mining and/or renewable projects on the Eyre Peninsula and whether they will proceed.⁷⁶

ElectraNet appreciates that both mining developments and renewable generation potential on the Eyre Peninsula are uncertain. Reflecting this uncertainty, we have applied a combination of both wholesale market modelling and real option value techniques to capture and test uncertainties in the analysis. Our approach to modelling the costs and market benefits of the credible options, in light of this uncertainty, is outlined in sections 5 to 8 of this PADR. ElectraNet considers that this treatment of future uncertainty, and assessment of the prudent and efficient investment decision to make today, is consistent with the RIT-T framework. Importantly, the wholesale market modelling undertaken for this RIT-T does not assume that wind generation will automatically locate on the Eyre Peninsula if the network is upgraded to 275 kV, but only if this represents the least cost generation solution given assumed demand conditions and the associated firming costs.

A number of parties raised the interaction between this RIT-T and the recommendation from the independent Finkel Review regarding the Australian Energy Market Operator (AEMO), in conjunction with transmission network providers, developing an integrated plan to facilitate the efficient development and connection of renewable energy zone across the NEM.⁷⁷ In particular, parties were concerned that a RIT-T committing to build transmission infrastructure on the Eyre Peninsula ahead of such planning may be premature, and may also result in additional costs being picked up by South Australian consumers.

ElectraNet considers that the Eyre Peninsula is a potential candidate for identification as a 'renewable energy zone' in future.

⁷⁴ Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, p. 2.

⁷⁵ Tim Kelly, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 27 July 2017, pp. 2-4.

⁷⁶ Engie, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 3-4.

⁷⁷ Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 3; Energy Security for SA Working Party, *Submission in relation to Eyre Peninsula RIT-T PSCR*, p. 2; and Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 6.

The RIT-T assessment in this PADR has captured this impact through inclusion of an 'environmental policy trigger' to upgrade operation of the network to 275 kV (outlined in section 6.2), and has also allowed for the uncertainty about whether this trigger will occur. Given that the condition of the existing network requires ElectraNet to make an investment decision now, it would not be prudent to wait for the out-workings of the AEMO process to identify renewable zones, which is not expected until mid-2018, at the earliest.

However, as with the case of mining development, if the Eyre Peninsula is designated as a priority renewable zone prior to the beginning of construction of the investment option under this RIT-T, then the analysis in this RIT-T indicates that the preferred option would remain unchanged (ie, Option 4B).

Business SA notes that ElectraNet's decision to build a new interconnector to either New South Wales or Victoria will be a key contributing factor in any case to build up the transmission capability of the Eyre Peninsula to export renewable energy.⁷⁸ ElectraNet notes the important interaction between the ability to develop wind generation on the Eyre Peninsula and the extent of interconnection with the rest of the NEM. We have consequently included a sensitivity test, investigating how the various costs and market benefits of each credible option are affected through the presence of a new interconnector.

3.6 Interaction with the coincident regulatory determination for ElectraNet

ElectraNet's revenue proposal for the 2018-2023 period includes two capex projects to refurbish the existing 132 kV transmission lines supplying the Eyre Peninsula a cost of approximately \$80 million (which has been included as Option 1 in this RIT-T).⁷⁹ The proposal also includes a contingent project to evaluate the options of a full line replacement, and potentially circuit duplication that would avoid expensive network support arrangements at Port Lincoln. This RIT-T is a key trigger event for this contingent project.⁸⁰

On 26 October 2017, the AER released its Draft Decision on the ElectraNet proposal, which accepted both the proposed forecast capex for the Eyre Peninsula line replacement projects, as well as the Eyre Peninsula contingent project.⁸¹

ElectraNet considers this to be the prudent and efficient way to proceed since:

- it is still investigating, and consulting on, the most cost-effective ways to improve supply reliability to the Eyre Peninsula (ie, via this RIT-T); but
- sections of the exiting line built in 1967 are nearing the end of their functional life (a standard line life of 55 years) and require replacement in the next few years.

CCP9 notes that the AEMC *Final rule on new planning arrangements for replacement assets by electricity network businesses* has been released and that the Eyre Peninsula reconductoring projects in the ex-ante revenue proposal exceed the investment threshold and would be the subject of a RIT-T under the new rule. They recommend that, given a closely related RIT-T process has been initiated, the reconductoring projects should be removed from the ex-ante revenue proposal and assessed as part of the Eyre Peninsula RIT-T.⁸²

⁷⁸ Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 1.

⁷⁹ ElectraNet, *Revenue Proposal 2019-2023*, Attachment 6 – Capital Expenditure, p. 19.

⁸⁰ ElectraNet, *Revenue Proposal 2019-2023*, Attachment 6 – Capital Expenditure, p. 47.

⁸¹ AER, *ElectraNet transmission determination 2018 to 2023*, Attachment 6 – Capital expenditure, October 2017, pp. 52-55.

⁸² Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 4.

However, as noted above, the AER has accepted ElectraNet's capital expenditure forecast in full, including the Eyre Peninsula line reconductoring projects.

This RIT-T considers the most appropriate long-term solution for the Eyre Peninsula. If the preferred Option 4B – or another option involving the building of new transmission lines – is confirmed to be the outcome of the RIT-T economic assessment, then the contingent project for the Eyre Peninsula would be triggered. The resulting contingent project application to the AER would seek additional revenue for the incremental capital expenditure over and above the about \$80 million allowed for in the AER revenue decision for the line reconductoring projects.

3.7 Application of a bespoke VCR estimate

Under the RIT-T assessment, the benefit associated with the reduction in unserved energy is valued at the Value of Customer Reliability (VCR), expressed in \$/kWh. In its submission, the CCP9 states concern about the bespoke VCR estimates proposed in the PSCR leading to increased capital expenditure.⁸³

As outlined in the PSCR, the suggestion to apply VCR estimates that depart from the standard AEMO estimates was to appropriately capture the severe and prolonged outages contemplated in this RIT-T and experienced by customers on the Eyre Peninsula.⁸⁴

The assessment in this RIT-T indicates that most of the market benefits associated with each of the investment options relates to their impact on the wholesale market, rather than on the level of unserved energy. ElectraNet has opted to apply the standard AEMO VCR estimates to valuing reductions in unserved energy expected from each credible option, considering the concerns raised by the CCP9, and given the non-materiality of the VCR value for the outcome of this RIT-T assessment.

ElectraNet has not undertaken a sensitivity on the VCR (or changes in transmission losses) since these categories of benefit are found to be immaterial in differentiating between credible options, as shown in section 9. Even assuming a VCR of \$0/kWh does not change the result.

3.8 Price impact to customers

Business SA and the CCP9 both raised the likely price effect to consumers of reinforcing the Eyre Peninsula transmission network.⁸⁵ The CCP9 stated a desire for the price impacts to customers to be explained.⁸⁶

Section 10 includes a discussion on the customer price impact of the preferred option that is shown in this draft report to deliver the greatest net benefits under the RIT-T economic assessment.

⁸³ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 9-10.

⁸⁴ The inappropriateness of applying AEMO's VCR estimates to assessing the cost to customers of events that cause wide-spread, severe or prolonged supply shortages is noted by AEMO in its VCR Application Guide. See: AEMO, *Value of Customer Reliability – Application Guide*, Final Report, December 2014, p. 20.

⁸⁵ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 8; and Business SA, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 20 July 2017, p. 1.

⁸⁶ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, p. 8.

4. The five sets of credible options assessed in this PADR

ElectraNet has investigated 10 variants of five broad options for supplying the Eyre Peninsula going forward, which reflect a wide variety of different network capacities and routes.

These options range from:

- maintaining equivalent capacity on the Eyre Peninsula to currently, ie, a single-circuit 132 kV line coupled with network support at Port Lincoln; through to
- upgrading the entire network to 275 kV, with two completely divergent network paths from Cultana to Port Lincoln in order to provide greater supply resilience.

Three options have been specifically designed to be dynamic and allow ElectraNet the 'option' of upgrading the network capacity at a future date, if a certain 'trigger' occurs (these options are 4C, 4D and 5C on the next page). This allows us to consider the benefit of spending more upfront in relation to a particular option to provide flexibility for upgrading that option to 275 kV at a lower cost later if required to serve potential future mining developments on the Eyre Peninsula or renewable energy developments.

The table on the next page summarises each of the 10 option variants we have assessed. Specifically, it outlines:

- the key features of each option, in terms of the network capacity and route(s);
- the respective costs under each option, including the *additional* cost for the three options that provide flexibility to upgrade to 275 kV later if required;
- high-level schematic of the network configuration under each option, including in different future 'states of the world' for the three flexible options that are initially operated at 132 kV, but can be energised to 275 kV later, if required.

ElectraNet has included a 'minimum capacity' option (Option 1) as the 'business as usual' base case in this RIT-T, reflecting the option of reconductoring the existing single-circuit 132 kV line and continuing with a network support arrangement at Port Lincoln.⁸⁷

The costs and benefits of all the other options have been assessed relative to this base case. This approach has been adopted as the alternative of 'doing nothing', would result in significant unserved energy to the Eyre Peninsula, which is unacceptable and not realistic.⁸⁸

These options are broadly consistent with the five options presented in the PSCR, but have been amended slightly to reflect further consideration, cost refinement and network modelling undertaken by ElectraNet.

⁸⁷ Option 1 is consistent with ElectraNet's submitted revenue proposal for the 2018-23 period, ie, in its proposal, ElectraNet included approximately \$80m for replacing the line conductor in high priority sections of the 132 kV lines.

⁸⁸ ElectraNet has included a summary of the detailed precursory economic assessment of Option 1 undertaken in 2016 and early 2017 as Appendix F. While it pre-dates this RIT-T, it has been included to illustrate the rigour sitting behind the decision to include Option 1 as the 'business as usual' base case in this RIT-T and illustrates that Option 1 is expected to generate net benefits (across a reasonable range of underlying assumptions).

Options 4C, 4D and 5C build on the double and single-circuit options presented in the PSCR to explicitly capture the option value ascribed to being able to upgrade that option to 275 kV later if sufficient mining or wind developments emerge. Therefore, the option numbering in the PADR is different to the PSCR.⁸⁹

The options also accommodate feedback received in submissions to the PSCR. ElectraNet released a Request for Tender (RFT) on 28 September 2017 that requested financial and operating parameters from network support proponents, including from proponents that submitted to the PSCR. ElectraNet has assessed these responses developed assumptions regarding future network support costs at Port Lincoln for Option 1 – outlined further in section 8.1 below.

In addition, since publication of the PSCR, ElectraNet has further refined the optimal routes for the geographically diverse single-circuit line options and concluded that for these options, one circuit should go from Cultana to Port Lincoln via Wudinna, with the other circuit going from Cultana to Port Lincoln via Yadnarie. Doing so allows for not only lower expected unserved benefits due to the significantly geographically diverse routes, but also better wind diversity through gaining access to wind resources south-west of Wudinna (around Elliston) and cheaper resource costs associated with connecting CEIP, if it eventuates.

As options 2 to 5 (including A, B, C and D variants) involve the construction of either a double-circuit or two single-circuit lines, they allow the current ETC reliability standard to be met without a network support agreement at Port Lincoln. However, if one of these options is selected as the preferred option, a network support arrangement for Port Lincoln would need to be maintained until it can be implemented – ElectraNet has modelled this cost using information provided by network support proponents in response to the RFT.

Option 1 will not relieve the existing constraints on the output of the wind farms on the Eyre Peninsula, nor will it facilitate any new wind generation locating on the Eyre Peninsula, or the connection of new loads. All other options will relieve, and may eliminate, the constraints on the operation of the existing wind farms. They will also facilitate new wind generation locating on the Eyre Peninsula.

In addition, these options would facilitate the connection of new mining load. ElectraNet notes that these options will not, in themselves, cause new mining loads to connect (this will be determined by world minerals prices), but they will allow new loads to connect with lower connection costs and without delays.

The scope and capital cost estimates for each of the options has been refined and updated since the PSCR along with annual operating and maintenance costs.








Each of the credible options is expected to be both technically and commercially feasible and able to be implemented in sufficient time to meet the identified need.⁹⁰

Options 2 to 5 will also require relevant statutory environmental approvals and acquisition of some easements for the transmission line routes. Possible commissioning dates listed in this section are subject to obtaining relevant development and environmental approvals.

⁸⁹ The PSCR included the following five broad options: Option 1 – continue network support arrangement at Port Lincoln and component replacement works on the existing 132 kV single-circuit transmission line (consistent with Option 1 in the PADR); Option 2 – Double circuit 132 kV line (consistent with Option 2 in this PADR); Option 3 – two single circuit 132 kV lines (consistent with Option 3 in this PADR, except with refined geographically diverse routes); Option 4 – double circuit 275 kV line, to be operated at 132 kV initially (consistent with Option 4A in this PADR); and Option 5 – two single circuit 275 kV lines (broadly consistent with Option 5A in this PADR, except with refined geographically diverse routes).













⁹⁰ In accordance with the requirements of National Electricity Rules (NER) clause 5.15.2(a).

Table 3 – Summary of the ten credible option variants assessed

Option overview	Estimated capital cost(s) ⁹¹	Affected/new network ⁹²
<u>Option 1 ('base case')</u> Continue network support at Port Lincoln and reconductor the existing 132 kV single-circuit line	\$80 million As well as operating costs of about \$9 million per year for network support	
<u>Option 2</u> A double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit rated to about 300 MVA	\$220 million	
<u>Option 3</u> Two single circuit 132 kV lines routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 300 MVA	\$390 million	
<u>Option 4A</u> Double circuit 275 kV following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit rated to about 600 MVA	\$390 million	
<u>Option 4B</u> Double circuit 275 kV between Cultana and Yadnarie, each circuit rated to about 600 MVA, and double circuit 132 kV between Yadnarie and Port Lincoln, each circuit rated to about 300 MVA	\$300 million	
<u>Option 4C</u> Double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit initially rated to about 300 MVA – with the ability to be upgraded to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	\$310 million <i>Plus \$50 million if the Cultana to Yadnarie line is upgraded to 275 kV</i> <i>Plus \$90 million if all lines are upgraded to 275 kV</i>	
<u>Option 4D</u> Double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route, each circuit initially rated to about 300 MVA – with the ability to upgrade the Cultana to Yadnarie section to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	\$270 million <i>Plus \$50 million if the Cultana to Yadnarie line is upgraded to 275 kV</i>	

⁹¹ Costs for all options are to be treated as indicative at this stage and are based off a preliminary design. All options have been designed, and costed, to be consistent with the relevant Australian Standards.

⁹² These schematics illustrate the affected/new network under each option. Under all options, the existing 132 kV line from Wudinna to Yadnarie remains unchanged and so is not shown in these high-level network diagrams.

Option overview	Estimated capital cost(s) ⁹¹	Affected/new network ⁹²		
<u>Option 5A</u> Two single circuit 275 kV lines following separated routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 600 MVA	\$610 million			
<u>Option 5B</u> Two single circuit lines between Cultana and Port Lincoln (one going via Wudinna), with the Cultana to Wudinna line built and operated at 275 kV and rated to about 600 MVA, and the rest only ever operated at 132 kV with each circuit rated to about 300 MVA	\$450 million			
<u>Option 5C</u> Two single circuit 132 kV lines following separated routes between Cultana and Port Lincoln (one going via Wudinna), each circuit rated to about 300 MVA – with the ability to be upgraded to 275 kV at a later date, if required, for a new rating of about 600 MVA for each circuit	<p>\$500 million</p> <p><i>Plus \$30 million if the Cultana to Wudinna line is upgraded to 275 kV</i></p> <p><i>Plus \$60 million if the Cultana to Wudinna line AND the Cultana to Yadnarie lines are upgraded to 275 kV</i></p> <p><i>Plus \$110m if all lines are upgraded to 275 kV</i></p>	   		
Key:	 Reconductored 132 kV	 Network support at Port Lincoln	 &  132 kV single-circuit & 132 kV double-circuit	 &  275 kV single-circuit & 275 kV double-circuit

We have included full breakdowns of the network components under each option in Appendix D.

Between the PSCR and publication of this PADR, ElectraNet has investigated versions of all options that are designed to a higher wind loading standard than has typically been applied for South Australian line construction. It is expected that designing for a higher wind loading may add between 5 and 20 per cent to the total lines cost, and could be offset by potential savings that may be identified during detailed design. This kind of optimisation will be further considered as part of ElectraNet's detailed engineering process, which will occur after the RIT-T.

ElectraNet has, however, further refined the geographically diverse single-circuit options since the PSCR and concluded that in these options, one circuit should go to Port Lincoln via Wudinna as it provides some additional benefits in terms of lower expected unserved energy due to de-radialising the transmission supply to the Wudinna connection point, and may improve the security of supply to the lower Eyre Peninsula due to the significantly geographically diverse routes.

Separate to the identified need for this RIT-T, ElectraNet is putting in-place connection facilities at Port Lincoln to provide for the connection of emergency response support.

In addition, ElectraNet is progressing a separate project focussed on improving restoration times on the Davenport to Cultana line (the 'Spencer Gulf Emergency Bypass Preparation').⁹³

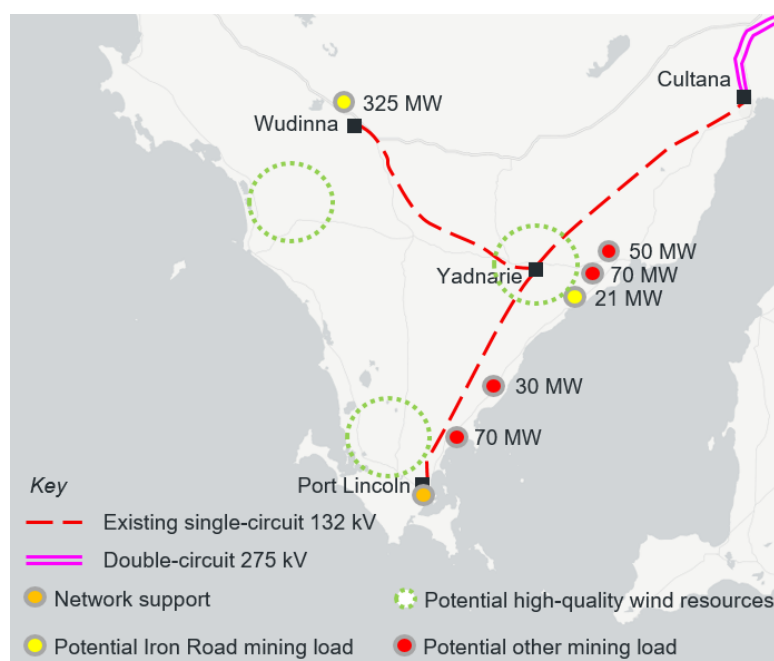
4.1 Option 1 – Continue network support at Port Lincoln and reconductor sections of the existing 132 kV single-circuit line ('base case')

This option involves continuing to meet the Port Lincoln ETC reliability standards by using a combination of transmission infrastructure and network support at Port Lincoln.

Option 1 involves live-line reconductoring of four sections (totalling 118 km) of the existing 132 kV network. It also involves the continuation of a network support agreement at Port Lincoln, which could be an extension of existing arrangement or a new contract with a third party.

The figure below illustrates the high-level network configuration under Option 1, as well as the locations of key mining and wind potential on the Eyre Peninsula. Due to the limited capacity of the network under this option, no additional mining load or wind generation can connect on the Eyre Peninsula.

Figure 7 – Network configuration under Option 1, as well as locations of key mining and wind potential



The reconductoring work on the existing 132 kV line will require additional generation support from Port Lincoln during construction, in order to maintain supply to Port Lincoln, Yadnarie, Wudinna, and Middleback.

⁹³ After the system black events in South Australia, ElectraNet undertook a critical sites risk workshop that identified specific transmission line sites that could prove difficult to respond to in a timely manner. One such area identified was the Spencer Gulf High Tower crossings for the Davenport – Cultana 275kV lines, which currently provide the only means of supply for the entire Eyre Peninsula from the rest of the South Australian transmission network.

Capital costs for the reconductoring works are estimated to be in the order of \$80 million. Reconductoring is expected to take 2 years, with commissioning possible by the end of 2020, subject to obtaining necessary environmental and development approvals.

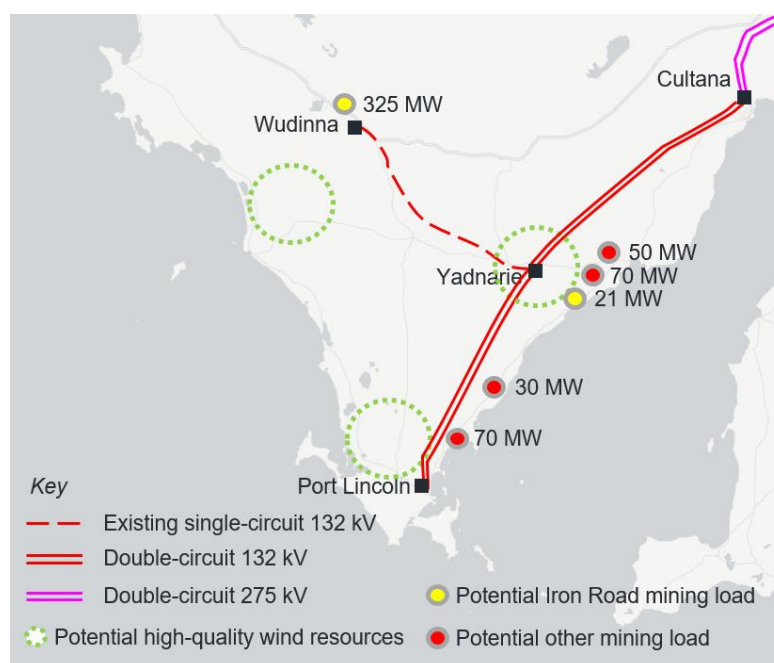
ElectraNet released a RFT on 28 September 2017 that requested financial and operating parameters from network support proponents, including from proponents that submitted to the PSCR. ElectraNet has assessed these responses and developed assumptions regarding future network support costs at Port Lincoln for Option 1, as outlined in section 8.1 below.

4.2 Option 2 – Double circuit 132 kV

This option involves construction of a double circuit 132 kV line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route.

The figure below illustrates the high-level network configuration under Option 2, as well as the locations of key mining and wind potential on the Eyre Peninsula. The existence of double-circuit 132 kV lines on the Eyre Peninsula means that additional wind can locate on the Eyre Peninsula.⁹⁴ Since this option does not involve a 275 kV line, it cannot support additional mining load and, should any of the mining scenarios eventuate, then it is assumed that they would need to source their energy by connecting back to the 275 kV network at Cultana.

Figure 8 – Network configuration under Option 2, as well as locations of key mining and wind potential



This option would utilise additional easements on the Eyre Peninsula that ElectraNet has acquired.

This option would involve additional generation support during construction, although it would be less than for Option 1 since it would only essentially be required for a short time, that is, when switching supply over to the new line.

⁹⁴ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

Capital costs for this option are estimated to be in the order of \$220 million. Construction is expected to take 2 years, with commissioning possible by the end of 2020, subject to obtaining necessary environmental and development approvals.

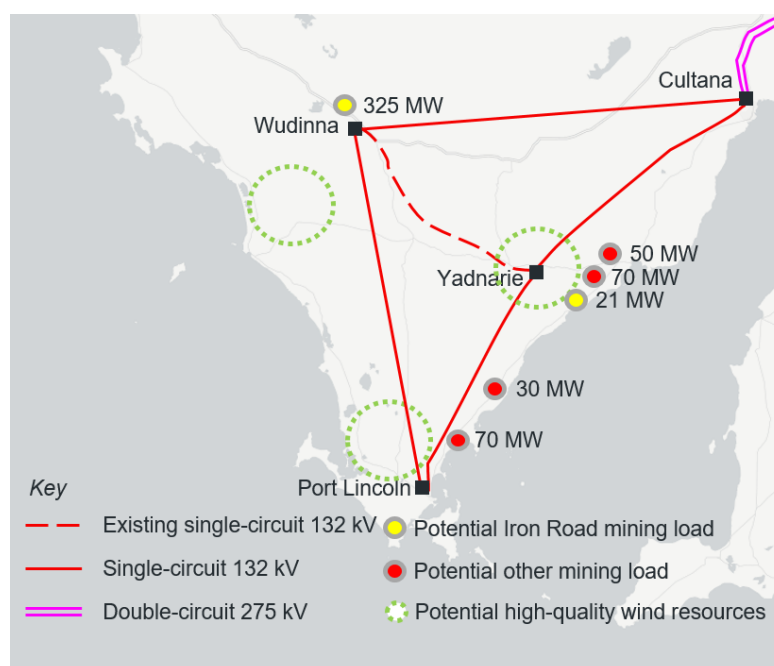
4.3 Option 3 – Two single circuit 132 kV lines (one going via Wudinna)

This option involves construction of two single circuit 132 kV lines from Cultana to Port Lincoln route, with one going via Yadnarie and another going via Wudinna.

The figure below illustrates the high-level network configuration under Option 3, as well as the locations of key mining and wind potential on the Eyre Peninsula. As with Option 2, the existence of two single-circuit 132 kV lines on the Eyre Peninsula means that additional wind can locate on the Eyre Peninsula.⁹⁵

However, since this option does not involve a 275 kV line, it cannot support additional mining load and, should any of the mining scenarios eventuate, then it is assumed that they would need to source their energy by connecting back to the 275 kV network at Cultana.

Figure 9 – Network configuration under Option 3, as well as locations of key mining and wind potential



Under this option, the two new circuits would be constructed on geographically separated easements, sufficiently far apart to reduce the risk of outages from a single weather event.

This option would involve additional generation support during construction, which would be similar to Option 2 in magnitude since it would only essentially be required for a short time, that is, when switching supply over to the new lines.

Capital costs for this option are estimated to be in the order of \$390 million. Construction is expected to take 5 years, with commissioning possible by the end of 2023, subject to land and easement acquisition and obtaining necessary environmental and development approvals.

⁹⁵ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

4.4 Option 4A – Double circuit 275 kV lines

Option 4A has been included as a high-capacity ‘set and forget’ option where the entire double-circuit line is built and operated at 275 kV initially.

Option 4A has been included to investigate whether it is ever efficient to build and operate the entire double-circuit line to 275 kV initially – in particular, where it is expected that mining and wind developments will come online with a high probability.⁹⁶

The figure below illustrates the high-level network configuration under Option 4A, as well as the locations of key mining and wind potential on the Eyre Peninsula.

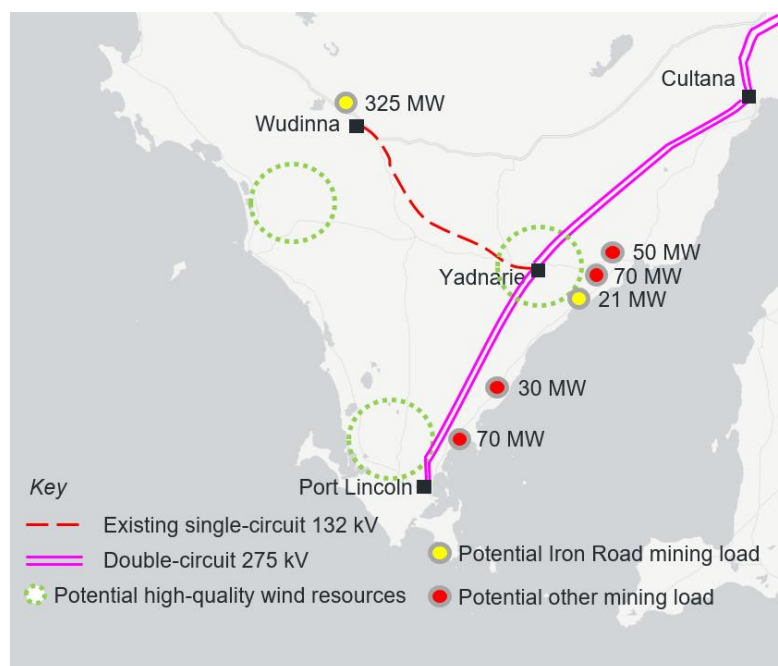
The combination of new double-circuit lines and 275 kV capacity means that significant additional wind can locate on the Eyre Peninsula under Option 4A.⁹⁷ In addition, the 275 kV capacity can support additional mining load associated with both the CEIP development and any other mining interests.⁹⁸

This option would utilise the additional easements on the Eyre Peninsula that ElectraNet has acquired.

This option would involve additional generation support during construction, although it would be less than for Option 1 since it would only essentially be required for a short time, that is, when switching supply over to the new line.

Capital costs for this option are estimated to be in the order of \$390 million. Construction is expected to take 2 years, with commissioning possible by the end of 2020, subject to obtaining necessary environmental and development approvals.

Figure 10 – Network configuration under Option 4A, as well as locations of key mining and wind potential



⁹⁶ Please see section 6 for a discussion of the probabilities assumed for mining load, and section 9 for the results and sensitivities to these assumed probabilities.

⁹⁷ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

⁹⁸ The exception to this is the 21 MW of load associated with the CEIP port facilities, which can be accommodated at Yadnarie.

4.5 Option 4B – Double circuit 275 kV between Cultana and Yadnarie and double circuit 132 kV between Yadnarie and Port Lincoln

Option 4B has been included as a low cost 275 kV ‘set and forget’ option where the Cultana to Yadnarie double-circuit line is built and operated at 275 kV initially while the Yadnarie to Port Lincoln double-circuit line is built and operated at 132 kV (and cannot be upgraded to 275 kV later).

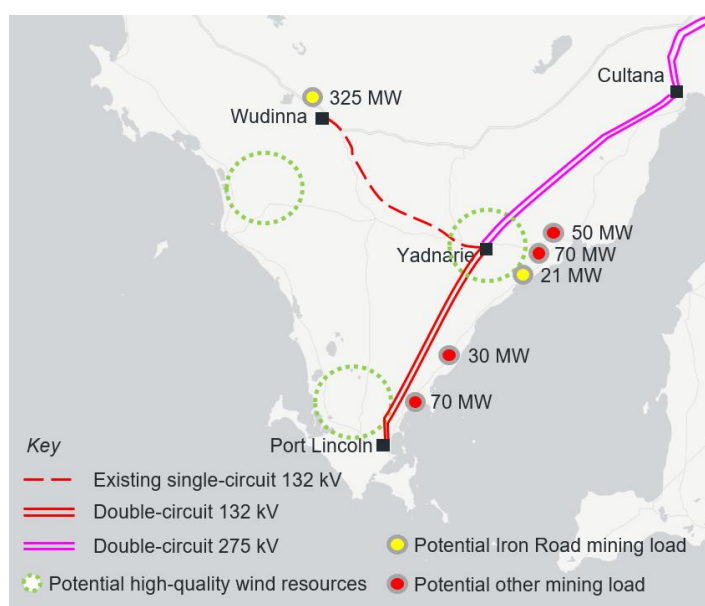
Option 4B considers the benefit of building and operating the top portion of the double-circuit line to 275 kV – in particular, where it is expected that CEIP will come online with a high probability.⁹⁹

The figure below illustrates the high-level network configuration under Option 4B, as well as the locations of key mining and wind potential on the Eyre Peninsula. The combination of new double-circuit lines and 275 kV capacity (at the top) means that additional wind can locate on the Eyre Peninsula under Option 4B.¹⁰⁰ In addition, the 275 kV capacity can support additional mining load associated with the CEIP development – should the other mining interests eventuate, then it is assumed that they would need to source their energy by connecting back to the 275 kV network at Cultana.¹⁰¹ This option would utilise the additional easements on the Eyre Peninsula that ElectraNet has acquired.

This option would involve additional generation support during construction, although it would be less than for Option 1 since it would only essentially be required for a short time, that is, when switching supply over to the new line.

Capital costs for this option are estimated to be in the order of \$300 million. Construction is expected to take 2 years, with commissioning possible by the end of 2020, subject to obtaining necessary environmental and development approvals.

Figure 11 – Network configuration under Option 4B, as well as locations of key mining and wind potential



⁹⁹ Please see section 6 for a discussion of the probabilities assumed for mining load, and section 9 for the results and sensitivities to these assumed probabilities.

¹⁰⁰ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

¹⁰¹ The exception to this is the 21 MW of load associated with the CEIP port facilities, which can be accommodated at Yadnarie.

4.6 Option 4C – Double circuit 132 kV with the ability to be upgraded to 275 kV

This option is similar in route and build design to options 2, 4A and 4B with the main difference being that, while it is built to be able to operate at 275 kV if required, it is initially operated at 132 kV. Option 4C therefore allows ElectraNet the option of being able to upgrade the network capacity to 275 kV later, if its efficient to do so.

The three figures on the next page illustrates the high-level network configuration under Option 4C, under each of the three key triggers.¹⁰² In particular, they demonstrate the flexibility in Option 4C compared to all other options (besides 4C and 5A) and the ability of its capacity and operation to be optimised by ElectraNet if certain events happen in the future.

A key difference between Option 4C and Options 1, 2 and 3 is that it may result in 275 kV network capacity on part, or all, of the Eyre Peninsula in the future. This allows less costly connection to the transmission network for mines (ie, as opposed to having to connect back to the 275 kV network at Cultana). It also means that more wind generation can locate on the Eyre Peninsula, both due to the greater capacity of a 275 kV line but also because mining load enables more wind to connect.¹⁰³

This option would utilise additional easements on the Eyre Peninsula that ElectraNet has acquired.

This option would involve additional generation support during construction of a similar magnitude to Option 2, that is, only for a short time when switching supply over to the new line.

Capital costs for this option built to 275 kV but operated at 132 kV initially are estimated to be in the order of \$310 million. The additional cost build associated with obtaining the 'option' of upgrading the network (or part of it) to 275 kV at a later date if mining and/or wind develop, is estimated as \$90 million; ie, the difference in upfront capital costs between Option 4C and Option 2.

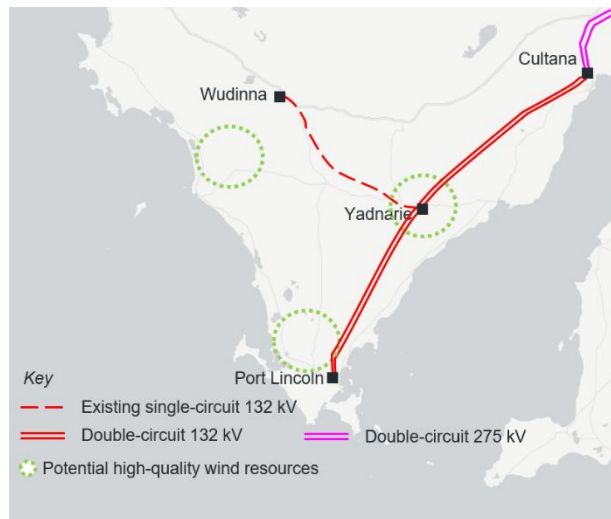
Initial construction is expected to take 3 years, with commissioning possible by the end of 2021, subject to land and easement acquisition and obtaining necessary environmental and development approvals. The future incremental capital works of moving from 132 kV operation to 275 kV operation centre on substation works¹⁰⁴ and are expected to take two years to complete.

¹⁰² Please see section 6 for a discussion of these three triggers.

¹⁰³ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

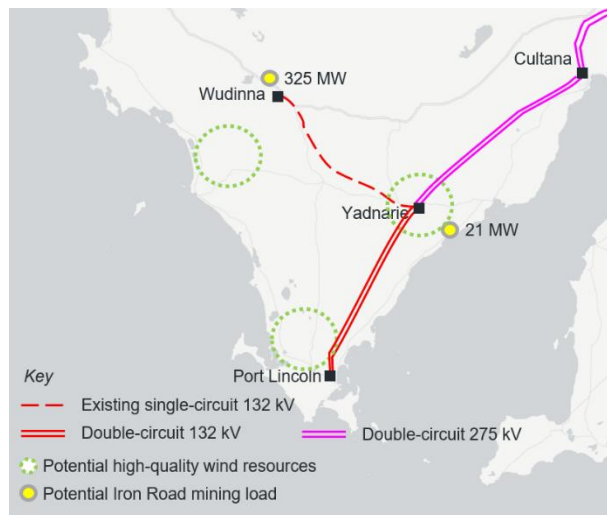
¹⁰⁴ At the Cultana, Yadnarie and Port Lincoln substations.

Figure 12 – Network configurations possible under Option 4C



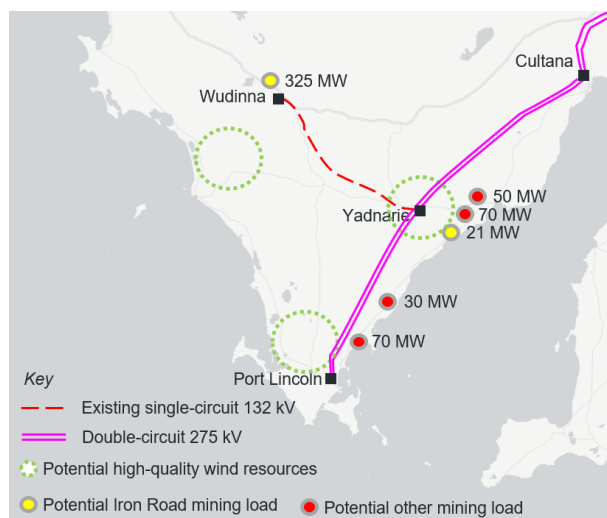
Stage 1

If no mining load commits or wind generation locates on the Eyre Peninsula then the entire double-circuit line will remain at 132 kV.



Stage 2

If Iron Road's CEIP reaches committed status, then ElectraNet will upgrade the Cultana to Yadnara double-circuit section to 275 kV.



Stage 3

The entire length of new double-circuit lines will be upgraded to 275 kV if:

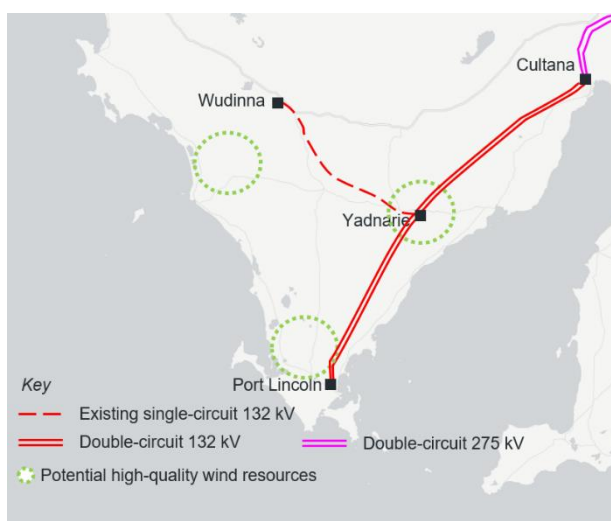
- the CEIP project reaches committed status as to do the other assumed mining loads; and/or
- the Eyre Peninsula is designated as a priority for renewable energy development

4.7 Option 4D – Double-circuit 132 kV with the ability for the Cultana to Yadnarie section to be upgraded to 275 kV

This option is similar in route and build design to options 2, 4A and 4B with the main difference being that, while it is initially operated at 132 kV, the top portion (ie, from Cultana to Yadnarie) is built to be able to operated at 275 kV, if required. The remainder of the Eyre Peninsula (ie, Yadnarie to Port Lincoln) is only ever built and operated at 132 kV. Option 4D therefore allows ElectraNet the option of being able to upgrade Cultana to Yadnarie network capacity to 275 kV later, if its efficient to do so.

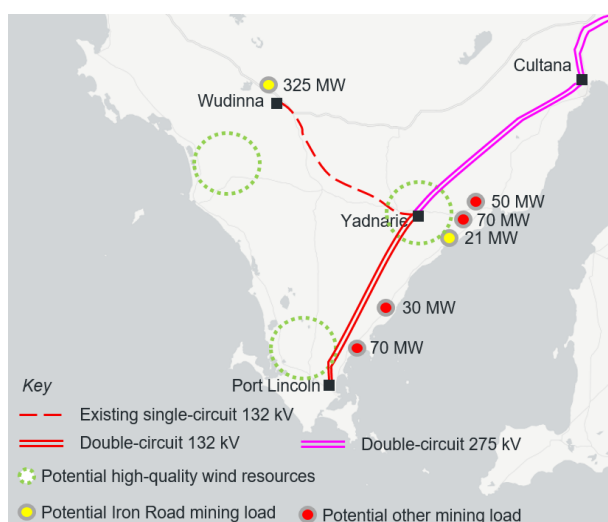
The two figures below illustrates the high-level network configuration under Option 4D, under each of the three key triggers.¹⁰⁵ In particular, they demonstrate the flexibility in Option 4D compared to all other options (besides 4C and 5C) and the ability of its capacity and operation to be optimised by ElectraNet if certain events happen in the future.

Figure 13 – Network configurations possible under Option 4D



Stage 1

If no mining load commits or wind generation locates on the Eyre Peninsula then the entire double-circuit line will remain at 132 kV.



Stage 2

The Cultana to Yadnarie new double-circuit lines will be upgraded to 275 kV if:

- the CEIP project reaches committed status as to do the other assumed mining loads; and/or
- the Eyre Peninsula is designated as a priority for renewable energy development

¹⁰⁵ Please see section 6 for a discussion of these three triggers.

As with Options 4D and 5C, a key difference between Option 4D and Options 1, 2 and 3 is that it may result in 275 kV network capacity on part of the Eyre Peninsula in the future. This allows less costly connection to the transmission network for mines (ie, as opposed to having to connect back to the 275 kV network at Cultana). It also means that more wind generation can locate on the Eyre Peninsula, both due to the greater capacity of a 275 kV line but also because mining load enables more wind to connect.¹⁰⁶

This option would utilise the additional easements on the Eyre Peninsula that ElectraNet has acquired.

This option would involve additional generation support during construction of a similar magnitude to Option 2, that is, only for a short time when switching supply over to the new line.

Capital costs for this option built to 275 kV but operated at 132 kV initially are estimated to be in the order of \$270 million. The additional cost build associated with obtaining the 'option' of upgrading the Cultana to Yadnarie network to 275 kV at a later date if mining and/or wind develop, is estimated as \$50 million; ie, the difference in upfront capital costs between Option 4D and Option 2.

Initial construction is expected to take 3 years, with commissioning possible by the end of 2021, subject to land and easement acquisition and obtaining necessary environmental and development approvals. The future incremental capital works of moving from 132 kV operation to 275 kV operation centre on substation works¹⁰⁷ and are expected to take two years to complete.

4.8 Option 5A – Two single-circuit 275 kV lines (one going via Wudinna)

Option 5A has been included as a high-cost/capacity 'set and forget' option where both circuits are built and operated at 275 kV initially.

Option 5A has been included to investigate whether it is ever efficient to build and operate the both single-circuits at 275 kV initially – in particular, what probability of mining load would be required to justify this option.¹⁰⁸

The figure below illustrates the high-level network configuration under Option 5A, as well as the locations of key mining and wind potential on the Eyre Peninsula. The 275 kV capacity means that significant additional wind can locate on the Eyre Peninsula under Option 5A.¹⁰⁹ In addition, the 275 kV capacity can support additional mining load associated with both the CEIP development and any other assumed mining interest.

Under this option, the two new circuits would be constructed on geographically separated easements, sufficiently far apart to reduce the risk of outages from a single weather event.

This option would involve additional generation support during construction, which would be like Option 2 in magnitude since it would only essentially be required for a short time, that is, when switching supply over to the new lines.

¹⁰⁶ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

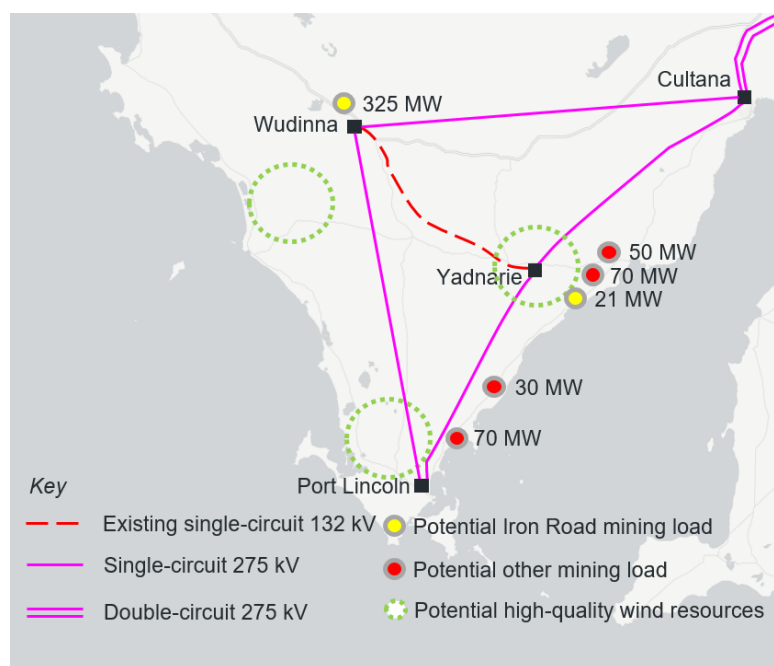
¹⁰⁷ At the Cultana and Yadnarie substations.

¹⁰⁸ Please see section 6 for a discussion of the probabilities assumed for mining load, and section 9 for the results and sensitivities to these assumed probabilities.

¹⁰⁹ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

Capital costs for this option are estimated to be in the order of \$610 million. Construction is expected to take 5 years, with commissioning possible by the end of 2023, subject to land and easement acquisition and obtaining necessary environmental and development approvals.

Figure 14 – Network configuration under Option 5A, as well as locations of key mining and wind potential



4.9 Option 5B – Two single-circuit lines, with the Cultana to Wudinna line built and operated at 275 kV

Option 5B has been included as a ‘set and forget’ version where the Cultana to Wudinna single-circuit line is built and operated at 275 kV initially while the rest of the Eyre Peninsula is built and operated at 132 kV (and cannot be upgraded to 275 kV later).

Option 5B has been included to investigate whether it is ever efficient to build and operate the Cultana to Wudinna line to 275 kV initially – in particular, what probability of mining load would be required to justify this option.¹¹⁰

The figure below illustrates the high-level network configuration under Option 5B, as well as the locations of key mining and wind potential on the Eyre Peninsula. The 275 kV line to Wudinna means that additional wind can locate on the Eyre Peninsula under Option 5B.¹¹¹ In addition, the 275 kV capacity can support additional mining load associated with the CEIP development – should the other assumed mining interests eventuate, then it is assumed that they would need to source their energy by connecting back to the 275 kV network at Cultana.

Under this option, the two new circuits would be constructed on geographically separated easements, sufficiently far apart to reduce the risk of outages from a single weather event.

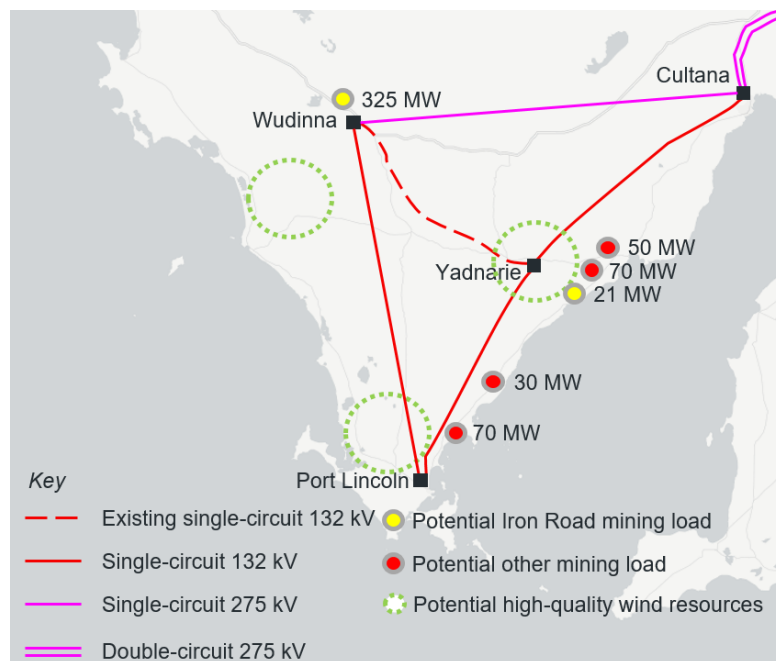
¹¹⁰ Please see section 6 for a discussion of the probabilities assumed for mining load, and section 9 for the results and sensitivities to these assumed probabilities.

¹¹¹ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

This option would involve additional generation support during construction, which would be like Option 2 in magnitude since it would only essentially be required for a short time, that is, when switching supply over to the new lines.

Capital costs for this option are estimated to be in the order of \$450 million. Construction is expected to take 5 years, with commissioning possible by the end of 2023, subject to land and easement acquisition and obtaining necessary environmental and development approvals.

Figure 15 – Network configuration under Option 5B, as well as locations of key mining and wind potential



4.10 Option 5C – Two single-circuit 132 kV lines (one going via Wudinna) with the ability to be upgraded to 275 kV at a later date, if required

This option is similar in route and build design to options 3, 5A and 5B with the main difference being that, while it is built to be able to operate at 275 kV if need be, it is initially operated at 132 kV. Option 5C, like 4C and 4D, therefore allows ElectraNet the option of being able to upgrade the network capacity to 275 kV later, if its efficient to do so.

The four figures on the next page illustrates the high-level network configuration under Option 5C, under each of the three key triggers.¹¹² In particular, they demonstrate the flexibility in Option 5C compared to all other options (besides 4C and 4D) and the ability of its capacity and operation to be optimised by ElectraNet if certain events happen in the future.

A key difference between Option 5C and Options 1, 2 and 3 is that it may result in 275 kV network capacity on part, or all, of the Eyre Peninsula in the future. This allows less costly connection to the transmission network for mines (ie, as opposed to having to connect back to the 275 kV network at Cultana).

¹¹² Please see section 6 for a discussion of these three triggers.

It also means that more wind generation can locate on the Eyre Peninsula, both due to the greater capacity of a 275 kV line but also because mining load enables more wind to connect.¹¹³

Under this option, the two new circuits would be constructed on geographically separated easements, sufficiently far apart to reduce the risk of outages from a single weather event.

This option would involve additional generation support during construction, which would be like Option 2 in magnitude since it would only essentially be required for a short time, that is, when switching supply over to the new lines.

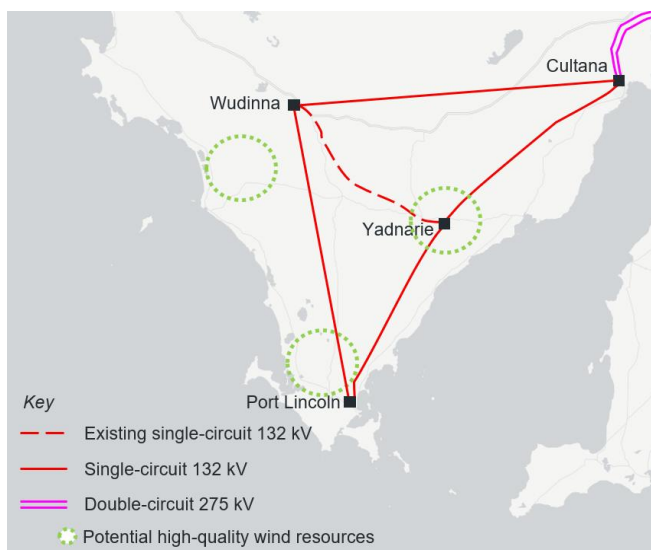
Capital costs for this option are estimated to be in the order of \$500 million. The additional cost build associated with obtaining the 'option' of upgrading the network (or part of it) to 275 kV at a later date if mining and/or wind develop, is estimated as \$110 million, ie, the difference in upfront capital costs between Option 5C and Option 3.

Initial construction is expected to take 5 years, with commissioning possible by the end of 2023, subject to land and easement acquisition and obtaining necessary environmental and development approvals. The future incremental capital works of moving from 132 kV operation to 275 kV operation centre on substation works¹¹⁴ and are expected to take two years to complete.

¹¹³ Please see section 5.2 for a discussion of the wind resource limits assumed for each option.

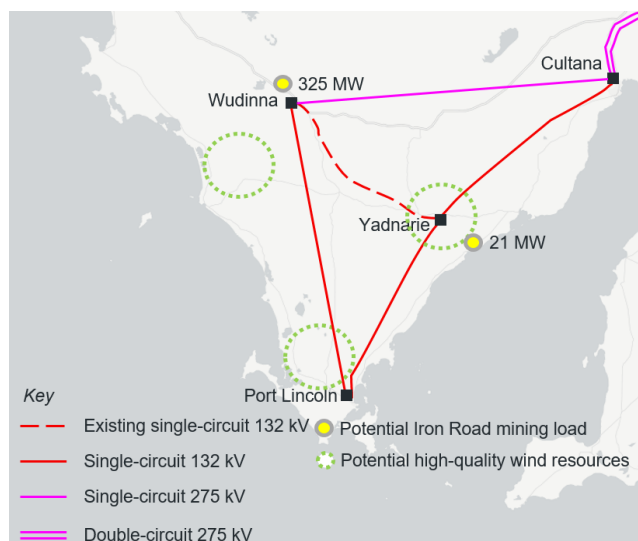
¹¹⁴ At the Cultana, Wudinna, Yadnarie and Port Lincoln substations.

Figure 16 – Network configurations possible under Option 5C



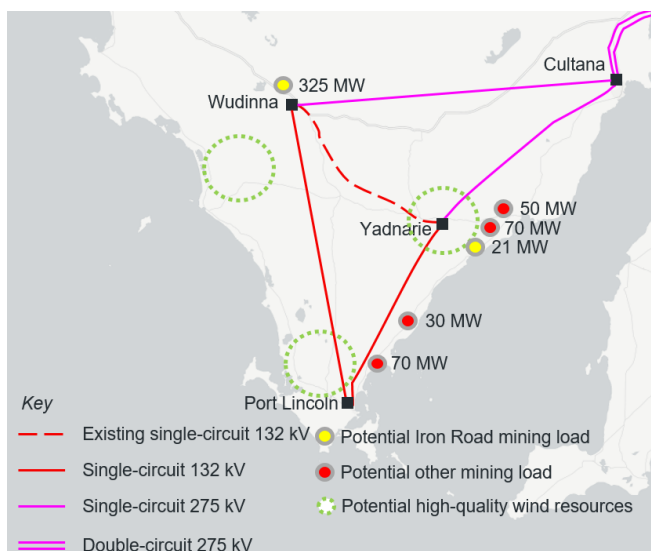
Stage 1

If no mining load commits or wind generation locates on the Eyre Peninsula then set of single-circuit sections will remain at 132 kV.



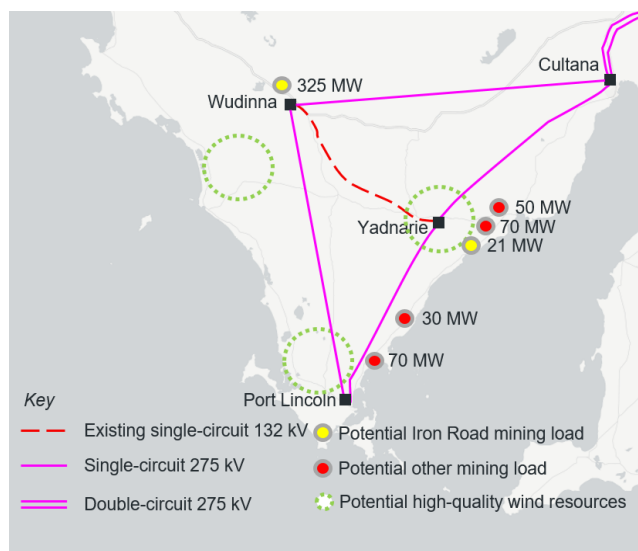
Stage 2

If Iron Road's CEIP reaches committed status, then ElectraNet will upgrade the Cultana to Wudinna section to 275 kV.



Stage 3

If the CEIP project reaches committed status as do the other assumed mining loads, then ElectraNet will upgrade both the Cultana to Wudinna and Cultana sections to 275 kV.



Stage 4

If the Eyre Peninsula is designated as a priority for renewable energy development, then ElectraNet will upgrade the entire set of single circuit lines to 275 kV.

5. Approach to including future potential mining and wind developments in the assessment

A key factor in determining the most appropriate supply solution for the Eyre Peninsula is the timing and extent of mining load and/or wind generation that may develop on the Eyre Peninsula going forward.

This section outlines the approach taken in this RIT-T analysis to incorporating these potential developments, and considering the associated uncertainty.

5.1 Assumptions regarding potential mining load on the Eyre Peninsula

This section outlines the key assumptions made regarding potential mining load on the Eyre Peninsula. In particular, it sets out assumptions about the magnitude of potential mining load, the connection costs for mining load to a 275 kV Eyre Peninsula network and how the mines would likely source their energy if the Eyre Peninsula network remains at 132kV.

5.1.1 Magnitude of potential mining load on the Eyre Peninsula

The Eyre Peninsula is a natural resource rich region of Australia with significant and proven undeveloped mineral deposits and mining potential. The region covers the mineral areas known as the Gawler Craton and the Eucla Basin, which have significant proven iron ore and other mineral deposits.¹¹⁵

Prior to international iron ore, and many other minerals, prices taking a downturn in recent years, five major mining developments on the Eyre Peninsula had reached a pre-feasibility stage and made formal enquiries with ElectraNet for connection to the transmission network. These connection enquiries were made by two primary companies – Iron Road and Centrex.

The table on the next page outlines the most recent information ElectraNet has on each of these prospective loads.

ElectraNet notes that these five potential mining developments represent a subset of the total mining potential on the Eyre Peninsula and relate only to those where ElectraNet has received a formal connection enquiry in the past. Specifically, the South Australian government currently recognises 10 potential mining projects on the Eyre Peninsula.¹¹⁶

¹¹⁵ <http://www.minerals.statedevelopment.sa.gov.au/mining>

¹¹⁶ http://www.minerals.statedevelopment.sa.gov.au/mining/mineral_projects

Table 4 – Summary of prospective mining loads assumed on the Eyre Peninsula, previously subject to formal connection enquiries

Mining development	Proponent	Location	Prospective load
CEIP	Iron Road	The mine itself is proposed to be situated approx. 35 km south-east of Wudinna, while a port would also be located on the coast near Yadnarie.	325 MW for the mine itself (near Wudinna) and 21 MW for port facilities (near Yadnarie)
Carrow	Centrex Metals	45 km north of Yadnarie	50 MW
Port Spencer aka Sheep Hill	Centrex Metals	26 km north of Tumby Bay	30 MW
Bungalow	Centrex Metals JV with Baotou Iron and Steel Group	10 km north-west of Cowell	70 MW
Fusion Magnetite Project (Koppio)	Centrex Metals	35 km north of Port Lincoln	70 MW

While the Eyre Peninsula harbours much more mining potential than these 5 potential developments, we have used the prospective loads associated with these 5 developments to define three mining scenarios for the modelling in this PADR – namely:

- mining scenario 1 – no mining locates on the Eyre Peninsula going forward (consistent with a ‘low world mineral prices’ future ‘state of the world’);
- mining scenario 2 – Iron Road’s CEIP project locates on the Eyre Peninsula;
- mining scenario 3 – Iron Road’s CEIP and the other four developments above locate on the Eyre Peninsula (consistent with a rebound in world minerals prices ‘state of the world’).

ElectraNet considers that these three scenarios encapsulate a reasonable range of additional load that may locate on the Eyre Peninsula over the next 20 years due to mining.

Mining scenario 2 has been constructed to just reflect one mine on the Eyre Peninsula going ahead – Iron Road’s CEIP. Of all five formal connection enquiries received in 2012-13, Iron Road is the only one that has been actively communicating with ElectraNet since then. They are also the only direct mining proponent that submitted to the PSCR.

ElectraNet notes that the prospect of increased load on the Eyre Peninsula due to mining has recently re-emerged. On 3 May 2017, after release of the PSCR, the Government of South Australia announced two key approvals for Iron Road’s Central Eyre Iron Project (CEIP). These are 21-year leases for a mining and minerals processing operation near Warramboo, and Development Authorisation for associated infrastructure components (transmission line, port, railway, water pipeline and worker village).¹¹⁷ In Iron Road’s submission to the PSCR, it stated it expects to make a Final Investment Decision by the end of 2017 on the CEIP, with financial close expected during 2018.¹¹⁸

¹¹⁷ Government of South Australia – Department of the Premier and Cabinet, *Submission to ElectraNet’s revenue proposal for 2018-23*, 12 July 2017, p. 3.

¹¹⁸ Iron Road, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 18 July 2017, p. 1.

We have assumed an 80 per cent capacity factor for each mine, reflecting the fact that mines typically operate most of the year-round.¹¹⁹







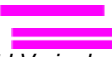
5.1.2 Assumed mining connection costs to the 275 kV Eyre Peninsula network

All mining developments require connection to a 275 kV network, as 132 kV is not sufficient to accommodate the loads set out in mining scenarios 2 and 3 above.

ElectraNet has estimated indicative connection costs for each mining load to the 275 kV network under each of the credible options that include 275 kV capacity on the Eyre Peninsula.

The table below summarises these costs for each possible network configuration and mining scenario, in aggregate (ie, across all relevant mines).¹²⁰

Table 5 – Summary of the connection costs to the Eyre Peninsula 275 kV network (where it exists)

Network configuration	Diagram	Mining Scenario	Indicative aggregate connection cost
275 kV to Yadnarie - existing easement		Iron Road	\$170m
		Iron Road + Others	\$560m
275 kV to Port Lincoln - existing easement		Iron Road	\$170m
		Iron Road + Others	\$560m
275 kV to Wudinna – new easement		Iron Road	\$85m
		Iron Road + Others	\$475m
275 kV to Wudinna and Yadnarie – new easement		Iron Road	\$85m
		Iron Road + Others	\$210m
275 kV to Port Lincoln via Wudinna – new easement		Iron Road	\$85m
		Iron Road + Others	\$210m
<div>Key:</div> <div><div> & 132 kV single-circuit & 132 kV double-circuit</div><div> & 275 kV single-circuit & 275 kV double-circuit</div></div>			

¹¹⁹ SKM, EC 11201 – Lower Eyre Peninsula Technical Options Analysis, September 2012

¹²⁰ Please note that these costs are indicative in nature and do not represent an offer to connect to ElectraNet's network and do not represent an offer by ElectraNet to construct any of the assets outlined – they have not been estimated to/from exact locations and do not represent formal ElectraNet estimates of what any actual connection costs may turn out to be.

5.1.3 How mines are assumed to source their energy requirements if the Eyre Peninsula network is not sufficient to enable their connection

We have investigated, from an economic perspective, how mines are most likely to source their energy requirements when there is insufficient network capacity on the Eyre Peninsula to supply them.

We have undertaken a high-level assessment and comparison of the costs of both:

- mines sourcing their energy from the existing 275 kV network – this is assumed to involve constructing a connection to back to the 275 kV grid at Cultana.¹²¹ Our assessment also took into account the TUOS costs the mines would be likely to pay under this option as well as estimates of costs of energy from the wholesale market; and
- mines sourcing their energy requirements from onsite generation – this is assumed to involve constructing two combined cycle gas turbines to be located near Wudinna to supply Iron Road and near Yadnarie to supply the other assumed mines in the region. In addition, this requires the construction of additional pipeline infrastructure to supply the generators with gas.¹²²

The analysis of these two supply options indicates that the optimal approach to supplying mining loads depends on future expectations around wholesale electricity prices and the availability of gas for new gas fired generation. The analysis indicates that it would be optimal for a mining load to connect to the grid for average future prices less than approximately \$75/MWh.¹²³

The assumed connection costs under this scenario of connecting back to Cultana are shown in the table below, in aggregate (ie, across all relevant mines).¹²⁴









¹²¹ The only assumed mining load that is not assumed to connect back to Cultana is the 21 MW associated with the CEIP port facilities near Yadnarie (since a 132 kV network can accommodate 21 MW).

¹²² SKM, *EC 11201 – Lower Eyre Peninsula Technical Options Analysis*, September 2012, p. 63.

¹²³ The threshold wholesale price for deciding to connect to the grid is lower in the case where more mining load is present owing to the economies of scale in building gas pipeline infrastructure to supply gas to generators on the Eyre Peninsula

¹²⁴ Please note that these costs are only indicative and high-level – they have not been estimated to/from exact locations and do not represent formal ElectraNet estimates of what any actual connection costs may turn out to be.

Table 6 – Summary of the connection costs to the 275 kV network at Cultana under different network configurations

Network configuration	Diagram	Mining scenario	Aggregate connection cost
Reconductored 132 kV single-circuit		Iron Road	\$260m
		Iron Road + others	\$650m
Double-circuit 132 kV		Iron Road	\$260m
		Iron Road + others	\$650m
Single-circuit 132 kV on diverse paths		Iron Road	\$260m
		Iron Road + others	\$650m
<div>Key:</div> <div><div> Reconductored 132 kV</div><div> Network support at Port Lincoln</div><div> &  132 kV single-circuit & 132 kV double-circuit</div><div> 275 kV single-circuit</div></div>			

Reflecting the uncertainty inherent in this decision, we have conducted a sensitivity analysis on the assumption regarding the alternate energy supply decision for mining loads.

We have assumed in our ‘core’ set of results that mines source their energy from the existing grid by connecting back at Cultana where the Eyre Peninsula network is not sufficient to enable their connection. We have also investigated a sensitivity where mines are assumed to build and operate their own onsite generators when the Eyre Peninsula’s network is not sufficient to enable their connection.

5.2 The quality and quantity of the wind resource on the Eyre Peninsula

This section outlines the key assumptions made regarding potential additional wind generation on the Eyre Peninsula. In particular, it sets out the assumptions made in this PADR about the quality of the wind resource on the Eyre Peninsula, as well as the potential magnitude of additional wind generation.

5.2.1 The quality of the wind resource on the Eyre Peninsula

The market modelling, outlined in section 7, assumes capacity factors for different areas of wind in the NEM, which have been sourced from AEMO’s National Electricity Transmission Network Development Plan (NTNDP) assumptions. One of the highest capacity factors currently included in the NTNDP for wind generators is 38.3 per cent and relates to the ‘Northern South Australia’ region, which includes the Eyre Peninsula (amongst other regions).

Since the Eyre Peninsula is widely renowned for having high-quality wind resources, we have assumed that any new wind generators locating on the Eyre Peninsula would have a capacity factor of 40 per cent. This assumption is consistent with the substantial work undertaken as part of the Green Grid report, which estimated that there is around 17,000 MW of wind potential on the peninsula with a capacity of more than 40 per cent.¹²⁵

However, recognising that this is a key assumption and driver of wholesale market benefits, we have also investigated a sensitivity of 38.3 per cent, as well as 36.6 per cent (which reflects the historical average capacity factor for wind farms in the mid-north region of South Australia). The results of doing so are presented and discussed in section 9.3.13.

5.2.2 The quantity of wind potential on the Eyre Peninsula

Expansion of the transmission network on the Eyre Peninsula will provide access to additional high-quality wind resources. To the extent that these wind resources on the Eyre Peninsula have higher capacity factors relative to the other resources within the NEM, increasing the amount of wind that can be built on the Eyre Peninsula will result in market benefits (as outlined in section 7.1 below).

The effect of expanding the existing network on the amount of wind generation that can connect on the Eyre Peninsula is captured through changes in wind resource limits. These limits represent the total amount of wind that can connect to the network over the modelling period. These limits act alongside annual build limits to constrain the profile of investment in new entrant wind generation over the modelling period.




Higher resource limits do not necessarily mean that new wind generation will be built to meet these limits. The market modelling outlined in section 7 below determines the extent to which Eyre Peninsula wind resources are required as part of the least cost plan to satisfy demand. Where mining is assumed to locate on the Eyre Peninsula, this further increases the capacity for wind generation since the mine(s) use the energy generated by wind farms – similarly, the assumption of additional interconnection between South Australia and the rest of the NEM also raises specific wind resource limits.

Table 7 shows the wind resource limits based on each configuration and under each mining load scenario. We define the different wind resource limit scenarios based on network configurations, since the option value scenarios involve shifting between different configurations over time in response to trigger variables.

Appendix E provides more detail on how these assumptions have been derived.

¹²⁵ Baker and McKenzie, WorleyParsons & Macquarie Bank, Green Grid – Unlocking Renewable Energy Resources in South Australia, 2010, p. 25

Table 7 – Summary of wind resource limits assumed under different network configurations

Network configuration	Diagram	Mining scenario	Resource limits – no interconnector (MW)	Resource limits – with interconnector (MW)
Reconductoring		No Mining	0	0
		Iron Road	0	0
		Iron Road + others	0	0
132 kV – existing easement		No Mining	300	300
		Iron Road	300	300
		Iron Road + others	400	400
132 kV – new easement		No Mining	300	300
		Iron Road	300	300
		Iron Road + others	400	400
275 kV to Yadnarie - existing easement		No Mining	1,000	1,000
		Iron Road	1,280	1,280
		Iron Road + others	1,450	1,450
275 kV to Port Lincoln - existing easement		No Mining	1,000	1,000
		Iron Road	1,280	1,280
		Iron Road + others	1,450	1,450
275 kV to Wudinna – new easement		No Mining	400	600
		Iron Road	680	880
		Iron Road + others	780	980
275 kV to Wudinna and Yadnarie – new easement		No Mining	500	900
		Iron Road	780	1,180
		Iron Road + others	950	1,350
275 kV to Port Lincoln via Wudinna – new easement		No Mining	1,000	1,000
		Iron Road	1,280	1,280
		Iron Road + others	1,450	1,450
Key:	 Reconductored 132 kV	 Network support at Port Lincoln	 &  132 kV single-circuit & 132 kV double-circuit	 &  275 kV single-circuit & 275 kV double-circuit

6. Real option valuation techniques have been used to estimate 'option value'

This RIT-T is the first to formally include real options analysis. 'Option value' in this RIT-T arises in relation to the three options that have been defined to be flexible, and which involve building some additional network capability now to gain the 'option' of upgrading the network, or part of it, to a greater capacity later in response to exogenous triggers. The market benefits afforded through the flexibility to easily upgrade the network capacity in the future if it is efficient to do so is referred to as 'option value' under the RIT-T.

Option value analysis essentially extends the range of future states of the world that can be considered and so enables a more sophisticated treatment of uncertainty. The modelling techniques used consider the relationships between different uncertain parameters, and how probabilities may change over time, in a structured way.

Overall, applying real option value techniques has allowed for a far greater number of futures states of the world to be modelled in this RIT-T than under a simple 'scenario analysis'.

6.1 Why 'option value' is relevant for the Eyre Peninsula upgrade

Transmission infrastructure investment decisions are typically assessed as a single upfront decision, whereby a single option is selected based on current information and without regard for future changes in the market environment. In contrast to this approach, in circumstances where an investment can be staged over time, the decision maker need not only make a single upfront decision - but can also make decisions in the future that utilise information that becomes available over time to optimise the size and scale of the infrastructure.

Real options analysis is a technique for analysing such circumstances. In these cases, additional value, known as 'option value', arises through the decision maker being able to optimise future investment decisions. This can result in avoided costs of future upgrades in circumstances where additional capacity is not required or additional benefits from future upgrades in circumstances where additional capacity is required.

In the case of the Eyre Peninsula, option value arises through the ability to stage decisions regarding operating voltages of the transmission network. As part of the initial decision, ElectraNet can decide whether to build transmission lines with a higher rating, ie, 275 kV, but to operate them at 132 kV, thereby deferring capital expenditure associated with installing 275 kV substations, and only incurring it in circumstances where it would be beneficial to do so. The cost of the 'option' is the incremental cost of building 275 kV lines relative to 132 kV lines.

Currently, there is uncertainty about future developments on the Eyre Peninsula. This uncertainty relates in particular to future mining loads and any future identification of the region as a priority zone for renewable energy development. Should mining loads eventuate, as several stakeholders have indicated, or should renewable energy policy favour Eyre Peninsula wind resources, then a higher capacity network would be valuable. However, if these events do not eventuate then higher capacity assets may not be needed.

In its submission to the PSCR, the CCP9 noted the importance of the option value of deferral/staging strategies in the context of the Eyre Peninsula and commends ElectraNet's commitment to the consideration of the option value of alternative investments as it can reduce the risk of consumers having to pay for assets that could otherwise be stranded.¹²⁶

6.2 Summary of key 'option value' assumptions

ElectraNet engaged HoustonKemp to undertake the option value modelling.

For assessing the potential option value associated with the flexible investment options, the model has defined the information available at each point in time by a number of variables – namely:

- demand;
- gas price;
- mining scenario; and
- renewable energy precinct.

Together these variables are considered to make up the 'state of the world' at that time.

The mining scenario and renewable energy precinct scenarios are 'trigger' variables that trigger future decisions to operate the flexible options at 275kV rather than 132kV. The table below summarises these trigger variables.

Table 8 – Triggers for upgrading parts, or all, of a new 132 kV line to 275 kV (Options 4C, 4D and 5C)

Trigger	Overview
Trigger 1	Iron Road's CEIP reaching committed status, involving 325 MW of load near Wudinna (for the mine itself) and 21 MW of load near Yadnarie (for the port facilities).
Trigger 2	Mining loads on the peninsula associated with the other assumed mines going ahead, involving 120 MW of load near Yadnarie and 100 MW between Yadnarie and Port Lincoln (as outlined in Table 4 above)
Trigger 3	The Eyre Peninsula being designated as a priority for renewable energy development. ¹²⁷

The other two variables (ie, electricity demand and gas price) are not considered to be 'trigger variables', as new information does not lead to a better ability to forecast future outcomes. However, the values of these variables influence the extent of market benefits calculated in each 'state of the world'.

¹²⁶ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 3-4 & 8.

¹²⁷ The potential designation of the Eyre Peninsula as a priority zone is based on the Finkel review recommendation that AEMO develop an 'integrated grid plan', which involves identification of prospective renewable zones. This trigger leads to an expansion of the network to 275 kV from Cultana to Port Lincoln, to the extent that this is possible for the option being considered.

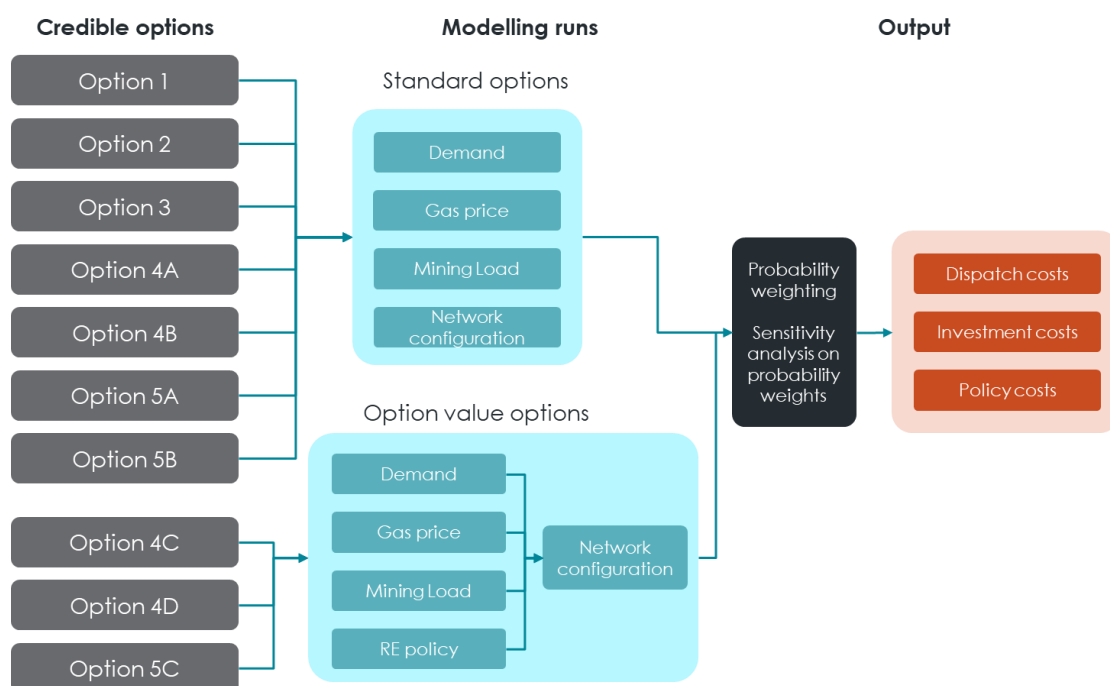
6.3 Structure and framework for the real options analysis

The figure below outlines the framework for the option value analysis. ElectraNet distinguishes between options that involve a single upfront decision ('standard options'), and those that allow optimisation of future decisions ('flexible options') from which 'option value' is derived.

For the standard options, the market benefits have been assessed arising under each demand, gas price, network configuration and mining load scenario. For the option value options, market benefits have been estimated for each of the 'state of the world' variables while upgrade decisions have been made based on the values of the trigger variables.

The cost outputs from the market modelling are broken out into four categories, ie, dispatch costs, investment costs and policy costs. In this context, policy costs refer to three separate costs, namely penalties under the current Large-Scale Renewables Energy Target, penalties under the South Australia Energy Target, and costs associated with firming, eg, storage investment costs.

Figure 17 – Overview of the option value framework



Several simplifying assumptions have been made to make the option value analysis tractable in terms of model run-time – namely:

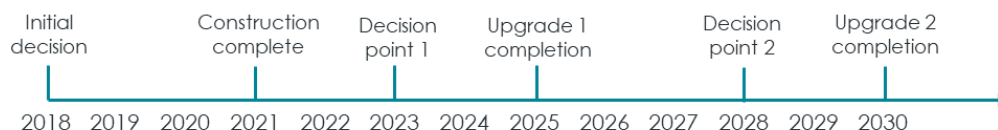
- An initial decision is assumed to be made in FY2018 – for the purposes of the option value analysis, construction for each option is assumed to be completed in FY2021;¹²⁸
- There are then two further decision points at five-year intervals, at which times new information becomes available with regards to the trigger variables, and upgrade decisions can be made based on this new information – upgrades then take two years to take effect should they be implemented.¹²⁹

¹²⁸ In reality, the different options differ slightly in terms of assumed construction timeframe, as discussed in section 4. However, this assumption is not expected to have a material impact on the outcome of the RIT-T assessment.

¹²⁹ Consistent with expected construction timeframes for Options 4C, 4D and 5C outlined in section 4.

The figure below outlines the assumed sequence of events in the option value analysis framework.

Figure 18 – Option value time line



To apply real options analysis, HoustonKemp simulated wholesale market outcomes under all feasible combinations of the above variables, reflecting the different potential future states of the world. The market benefit estimates from each of these model runs were then weighted by assumed probabilities to estimate the expected market benefits across all scenarios. In addition, HoustonKemp conducted sensitivity analysis to ascertain how sensitive the preferred option is to assumptions regarding probabilities of different future states of the world occurring.

Section 7 describes HoustonKemp's approach to the market modelling in more detail, as well as this sensitivity analysis.

Relative to initial expectations, the analysis conducted for the PADR indicates that there is less option value associated with the flexible options considered. We discuss the reasons for this in the discussion of our results in Section 9.

7. How wholesale market modelling has been applied to estimate net market benefits

ElectraNet considers that a market dispatch modelling methodology is relevant for this RIT-T application, and therefore has adopted this approach in order to calculate market benefits associated with the credible options included in the RIT-T analysis.¹³⁰

The RIT-T requires many of the categories of market benefit to be calculated by comparing the 'state of the world' in the base case (where no action is undertaken by ElectraNet) with the 'state of the world' with each of the credible options in place, separately. The 'state of the world' is essentially a description of the NEM outcomes expected in each case, and includes the type, quantity and timing of future generation investment as well as the market dispatch outcomes over the assessment period.

7.1 Overview of the market benefits estimated using market modelling

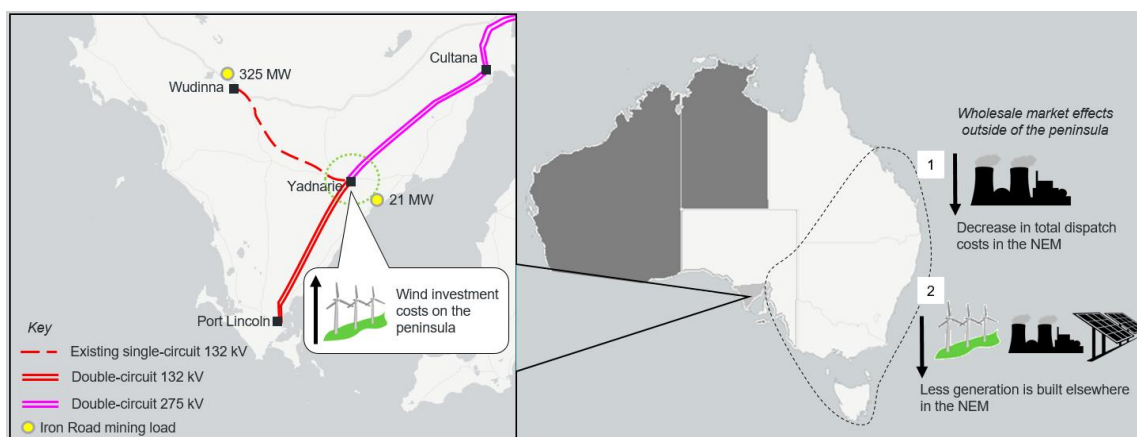
The market modelling has been used to estimate the following market benefits:

- changes in fuel consumption in the NEM arising through different patterns of generation dispatch; and
- changes in costs for parties, other than the RIT-T proponent (namely generators).

These benefits are expected where credible options allow different patterns of generation dispatch and future construction (and retirement) of generators in the NEM, compared to where the existing single-circuit 132 kV line is retained (Option 1). Both of these categories are driven by the ability of credible options to facilitate additional wind generation connecting on the Eyre Peninsula (which cannot be accommodated under Option 1).

The figure below illustrates these effects, and the two market benefits above, using Option 4B and the assumed 'state of the world' where only Iron Road's CEIP locates on the peninsula as an example. It illustrates how wind generation locating on the Eyre Peninsula results in lower total dispatch costs in the NEM as well as less generation being built.

Figure 19 – Summary of key wholesale market effects – using Option 4B as an example



¹³⁰ The RIT-T requires that in estimating the magnitude of market benefits, a market dispatch modelling methodology must be used, unless the TNSP can provide reasons why this methodology is not relevant. See: AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 11, p. 6.

We have included firming requirement for wind generation through allowing new entrant wind farms to opt to be eligible for the South Australian Energy Security Target through incurring additional costs equal to 20 per cent of their capital and fixed and variable operating costs. This approach assumes that with these additional costs, wind generators will be eligible for participation in the scheme by meeting dispatchability and system security requirements. This approach is in line with the approach adopted for the South Australia Energy Transformation RIT-T.

In addition, the analysis assumes that additional large scale solar PV generation in each state beyond certain penetration levels must be accompanied by storage.¹³¹ Table 9 summarises these penetration limits. No limit is assumed for Tasmania owing to the large proportion of generation from hydroelectric generators which are more able to adjust output in response to increased solar PV capacity.

Table 9 – Solar PV build limits after which storage is required

Region	Solar PV Build Limit
New South Wales	3,300 MW
Victoria	800 MW
Queensland	2,300 MW
South Australia	0 MW ¹³²

7.2 Overview of the market modelling undertaken

ElectraNet engaged HoustonKemp to undertake market modelling to assess the market benefits expected to arise under each of the options. This market modelling has been conducted in the context of a real option analysis framework. Therefore, a moderately simplified market model has been applied to facilitate the large number of simulations to be run within the framework. ElectraNet considers that this is a proportionate approach, and it is not expected to affect the outcome of the RIT-T assessment.

For the purposes the market modelling, ElectraNet and HoustonKemp have defined three sets of market modelling inputs, namely:

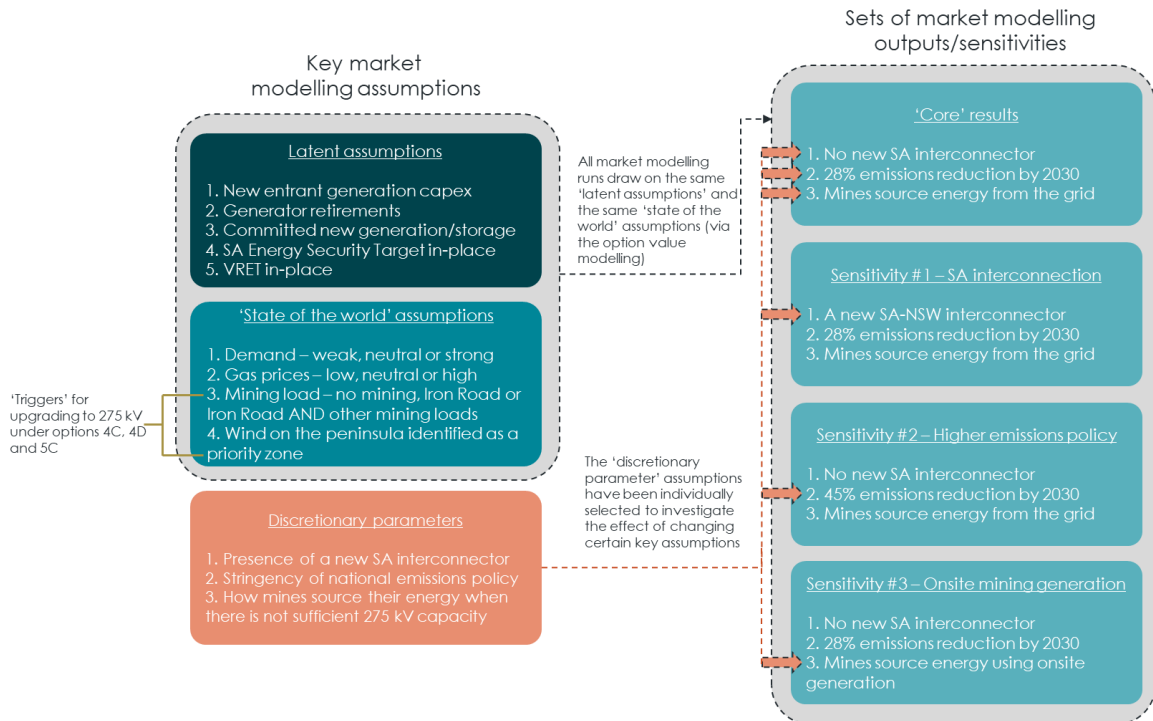
- ‘Latent’ assumptions – these are assumptions that apply across all scenarios and model runs, eg, generator technical and financial parameters, the stringency of the current Renewable Energy Target and capital costs of new entrant generators;
- ‘State of the world’ assumptions – these are the assumptions that define each ‘state of the world’ modelled in the option value analysis, ie, ‘a low demand world’ vs. a ‘high demand world’; and
- ‘Discretionary’ parameters – these are parameters which represent a material uncertainty with regards to the market modelling. The entire market modelling and option value analysis has been calculated for each set of discretionary parameters.

¹³¹ After the limit is reached each additional 1 MW of solar PV capacity requires 1 MW storage capacity required

¹³² The assumed limit is zero as minimum demand is approaching zero.

The figure below provides an overview of the framework for the market modelling undertaken, including the interaction between these sets of assumptions.

Figure 20 – Overview of the market modelling



The latent assumptions relied upon for the market modelling are based on public sources, such as AEMO's NTNDP, and ElectraNet's own internal analysis.

The latent assumptions also align with the assumptions adopted for the market modelling currently being undertaken by ElectraNet for the coincident South Australian Energy Transformation RIT-T.

As described above, the 'state of the world' assumptions include demand and gas price assumptions and mining load and renewable energy policy 'trigger' variables. The 'state of the world' assumptions have several effects in the modelling framework:

- triggering network upgrades in the options that possess option value (4C, 4D and 5C);
- for cases with mining loads, increasing demand in South Australia; and
- allowing new wind resources to be established on the Eyre Peninsula.

The demand assumptions adopted are taken from AEMO's demand projections released with the 2017 Electricity Statement of Opportunities.¹³³

In line with the approach adopted for the South Australian Energy Transformation RIT-T, and reflecting comments received from stakeholders to that RIT-T process, a wider range of gas prices than is assumed by AEMO has been adopted.

¹³³ Retrieved through AEMO's Forecasting Data Portal.

In particular, the high gas price scenario is defined as \$3.50/GJ above the neutral case and the low gas price scenario is defined as \$2.50/GJ below it – for reference the neutral case sees gas price forecasts for Torrens Island from \$7.63/GJ in 2018 to \$8.40/GJ from 2023 onwards.

The modelling assumes that the first auction under the Victorian Renewable Energy Auction Scheme is held in 2018 and that the auction successfully procures the full quantity of capacity contracts available; ie, 100 MW of solar PV generation and 550 MW of technologically neutral renewable generation. Recognising the uncertainty regarding future state-based renewable energy targets, the modelling does not make any assumptions regarding longer-term renewable energy targets for Victoria or other jurisdictions.

The modelling captures limitations on the uptake of wind generation for system security reasons through two related constraints, namely a floor on the amount of synchronous generation and a cap on the amount of non-synchronous generation. The constraints and associated parameters are based on AEMO's recent assessment of system strength in South Australia¹³⁴ and their finding in the report regarding the relationship between levels of non-synchronous generation and the requirements for synchronous generation to be online to provide system strength.

The contribution of synchronous generators to system strength is a function of the operating status of the plant; ie, the full contribution of a plant is achieved once it reaches a stable operating level, beyond which it is not materially impacted by the output of the plant.

However, to incorporate the constraints in the option value modelling framework, the constraint has been converted into one that can be applied within a linear optimisation model, which cannot incorporate binary variables, such as whether a plant is operating or not. Therefore, the contributions of synchronous generators towards system strength has been based on the level of output of these generators rather than the plant's operating status. Full contribution to system strength of a synchronous generator is then expected to be achieved at an operating level that is 80 per cent of capacity.

The synchronous floor requires a minimum of 360 MW of synchronous generation output at all times within South Australia, which is equivalent to approximately 450 MW of online capacity. When 360 MW of synchronous generation is operating, 1,200 MW of non-synchronous generation is allowed to operate. If more than 360 MW of synchronous generation is operating, then the allowable synchronous generation increases based on its incremental contribution towards system strength.

Table 10 below outlines the factors assumed for the contribution of synchronous generators to the non-synchronous cap. These assumptions are aligned with the assumptions applied in modelling for the SA Energy Transformation RIT-T.

¹³⁴ AEMO, *South Australia System Strength Assessment*, September 2017

Table 10 – Contribution to non-synchronous generation cap per MW output

Plant	Contribution to Non-synchronous generation cap per MW output
Pelican Point	1.99
Torrens Island A	0.5
Torrens Island B	0.45
Quarantine	1.25
Osborne	1.44
New entrant CCGT	1.99

The synchronous floor is assumed to be in place until 2022, beyond which, no explicit requirements exist for synchronous generation. This reflects the potential for other technologies such as synchronous condensers and storage to contribute towards system security and strength.

ElectraNet regards this as a realistic timeframe for technology solutions to develop such that synchronous generation is no longer the only means of meeting system security requirements.

Recognising the significant uncertainty regarding future requirements for system strength, ElectraNet has considered a sensitivity that assumes that the requirement for synchronous generation from gas fired generation remains over the modelling period. However, this is an unrealistic scenario that represents the upper bound of requirements for system strength from conventional generation into the future. See Section 9.3.5 for a discussion of this sensitivity analysis.

The South Australian Energy Security Target is assumed to take effect from 2020 onwards. The target requires a specified quantity of generation to be met by generation located in South Australia that meets dispatchability and system security requirements and that utilises gas or renewable fuel sources.¹³⁵ The modelling assumes that the target is met through either generation from generators that satisfy the requirements of the scheme or through payments of the penalty price of \$50/MWh.

New non-synchronous renewable generators are assumed to be eligible for the scheme if they incur additional costs equal to 20 per cent of their capital and fixed and variable operating costs. This cost uplift assumes that these generators will be required to install storage to satisfy dispatchability requirements and synchronous condensers to meet system security requirements. The modelling assumes that generators that opt to be eligible under the Energy Security Target will not fall under the non-synchronous cap.

The quality of Eyre Peninsula wind relative to other sources of generation in South Australia is a key determinant of the market benefits expected from expanding the Eyre Peninsula. The primary alternate region for wind in South Australia is the mid-north region, located between Davenport and Robertstown. The market modelling assumes a capacity factor for the mid-north region of 36.6 per cent based on the average historical capacity factor of wind generators in the region and utilises a trace based on the historical output from Hornsdale wind farm.

¹³⁵ Draft legislation for the scheme Electricity (General) (Electricity Security Target) Variation Regulations 2017.

Reflecting the uncertainty regarding the relative quality of wind resources within South Australia, we have considered a sensitivity case where the capacity factor of wind on the Eyre Peninsula is set equal to that of the mid-north region.

Wind capacity factor and trace assumptions for other NEM regions have been based on the available new entrant traces in the AEMO 2016 NTNDP assumptions and traces from existing wind farms where new entrant traces were not available. Key capacity factor assumptions for competing wind bubbles in other regions include 39.7 per cent for West New South Wales, 39.1 per cent for North West Tasmania, 39 per cent for North West Victoria and 37.8 per cent for Far West New South Wales.

Capital cost assumptions have been sourced from the AEMO 2016 NTNDP assumptions. Under these assumptions, decreases in the costs of solar PV generators are more pronounced relative to wind generators going forward and, therefore, in South Australia, solar PV becomes cost competitive relative to wind generation from the mid-2020's.

The market modelling also captures the reduction in curtailment of the existing wind farms on the Eyre Peninsula (ie, the Mount Millar and Cathedral Rocks wind farms). The modelling assumes that under all options, except Option 1, the aggregate output from these wind farms increases by 5MW on average. This results in an increase in the annual output of these generators of approximately 12 per cent.

To assess the uncertainty regarding key future market outcomes on the selection of the preferred option, the option analysis has been conducted to assess the sensitivity of results to changes in key underlying parameters, ie, those termed 'discretionary parameters' above. The following assumptions have been made to derive the 'core' set of market modelling outputs:

- that no new interconnection is built between South Australia and other regions;
- policies that lead to a 28 per cent emissions reduction level by 2030 are implemented; and
- mining loads are supplied through connection to the 275 kV transmission network at Cultana, if the Eyre Peninsula network remains at 132 kV.

To assess the sensitivity of the selection of the preferred option to these assumptions, HoustonKemp produced market modelling results for three key sensitivities to this core set of assumptions, namely:

- construction of an interconnector between South Australia and NSW;¹³⁶
- a more stringent emissions reduction target of 45 per cent emissions reduction by 2030; and
- mining loads invest in their own on-site generation, if the Eyre Peninsula network remains at 132 kV.

HoustonKemp has applied its long-term planning and dispatch market model to estimate the market benefits for each option, 'state of the world' and set of discretionary parameters.

¹³⁶ At the time of producing this PADR, the South Australian Energy Transformation RIT-T is not yet complete. As a placeholder for a potential new interconnector HoustonKemp assumed an interconnector with a thermal limit of 750MW.

This model applies linear optimisation to project dispatch and investment outcomes for the NEM to satisfy demand, subject to a range of constraints due to, for example, network and planning limitations, emissions and renewable energy policies and system security requirements. The modelling has involved a total of approximately 4,000 runs of the long-term planning and dispatch model.

Probability assumptions have been adopted to weight the estimates of market benefits from each of the scenarios analysed. The demand and gas price scenarios are assumed to occur with equal probability; ie, 1/3 each.

For the purposes of presenting aggregate weighted results, the probability of the Iron Road or Iron Road and other mines scenarios eventuating at each decision point is assumed to be 0.2 and the probability of a renewable energy policy being implemented at a decision point is 0.5. However, for these variables, sensitivity analysis was conducted to identify whether the order of options changes based on these probabilities.

8. Other assumptions used to estimate expected market benefits

This section details several other assumptions and the approaches taken to estimate the net market benefits of the credible options considered.

In particular, it outlines key assumptions related to the following market benefits (and categories under the RIT-T):

- avoided network support costs associated with not re-signing a contract for Port Lincoln (ie, 'changes in costs for parties, other than the RIT-T proponent' under the RIT-T);
- improved supply reliability to customers on the Eyre Peninsula (ie, 'changes in involuntary load shedding' under the RIT-T); and
- reduced transmission losses from replacing the existing lines (ie, 'changes in network losses' under the RIT-T).

It also outlines market benefit categories not considered material for this RIT-T, as well as providing a description of general modelling parameters adopted.

8.1 Avoided future network support costs at Port Lincoln

ElectraNet received submissions to the PSCR from a number of parties offering network support at Port Lincoln.

ElectraNet has subsequently been liaising with these parties regarding the ability of their proposed network support solutions and, on 28 September 2017, released a formal RFT that requested financial and operating parameters from network support proponents.

ElectraNet has assessed these responses and developed revised assumptions regarding future network support costs at Port Lincoln for Option 1. This assessment has resulted in an annualised cost of \$9.1 million being assumed, which involves consideration of connection costs, annual standby charges quoted (where relevant), cost per 'start-up' and running charges.

8.2 Reduced unserved energy to customers

A key benefit for those that reside on the Eyre Peninsula is the expected reduction in the amount of load that would be shed on the Eyre Peninsula, including following severe weather events. Under the RIT-T assessment, the benefit associated with the expected MWh reduction in unserved energy is valued at the VCR, expressed in \$/kWh.

ElectraNet has estimated the change in the expected MWh of unserved energy under each of the investment options and states of the world, relative to Option 1. Unserved energy under the options that do not involve geographically diverse paths is assumed to be 80 per cent lower than Option 1. Unserved energy under the options with geographically diverse paths is assumed to be negligible.

These values have then been multiplied by AEMO's estimated VCR for South Australia of \$41,230.¹³⁷

¹³⁷ This estimate was derived by adjusting the AEMO's estimate from the 2014 value of customer reliability review by inflation (see AEMO, Value of Customer Reliability Review, September 2014).

In its submission, the CCP9 states concern about the bespoke VCR estimates proposed in the PSCR leading to increased capital expenditure.¹³⁸ As outlined in the PSCR, the suggestion to apply VCR estimates that depart from the standard AEMO estimates was to appropriately capture the severe and prolonged outages contemplated in this RIT-T and experienced by customers on the Eyre Peninsula.¹³⁹

ElectraNet has opted to apply the standard AEMO VCR estimates to valuing reductions in unserved energy expected from each credible option, considering the concerns raised by the CCP9, and given the non-materiality of the VCR value for the outcome of this RIT-T assessment.

As shown in section 9 below, the identification of the preferred option is found to be insensitive to underlying VCR assumptions. In fact, since differences in expected unserved energy between options is estimated to be so small, relative to other market benefits, even assuming a VCR of \$0/kWh does not change the result.

8.3 Reduced transmission losses

ElectraNet has undertaken network modelling in order to ascertain the reductions in electrical losses under each of the credible options, relative to the option of reconductoring the four poor-condition sections of the existing line (ie, Option 1).

ElectraNet has applied an annual value of losses reflecting the average short-run marginal cost of generation in South Australia obtained from internal market modelling undertaken by HoustonKemp, to the annual MWh difference in losses, in order to estimate the value of the change in losses for each option.

Differences in expected transmission losses between options are expected to be relatively minor, with the geographically diverse single-circuit options expected to result in slightly less losses. ElectraNet considers that a more detailed estimation of the losses would represent a disproportionate level of analysis, given the limited magnitude of the market benefit associated with losses, and since the precise numbers assumed do not affect the outcome of the RIT-T.

8.4 Classes of market benefit not expected to be material

The NER requires that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material in relation to the RIT-T assessment for a specific option.¹⁴⁰

At the PSCR stage, ElectraNet considered that all of the categories of market benefit identified in the RIT-T had the potential to be material for this RIT-T assessment. Since publication of the PSCR, further assessment undertaken by ElectraNet has highlighted that several categories of market benefit are either unlikely to affect the ranking of the credible option for this RIT-T analysis, or would represent a disproportionate level of analysis.

¹³⁸ Consumer Challenge Sub-Panel No. 9, *Submission in relation to Eyre Peninsula RIT-T PSCR*, 21 July 2017, pp. 9-10.

¹³⁹ The inappropriateness of applying AEMO's VCR estimates to assessing the cost to customers of events that cause wide-spread, severe or prolonged supply shortages is noted by AEMO in its VCR Application Guide. See: AEMO, *Value of Customer Reliability – Application Guide*, Final Report, December 2014, p. 20.

¹⁴⁰ NER clause 5.16.1(c)(6). Under NER clause 5.16.4(b)(6)(iii), the PSCR should set out the classes of market benefit that the NSP considers are not likely to be material for a particular RIT-T assessment.

The reasons for these conclusions are set out in the table below in relation to each of the relevant categories of market benefit.

Table 11 – Market benefit categories under the RIT-T not expected to be material

Market benefits	Reason for excluding from this RIT-T
Changes in ancillary services costs	<p>The cost of frequency control ancillary services (FCAS) may increase as a consequence of any increase in the installed capacity or output of wind generation resulting from the network investment options considered. However, FCAS costs are relatively small compared to total market impacts, and so are not likely to be material in the selection of the preferred option under the RIT-T.</p> <p>Inclusion of all, or some, of the FCAS markets using market modelling under the RIT-T would lead to a substantial increase in the complexity and cost of the RIT-T assessment. ElectraNet consider that such increased complexity is not warranted given that changes in FCAS costs will not have a role in determining the preferred option for this RIT-T assessment.</p> <p>There is no expected change to the costs of Network Control Ancillary Services and System Restart Ancillary Services as a result of the options being considered. Therefore, these costs are considered not material in the assessment of a preferred option in this RIT-T assessment.</p>
Competition benefits	<p>Competition benefits are net changes in market benefit arising from the impact of the credible option on participant bidding behaviour.</p> <p>However, none of the credible options considered address network constraints between competing generating centres and therefore is unlikely to offer any material competition benefits. Moreover, the calculation of competition benefits would require substantial additional market modelling. For this reason, ElectraNet has not estimated any competition benefits as part of this RIT-T assessment.</p>
Voluntary load curtailment	<p>ElectraNet notes that the level of voluntary load curtailment currently present in the NEM is limited. Where the implementation of a credible option affects pool price outcomes, and results in pool prices reaching higher levels on some occasions than in the base case, this may have an impact on the extent of voluntary load curtailment.</p> <p>ElectraNet considers that the market benefit associated with this category of benefit is not expected to be material for this RIT-T assessment, given the limited extent to which such curtailment currently occurs in the market, and therefore the expected low magnitude of this benefit.</p>
Non-related network investment	<p>Under the RIT-T, differences in the timing of transmission investment must be quantified if the changed transmission investment is driven by a need unrelated to any of the works that form part of the credible option.</p> <p>ElectraNet does not believe that the timing of any non-related transmission investments will be affected by any of the credible options being considered as part of this RIT-T. Consequently, ElectraNet has not estimated any market benefits associated with the timing of any non-related network investments as part of this RIT-T assessment.</p>

8.5 Description of general modelling parameters adopted

This section outlines the assessment period selected, as well as the assumptions regarding an appropriate commercial discount rate.

8.5.1 Assessment period

The RIT-T analysis has been undertaken over a 20-year period, from 2018 to 2037.

ElectraNet considers that a 20-year period takes into account the size, complexity and expected life of the relevant credible options to provide a reasonable indication of the market benefits and costs of all credible options.

Specifically, consistent with the AER RIT-T Application Guidelines, we consider that by the end of the modelling period, the network will be in a 'similar state' in relation to needing to meet a similar identified need to where it is at the time of this investment.¹⁴¹

While the capital components of the credible options have asset lives greater than 20 years, ElectraNet applied a terminal value approach to incorporating capital costs in the assessment. This ensures that the capital cost of long-lived options is appropriately captured in the 20-year assessment period.

8.5.2 Commercial discount rates applied

The commercial discount rate is applied to calculate the NPV of costs and benefits of credible options.¹⁴²

ElectraNet has adopted a real, pre-tax discount rate of 6 per cent as the central assumption for the NPV analysis presented in this PADR.¹⁴³

The RIT-T requires that sensitivity testing be conducted on the discount rate and that the regulated real, pre-tax weighted average cost of capital (WACC) be used as the lower bound discount rate in the sensitivity testing. ElectraNet has therefore tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound discount rate of 3.62 per cent,¹⁴⁴ and an upper bound discount rate of 8.5 per cent.

¹⁴¹ AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, June 2010, version 1, p 41.

¹⁴² AER, *Final | Regulatory investment test for transmission*, 29 June 2010, paragraph 2.

¹⁴³ ElectraNet notes that it is consistent with the recent Powering Sydney's Future RIT-T, jointly undertaken by TransGrid and Ausgrid.

¹⁴⁴ AER, Draft decision *ElectraNet transmission determination – Post tax revenue model*, 26 October 2017, 'WACC' spreadsheet. The real, pre-tax WACC of 3.62% corresponds to a 'headline' nominal vanilla WACC of 5.75%.

9. Net present value results

This section presents the results of the RIT-T assessment. In particular, it presents the costs and gross market benefits estimated for each credible option under the 'core' set of assumptions, as well as the consequent, estimated net market benefits.¹⁴⁵ Appendix G presents the detailed breakdown of these costs and benefits, while Appendix H provides further insight into the key wholesale market benefits estimated.

This section also reports on key sensitivities relating to changing input assumptions in the core results. These include the impact on the RIT-T outcome of:

- additional interconnection commissioned between South Australia and the rest of the NEM at some stage in the future – recognising the concurrent South Australia Energy Transformation RIT-T process;
- an increase in the emission reduction required by 2030 to 45 per cent (consistent with the AEMO's 'high emission target' assumptions); and
- assuming that mining developments on the Eyre Peninsula elect to source their energy requirements from onsite mining generation where there is insufficient 275 kV network capacity on the Eyre Peninsula, as opposed to from the grid.

Finally, this section also presents the results of general sensitivities undertaken, including in relation to the probabilities relating to the assumed trigger variables (ie, development of mining load and designation of the Eyre Peninsula as a renewable energy zone), the quality of the wind resource on the Eyre Peninsula, assumed gas prices and electricity demand, assumed background future system security requirements, assumed discount rate and capital costs.

9.1 Net market benefits estimated for each credible option

Figure 21 below outlines the expected net market benefit estimated for each of the credible options under the 'core' set of assumptions, in present value terms. Figure 22 breaks these total estimated net market benefits into aggregate direct costs (ie, capital and operating costs) and individual categories of market benefit for each option. Figure 23 provides a further breakdown of the wholesale market benefits into those relating to generator dispatch costs, generation investment and 'policy' costs (ie, penalties under the current Large Scale Renewables Energy Target, penalties under the South Australia Energy Target, and costs associated with firming, eg, storage investment costs).

All the options considered provide market benefits in terms of increased reliability (and therefore decreased USE) for consumers on the Eyre Peninsula. However, this benefit category forms only a small proportion of the total market benefits estimated (as do benefits from changes in transmission losses).

The primary source of market benefit comes from the expected impact on the wholesale market via facilitating more wind generation locating on the Eyre Peninsula. In particular, avoided dispatch costs in the NEM from additional, high quality wind generation, delivers the greatest category of market benefit (as shown in Figure 23 below), particularly for options that energise all, or part, of the Eyre Peninsula to 275 kV.

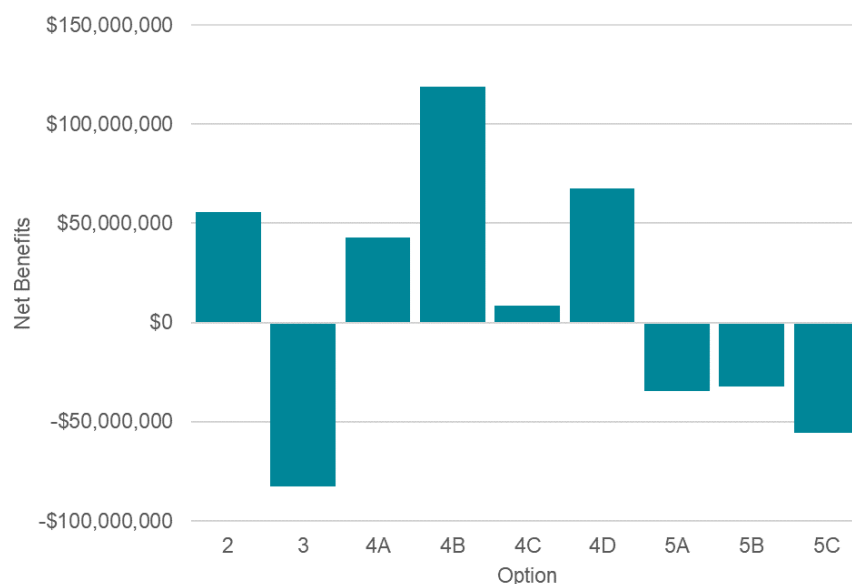
¹⁴⁵ All estimated costs and market benefits in this section are shown relative to Option 1, ie, the 'minimum capacity' option reflecting the 'business as usual' base case. shown relative to Option 1, ie, the 'minimum capacity' option reflecting the 'business as usual' base case.

All options are also found to deliver a significant benefit in terms of deferred generator investment in the NEM, as well as lower aggregate 'policy' costs.

More specifically, market benefits from expansion of Eyre Peninsula transmission capacity are primarily due to the following impacts on future dispatch and investment outcomes:¹⁴⁶

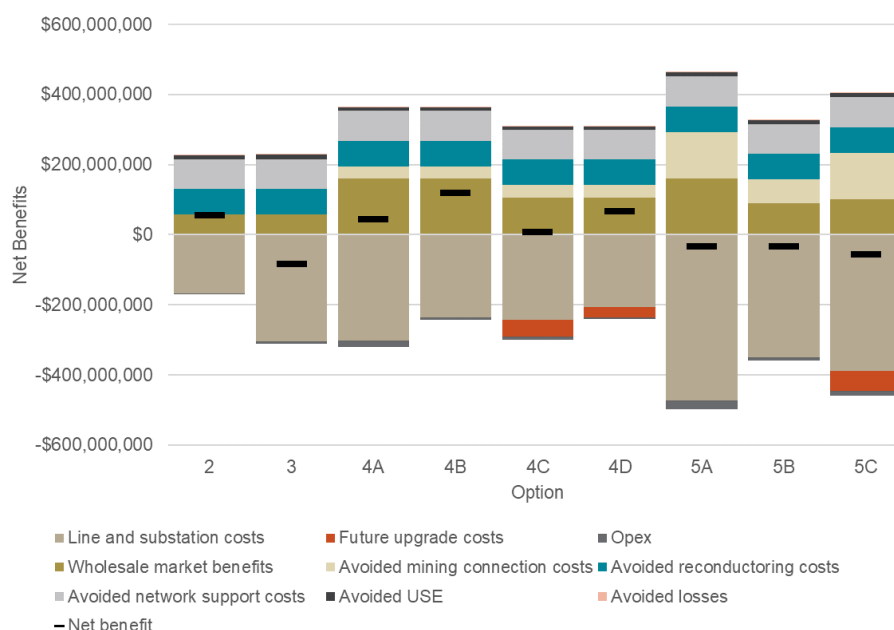
- a reduction in investment in new wind farms in the mid-north region of South Australia;
- a reduction in investment in solar PV generation in South Australia;
- a reduction in investment in wind in Victoria, and, to a lesser extent, New South Wales; and
- a reduction in dispatch of gas-fired generation in South Australia.

Figure 21 – Estimated net market benefits for credible option under the 'core' set of assumptions



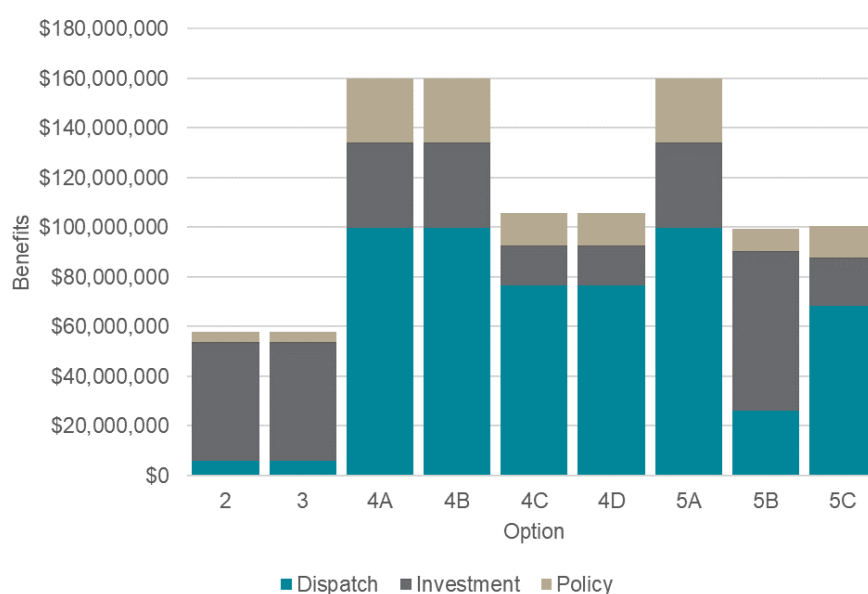
¹⁴⁶ See Appendix H for a breakdown of the dispatch and investment impacts under each option and sensitivity.

Figure 22 – Breakdown of estimated net market benefits for credible option under the ‘core’ set of assumptions



While Figure 22 provides the breakdown of gross market benefits and costs across all options, in present value terms, it also presents the net market benefits (via the black dash markers). For clarity, the net market benefit results shown in Figure 23 are equal to the net market benefit figures shown in Figure 22 above.

Figure 23 – Breakdown of estimated wholesale market benefits for credible option under the ‘core’ set of assumptions



Importantly, the assessment in this RIT-T is not predicated on an assumption that additional wind generation will automatically locate on the Eyre Peninsula, if the transmission lines are augmented to 275 kV. Rather, the market modelling demonstrates that additional wind generation would locate on the Eyre Peninsula when it represents the least cost solution (considering the associated firming costs), and that this is particularly the case in the high and medium demand states of the world.

The second largest category of benefit, relative to Option 1, is the avoided network support costs associated with maintaining the required current ETC reliability standard at Port Lincoln. This avoided cost is, however, the same for all credible options and so does not affect the ranking of the options, and therefore the choice of preferred option.

The 'core' results demonstrate that avoided mine connection costs are also a significant source of benefit for options that result in all, or part, of the Eyre Peninsula being operated at 275 kV capacity. These avoided connection costs are largest when a 275 kV line is assumed to go via Wudinna (ie, 5A, 5B and 5C) due to the main CEIP load being located near Wudinna. For these options, these avoided connection costs are roughly the same, or slightly greater, than the wholesale market benefits.

Overall, Option 4B is found to have the greatest estimated net market benefits of the options considered. Option 4B involves building and operating a Cultana to Yadnarie double-circuit line at 275 kV initially, while the Yadnarie to Port Lincoln double-circuit line is built and operated at 132 kV (and cannot be upgraded to 275 kV later).

Option 4B is the preferred option primarily owing to it having the equal third highest market benefits among the options (behind options 5A and 5C) in combination with among the second lowest total capital and operating costs (behind Option 2).

While Option 4A has higher costs than Option 4B (due to the entire route being built and operated to 275 kV), it provides no additional market benefits. This is driven by the assumption that the additional 275kV lines from Yadnarie to Port Lincoln do not allow any additional wind generation to connect on the Eyre Peninsula, as the capacity for additional wind connection is already utilised by additional wind generation located around Yadnarie. The 132 kV lines between Yadnarie and Port Lincoln would be capable of accepting about 500 MVA additional wind or other generation.

Relative to the option value '4' options (ie, Options 4C and 4D), Option 4B has higher market benefits owing to the deferred expansion of the network under these more flexible options, and the subsequent loss in benefits from being unable to access the wind resources on the Eyre Peninsula earlier. This effect is exaggerated by the fact that solar PV generation becomes increasingly cost effective relative to wind throughout the modelling period, and therefore, having access to the Eyre Peninsula wind resources later means the resources are less utilised, with lower quality wind resources located elsewhere in the NEM being developed instead.

Under the core set of assumptions, the higher capital costs associated with building lines on the geographically diverse path via Wudinna (ie, options 5A, 5B and 5C) are not offset by the additional benefits arising from reductions in unserved energy or reductions in mining connection costs.

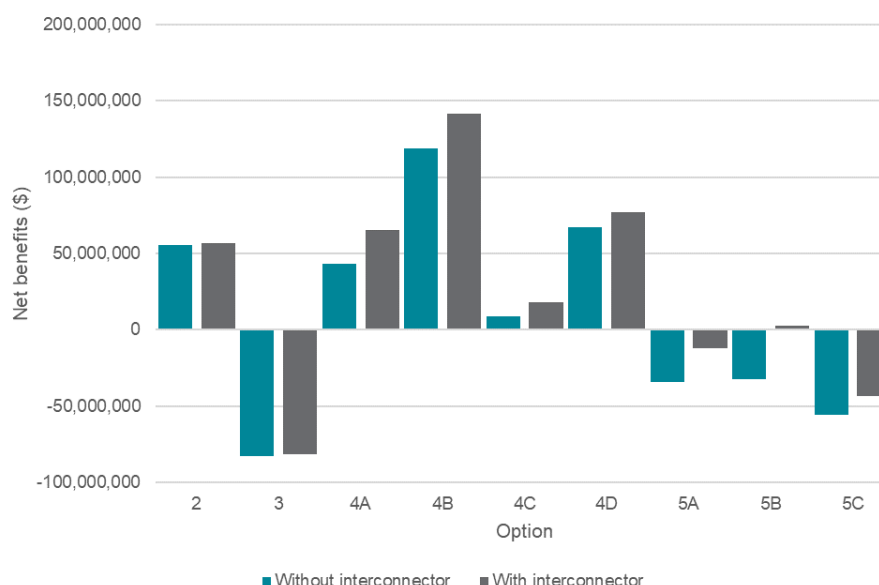
9.2 Sensitivity analysis on key 'discretionary parameters'

As outlined in section 7, to thoroughly assess the uncertainty regarding key future market outcomes on the selection of the preferred option, the analysis has been conducted to assess the sensitivity of results to changes in key underlying parameters, ie, those termed 'discretionary parameters'. Specifically, three key sensitivities have been constructed and tested, which are discussed in-turn below.

9.2.1 Additional interconnection commissioned between SA and the rest of the NEM

The figure below outlines the net market benefits estimated for each option assuming that additional interconnection is commissioned between South Australia and the rest of the NEM, and shows how these compare with the core results reported above. This recognises the concurrent SA Energy Transformation RIT-T process.

Figure 24 – Net market benefits estimated for each credible option where additional interconnection is commissioned between SA and the rest of the NEM



The introduction of a SA-NSW interconnector increases the market benefits for each of the options. This reflects the fact that a new interconnector increases the export capacity of South Australia and allows more wind generation from the Eyre Peninsula to reach other regions.

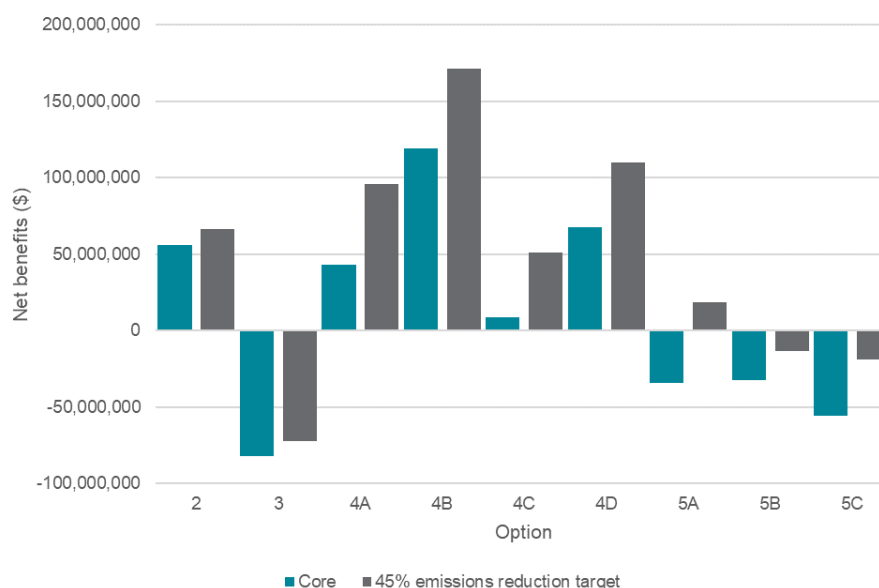
In addition, the introduction of a new interconnector has been assumed to increase the security limit on the maximum amount of generation within South Australia that can be impacted by any single credible contingency from 300 MW to 500 MW. This limit constrains the amount of wind generation that the network is able to accommodate under Options 5B and 5C in the 'core' set of results and so a portion of the increase in market benefits for these two options is due to the increase in the limit.

Overall, Option 4B remains the preferred option under this scenario. The preferred option for the Eyre Peninsula is not therefore expected to be affected by the outcome of the SA Energy Transformation RIT-T process.

9.2.2 National renewables policy requiring 45 per cent renewables by 2030

The figure below outlines the net market benefits estimated for each option – and again compares these with the 'core' set of results - where renewables policy required a reduction of 45 per cent in emissions by 2030. This scenario is consistent with AEMO's 'high emissions reduction' scenario.

Figure 25 – Net market benefits estimated for each credible option where a national renewables policy requiring of 45 per cent renewables by 2030 is assumed



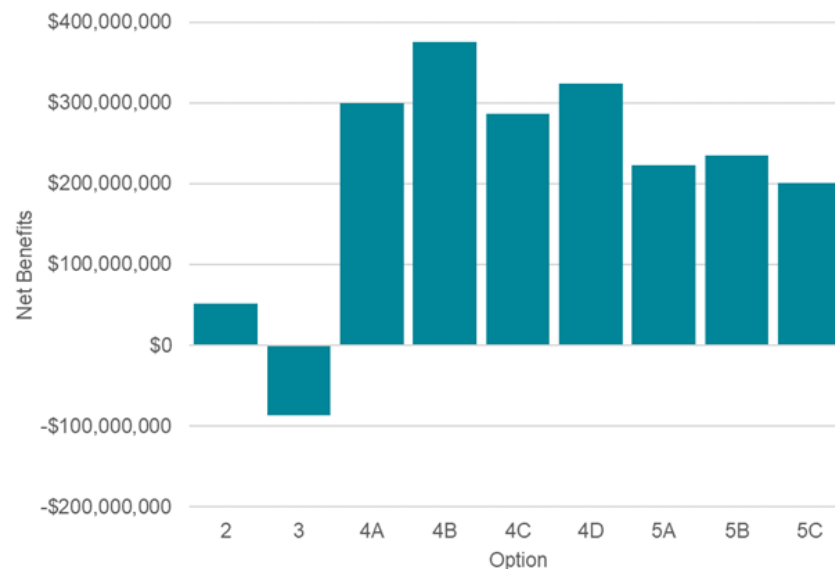
The adoption of a more ambitious target for emissions reduction increases the market benefits associated with each of the options. This reflects that fact that more renewable generation is required to be built under this scenario and therefore, there is a higher value associated with having access to the high quality wind resources on the Eyre Peninsula.

Owing to the consistency of the impact on market benefits across each of the options, Options 4B remains the preferred option under this scenario. The preferred option for the Eyre Peninsula is not therefore expected to be affected if a stronger national renewables policy is assumed.

9.2.3 Mines elect to source their energy from onsite generation

The figure below outlines the net market benefits estimated for each option, where it is assumed mines elect to source their energy requirements from onsite generation, rather than a grid connection via Cultana. Under this sensitivity, mines are assumed to source their energy requirements from onsite generation where the network does not provide sufficient capacity to accommodate their demand, ie, under Options 1, 2 and 3, rather than build connections back to Cultana. Under the variants of Options 4 and 5, the network on the Eyre Peninsula can accommodate their demand and therefore mines opt to connect to the network, either locally (Option 5) or through building network infrastructure to Yadnarie (Option 4).

Figure 26 – Net market benefits estimated for each credible option where it is assumed mines elect to source their energy requirements from onsite generation in Options 1, 2, and 3



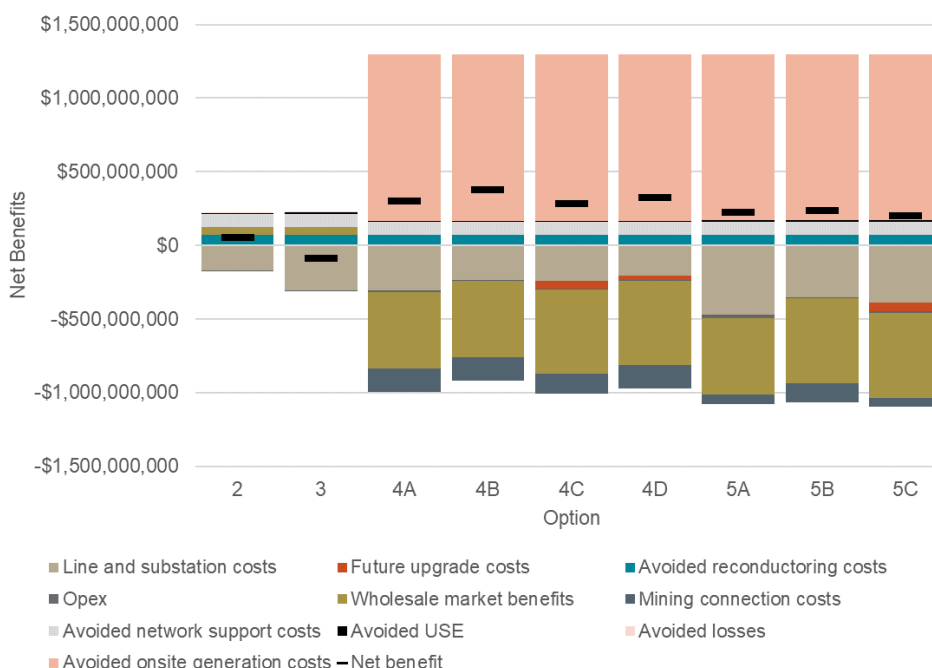
A key difference between the results under this sensitivity and others is that a decision by the mines to service their load through on-site mining generation leads to *negative* wholesale market benefits for the Options under 4 and 5 relative to Option 1 (as shown in Figure 28). This is because for the Options under 4 and 5, the amount of load to be met from the wholesale market is higher due to the mining load, and therefore wholesale market costs are correspondingly higher. However, this negative market benefit is more than offset by the avoided on-site mining generation costs under these options.

When mines are assumed to service their energy needs by constructing their own generation on-site under Options 1, 2 and 3, rather than connecting to the grid, the net benefits associated with all Options under 4 and 5 increase owing to the benefits resulting from avoiding high onsite mining generation costs.

In addition, those options that have a higher proportion of benefits arising from wholesale market benefits perform less well under this scenario owing to the fact that the mining load no longer contributes towards increasing the amount of wind generation that is able to be connected on the Eyre Peninsula. Therefore, the option value options improve relative to the other options.

However, despite these changes in the make-up of the relative net benefits associated with each option, Option 4B remains identified as the preferred option.

Figure 27 – Breakdown of net market benefits estimated for each credible option where it is assumed mines elect to source their energy requirements from onsite generation in Options 1, 2, and 3



9.3 General sensitivities undertaken

Sensitivity analysis has also been undertaken to test the robustness of the RIT-T assessment to several other key assumptions. Each of these is discussed in-turn below.

ElectraNet has not undertaken sensitivities of assumptions feeding into estimated reductions in involuntary load shedding (eg, the VCR) or changes in transmission losses. As shown above, these categories are found to be immaterial in differentiating between credible options.

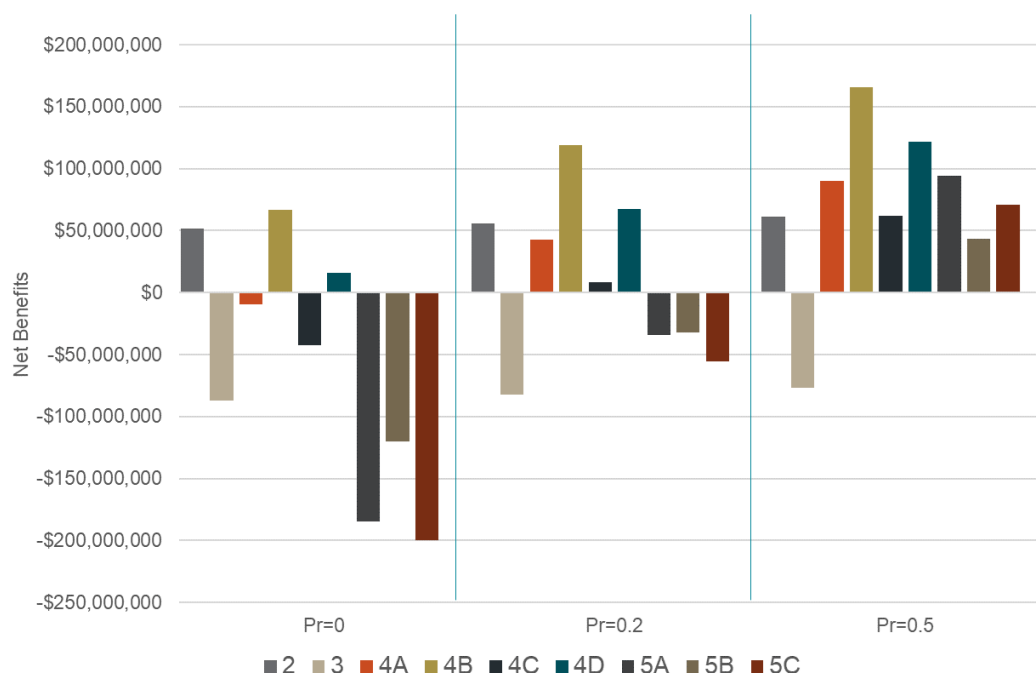
9.3.1 The likelihood of mining load locating on the Eyre Peninsula

The figure below illustrates the sensitivity of the results to the underlying assumptions made regarding the likelihood of mining load locating on the Eyre Peninsula. In particular, it illustrates three cases of net market benefits estimated for each credible option – namely:

- where no mining ever locates on the Eyre Peninsula – on the left-hand side;
- the ‘core’ assumption where each of the two mining scenarios outlined in section 5.1.1 are assumed to come online with a probability of 0.2 each – in the middle; and
- where each of the two mining scenarios outlined in section 5.1.1 are assumed to come online with a probability of 0.5 each¹⁴⁷ – on the right-hand side.

¹⁴⁷ This is equivalent to Iron Road mining loads coming online with certainty and the other assumed mining loads coming online with a probability of 0.5.

Figure 28 – Sensitivity of net market benefits estimated for each credible option to the underlying assumed likelihood of mining load locating on the Eyre Peninsula



While the magnitudes of estimated net market benefits are found to vary with the underlying assumption regarding mining load likelihood, Option 4B continues to be the preferred option. Even if mining load never located on the Eyre Peninsula, Option 4B would still yield the greatest net market benefits of all options assessed.

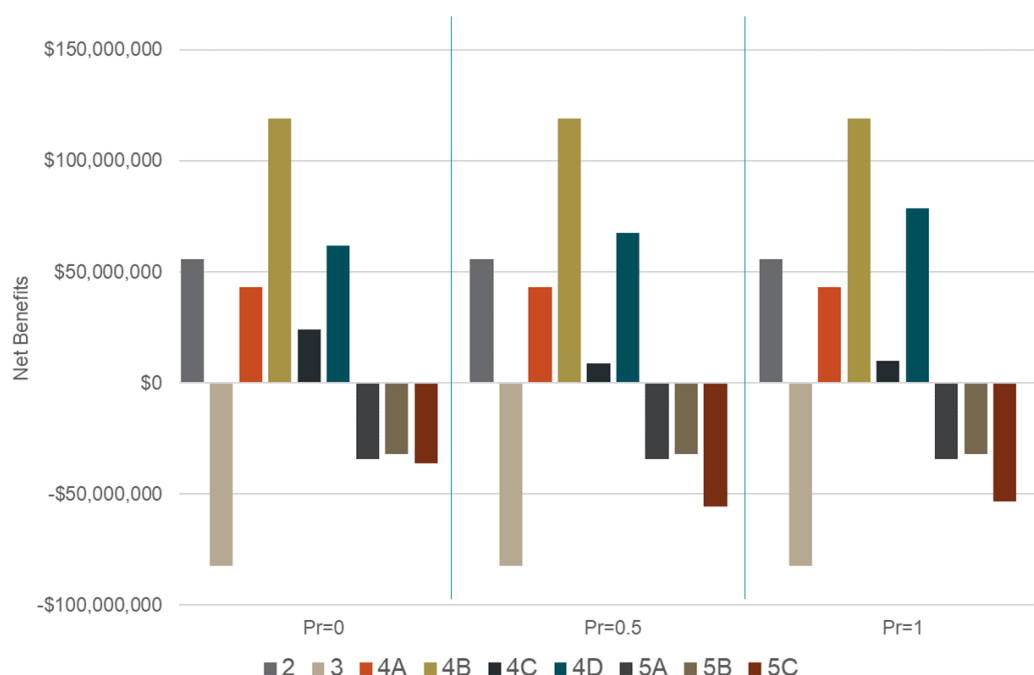
9.3.2 The likelihood of a policy designating the Eyre Peninsula as a renewable energy zone

The figure below illustrates the sensitivity of the results to underlying assumptions regarding the likelihood of the Eyre Peninsula being designated a renewable energy zone. The potential designation of the Eyre Peninsula as a priority renewable energy zone is based on the Finkel review recommendation that AEMO develop an ‘integrated grid plan’, which involves identification of prospective renewable zones.¹⁴⁸ In particular, it illustrates three cases of net market benefits estimated for each credible option – namely:

- where the Eyre Peninsula is never designated as a renewable energy zone – on the left-hand side;
- the ‘core’ assumption where the likelihood of the Eyre Peninsula being designated as a renewable energy zone is 50 per cent – in the middle; and
- where the Eyre Peninsula is designated a renewable energy zone with certainty – on the right-hand side.

¹⁴⁸ Finkel, A. *Independent Review into the Future Security of the National Electricity Market - Blueprint for the Future*, June 2017 – see Recommendation 5.1, p. 124

Figure 29 – Sensitivity of net market benefits estimated for each credible option to the underlying assumed likelihood of the Eyre Peninsula being designated a renewable energy zone



The effect of the probability of the Eyre Peninsula being designated as a renewable energy zone on results is relatively minor. This is a result of a number of assumptions within the modelling, namely:

- the trigger has the largest impact in cases where there is no mining load, ie, the trigger causes an upgrade of the full Eyre Peninsula, rather than incremental to upgrades that have occurred for mining loads. However, in these cases, demand is systematically lower under these cases owing to the lack of mining load; and
- the amount of incremental wind capacity that the network is able to handle when the entire peninsula is upgraded to 275kV relative to other upgrade cases is not significant.

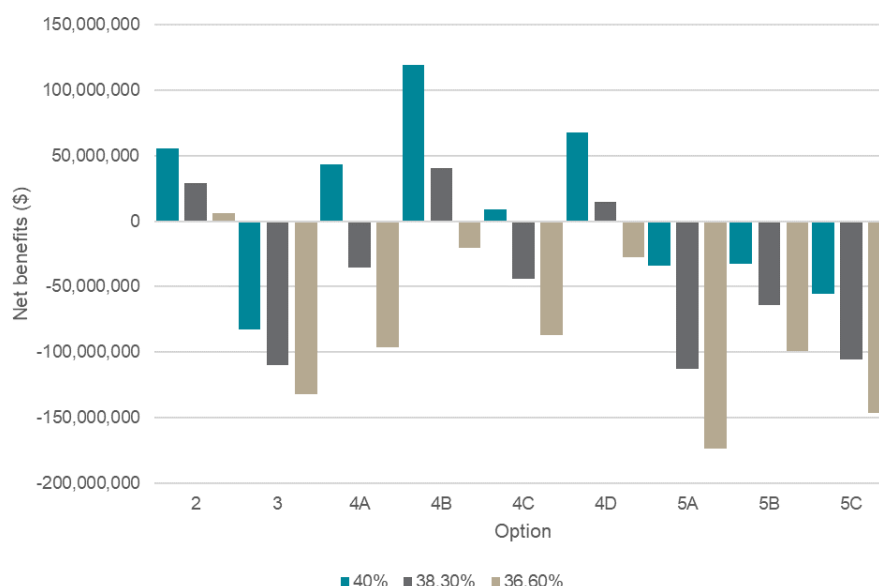
Overall, Option 4B is expected to yield the greatest net market benefits of all options assessed.

9.3.3 Assumed quality of new wind generation on the Eyre Peninsula

Given the importance of additional wind generation in driving the market benefit results for the options, we have investigated whether the outcome of the RIT-T would change if the assumed quality of the wind resource on the Eyre Peninsula was lower than in the Green Grid analysis.

The figure below outlines the net market benefits estimated for each option, where a lower capacity factor for any new wind generation on the Eyre Peninsula is assumed, relative to the 'core' set of results. In particular, we have investigated an alternate of 38.3 per cent, ie, consistent with the 'Northern South Australia' region in the NTNDP, compared to the 'core' assumption of 40 per cent sourced from the Green Grid report.

Figure 30 – Change in net market benefits estimated for each credible option where a lower wind farm capacity factor is assumed for the Eyre Peninsula



A reduction in the assumed capacity factor for wind on the Eyre Peninsula from 40 per cent to 38.3 per cent results in a decrease in the market benefits associated with each option of approximately 40 per cent. The effect of this is a substantial reduction in the net benefits of each option. In particular, those options with a higher proportion of net benefits derived from wholesale market benefits decrease more relative to other options, eg, Option 4A decreases by more than option 4D.

However, despite the reduction in benefits for each option and some changes in relative levels of net benefits, Option 4B still remains the preferred option and has a positive net benefit.

To thoroughly test the sensitivity of the results to the assumed capacity factor of new wind farms, we have also investigated a more extreme lower assumed capacity factor of 36.6 per cent, consistent with historical average capacity factors of the existing wind farms in the mid-north region of South Australia.

As shown above, this results in negative expected net market benefits for all options except Option 2 (Option 4B is ranked second with marginally negative estimated net market benefits). ElectraNet considers that this is an extreme sensitivity and that there are good reasons why any new wind farms locating on the Eyre Peninsula can be expected to have higher capacity factors, including that the Eyre Peninsula is generally considered a superior wind resource to the mid north region and that any new wind farms locating on the Eyre Peninsula would utilise new turbine technologies, which typically have higher associated capacity factors than older/existing wind farms.

9.3.4 Assumed gas prices and electricity demand

To understand the effect of forecasts for electricity demand and gas prices on the calculation of market benefits, we have conducted sensitivity analysis on the assumed demand and gas price forecasts.¹⁴⁹

Figure 31 shows that the aggregate level of net benefits is materially affected by the gas price assumption. As described in Section 7.2, for the purposes of this study we have adopted gas price assumptions that cover a broader range of prices relative to the assumptions adopted by AEMO. In particular, the high gas price scenario is defined as \$3.50/GJ above the AEMO neutral case and the low gas price scenario is defined as \$2.50/GJ below the neutral case.

Under a high gas price assumption, the market benefit from enabling additional to connect on the Eyre Peninsula are higher, reflecting the higher benefits from avoiding dispatch of gas fired generation in South Australia and other regions. Therefore, those options that have a higher proportion of their benefits driven by market benefits are more sensitive to the gas price assumption. While the level of net benefits changes substantially with the assumed gas price forecasts, in each case, Option 4B remains the preferred option and has positive net market benefits.

Figure 31 – Change in net market benefits estimated for each credible option under high, neutral and low gas prices

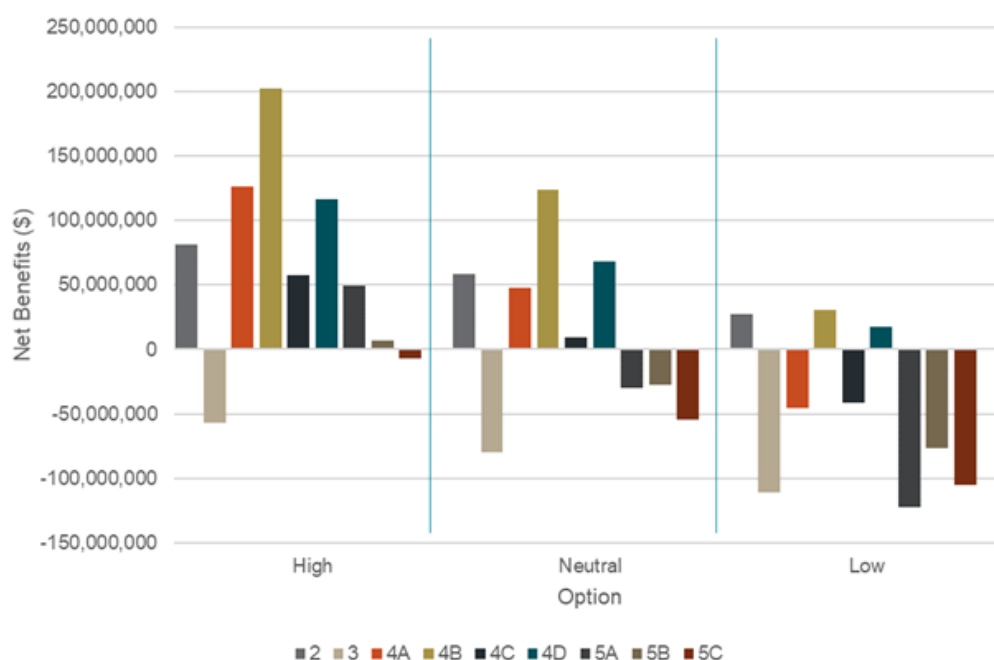


Figure 33 shows the net benefits under strong, neutral and weak AEMO demand forecasts. Unlike the results for gas price forecasts, the value of net benefits does not exhibit a linear relationship with the level of demand.

The neutral demand forecast case exhibits the lowest net benefits across all options when compared to the 'business as usual' base case. This is because in the neutral demand forecast case, investment in Eyre Peninsula wind generation results in reduced investment in and dispatch of new Victorian wind generation. This has a low impact on market dispatch costs, leading to a low wholesale market benefit.

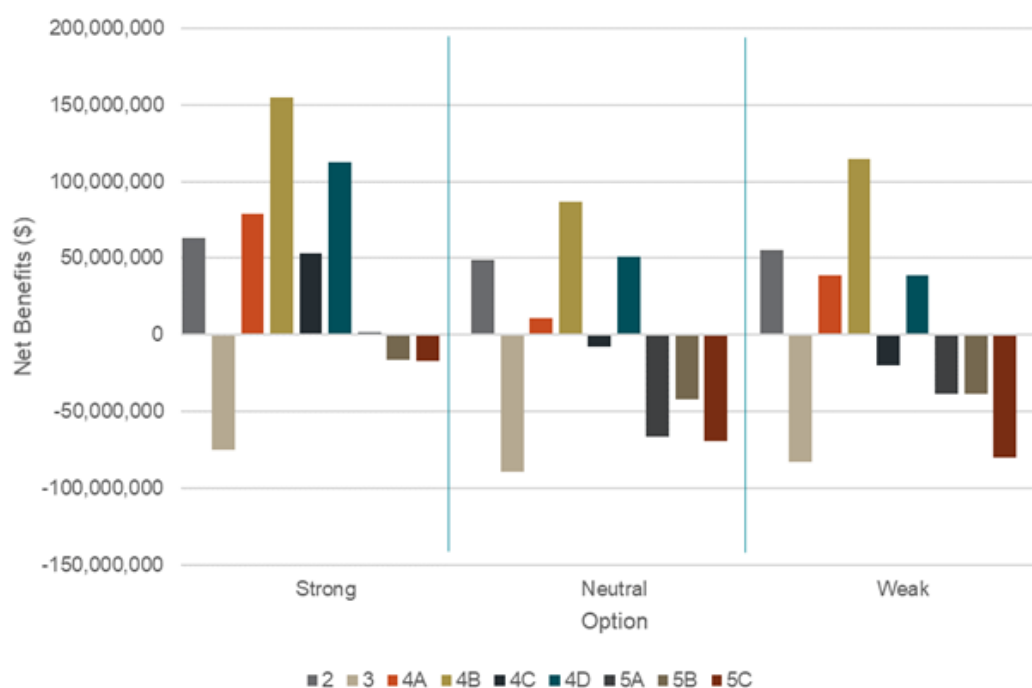
¹⁴⁹ In the results for the core scenario, demand and gas price scenarios are weighted equally (ie, 1/3 each)

In contrast, in the weak demand case, additional wind generation on the Eyre Peninsula primarily displaces existing South Australian gas fired generation, significantly reducing wholesale market dispatch costs (and hence providing a significant wholesale market benefit). This impact is less pronounced under the neutral and strong demand forecast cases, as there is sufficient demand for existing gas generators to continue running at an output similar to their existing level.

In the strong demand case, investment in wind generation on Eyre Peninsula has the primary effect of allowing significantly reduced future investment in grid connected solar PV investment in South Australia and New South Wales, allowing emissions targets to be met at a lower cost.

As with the sensitivity analysis on gas price forecasts, Option 4B remains the preferred options under each demand forecast scenario and has a positive net benefit.

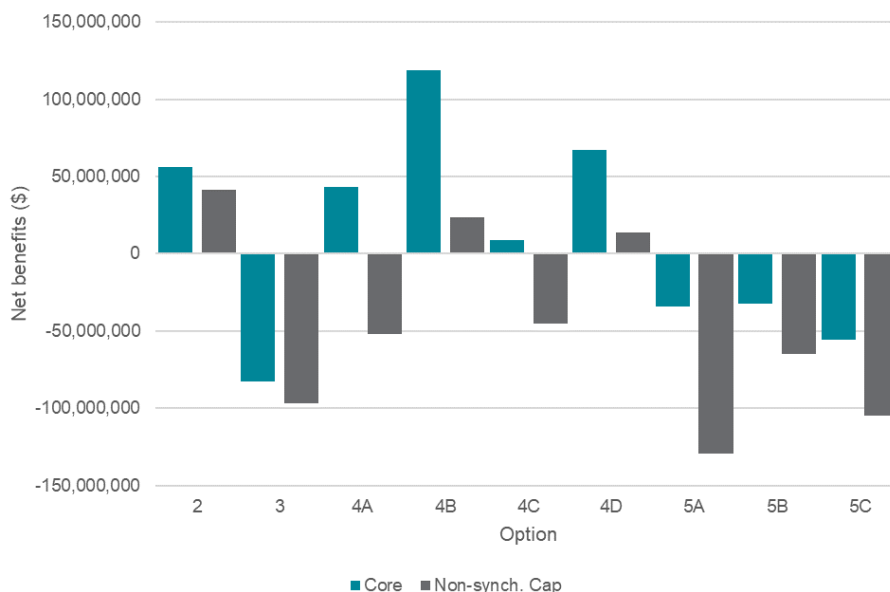
Figure 32 – Change in net market benefits estimated for each credible option under high, neutral and weak AEMO demand forecasts



9.3.5 Assumed future system security requirements

The figure below outlines the net market benefits estimated for each option, where it is assumed that the cap on non-synchronous generation and floor on synchronous generation continues (ie, for the whole modelling period). This differs from the 'core' assumption that the cap and floor end in 2022.

Figure 33 – Net market benefits estimated for each credible option where it is assumed that the cap on non-synchronous generation continues into the future



Under this set of assumptions, the market benefits associated with upgrading the network on the Eyre Peninsula reduce substantially. Relative to the core case, the reduction in market benefits is most pronounced for options that facilitate high uptake of wind generation, eg, options involving upgrading to 275kV, as the additional capacity for wind planting made available is not utilised due to restrictions on wind output for system security reasons.

Under this assumption, Option 4B still has positive market benefits; however, Option 2 has higher net benefits, owing to the asymmetric reduction in market benefits for Option 4B relative to Option 2.

ElectraNet is of the view that this scenario is unrealistic and represents an upper bound on restrictions on additional wind generation in South Australia due to system security requirements.

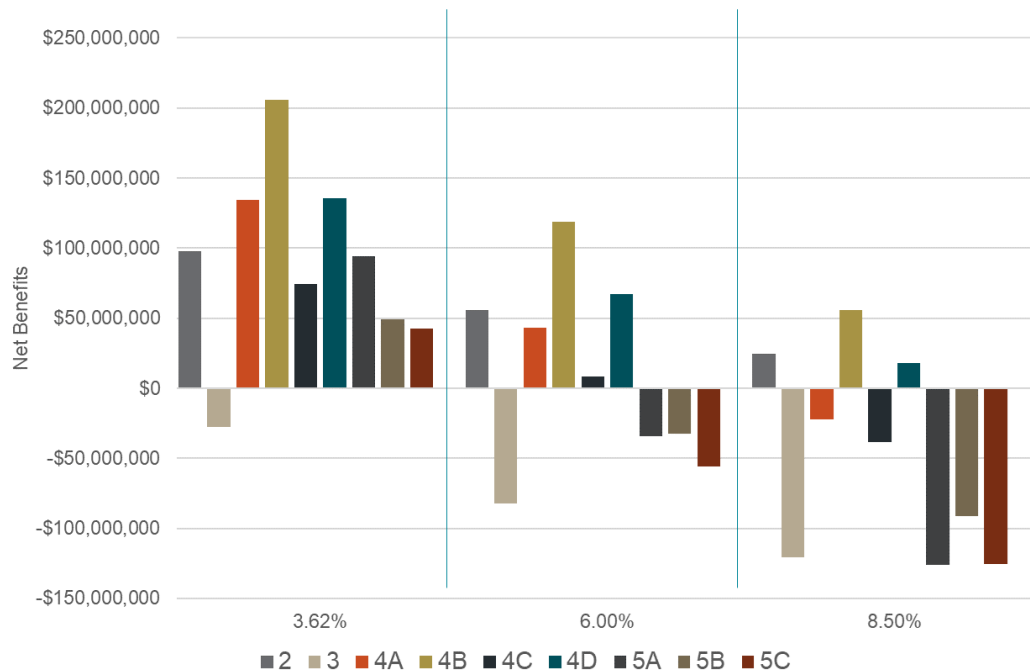
9.3.6 Assumed discount rates

The figure below illustrates the sensitivity of the results to different discount rate assumptions. In particular, it illustrates three tranches of net market benefits estimated for each credible option – namely:

- a low discount rate of 3.62 per cent – on the left-hand side;
- the 'core' discount rate assumption of 6 per cent – in the middle; and
- a high discount rate of 8.5 per cent – on the right-hand side.

While the magnitudes of estimated net market benefits, in present value terms, are found to vary with the underlying discount rate, Option 4B is always found to be the preferred option.

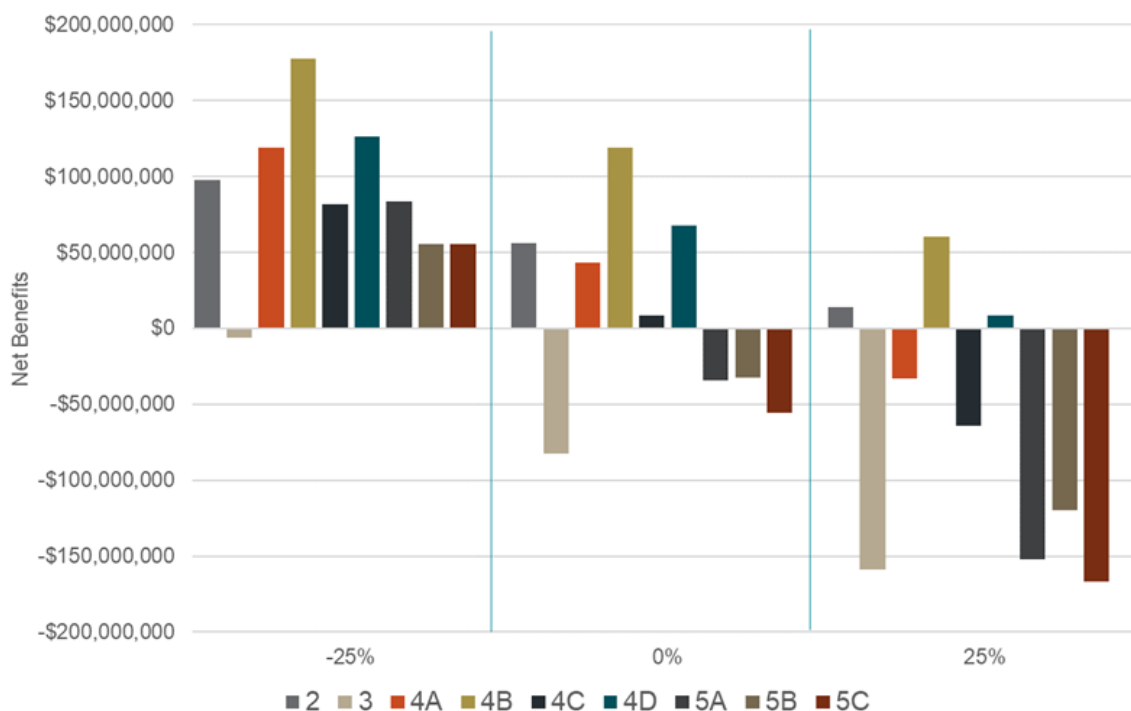
Figure 34 – Sensitivity of net market benefits estimated for each credible option to the assumed discount rate



9.3.7 Assumed capital costs

Site-specific issues, such as variations in soil conditions, would be expected to have a similar relative effect on all options other than Option 1. Therefore, ElectraNet has investigated the impact of changes in capital costs for all options relative to Option 1. However, as there is no reason to expect the accuracy of the current cost estimates to differ *between* options, and given the magnitude of benefits compared to these cost estimates, these sensitivities even at plus 25 per cent were not found to affect the draft finding of the RIT-T, that Option 4B is the preferred option.

Figure 35 – Sensitivity of net market benefits estimated for each credible option to the assumed capital costs



ElectraNet further stress-tested the results and found that capital costs for Option 4B would have to increase by 51 per cent for it to no longer be expected to have a positive net market benefits (ie, NPV = \$0).

ElectraNet also found that the capital costs for Option 4B would have to increase by 27 per cent for Option 2 to be the preferred option. For clarity, this assessment kept the capital costs of Option 2 constant and varied those of Option 4B only. ElectraNet considers this unlikely as the cost drivers of Options 2 and 4B are largely the same and so it cannot be reasonably expected that the capital costs of Option 4B would be significantly under (or over) estimated relative to Option 2.

10. Proposed preferred option and customer price impact

10.1 Preferred option

The RIT-T assessment undertaken and presented in this PADR identifies that Option 4B is the preferred credible option that simultaneously ensures reliable electricity supply to the Eyre Peninsula going forward, consistent with the ETC reliability standards, and delivers the most efficient long-term solution for the NEM.

This conclusion has been found to be the case for not only a central ‘core’ set of key assumptions but also for a range of alternate underlying assumptions regarding the future ‘state of the world’, as well as under numerous sensitivity tests on other key modelling assumptions. Across all reasonable alternate assumptions investigated, Option 4B was consistently found to be the preferred credible option and, in all cases, was found to deliver net market benefits.

ElectraNet has given consideration in this RIT-T to whether a staged development of the network on the Eyre Peninsula may provide a greater net market benefit, due to the ‘option value’ it would provide to delay the timing of additional investment until developments on the Eyre Peninsula were known with greater certainty. In particular, real options analysis has been used to estimate the net market benefits associated with a number of ‘flexible’ options (options 4C, 4D and 5C), and to compare these with the ‘fixed’ investment options. Even taking the additional benefits provided by this flexibility into account, option 4B remains the preferred option under the RIT-T.

Option 4B would remain the preferred option if the Iron Road mining development becomes committed prior to the start of construction of this network option. It would also be the preferred option even if mining load never located on the peninsula.

Option 4B involves constructing a double-circuit 275 kV line between Cultana and Yadnarie and a double circuit 132 kV line between Yadnarie and Port Lincoln – namely:

- building new double circuit 275 kV lines from Cultana to Yadnarie (about 142 km)
- building new double circuit 132 kV lines from Yadnarie to Port Lincoln (about 130 km);
- two new 275 kV exits at Cultana;
- a new 275/132 kV yard including transformers at Yadnarie West;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

Construction is expected to take 2 years, with commissioning possible by the end of 2020, subject to obtaining necessary environmental and development approvals.

10.2 Customer price impact

The costs of the preferred option are estimated to be about \$300 million, in present value terms. The estimated capital cost of the preferred option is about \$220 million more than the ‘business as usual’ base case of replacing components of the existing transmission line and establishing a new backup generation network support arrangement at Port Lincoln.

However, the preferred option would remove the need for the backup network support arrangement and therefore save ongoing operating costs of about \$9 million per annum, which are paid for by electricity customers in South Australia.

The preferred option is estimated to deliver net market benefits of \$120 million over 20 years (in present value terms) and add less than \$3 to the transmission component of the annual electricity bill for the average residential customer in South Australia¹⁵⁰.

10.3 Other matters

ElectraNet notes that Option 4B is not likely to have a material inter-regional impact.¹⁵¹

ElectraNet is confident that this PADR, the accompanying detailed analysis and the preferred option satisfy the RIT-T.

¹⁵⁰ This estimate has been determined using the AER's Post Tax Revenue Model.

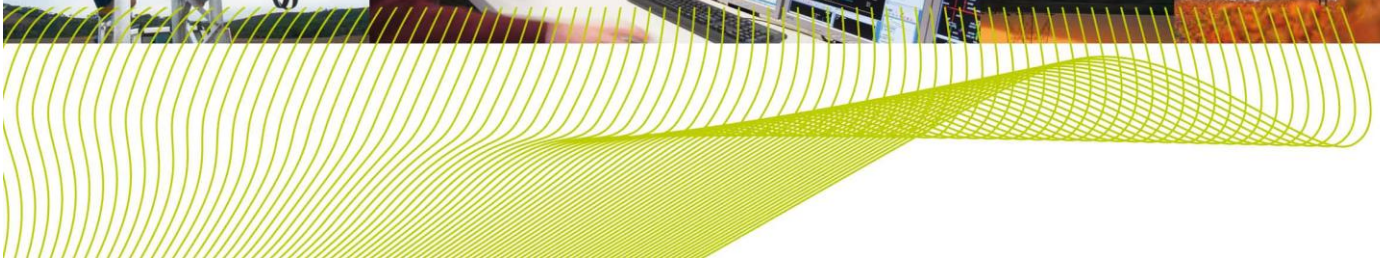
¹⁵¹ As determined by reference to AEMO's screening test (as presented in section 4.7 of the PSCR).



Eyre Peninsula Electricity Supply Options

Appendices

15 November 2017



Appendix A Checklist of compliance clauses

This section sets out a compliance checklist which demonstrates the compliance of this PADR with the requirements of clause 5.16.4(k) of the National Electricity Rules (NER) version 101.

Rules clause	Summary of requirements	Relevant section(s) in the PADR
5.16.4(k)	The project assessment draft report must include:	-
	(1) a description of each credible option assessed;	4
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	3 and throughout the document
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	4 & 9.1
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	5, 6, 7 & 8
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	8.4
	(6) the identification of any class of market benefit estimated to arise outside the <i>region</i> of the <i>Transmission Network Service Provider</i> affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	9
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	9
	(8) the identification of the proposed preferred option;	10
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a <i>material inter-network impact</i> and if the <i>Transmission Network Service Provider</i> affected by the RIT-T project has received an <i>augmentation technical report</i> , that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the <i>regulatory investment test for transmission</i> .	4 & 10

Appendix B Definitions

All laws, regulations, orders, licences, codes, determinations and other regulatory instruments (other than the NER) which apply to Registered Participants from time to time, including those applicable in each participating jurisdiction as listed below, to the extent that they regulate or contain terms and conditions relating to access to a network, connection to a network, the provision of network services, network service price or augmentation of a network.

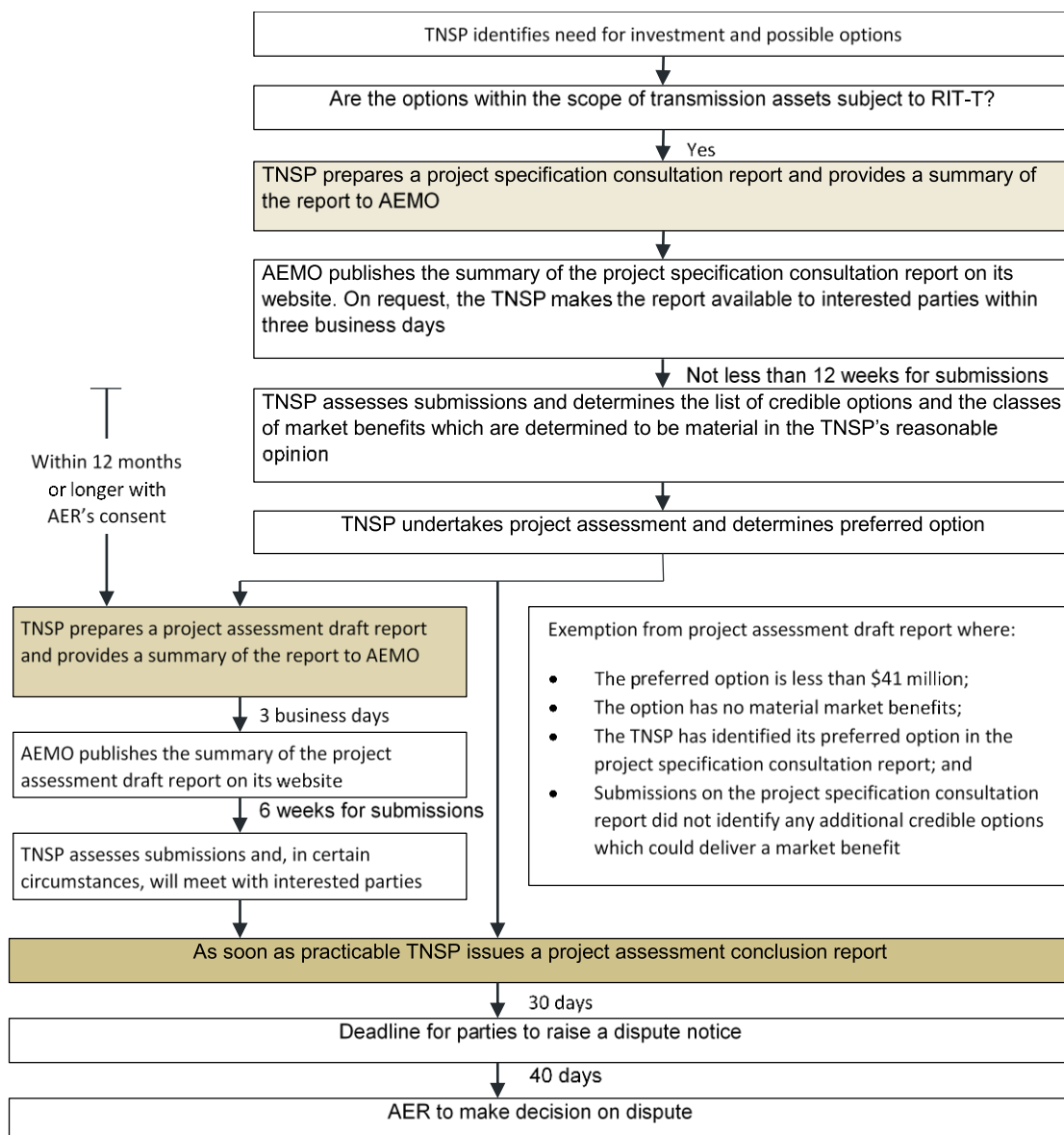
A comprehensive list of applicable regulatory instruments is provided in the NER.

Applicable regulatory instruments	
AEMO	Australian Energy Market Operator
Base case	A situation in which no option is implemented by, or on behalf of the transmission network service provider.
Commercially feasible	An option is commercially feasible if a reasonable and objective operator, acting rationally in accordance with the requirements of the RIT-T, would be prepared to develop or provide the option in isolation of any substitute options. This is taken to be synonymous with 'economically feasible'.
Costs	Costs are the present value of the direct costs of a credible option.
Credible option	A credible option is an option (or group of options) that: <ol style="list-style-type: none"> 1. address the identified need; 2. is (or are) commercially and technically feasible; and 3. can be implemented in sufficient time to meet the identified need.
Economically feasible	An option is likely to be economically feasible where its estimated costs are comparable to other credible options which address the identified need. One important exception to this Rules guidance applies where it is expected that a credible option or options are likely to deliver materially higher market benefits. In these circumstances the option may be "economically feasible" despite the higher expected cost. This is taken to be synonymous with 'commercially feasible'.
Identified need	The reason why the Transmission Network Service Provider proposes that a particular investment be undertaken in respect of its transmission network.
Market benefit	Market benefit must be: <ol style="list-style-type: none"> a) the present value of the benefits of a credible option calculated by: <ol style="list-style-type: none"> i. comparing, for each relevant reasonable scenario: <ol style="list-style-type: none"> A. the 'state of the world' with the credible option in place to B. the 'state of the world' in the base case, And ii. weighting the benefits derived in sub-paragraph (i) by the probability of each relevant reasonable scenario occurring. b) a benefit to those who consume, produce and transport electricity in the market, that is, the change in producer plus consumer surplus.
Net market benefit	Net market benefit equals the market benefit less costs.
Preferred option	The preferred option is the credible option that maximises the net economic benefit to all those who produce, consume and transport electricity in the market compared to all other credible options. Where the identified need is for reliability corrective action, a preferred option may have a negative net economic benefit (that is, a net economic cost).
Reasonable Scenario	Reasonable scenario means a set of variables or parameters that are not expected to change across each of the credible options or the base case.

Appendix C Process for implementing the RIT-T

For the purposes of applying the RIT-T, the NER establishes a three-stage process: (1) the PSCR; (2) the PADR; and (3) the PACR. This process is summarised in the figure below.

Figure 36 – The RIT-T assessment and consultation process



Source: AER, *Final Regulatory investment test for transmission application guidelines*, June 2010, p.43

Appendix D Further detail on credible options assessed

This appendix details the key components of each of the credible options assessed in this PADR.

Option 1 – Continue network support at Port Lincoln and reconductor the existing 132 kV single-circuit line ('base case')

Option 1 involves the following:

- live-line reconductoring of the four sections (totalling 118 km) of the existing 132 kV network;
- no associated upgrade to substations on the Eyre Peninsula; and
- continuation of a network support agreement at Port Lincoln, which could be an extension of existing arrangement or a new contract with a third party.

Option 2 – Double circuit 132 kV

Option 2 involves:

- building a new double circuit 132 kV circuit lines from Cultana to Yadnarie (about 142 km) and Yadnarie – Port Lincoln (about 130 km);
- establishing an additional 132 kV exit at the Cultana substation;
- establishing two additional 132 kV exits at Yadnarie substation;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and Yadnarie to Port Lincoln.

Option 3 – Two single circuit 132 kV lines (one going via Wudinna)

Option 3 involves:

- building a new single-circuit 132 kV line from Cultana to Yadnarie (about 142 km) and from Yadnarie to Port Lincoln (about 130 km);
- building a new single-circuit 132 kV line from Cultana to Wudinna (about 210 km) and from Wudinna to Port Lincoln (about 190 km),
- establishing an additional 132 kV exit at Cultana substation;
- establishing two additional 132 kV exit at Wudinna substation;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

Option 4A – Double circuit 275 kV

Option 4A involves:

- building new double circuit 275 kV lines from Cultana to Port Lincoln via Yadnarie (about 272 km);
- two new 275 kV exits at Cultana;
- a new 275/132 kV yard including transformers at Yadnarie West; and
- a new 275/132 kV yard including transformers at Port Lincoln North.
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

Option 4B – Double circuit 275 kV between Cultana and Yadnarie and double circuit 132 kV between Yadnarie and Port Lincoln

Option 4B involves:

- building new double circuit 275 kV lines from Cultana to Yadnarie (about 142 km)
- building new double circuit 132 kV lines from Yadnarie to Port Lincoln (about 130 km);
- two new 275 kV exits at Cultana;
- a new 275/132 kV yard including transformers at Yadnarie West;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

Option 4C – Double circuit 132 kV with the ability to be upgraded to 275 kV at a later date, if required

This option is similar in route and build design to Option 2 with the main difference being that, while it is built to be able to operate at 275 kV if required, it is initially operated at 132 kV.

Option 4C initially involves:

- building new double circuit 275 kV lines from Cultana to Yadnarie (about 142 km) and from Yadnarie to Port Lincoln (about 130 km) – lines to be initially operated at 132 kV;
- establishing an additional 132 kV exit at Cultana substation;
- establishing two additional 132 kV exits at Yadnarie substation;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

The future incremental capital works of moving from 132 kV operation to 275 kV operation involve the following components:

- two new 275 kV exits at Cultana;

- a new 275/132 kV yard including transformers at Yadnarie West;
- a new 275/132 kV yard including transformers at Port Lincoln North; and
- establishing an additional 132 kV exit at Port Lincoln Terminal substation

Option 4D – Double circuit 132 kV with the ability to upgrade the Cultana to Yadnarie section 275 kV at a later date, if required

Option 4D initially involves:

- building new double circuit 275 kV lines from Cultana to Yadnarie (about 142 km) – lines to be initially operated at 132 kV;
- building new double circuit 132 kV Yadnarie to Port Lincoln (about 130 km);
- establishing an additional 132 kV exit at Cultana substation;
- establishing two additional 132 kV exits at Yadnarie substation;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

The future incremental capital works of moving from 132 kV operation to 275 kV operation for the Cultana to Yadnarie section involve the following components:

- two new 275 kV exits at Cultana; and
- a new 275/132 kV yard including transformers at Yadnarie West.

Option 5A – Two single circuit 275 kV (one going via Wudinna)

Option 5A involves:

- build a new single-circuit 275 kV line from:
 - Cultana to Yadnarie (about 142 km);
 - Yadnarie to Port Lincoln (about 130 km);
 - Cultana to Wudinna (about 210 km); and
 - Wudinna to Port Lincoln (about 190 km).
- two new 275 kV exits at Cultana;
- a new 275/132 kV yard including a transformer at Yadnarie West;
- a new 275/132 kV yard including a transformer at New Wudinna; and
- a new 275/132 kV yard including transformers at Port Lincoln North.
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

Option 5B – Two single circuit lines, with the Cultana to Wudinna line operated at 275 kV initially

Option 5B involves:

- build a new single-circuit 132 kV line from Cultana to Yadnarie (about 142 km), as well as from Yadnarie to Port Lincoln (about 130 km) and Port Lincoln to Wudinna (about 190 km);
- build a new single-circuit 275 kV line from Cultana to Wudinna (about 210 km),
- a new 275 kV exit at Cultana;
- a new 275/132 kV yard including a transformer at New Wudinna;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation;
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln; and

Option 5C – Two single circuit 132 kV lines (one going via Wudinna) with the ability to be upgraded to 275 kV at a later date, if required

This option is similar in route and build design to Option 3 with the main difference being that, while it is built to be able to operate at 275 kV if need be, it is initially operated at 132 kV.

Option 5C initially involves:

- build a new single-circuit 275 kV line from Cultana to Yadnarie (about 142 km) and from Yadnarie to Port Lincoln (about 130 km) – to be operated initially at 132 kV;
- build a new single-circuit 275 kV line from Cultana to Wudinna (about 210 km) and from Wudinna to Port Lincoln (about 190 km) – to be operated initially at 132 kV;
- establishing an additional 132 kV exit at Cultana substation;
- establishing two additional 132 kV exit at Wudinna substation;
- establishing an additional 132 kV exit at Port Lincoln Terminal substation; and
- decommissioning the existing single circuit 132 kV lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln.

The future incremental capital works of moving from 132 kV operation to 275 kV operation involve the following components:

- two new 275 kV exits at Cultana;
- a new 275/132 kV yard including a transformer at Yadnarie West;
- a new 275/132 kV yard including a transformer at New Wudinna;
- a new 275/132 kV yard including transformers at Port Lincoln North; and
- establishing an additional 132 kV exit at Port Lincoln Terminal substation;

Appendix E Additional detail regarding wind assumptions

Expansion of the transmission network on the Eyre Peninsula will provide access to additional high-quality wind resources. To the extent that these wind resources on the Eyre Peninsula have higher capacity factors relative to the other resources within the NEM, increasing the amount of wind that can be built on the Eyre Peninsula will result in additional market benefits (as outlined in section 5 above).

The effect of expanding the existing network on the amount of wind generation that can connect on the Eyre Peninsula is captured through changes in wind resource limits. These limits represent the total amount of wind that can connect to the network over the modelling period. These limits act alongside annual build limits to constraint the profile of investment in new entrant wind generation over the modelling period.

Higher resource limits do not necessarily mean that new wind generation will be built to meet these limits. The market modelling undertaken determines the extent to which Eyre Peninsula wind resources are required as part of the least cost plan to satisfy demand.


The table on the next page shows the wind resource limits based each configuration and under each mining load scenario. We define the different wind resource limit scenarios based on network configurations, since the option value scenarios involve shifting between different configurations over time in response to trigger variables.

ElectraNet assumes that under configuration 1, no additional wind capacity can connect to the network. Under this option, the capacity of the transmission does not change relative to its current capacity and therefore, the network cannot handle additional supply. If loads from new mining activity were to eventuate, ElectraNet assumes that the network would be unable to handle the additional loads and therefore, the mine must build transmission infrastructure to Cultana sufficient to handle the load, ie, a single circuit 275 kV line.

For configurations 2 and 3, ElectraNet assumes that 300 MW of additional wind generation could connect to the new 132 kV lines. This limit assumes that two 132 kV lines would be able to handle a peak load of approximately 400 MW. Currently, due to the supply from wind farms and existing load on the Eyre Peninsula, the net peak flow out of the Eyre Peninsula is approximately 100 MW. This offsets the capacity of the network and therefore, the network be only be able to accommodate 300 MW of additional supply.

As was the case with configuration 1, if loads from new mining activity were to eventuate, ElectraNet assumes that a single circuit 132 kV network cannot handle the additional load and therefore, the mine builds a transmission line to Cultana.

Table 12 – Summary of wind resource limits assumed under different network configurations

Network configuration	Diagram	Mining Scenario	Resource limits – no new interconnector (MW)	Resource limits – with new interconnector (MW)
Configuration 1 Reconductoring (Option 1)		No Mining Iron Road Iron Road + others	0 0 0	0 0 0
Configuration 2 132 kV – existing easement (Option 2, and stage 1 of Options 4C and 4D)		No Mining Iron Road Iron Road + others	300 300 400	300 300 400
Configuration 3 132 kV – new easement (Option 3, and stage 1 of Option 5C)		No Mining Iron Road Iron Road + others	300 300 400	300 300 400
Configuration 4 275 kV to Yadnarie - existing easement (Option 4B, and stage 2 of Options 4C and 4D)		No Mining Iron Road Iron Road + others	1,000 1,280 1,450	1,000 1,280 1,450
Configuration 5 275 kV to Port Lincoln - existing easement (Option 4A, and stage 3 of Option 4C)		No Mining Iron Road Iron Road + others	1,000 1,280 1,450	1,000 1,280 1,450
Configuration 6 275 kV to Wudinna – new easement (Option 5B, and stage 2 of Option 5C)		No Mining Iron Road Iron Road + others	400 680 780	600 880 980
Configuration 7 275 kV to Wudinna and Yadnarie – new easement (Stage three of Option 5C)		No Mining Iron Road Iron Road + others	500 780 950	900 1,180 1,350
Configuration 8 275 kV to Port Lincoln via Wudinna – new easement (Option 5A, and stage four of Option 5C)		No Mining Iron Road Iron Road + others	1,000 1,280 1,450	1,000 1,280 1,450
<p>Key:</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Reconductored 132 kV </div> <div style="text-align: center;">  Network support at Port Lincoln </div> <div style="text-align: center;">  &  132 kV single-circuit & 132 kV double-circuit </div> <div style="text-align: center;">  &  275 kV single-circuit & 275 kV double-circuit </div> </div>				

For configurations 4 and 5, ElectraNet assumes that in the absence of new mining load, 1,000 MW of new wind capacity could be connected to the network. This is in addition to the existing Eyre Peninsula wind farms, and is limited by the combined capacity of the double circuit 275 kV lines. The additional 275 kV network from Yadnarie to Port Lincoln does not enable any additional wind generation to be installed because the network between Cultana and Yadnarie is binding in both cases.

Under these configurations, if loads from new mining activity eventuate, ElectraNet assumes that these loads will connect to the 275 kV lines at Yadnarie and therefore will offset the impact on the network of new wind generation. This will enable additional wind capacity to be installed in line with the additional mining load, adjusted for the assumed mining load capacity factor of 80 per cent (outlined in section 5.1 above). For the Iron Road mining load scenario this leads to an increase in the wind resource limit of 280 MW and for the 'Iron Road + others' mining load scenario this leads to an increase of 450 MW.

For configuration 6, the 275 kV link between Cultana and Wudinna means that additional wind generation from the region around Elliston is able to connect to the network. However, the amount of this new wind generation would be limited by the limit of the largest allowable credible generation contingency in South Australia, which is currently about 300 MW. ElectraNet assumes that the remaining 132 kV network would handle an additional 100 MW of wind capacity, given the current wind generation and loads that already exist on the Eyre Peninsula. Therefore, the total the total of new wind generation capacity that the network would be able to handle is 400 MW.

Under configuration 6, ElectraNet assumes that if the Iron Road mining load was to eventuate then the mine would establish a connection at Wudinna and utilise ElectraNet's transmission capacity from Wudinna to Cultana. Therefore, additional wind would be able to be installed in the Elliston region and offset this load. If, in addition to the Iron Road load, the other assumed mining load was to eventuate then ElectraNet assumes that approximately half of the other assumed mining load could be accommodated on the 132 kV network between Port Lincoln and Cultana. Therefore, an additional 100 MW of wind generation would be able to be installed on the 132 kV network.

For configuration 7, the 275 kV links between Cultana and Wudinna and Cultana and Yadnarie, mean that additional wind generation would be able to connect from around Elliston and Yadnarie. However, as with configuration 6, the amount of this new wind generation in both locations would be restricted by the limit on the largest allowable credible generation contingency in South Australia, which is currently about 300 MW.

Under configuration 7, ElectraNet assumes that all loads from both Iron Road and other mines would connect to ElectraNet's transmission network and, therefore, no additional transmission infrastructure is needed to be built to supply these mines. This additional load on the network would offset new wind generation and therefore, additional wind generation capacity equivalent to the average mining load is able to connect, ie, 280 MW and 450 MW for the Iron Road and Iron Road and others scenarios respectively.

Under configuration 8, the 275 kV network down to Port Lincoln means that additional wind generation is able to connect from the Elliston, Port Lincoln or Yadnarie regions. ElectraNet assumes that the amount of new wind generation that can connect is limited by the capacity of the network, which, after considering existing loads and generation is assumed to be 1,000 MW.

Under configuration 8, as with configuration 7, ElectraNet assumes that all mining loads from both Iron Road and other assumed mining developments would connect to ElectraNet's transmission network, and, therefore, no additional transmission infrastructure is needed to be built to supply the mines. This additional load on the network would offset new wind generation and therefore, additional wind generation capacity equivalent to the average mining load is able to connect, ie, 280MW and 450MW for the Iron Road and Iron Road and others scenarios respectively.

For the scenario where the South Australia Energy Transformation RIT-T finds that building an SA-NSW interconnector is appropriate, the wind resource limits increase for configurations 6 and 7 increase from 300 MW and 500 MW to 500 MW and 900 MW respectively. This assumes that with the construction of a new interconnector, the largest allowable credible generation contingency within South Australia will increase from 300 MW to 500 MW.

Appendix F ElectraNet's earlier economic assessment of 132 kV supply options for the Eyre Peninsula

During 2016 and early 2017, ElectraNet undertook an assessment of a number of options to address the issue of the Eyre Peninsula line replacement¹⁵². This assessment was used to assist ElectraNet in developing its *ex ante* capital expenditure proposal for the forthcoming regulatory control period.

ElectraNet's Revenue Proposal included capital expenditure of about \$80 million for component replacement works on the existing 132 kV transmission line and the corresponding network support operating costs to continue to provide backup supply to Port Lincoln.

The AER accepted these 'business as usual' base case costs in its draft decision on ElectraNet's Revenue Proposal, released on 26 October 2017 (i.e. Option 1 in this PADR).

Background

This appendix provides a summary of the economic assessment undertaken of Option 1 compared to the higher operating and maintenance costs associated with maintaining the existing 132 kV single circuit transmission lines and no lines capital cost.

While the assessment presented in this appendix pre-dates this RIT-T, it has been included to illustrate the analysis sitting behind the decision to include Option 1 as the 'business as usual' base case in this RIT-T.

This appendix reproduces precursory work undertaken during 2016 and early 2017. Any discrepancies in cost estimates between those presented below and the revenue proposal, and this RIT-T, are because the costs and components have been revised and refined, including for real price escalation (amongst other things).

Options considered as part of this assessment

Options investigated for the Eyre Peninsula reinforcement project are summarised in the table on the next page. Option 1 below is consistent with Option 1 in the body of this PADR.¹⁵³

¹⁵² Segments of the existing 132 kV transmission line conductor has been identified as needing replacement within the next five years.

¹⁵³ This precursory assessment also investigated the complete build of a 269km 132kV double circuit transmission line and associated substation works during (both in the optimally determined 2021 and 2022, as well as a deferred option), as well as several options 'considered but not progressed'. This appendix excludes these options as its purpose is to demonstrate that the re-conductoring option has net market benefits.

Table 13 – Capital cost assumed for each option (\$million, 2017)

Option	Option 1	Option 1A
Option description	Reconductor 118 km of the existing 132 kV single circuit transmission line, being the four poor condition sections during 2021 and 2022	Reconductor 118 km of the existing 132 kV single circuit transmission line, being the four poor condition sections during 2026 and 2027 (Deferred version of Option 1)
Lines/reconductoring capex	58.5	58.5
ElectraNet project delivery costs	4.6	4.6
Capitalised generation support during construction	10.5	10.5
Substation works	None	None
Total capex	73.6	73.6

Cost benefit analysis results

A breakdown of NPVs for each option, relative to a 'do nothing' case, are presented below – positive figures denote either avoided costs or additional benefits relative to the 'do nothing' case, while negative figures (in brackets) denote additional costs relative to the 'do nothing' case.

Table 14 – Cost and benefits for options relative to the 'do nothing' case (PV \$millions, 2017)¹⁵⁴

	Costs/benefits	Option 1	Option 1A
	Capital expenditure: line works, project delivery, gen support during works	(47.9)	(29.5)
Costs	Avoided generation support costs	None	None
	Avoided operational expenditure	6.9	5.5
Benefits ¹⁵⁵	'Risk cost reduction' ¹⁵⁶ benefit on the Yadnarie to Pt Lincoln 132 kV line	55.8	46.0
	'Risk cost reduction' benefit on the Cultana to Yadnarie 132 kV line	73.2	61.3
	Total net present benefits	88.1	83.3

¹⁵⁴ Results presented in Table 14 have been generated using a discount rate of 6 per cent.

¹⁵⁵ We note that there are other categories of costs and benefits under the RIT-T that were not considered in the preliminary assessment of Option 1 viability, but which have been included in the wider RIT-T assessment, including changes in fuel consumption, changes in the timing and type of generation investment and option value.

¹⁵⁶ Reductions in the expected cost arising from equipment failures ('risk cost reductions') were accommodated in the economic assessment. In particular, the probability of failure (PoF), the likelihood of consequence (LoC) and the cost of consequence (CoC) was estimated exogenously by an external consultant (AMCL) for the options (as well as the base case) and was treated as a category of benefit – ie, the product of these three variables for an option (or the base case) provides an estimate of the expected cost arising from equipment failures. A decrease in the expected cost arising from potential future equipment failures relative to the 'do nothing' case is counted as a benefit.

Appendix G NPV results

Please refer to separate Excel appendix summarising the costs and market benefits estimated.

Appendix H Summary of wholesale market benefits

Please refer to separate Excel appendix summarising the wholesale market benefits estimated.

ELECTRANET

52–55 East Terrace, Adelaide,
South Australia 5000
PO Box, 7096, Hutt Street Post Office,
Adelaide, South Australia 5000

T: +61 8 8404 7966

F: +61 8 8404 7104

Toll Free: 1800 243 853