Network Capability Incentive Parameter Action Plan

27 March 2015

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Glossary of Terms

Term	Description
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CT	Current Transformer
kV	kiloVolts
MMS	Market Management System
MVA	MegaVolt-Ampere
MW	MegaWatt
MWh	MegaWatt hour
NCIPAP	Network Capability Incentive Parameter Action Plan
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NTNDP	National Transmission Network Development Plan
PACR	Project Assessment Conclusions Report
SRMC	Short-run marginal cost
STPIS	Service Target Performance Incentive Scheme
RIT-T	Regulatory Investment Test for Transmission
TNSP	Transmission Network Service Provider

1. Introduction

This document presents ElectraNet's proposed Network Capability Incentive Parameter Action Plan (NCIPAP or Plan) for the 2015-16 to 2017-18 period.

The Plan operates under the Network Capability Component which forms part of the Australian Energy Regulator's (AER's) electricity transmission Service Target Performance Incentive Scheme (STPIS). The Network Capability Component was introduced to the STPIS in December 2012.

The AER issued a determination in December 2013 that the Rules prevent the AER from applying the Network Capability Component of the STPIS to Transmission Network Service Providers (TNSPs) where the relevant regulatory control periods for those TNSPs had already commenced, including ElectraNet.[1] Consequently, while currently in place in most States, the Network Capability Component would not apply in South Australia until 2018 under the Rules.

In early 2014, ElectraNet proposed a change to the National Electricity Rules (NER) to enable a transmission business to seek early implementation of the Network Capability Component of the STPIS. On 19 February 2015, the Australian Energy Market Commission (AEMC) published a final determination and made a Rule[2] which permits a transmission business such as ElectraNet to apply for the introduction of the network capability component of the STPIS during its current regulatory control period by submitting a NCIPAP to the AER for approval.

This NCIPAP together with the accompanying supporting information addresses in full the applicable requirements of the Rule change and the STPIS currently in force.

1.1 Overview of the Network Capability Component

The Network Capability Component is set out in Section 5 of the STPIS guideline[3].This Component measures the improvements in the capability of transmission assets through operating expenditure and minor capital expenditure on a transmission network that results in:

1. improved capability of those elements of the transmission system most important to determining spot prices, or
2. improved capability of the transmission system at times when Transmission Network Users place greatest value on the reliability of the transmission system.

The Network Capability Component has been designed to improve the capability of the transmission network to the benefit of consumers. It seeks to incentivise TNSPs to review the capability of the transmission network and to identify low cost network improvements that would provide greatest value.

As a result of such improvements, generation is less likely to be constrained by network limits, leading to more efficient dispatch. Customers benefit from the resulting lower

[1] AER, Service Target Performance Incentive Scheme for Transmission Businesses: Early Application of Version 4 – Final Position, December 2013, p 11

[2] AEMC, Rule Determination: National Electricity Amendment (Early application of service target performance incentive scheme (STPIS) components *to transmission businesses) Rule 2015,* 19 February 2015

[3] AER, Final Electricity Transmission Network Service Providers Service Target Performance Incentive Scheme, Version 4.1, 16 September 2014, pp12-17.

wholesale costs and efficient improvements in network capability to meet increases in peak demand.

This plan proposes six projects that will contribute to improving the capability of South Australia's transmission network in terms of both the elements most important to determining spot prices and the times when users place the greatest value on the reliability of the system.

The elements most important to determining spot prices tend to be interconnector limits and major intra-regional constraints. Many of the projects in the plan are targeted directly at these network elements.

1.2 Period of the Plan

The Plan covers a three year period from a proposed start date of 1 July 2015 to 30 June 2018.

1.3 ElectraNet's Existing Practice

ElectraNet's Revenue Proposal of May 2012 included a number of projects which would be expected to satisfy the AER's criteria of low cost operational / minor capital works to increase network capability.

In its Draft Decision on ElectraNet's Revenue Proposal of November 2012, the AER disallowed funding for these initiatives, noting the proposed introduction of the network capability component of the STPIS.[4]

Consequently, ElectraNet removed all such projects from its expenditure forecasts in its revised Revenue Proposal lodged in January 2013.[5] The AER's final Transmission Determination of April 2013 was made on this basis.

Consistent with the requirements of the Network Capability Component, ElectraNet's approved operating and capital expenditure allowances for the current regulatory period of 1 July 2013 to 30 June 2018 therefore contain no funding for the network capability projects contained in this proposed Plan.

[4] AER, ElectraNet Transmission Determination 2013-14 to 2017-18: Draft Decision, pp 140, 155, 285-286.
[5] ElectraNet, ElectraNet Transmission Network: Revised Revenue Proposal 1 July 2013 – 30 June 2018, 16 January 2013, p 106.

2. Approach

This chapter outlines the approach ElectraNet has used to identify and rank projects for the purposes of this proposed Plan and the engagement it has undertaken with key stakeholders including AEMO and customers.

2.1 Requirements of the Scheme

The STPIS requires this Plan to:

- Identify for every transmission circuit or injection point on its network, the reason for the limit for each transmission circuit or injection point.
- Propose the priority projects to be undertaken in the regulatory control period to reduce the limits on the transmission circuits and injection points listed above through operational and/or minor capital expenditure projects. This proposal must include:
  - (i) the total operational and capital cost of each priority project;
  - (ii) the proposed value of the priority project improvement target in the limit for each priority project;
  - (iii) the current value of the limit for the transmission circuits and/or injection points which the priority project improvement target is seeking to improve; and
  - (iv) the ranking of the priority projects in descending order based on the likely benefit of the priority project on customers or wholesale market outcomes.[6]

These requirements are addressed below.

2.2 Approach to Identifying Projects

ElectraNet has systematically reviewed limits, operating conditions and constraints on its network to identify projects for inclusion in the proposed Plan. The reviews that have been undertaken to identify projects involved:

- Review of the limits for each transmission line, connection point and transformer, including identification of all limiting factors less than the conductor thermal rating (a confidential spreadsheet identifying these limits accompanies this application);
- Identification of credible contingencies where increased capability would improve wholesale market outcomes or supply to loads;
- Studies on interconnectors;
- Review of binding transmission constraints from 2011 onwards to identify capability improvements that would improve wholesale market outcomes;
- Discussions with ElectraNet's system operators to identify operating conditions where capability improvements could provide benefits;

[6] AER, *Final Electricity Transmission Network Service Providers Service Target Performance Incentive Scheme*, September 2014, p12

- Discussions with planning staff at AEMO to identify operating conditions where capability improvements could provide benefits; and
- Discussions with asset management and design staff at ElectraNet to identify innovations that could provide capability improvements.

This work has been done in collaboration with AEMO in its role as national transmission planner and market operator.

The future scenarios considered in developing this plan include those considered in the recent National Transmission Network Development Plans (NTNDP) published by AEMO including the 2014 NTNDP.[7]

2.3 Approach to Ranking Projects

The STPIS requires proposed projects to be ranked in descending order based on the likely benefit of the project to consumers or wholesale market outcomes.

ElectraNet and AEMO have taken the following approach to ranking the projects:

- Projects to improve the network capability under system normal or single contingency events have been given priority over other projects, such as those that improve the network capability under multiple contingencies;
- Particular focus has been given to projects that have the potential to reduce expected unserved energy in the National Electricity Market; and
- The payback period is used as a key input to rank the projects following the above steps.

2.3.1 Project Considered but not Proposed

ElectraNet explored 17 projects with total costs estimated at $32.6 million with AEMO. A number of projects were identified but not considered to be of greatest value for inclusion in the Plan as priority projects. These projects included:

- Voltage support in the Riverland to support additional exports to Victoria under high demand conditions;
- Assessment and application of short term ratings through the Mid-North;
- Increasing the ratings of lines in the Mid-North;
- Removal of plant limits on the Davenport–Robertstown 275kV network;
- Reconfiguration of the Canowie substation; and
- Projects with an uncertain likelihood that the capability will be required before the end of the current regulatory period, which therefore have lower economic benefits at this time.

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7 AEMO, *2012 National Transmission Network Development Plan*, December 2012; *2013 National Transmission Network Development Plan*, December 2013; *2014 National Transmission Network Development Plan*, December 2014.

2.4 Consultation with AEMO

The STPIS requires ElectraNet to consult with AEMO prior to submitting the Plan as to:

1. Whether there is potential for co-ordinated projects with other TNSPs;
2. Whether the proposed priority project improvement targets for its projects will result in a material benefit;
3. Which projects should be classified as priority projects based on their likely benefit to consumers or wholesale market outcomes, and
4. The ranking of the priority projects.[8]

ElectraNet has worked collaboratively with AEMO in the development of this plan, including detailed consultation on these four factors. ElectraNet has also provided AEMO with a copy of its capital expenditure program for the relevant regulatory control period as required under the STPIS, as discussed further in Section 2.6.

AEMO's comprehensive project assessment methodology included independent modelling and analysis of network limitations, historical congestion, future network flows and reliability and security implications.

Following its assessment, AEMO has provided its formal endorsement of the final six priority projects contained in this NCIPAP by letter dated 20 March 2015 (a copy of which accompanies this application) including the total value of the projects and the ranking of the priority projects. AEMO also assessed that each project has positive net market benefits and, in its view, will deliver value to customers.

2.5 Consultation with Consumers

ElectraNet has consulted with consumers through the release of a draft NCIPAP and explanatory fact sheet for public comment in December 2014. A round table for interested participants was also held on 28 January 2015 to discuss the proposals in detail. This followed initial information on the NCIPAP proposals presented at ElectraNet's Transmission Annual Planning Report public forum and published in September 2014.

Written submissions on the Draft NCIPAP were received from the South Australian Council of Social Service (SACOSS), AEMO, Major Energy Users Inc (MEU) and BHP Billiton. The round table was attended by the MEU, South Australian Department of State Development, SA Power Networks and AEMO.

In response to the feedback received through this consultation, ElectraNet has modified its NCIPAP proposals in a number of areas to address the issues raised, including:

- Key project changes, including confirmation of the Lower South East uprating project as a stand-alone project, and the removal of the proposed project to remove plant limits at Davenport–Robertstown;

- Clarification of the timing and nature of the benefits to be delivered for consumers from the proposed projects, including the benefits from projects that are additional to committed projects such as the Heywood Interconnect Upgrade;

[8] AER, *Final Electricity Transmission Network Service Providers Service Target Performance Incentive Scheme*, September 2014, p13

- Confirmation that the total value of proposed projects is a full one per cent of the average maximum allowed revenue for the applicable period and that the Plan can be amended on application to the AER if circumstances change.

Full details on the issues raised by consumers and others stakeholders and the manner which these have been addressed is contained within the Consultation Summary document which accompanies this application.

2.6 Relationship with Capital and Operating Expenditure

As noted above, the costs associated with the projects proposed in this plan are not included in the capital or operating expenditure allowances approved by the AER in respect of the current regulatory control period.

As part of its South Australian Advisory Functions AEMO reviews ElectraNet's proposed capital expenditure allowances[9]. AEMO also reviews ElectraNet's Transmission Annual Planning Reports on an annual basis for consistency with the capital expenditure program approved by the AER[10]. AEMO therefore has a copy of and is closely familiar with ElectraNet's approved capital expenditure program for the current regulatory control period, and has provided its endorsement on this basis.

2.7 Annual reporting

ElectraNet will report on outcomes from the Network Capability Component on an annual basis, as required under the Scheme.

ElectraNet also notes that, should changes outside its control occur which would result in a priority project no longer likely resulting in a material benefit, ElectraNet may propose to the AER to remove the project and may also propose a replacement project consistent with the objectives of the Scheme. ElectraNet must consult with AEMO prior to making such a proposal. This allows for changes to the plan to be made should conditions unexpectedly change, in order to ensure maximum benefits are delivered for consumers.

[9] AEMO, *2012 ElectraNet Revenue Cap Review: Capital Projects Assessment Report,* June 2012
[10] AEMO, *Comparison of ElectraNet's 2014 TAPR Projects and the Plan accepted by the AER,* September 2014

3. Network Action Plan

ElectraNet proposes six projects to contribute to improving the capability of South Australia's transmission network. These proposed timing and benefits to be delivered by these projects are summarised in Table 3.1 and 3.2 below and detailed in the following sections.

The total value of the proposed projects identified is $10.05 million. One per cent of ElectraNet's average Maximum Allowed Revenue from the AER's prevailing revenue determination for the relevant years of the current regulatory control period (most recently amended for the Heywood Interconnector Upgrade Contingent Project) is $10.05 million. Therefore, the average annual value of the proposed projects identified does not exceed one per cent of the average maximum allowed revenue for this period.

Table 3-1: Proposed Network Capability Incentive Projects ($m nominal)

Category	Project	2015-16	2016-17	2017-18	Estimated Cost	Rank
Transmission line uprating	Upper South East uprating	2.30			**2.30**	1
	Riverland uprating		4.43		**4.43**	2
	Robertstown – Waterloo East uprating			1.33	**1.33**	3
	Lower South East uprating	1.83			**1.83**	6
Planning studies	Load model enhancements	0.07	0.04		**0.11**	4
	Distributed rooftop solar PV response to frequency disturbances	0.06			**0.06**	5
Total		**4.26**	**4.47**	**1.33**	**10.05**	

Table 3-2: Estimated benefits from Transmission line uprating projects ($m nominal)[11]

Project	Completion date	Estimated Cost ($m)	Estimated benefits ($m pa)	Payback period
Upper South East uprating	2015-16	**2.30**	> 2.6	< 1 year
Riverland uprating	2016-17	**4.43**	> 2.4	< 2 years
Robertstown – Waterloo East uprating	2017-18	**1.33**	~ 0.3	~ 5 years
Lower South East uprating	2015-16	**1.83**	~ 0.32	~ 5.7 years

[11] The benefits of the planning studies are described in qualitative terms in section 3.2

3.1 Transmission line up-ratings

3.1.1 Priority Project 1 – Upper South East uprating

Figure 2 is a geographical diagram of the South East transmission network. The South East region is bounded by the South Australia/Victoria border on the east, the Riverland region to the north, the Eastern Hills region to the north-west and the Southern Ocean to the west.

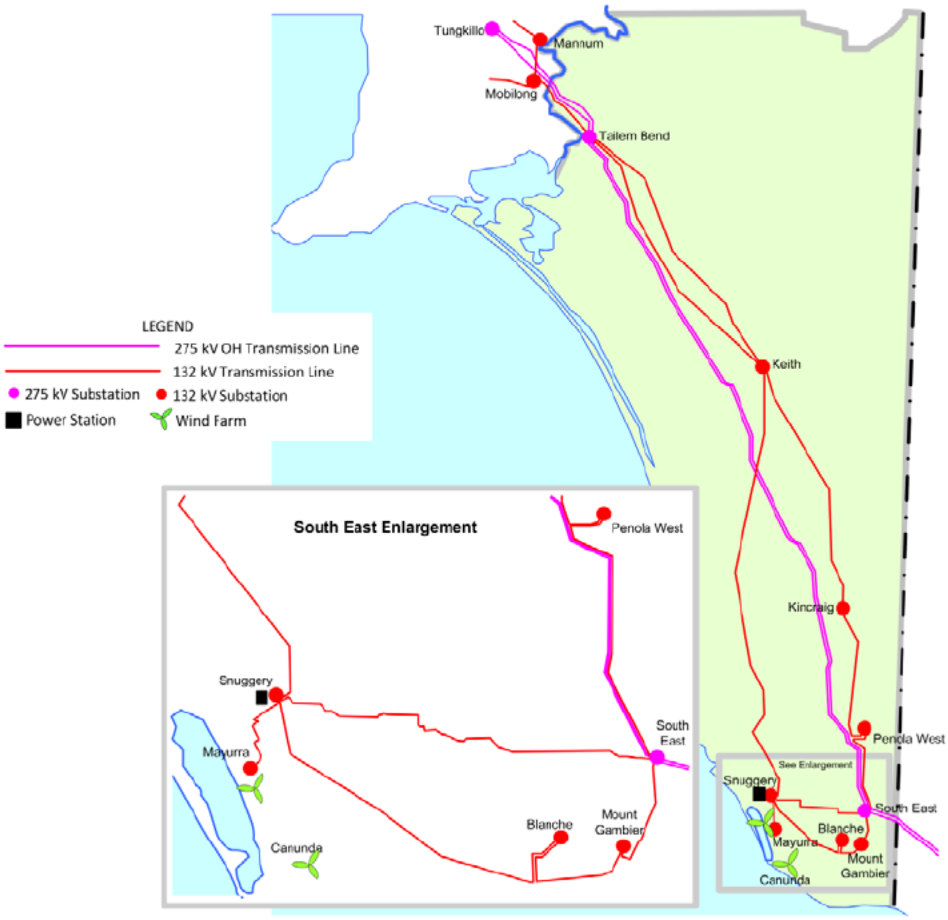

Figure 2: Geographical diagram of the South East transmission region

Transmission Circuit/ Injection Point	Tailem Bend to Tungkillo 275 kV Tailem Bend to Mobilong 132 kV
Limit and Reason for the Limit	Thermal design capability of the lines.
Project	Upper South East Uprating
Project Description	Increase the conductor clearances of all the relevant lines to increase the operating temperature of these lines from 80°C to allow 100°C degree ratings.
Present Limit	Transmission circuit / Summer rating (MVA) / Winter rating (MVA) Tailem Bend – Tungkillo 275 kV / 451 / 564 Tailem Bend – Mobilong 132 kV / 141 / 173
Target Limit	Transmission circuit / Summer rating (MVA) / Winter rating (MVA) Tailem Bend – Tungkillo 275 kV / 597 / 682 Tailem Bend – Mobilong 132 kV / 183 / 207
Capital cost ($ nominal)	$2.30 million
Operating Cost	$0
Priority project improvement target	Transmission circuit / Summer rating (MVA) / Winter rating (MVA) Tailem Bend – Tungkillo 275 kV / 146 / 118 Tailem Bend – Mobilong 132 kV / 42 / 29

Reasons to undertake the project:

Following the Heywood interconnector upgrade, the next limit on the Heywood interconnector will be the capability of the Tailem Bend to Tungkillo 275 kV line and the Tailem Bend to Mobilong 132 kV line. Depending on the pre-contingent flow either of these two lines have the potential to be the limiting factor on imports.

The most recent AEMO forecasts from AEMO's current planning reports highlight the potential for increased utilisation of the Heywood interconnector before the end of ElectraNet's current regulatory period. Most importantly, AEMO is forecasting a potential increase in the gas price from the average of $3.8/GJ in 2014 to $6.47/GJ by 2017-18.[12] Gas powered generation in South Australia, which accounts for around 50 per cent of South Australian electricity supply, is expected to reduce by around half before end of the current ElectraNet regulatory period[13]. AGL has announced that the 480 MW Torrens Island A power station will be mothballed from 2017.[14]

This may lead to increasing flows and hence congestion on the Heywood interconnector into South Australia.

[12] AEMO New Entrant CCGT – ADE
[13] AEMO 2013 GSOO
[14] AGL Media Release – Wednesday 10 December 2014

Benefits:

The majority of the benefits will be realised through increasing the capability of the Heywood interconnector to import power from Victoria.

AEMO is forecasting an increase in the price of gas in South Australia before the end of ElectraNet's current regulatory period. This may lead to an increase in flows across the Heywood interconnector. This project will also facilitate increased exports of wind from South Australia.

The Heywood Interconnector Upgrade RIT-T estimated that hours of congestion on the Tailem Bend to Tungkillo line will range from 2,298 to 2,819 hours per annum over the remainder of ElectraNet's regulatory period. This project will alleviate the next constraints on the Heywood interconnector and will be in additional to the benefits of the currently committed project of uprating the interconnector.

Depending on the pre-contingent system operating conditions, either the Tungkillo – Tailem Bend circuit or the Tailem Bend – Mobilong circuit has the potential to be the limiting factor on the flow across the Tungkillo – Tailem Bend interface, which forms part of the Heywood Interconnector corridor. For the purposes of estimating the potential market benefit of the proposed projects, the average improvement target of 132 MVA across the Tailem Bend – Tungkillo interface has been assumed.

The value of congestion across this corridor is estimated at around $25/MWh. This value is a high level estimate of the historical substitution of gas for brown coal.

Benefits have been moderated to reflect the fact that the full network improvement will not always be utilised by the market. A utilisation factor has been determined based on the historical usage of the Heywood interconnector. Based on a notional capability of 460 MW, the interconnector has the capability to import 4.0 TWh annually. In 2013-14, the interconnector imported approximately 1.8 TWh, leading to a utilisation factor of 45 per cent.

Annual benefits have been estimated as:

Duration (Hours) * Target (MW) * Value ($/MWh) * Utilisation Factor

This has resulted in annual benefits ranging from $2.6 million to $2.9 million or a pay-back period of around 10 months.

Two value sensitivities have also been considered. A higher sensitivity value has been derived from the difference in estimated Short-Run Marginal Cost (SRMC) between Latrobe Valley coal generators and metropolitan Adelaide gas generators as estimated for the year 2017 in the 2013 NTNDP. This value is estimated at $74.80/MWh has been applied to congestion into South Australia.

A lower sensitivity of $10/MWh has also been tested.

The pay-back period under the two value sensitivities ranges from three months to around two years.

3.1.2 Priority Project 2 – Riverland uprating

Figure 1 is a geographical diagram of the Riverland region transmission network. The Riverland region is bound by Robertstown to the west and the South Australian/New South Wales/Victorian borders to the east.

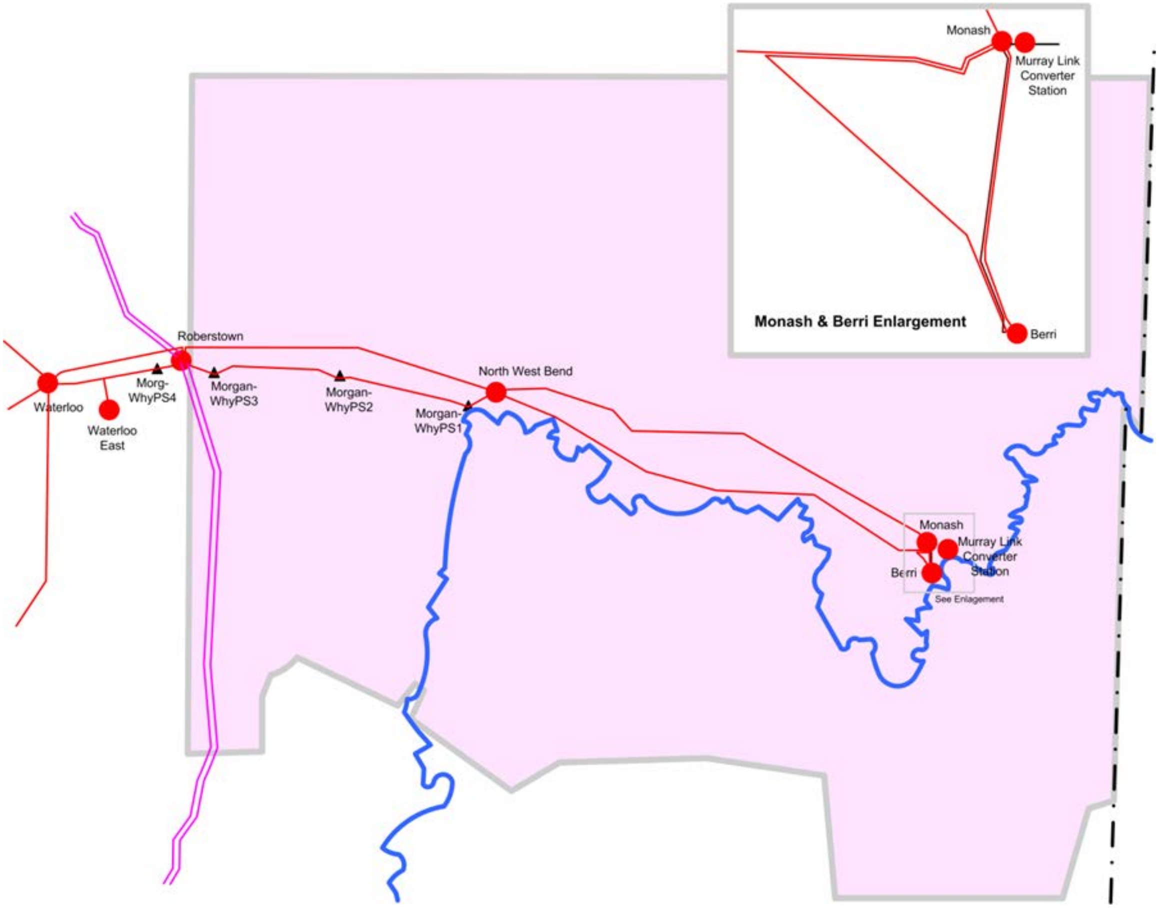

Figure 1: Geographical diagram of the Riverland transmission region

<table>
<tr><td>Transmission Circuit/ Injection Point</td><td>Robertstown – Morgan Whyalla Pump No. 3 (MWP3) 132 kV
Morgan Whyalla Pump No. 3 – Morgan Whyalla Pump No. 2 (MWP2) 132 kV
Morgan Whyalla Pump No. 2 – Morgan Whyalla Pump No. 1 (MWP1) 132 kV
Morgan Whyalla Pump No. 1 – North West Bend 132 kV
North West Bend – Monash #2 132 kV</td></tr>
<tr><td>Limit and Reason for the Limit</td><td>Thermal design capability of the lines.</td></tr>
<tr><td>Project</td><td>Riverland Uprating</td></tr>
<tr><td>Project Description</td><td>Increase the conductor clearances of all the relevant lines to increase the operating temperature of these lines from 80°C to allow 100°C degree ratings.</td></tr>
<tr><td>Present Limit</td><td>
<table>
<tr><th><u>Transmission circuit</u></th><th><u>Summer rating (MVA)</u></th><th><u>Winter rating (MVA)</u></th></tr>
<tr><td>Robertstown – MWP3 132 kV</td><td>141</td><td>173</td></tr>
<tr><td>MWP3 – MWP2 132 kV</td><td>141</td><td>173</td></tr>
<tr><td>MWP2 – MWP1 132 kV</td><td>141</td><td>173</td></tr>
<tr><td>MWP1 – North West Bend 132 kV</td><td>141</td><td>173</td></tr>
<tr><td>North West Bend – Monash 132kV circuit #2</td><td>110</td><td>126</td></tr>
</table>
</td></tr>
<tr><td>Target Limit</td><td>
<table>
<tr><th><u>Transmission circuit</u></th><th><u>Summer rating (MVA)</u></th><th><u>Winter rating (MVA)</u></th></tr>
<tr><td>Robertstown – MWP3 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>MWP3 – MWP2 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>MWP2 – MWP1 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>MWP1 – North West Bend 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>North West Bend – Monash 132kV circuit #2</td><td>141</td><td>158</td></tr>
</table>
</td></tr>
<tr><td>Capital cost
($ nominal)</td><td>$4.43 million</td></tr>
<tr><td>Operating Cost</td><td>$0</td></tr>
<tr><td>Priority project improvement target</td><td>
<table>
<tr><th><u>Transmission circuit</u></th><th><u>Summer rating (MVA)</u></th><th><u>Winter rating (MVA)</u></th></tr>
<tr><td>Robertstown – MWP3 132 kV</td><td>42</td><td>32</td></tr>
<tr><td>MWP3 – MWP2 132 kV</td><td>42</td><td>32</td></tr>
<tr><td>MWP2 – MWP1 132 kV</td><td>42</td><td>32</td></tr>
<tr><td>MWP1 – North West Bend 132 kV</td><td>42</td><td>32</td></tr>
<tr><td>North West Bend – Monash 132kV circuit #2</td><td>31</td><td>32</td></tr>
</table>
</td></tr>
</table>

Reasons to undertake the project:

This project will increase the capability of Murraylink to export power to Victoria under high Riverland demand by approximately 24 MW.

This project will also increase the capability of South Australian wind farms to export power under high wind generation conditions at all times of the year.

This project will have an impact in increasing supply in the NEM, with benefits accruing to both consumers and producers. In particular, the bulk of the benefits to consumers will accrue to consumers in the Riverland and western Victoria through an increase in supply reliability.

Benefits:

The value of congestion across the Murraylink interconnector has been determined from the average marginal values in AEMO's Market Management System (MMS) table MCC_ConstraintSolution. The constraint S>>V_NIL_NIL_RBNW has been used which manages congestion between Robertstown to North West Bend with marginal values capped at the market price cap. The average value of congestion during 2014 was $855/MWh. A sensitivity case has been tested using the average of the last five years of $399/MWh.

ElectraNet has estimated the hours of congestion before the end of the current ElectraNet regulatory period as ranging from 119 to 174 hour per year. These values were estimated during the Heywood Interconnector upgrade Regulatory Investment Test for Transmission (RIT-T). Historically, congestion from this limitation has averaged 132 hours congestion per annum. Most recently, the constraint has bound for 242 hours in 2014.

The market benefits have been estimated based on an improvement of 24 MW, which is the expect increase in capability that will be available under high demand conditions. A greater improvement will occur at other times.

Benefits have been estimated as:

Duration (Hours) * Target (MW) * Value ($/MWh)

which gives annual benefits of around $2.4 million indicating a pay-back period of less than two years. Analysis of the value sensitivities ($399/MWh) indicates a payback period of up to four years.

ElectraNet notes that AEMO's Regional Victoria Thermal Upgrade RIT-T stage 3 Project Assessment Conclusions Report (PACR) identifies that limitations in Victoria, following the completion of either of the two projects ranked first, will have a residual cost to the market of between $61 million and $74 million. Residual annual costs to the market before the end of ElectraNet's current regulatory period will range from $3.1 million to $20.5 million. This indicates the reasonableness of estimated benefits[15].

[15] http://aemo.com.au/Electricity/Planning/Regulatory-Investment-Tests-for-Transmission/Regional-Victorian-Thermal-Capacity-Upgrade

3.1.3 Priority Project 3 – Robertstown – Waterloo East uprating

Figure 3 is a geographical diagram of the Mid North transmission network. The Mid North region is comprises of both a 132 kV sub-transmission system and the Main Grid 275 kV system.

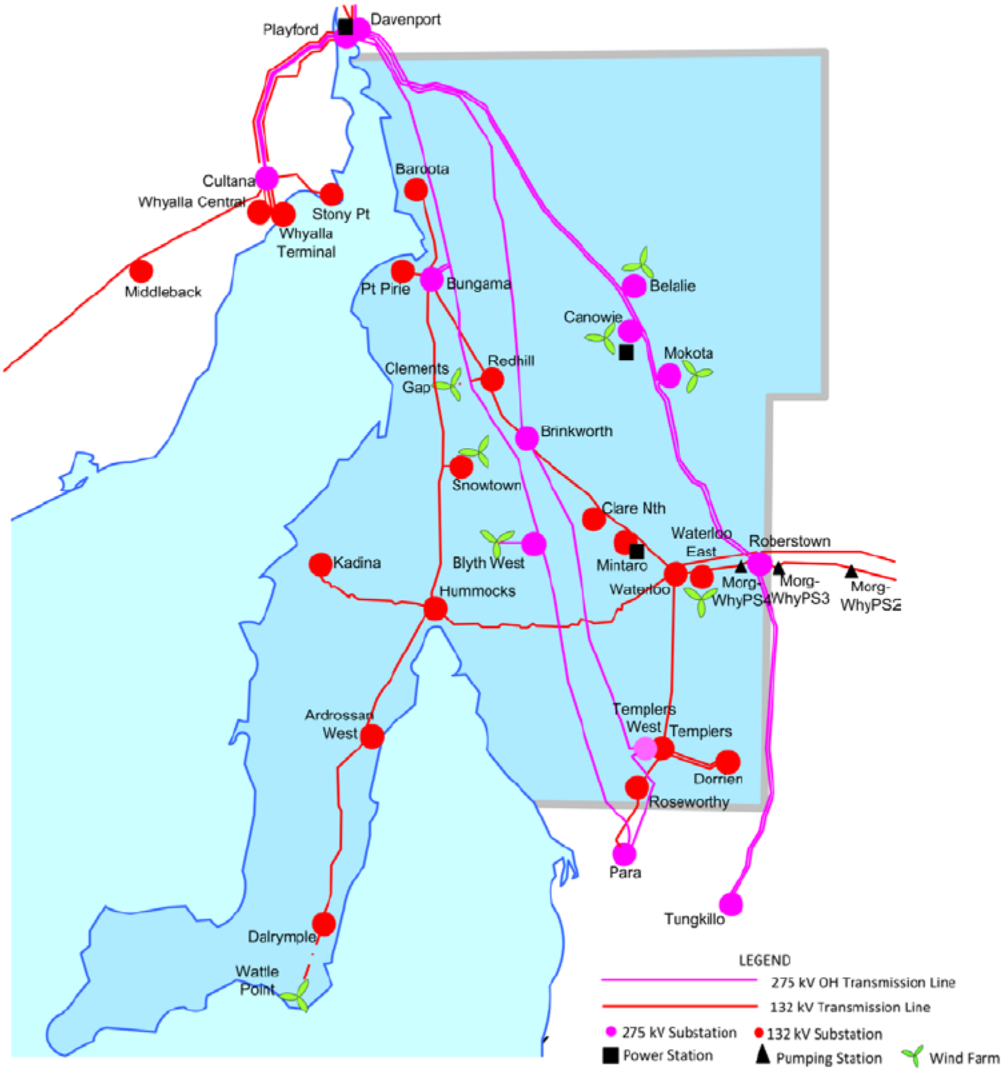

Figure 3: Geographical diagram of the Mid North transmission region

<table>
<tr><td>Transmission Circuit/ Injection Point</td><td colspan="3">Robertstown – Morgan Whyalla Pump No. 4 (MWP4) 132 kV
Waterloo East – Morgan Whyalla Pump No. 4 132 kV</td></tr>
<tr><td>Limit and Reason for the Limit</td><td colspan="3">Thermal design capability of the lines due to conductor clearance.</td></tr>
<tr><td>Project</td><td colspan="3">Robertstown – Waterloo East uprating</td></tr>
<tr><td>Project Description</td><td colspan="3">Increase the clearance of the conductors.</td></tr>
<tr><td rowspan="3">Present Limit</td><td><u>Transmission circuit</u></td><td><u>Summer rating (MVA)</u></td><td><u>Winter rating (MVA)</u></td></tr>
<tr><td>Robertstown – MWP4 132 kV</td><td>141</td><td>173</td></tr>
<tr><td>Waterloo East – MWP4 132 kV</td><td>141</td><td>173</td></tr>
<tr><td rowspan="3">Target Limit</td><td><u>Transmission circuit</u></td><td><u>Summer rating (MVA)</u></td><td><u>Winter rating (MVA)</u></td></tr>
<tr><td>Robertstown – MWP4 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>Waterloo East – MWP4 132 kV</td><td>183</td><td>205</td></tr>
<tr><td>Capital cost
($ nominal)</td><td colspan="3">$1.33 million</td></tr>
<tr><td>Operating Cost</td><td colspan="3">$0</td></tr>
<tr><td>Priority project improvement target</td><td colspan="3">42 MVA (Summer rating) / 32 MVA (winter rating)</td></tr>
<tr><td colspan="4">Reasons to undertake the project:

Exports from South Australia across Murraylink are at times limited under high wind conditions by the rating of the Robertstown – MWP4 – Waterloo East 132 kV conductor. This limitation has been increasing in frequency, having bound for a total of 126 hours in the current year to 19 December 2014. This project will have a marginal impact in increasing supply in the NEM. Increases in supply benefit both consumers and producers.</td></tr>
<tr><td colspan="4">Benefits:

Releasing congestion across this line will allow for greater exports of renewable wind generation from South Australia.

For the market benefits calculation, An average of the summer and winter ratings of 37 MVA has been used, assuming a unity power factor.

The value of congestion has been estimated as $30/MWh. This is an approximate figure for the substitution of thermal generation for renewables. A sensitivity of $55/MWh has also been tested.

ElectraNet's economic network models have estimated future congestion across this path will rise to 359 hours before the end of the current regulatory period. This estimate does not include any additional wind farms connecting to the 132 kV Mid-North network. Additional connections would likely increase the incidence of congestion.

Benefits have been estimated as:

Duration (Hours) * Target (MW) * Value ($/MWh)

This gives annual Net Present Value (NPV) benefits of approximately $300,000 indicating a pay-back period of around five years. Under the higher value sensitivity the payback period is around two and a half years.</td></tr>
</table>

3.1.4 Priority Project 6 – Lower South East uprating

A geographical description of the Lower South East uprating can be found in the priority project 2 – Upper South East uprating project.

Transmission Circuit/ Injection Point	South East to Tailem Bend 275 kV #1 South East to Tailem Bend 275 kV #2		
Limit and Reason for the Limit	Design capability of the lines due to conductor clearance.		
Project	Lower South East Uprating		
Project Description	Increase the conductor clearances of all the relevant lines to increase the operating temperature of these lines from 100°C to allow 120°C degree ratings.		
Present Limit	Transmission circuit	Summer rating (MVA)	Winter rating (MVA)
	South East - Tailem Bend 275 kV #1	591	675
	South East - Tailem Bend 275 kV #2	591	675
Target Limit	Transmission circuit	Summer rating (MVA)	Winter rating (MVA)
	South East - Tailem Bend 275 kV #1	700	768
	South East - Tailem Bend 275 kV #2	700	768
Capital cost ($ nominal)	$1.83 million		
Operating Cost	$0		
Priority project improvement target	109 MVA (summer rating) / 93 MVA (winter rating)		

Reasons to undertake the project:

Following the Heywood interconnector upgrade, limitations on the South East to Tailem Bend corridor will become apparent. Congestion along this corridor will become more apparent following the Upper South East project to be also undertaken as part of the network capability incentive.

The most recent AEMO forecasts from the suite of the AEMO planning reports highlight:

- A potential increase in the gas price from the 2014 average of $3.8/GJ to $6.47/GJ by 2017-18 – an increase of 70 per cent; and
- Gas price forecasts which are higher than forecast in the Heywood RIT-T in all scenarios[16]; and
- An increase in the level of wind generation in South Australia[17].

[16] http://www.aer.gov.au/node/19916
[17] AEMO's 2014 NTNDP Generation Investment

These events will lead to increasing congestion on the Heywood interconnector in both directions. The effects of these events on the market benefits are discussed in more detail in the next section.

Benefits:

The benefits of this project will be through increasing the capability of the Heywood interconnector to import power from and export power to Victoria. AEMO is forecasting an increase in the price of gas in South Australia before the end of the regulatory period. Subsequently a reduction in the generation from gas fired power stations in South Australia is also forecast. This will lead to an increase in flows across the Heywood interconnector into South Australia. This project will also facilitate increased exports of wind from South Australia.

The Heywood Interconnector Upgrade RIT-T estimated that hours of congestion across the Tailem Bend to South East line will range from 1,546 to 1,750 hours per annum over the remainder of ElectraNet's regulatory period. This congestion is forecast to be split to average 803 hours into South Australia and 845 hours out of South Australia. This project will alleviate the next constraints on the Heywood interconnector and will be in additional to the benefits of the currently committed project of uprating the interconnector.

The value of congestion across this corridor is estimated at $25/MWh into South Australia and $30/MWh out of South Australia. This value into South Australia is a high level estimate of the historical substitution of gas for brown coal. The export value is an approximate figure for the substitution of thermal generation for renewables.

Two value sensitivities have also been considered. A lower value sensitivity of $25/MWh in both directions.

A high value sensitivity has been considered at $74.80/MWh[18], reflective of the forecast difference in SRMC between La Trobe Valley coal generators and metropolitan Adelaide gas generators for flows into South Australia.

The summer line capacity improvement target for this project is 109 MVA and the winter improvement of 93 MVA. A unity power factor has been assumed in the conversion between MW and MVA for the market benefits assessment.

Benefits have been moderated to reflect:

- The utilisation factor of 45 per cent which has been determined based on the historical usage of the Heywood interconnector. Based on a notional capability of 460 MW, the interconnector has the capability to import 4.0 TWh. In 2013-14, the interconnector imported approximately 1.8 TWh, leading to 45 per cent utilisation;
- The capacity of the Victorian network between the South Australian border and the Heywood substation which will limit the interconnector depending on the temperature and
- The potential influence of voltage stability limitations in South Australia to restrict imports by a further 43 per cent. An additional sensitivity has also been considered that reduces the capability in both directions by 65 per cent to reflect the potential influences of dynamic limitations in both South Australia and Victoria. This includes the Victorian voltage and transient stability limitations for exports and transient instability for South Australian exports.

Following this upgrade, various limitations will exist that will, under certain operating

[18] AEMO's 2014 NTNDP Plexos model – Planning scenario

conditions, restrict the network below the thermal capacity of the network in South Australia. These limitations however are not expected to prevent the project from delivering substantial benefits under most operating conditions.

Annual benefits have been estimated as:

Duration (Hours) * Target (MW) * Value ($/MWh) * moderating factors.

This has resulted in annual benefits of approximately $317,000 or a pay-back period of around 5.7 years. Under the range of scenarios considered, the payback period may range from 2.2 years to 9 years.

3.2 Planning studies

3.2.1 Priority Project 4 - Load model enhancements

Limit and Reason for the Limit	As a result of ongoing changes in loads associated with consumer devices as well as the increase in solar PV systems connected via the distribution network, the behaviour of load under disturbed system conditions requires detailed review to allow for accurate representation in power system studies.
Project	Examine characteristic load behaviour across the South Australian network
Limit Addressed	Evaluation of load behaviour under disturbed system conditions will enable the refinement of load modelling in power system studies.
Project Description	Evaluation of load behaviour under disturbed system conditions
Capital cost ($ nominal)	$37,772
Operating Cost	$66,850
Priority Project Improvement Target	Progress reports and a final assessment report including model validations against system events to be compiled.

Reasons to undertake the project:

ElectraNet relies on accurate models of the power system for planning and operating the power system. The results of simulations and studies that utilise power system models underpin the design and development of the transmission system and the development of constraint equations utilised to ensure the secure operation of the system.

One key area is the representation of load behaviour under disturbed system conditions in these power system models. Across the NEM, voltage dependant load indices of Np=1 and Nq=3 have been widely adopted; however, frequency dependence of loads is not commonly represented.

In order to establish the load dependence on frequency ElectraNet will install portable measurement equipment within distribution substations owned SA Power Networks and record the behaviour of feeder loads for system frequency disturbances. Load voltage dependence for naturally occurring voltage steps (e.g. from transformer on-load tap changer operation) will also be measured so that up to date load representations can be maintained.

For the avoidance of doubt priority projects 4 and 5 aim to develop and/or validate explicit and distinctly separate steady-state loadflow representations and dynamic (transient) models for solar PV (Project 5) and real/native load (Project 4).

Benefits:

ElectraNet has previously undertaken load voltage dependence measurement projects to assess the impact of voltage disturbances on load behaviour. This project aims to further refine the representation of loads for power system studies by assessing the frequency dependence of system loads and also maintaining up to date information on the voltage dependence of loads.

The outcomes of these studies may allow for refinements to when formulating network limitations. Greater accuracy of the limit formulation may allow for improvements such as reducing operating margins, improving network limitations and a better understanding of the risks under certain operating conditions. Progress reports and outputs from this work will also be made available to AEMO for review.

3.2.2 Priority Project 5 - Distributed Rooftop Solar PV Response to frequency disturbances

Limit and Reason for the Limit	Increase in distributed PV systems in the SA network may have negative impacts on system inertia and post-contingency frequency control.
Project	Examine PV inverter responses to frequency disturbances
Limit Addressed	Examine the possible increased risk of severe frequency disturbances due to the response of distributed PV systems will allow for greater insights into the likely operation of PV systems under disturbed conditions
Project Description	Examine the possible increased risk of severe frequency disturbances due to the response of distributed PV systems
Capital cost ($ nominal)	$0
Operating Cost	$53,725
Priority Project Improvement Target	Progress reports and a final assessment report including model validations against system events to be compiled.

Reasons to undertake the project:

ElectraNet relies on accurate models of the power system for planning and operating the power system. In the last few years South Australia has experienced a rapid increase in the number of rooftop solar PV systems installed in SA Power Network's distribution network, with an excess of 579MW of PV capacity now installed in SA[19].

Under the requirements of the existing Australian Standard AS4777.3-2005 for grid connection of energy systems via inverters, solar PV inverters are designed to disconnect from the power system for voltage and frequency conditions outside of normal operating ranges to prevent the continued injection of energy that may form an unintentional power island.

The actual trip settings applied across the existing fleet of solar PV systems in Australia are not well understood, but historically has been as tight as +/-0.2Hz, especially for inverters installed prior to 2011. There is a risk that for under-frequency events on the transmission system, large scale disconnection of solar PV systems may exacerbate the low frequency conditions. Under worst case SA islanding scenarios, the islanded SA system may experience a cascade frequency collapse, leading to a state-wide blackout and consequently, significant economic and social impact.

This project will determine the risk that solar PV systems will contribute to a cascading failure of the network following a system under frequency event.

ElectraNet is aware that TransGrid is currently pursuing a similar project with respect to solar PV in the NSW region. The findings from the NSW region, while complementary, are not directly applicable to the SA region. The distributed nature of rooftop solar PV means its impact can differ on the localised (regional) basis due to factors such as solar PV penetration at specific points in the network, the extent of meshing of the local distribution network, reactive support availability on both transmission and distribution networks and the regional generation mix. Together these factors support separate solar PV studies in the different regions, in order to better understand the impact of regional network diversity on the overall issue of solar PV impact in the NEM.

[19] Australian Clean Energy Regulator STC register as of 31 January 2015

Benefits:

These studies will assess the risk to network security caused by the wide spread and rapid uptake of solar PV systems to the South Australian network. Undertaking this project will allow for greater insights into the likely operation of PV systems under disturbed conditions. This information will assist ElectraNet to identify the appropriate timing and design of corrective action to prevent limitations on further installations of PV systems or the unexpected effects of PV systems on the grid in general such as the potential to contribute to a cascading failure. Progress reports and outputs from this work will also be made available to AEMO for review.