

# SOUTH AUSTRALIAN TRANSMISSION ANNUAL PLANNING REPORT OVERVIEW

June 2017

# Introduction

**South Australia's transmission network plays a major role in the State's electricity supply, in an unprecedented environment of change.**

South Australia is at the forefront of energy transformation with world-leading levels of intermittent renewable energy compared to demand.

In 2016 – 17, a number of significant events impacted the supply of electricity to large numbers of South Australian customers, including a state-wide system black event in September 2016. These events have highlighted the importance of system security and reliability as we transition to a lower carbon emissions future.

Within this context, ElectraNet's annual planning process has sought to pre-empt network obstacles or opportunities, and ensure plans are in place to accommodate them.

This South Australian Transmission Annual Planning Report summarises the outcomes of this planning process over a ten-year planning period and includes ElectraNet's response to the emerging challenges facing South Australia's electricity transmission network, including initiatives for:

- investigating the technical and economic feasibility of a new transmission interconnector between South Australia and the Eastern States and non-network alternatives
- pursuing a grid-scale battery energy storage project to support higher levels of intermittent renewable energy
- working with the Australian Energy Market Operator (AEMO) to address the changing requirements for system strength and frequency control to manage system security.

We continue to plan and prepare the network to accommodate the changing ways that electricity will be generated and consumed in the future.

As we plan the future, we are focused on providing meaningful opportunities for customers to have input and ultimately, help us improve the value of electricity transmission services in South Australia.





## Purpose of ElectraNet's South Australian Transmission Annual Planning Report

The South Australian Transmission Annual Planning Report provides information to interested parties on the current capacity and emerging limitations of South Australia's electricity transmission network.

The report includes:

- projections of electricity demand
- emerging network limitations or constraints
- information on completed, committed, pending, proposed and potential transmission network developments
- discussion of a system in transition at a time when the forces of change are unprecedented.

This information helps potential generators and customers to identify and assess opportunities to connect to the network.

This year's Transmission Annual Planning Report has been prepared at a time of significant transition in the National Electricity Market (NEM). Technological changes continue to be embraced by market participants and customers, and there are a significant number of reviews being performed and market rule changes being consulted on and implemented.

This overview touches on key points which are explored in greater detail in the full document available from [www.electranet.com.au](http://www.electranet.com.au).



# Our role in supplying electricity

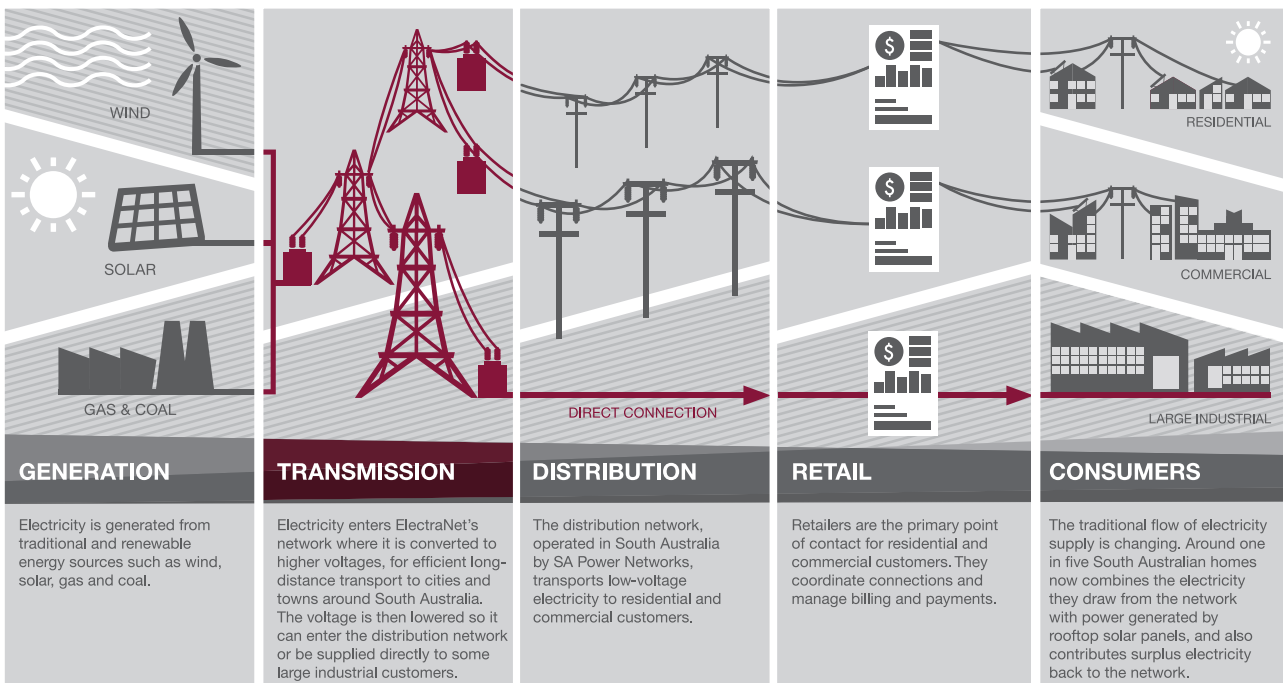
ElectraNet is the principal Transmission Network Service Provider in South Australia operating in the NEM.

South Australia's electricity transmission network is the backbone of the electricity supply system. Our network transports power generated from local and interstate sources to metropolitan, regional and remote areas of demand (load centres).

ElectraNet's direct customers include power generators, the state's electricity distributor SA Power Networks, and large industry. The services we provide also impact on the cost and reliability of electricity for customers that are connected to SA Power Networks' distribution network.

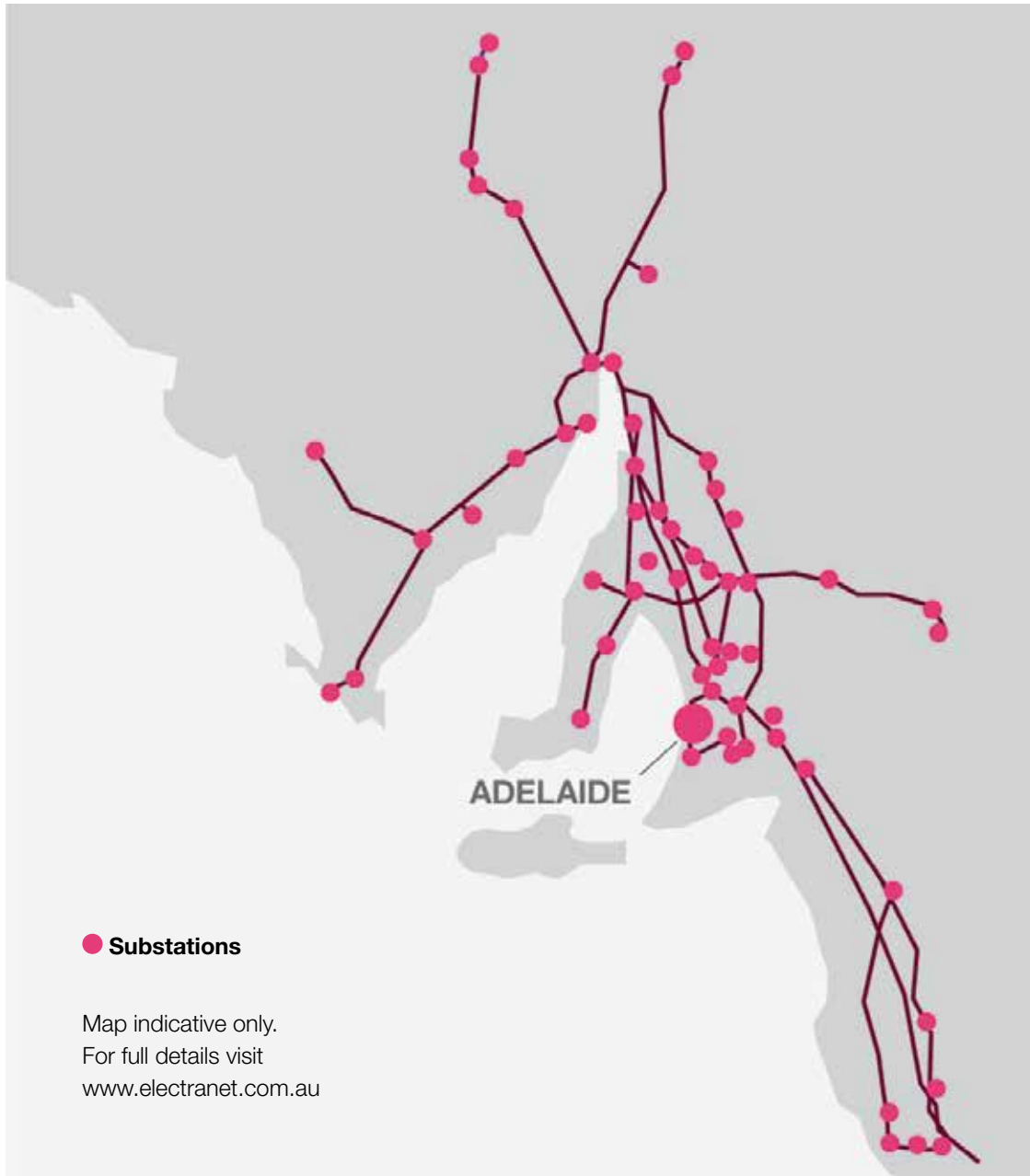
We are planning for the future – preparing for the changing way that electricity will be generated and used.

## How electricity gets to you



# The South Australian transmission system

The South Australian transmission network is made up of over 5,600 circuit kilometres of transmission lines and cables that operate at voltages of 275 kV, 132 kV and 66 kV, as well as 91 high-voltage substations with modern centralised monitoring, control and switching facilities.



# Highlights in 2017



## A system in transition

A strong, secure electricity transmission network is more important than ever. The report describes the positive contribution that ElectraNet is making towards the successful transformation of South Australia's electricity system.



## Delivery of the Heywood Interconnector Upgrade

The upgrade of the Heywood interconnector was completed in 2016, and is currently enabling imports of up to 600 MW and exports of up to 500 MW. The full 650 MW capacity in both directions will be released following the completion of inter-network testing, which is expected by the end of 2017.



## Grid connected battery storage

Subject to further analysis and approvals, we are pursuing a proof-of-concept battery energy storage project at Dalrymple by this coming summer, to improve power system reliability and security.



## Connection opportunities

This year we provide an increased level of detail about the ability of the South Australian system to accommodate additional generation, over a wide range of system demands and conditions.

# Demand forecasts

Transmission network planning is based on forecasts of maximum and minimum electricity demand<sup>1</sup>, to ensure the network has sufficient capacity and flexibility to reliably supply electricity across the full range of demand conditions. A decline in large industrial demand forecasts, the rapid uptake of rooftop solar PV systems and customer energy efficiency measures have all had an impact on reducing electricity consumption from the grid.

AEMO publishes an annual South Australian state-wide maximum and minimum demand forecast in June, as part of its National Electricity Forecast Report (NEFR). The AEMO NEFR demand forecast is based on econometric modelling and does not consider load requirements at a localised connection point level.

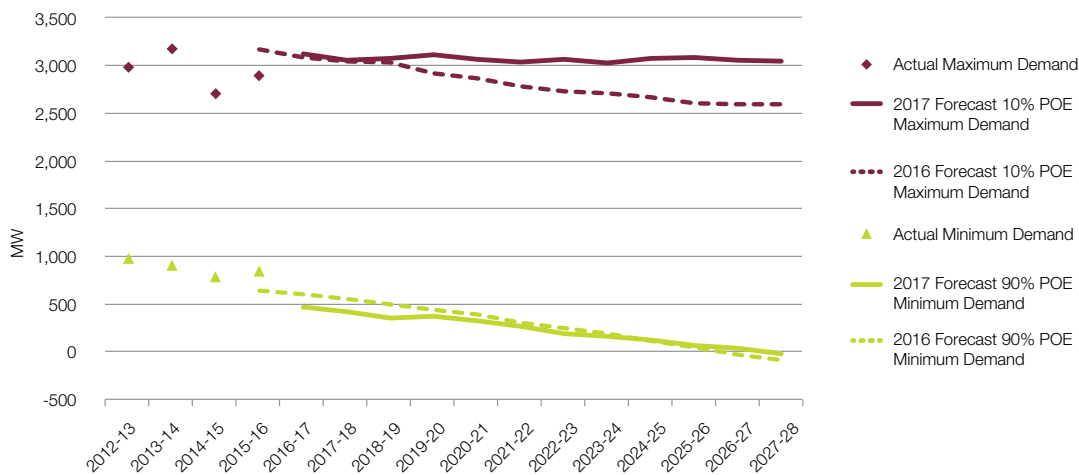
AEMO also publishes South Australian connection point maximum demand forecasts, most recently in July 2016.

SA Power Networks and customers connected directly to the transmission network annually provide demand forecasts for their connection points to the transmission network. ElectraNet uses these forecasts to develop regional demand forecasts, which are a key input to the planning and development of the transmission network.

AEMO's 2016 NEFR forecast South Australian state-wide 10% Probability of Exceedance (POE)<sup>2</sup> maximum demand to reduce steadily to around 2,600 MW by summer 2028-29, and then remain steady for the rest of the forecast period. Minimum demand is forecast to reduce rapidly, with zero net demand for the 90% POE minimum demand forecast expected to be reached by summer 2026-27 (in the middle of sunny minimum demand days).

AEMO's NEFR has been replaced by its National Forecasting Insights, which was not published at the time of this Transmission Annual Planning Report. However, we understand the 2017 NFI forecast maximum demand will remain steady at around 3050 MW for the central planning scenario, and that the minimum demand forecast will see operational demand reaching zero in South Australia one year later compared to the 2016 NEFR. These forecasts are shown below along with the 2016 NEFR used in the development of the 2017 TAPR.

## 2016 NEFR neutral growth forecasts



1 Electricity demand is the amount of electrical power (the rate at which energy flows) being consumed at any given time.

2 10% POE indicates a value that is expected to be exceeded, on average, once in every ten years.

## A system in transition

Driven by renewable energy policies, rapidly evolving technology and changing customer needs, South Australia has reached world-leading levels of intermittent renewable energy penetration as a percentage of peak demand, through large scale wind generation developments and rooftop solar photovoltaic (PV) installation.

The proportion attributable to renewables continues to grow, with approximately 42% of energy generated in South Australia coming from renewable energy sources since the commissioning of the Hornsdale Wind Farm and the closure of Northern Power Station. Government policies are expected to continue to drive this increasing

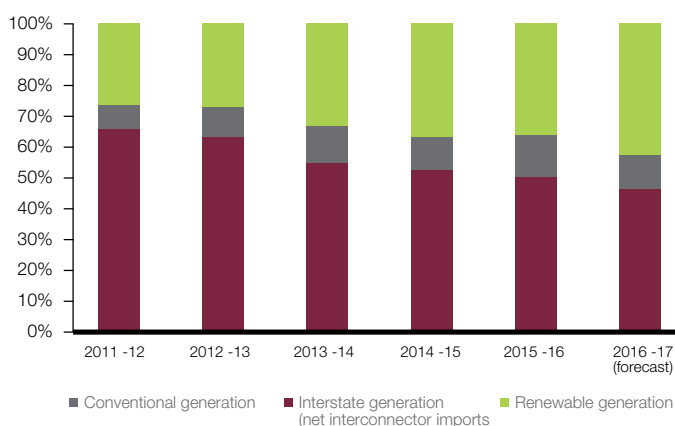
uptake. Overall, the generation mix has changed substantially in South Australia over in recent years, as shown in the graphs below.

South Australia has limited interconnection to the rest of the NEM, so has greater exposure to the system security challenges posed by high levels of renewable generation, unlike other parts of the world such as Denmark, which have greater interconnection to other networks.

For these reasons, the challenges of energy transformation are nowhere more evident, or pressing, than in South Australia today.

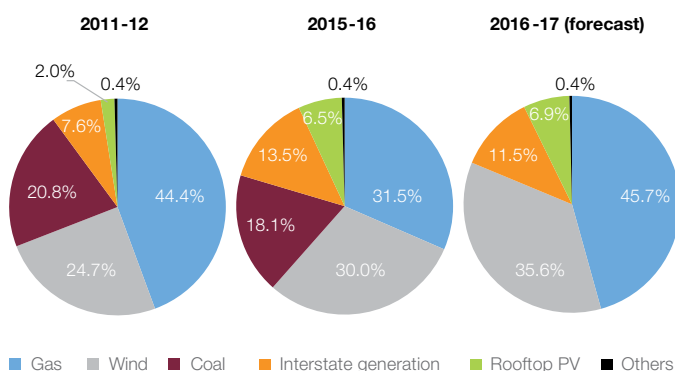
### Energy generation patterns have changed significantly in recent years.

Source: AEMO's 2016 South Australian Historical Market Information Report, and AEMO's 2016 South Australian Generation Forecasts report.



### Renewable energy from wind and rooftop solar photovoltaic systems has increased significantly in recent years.

Source: AEMO's 2016 South Australian Historical Market Information Report, and AEMO's 2016 South Australian Generation Forecasts report.





## South Australian Energy Transformation

On 7 November 2016, we published a Project Specification Consultation Report (PSCR) and subsequently published a Market Modelling Approach and Assumptions Report, and a Supplementary Information Paper to provide further information and opportunity for engagement.

A cost effective new interconnector would:

- deliver system security benefits by reducing the likelihood of a system disturbance leading to a major disruption to electricity supply
- facilitate greater competition between sources of generation and thus deliver better prices for customers, by allowing increased access to a range of power sources
- open up access to the market for more renewable generation developments.

ElectraNet has identified four credible network options in consultation with the relevant Jurisdictional Planning Bodies. These involve constructing a new interconnector between South Australia and the eastern states, together with a range of potential non-network solutions. The options will be analysed further in the next stage of the RIT-T process. This analysis will take into account the South Australian government's energy plan, released on 14 March 2017.

A new interconnector project, or non-network alternative, could be operational by 2022, but would only proceed if sufficient benefits to customers can be demonstrated.

## Grid connected battery storage

Subject to further analysis and approvals, we are pursuing a proof-of-concept battery energy storage project by this coming summer to improve the reliability and security of the power system.

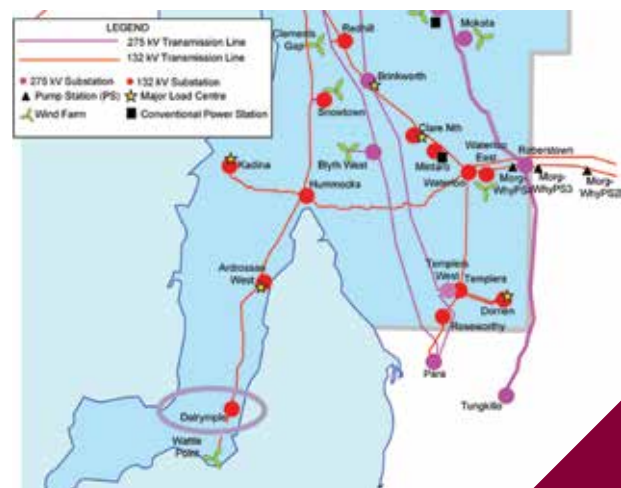
This project involves installing a 30 MW 8 MWh battery energy storage system (BESS) connected at Dalrymple. The project will provide both regulated and non-regulated services.

The BESS is intended to provide regulated services to improve reliability of supply for customers at Dalrymple and provide fast frequency response that can address rate of change of frequency (RoCoF) concerns.

ElectraNet intends to lease the operation of the battery to AGL, who will use it to provide non-regulated, competitive market services.

The need for such projects has also been identified in reviews such as the Finkel Review<sup>3</sup> and AEMO's Future Power System Security work program<sup>4</sup>, and by the COAG Energy Council.

We believe that utility scale energy storage can play an effective role in addressing emerging system security concerns resulting from the high penetration of non-synchronous renewable generation and, thereby, be a key enabler of renewable energy on an interconnected power system.



<sup>3</sup> The Finkel Review's Final Report was published on 9 June 2016, and is available at <http://www.environment.gov.au/energy/publications/electricity-market-final-report>

<sup>4</sup> Publications related to AEMO's Future Power System Security work program are available at <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/FPSSP-Reports-and-Analysis>

## Northern SA Voltage Control

In August 2016, ElectraNet commenced a RIT-T to address a need for improved voltage control in the northern South Australia region following the closure of Northern Power Station.

A Project Specification Consultation Report (PSCR) was prepared in accordance with the requirements of the Rules, as the first stage of the consultation process in relation to application of the RIT-T.

Subsequently, customers provided new information about the dynamic behaviour of customer demand at Olympic Dam, Roxby Downs, and Prominent Hill. The dynamic behaviour of this demand is critical to the identified need.

Our findings based on the new demand information provided by customers showed that voltage control in the northern South Australian region meets the requirements of the Rules. This means that the identified need for this RIT-T no longer exists.

For this reason, ElectraNet announced the cancellation of the RIT-T on 24 March 2017, as the continuation of the process was no longer required.

## Eyre Peninsula Electricity Supply Options

ElectraNet understands the importance of a reliable electricity transmission supply to regional areas such as the Eyre Peninsula and the contribution it makes to the ongoing development of the wider South Australian economy.

The extreme weather event of 28 September 2016 and other recent events have highlighted the importance of supply reliability to these areas and the impacts of extended outages.

The Eyre Peninsula is served by a radial 132 kV transmission line which runs from Cultana to Yadnarie to Port Lincoln. A radial 132 kV line also extends to Wudinna to supply the West Coast. The original line to Port Lincoln was established in 1967. We have in recent years been rebuilding and reinforcing the Cultana and Whyalla substations.

Supply to Port Lincoln is supported by a network support agreement, which expires in December 2018. Under this agreement, ElectraNet is able to call upon the services of three diesel-fired gas turbines connected at Port Lincoln when needed. The reliability standards require that ElectraNet provide “N-1” equivalent line capacity to the Port Lincoln exit point, so that back-up supply is available for Port Lincoln when supply from the 132 kV line is interrupted.

ElectraNet has been actively exploring options to replace or upgrade the transmission lines serving the Eyre Peninsula. Our most recent assessment of the condition of the line assets indicates that components of the line are nearing the end of their functional life and will need to be replaced in the next few years.

To enable this work, our plans include an allowance for the replacement of major transmission line components on the Eyre Peninsula at an estimated cost of approximately \$80m, involving replacing the line conductor in high priority sections of the lines.

Alternatively, the full replacement of the line (for example as a double circuit line) may be more cost effective and deliver greater benefits to Eyre Peninsula customers by potentially improving supply reliability and avoiding ongoing costs of generation support at Port Lincoln.

To take this forward, we are exploring the economic case for a full line replacement and alternative options in more detail. This involves undertaking the RIT-T, to assess the costs and benefits of alternative network and non-network solutions.

We will continue to actively monitor and maintain the condition of our lines on the Eyre Peninsula, to ensure the safety, security and reliability of transmission supply while the RIT-T process is undertaken.

We will also continue working closely with ESCOSA as the body responsible for setting reliability standards for South Australia’s transmission network as it reviews the reliability standard for the Eyre Peninsula following a recent request by the South Australian Treasurer and Minister for Energy.

Option	Description	Comment	Estimated cost (\$ million)
1	Continue network support arrangement at Port Lincoln and component replacement works on the existing 132 kV single-circuit transmission line	This option would also have significant operating costs for ongoing network support at Port Lincoln	80
2	Construct a new double circuit 132 kV transmission line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route	We will investigate the potential benefits of additional emergency restoration measures that may include network support  We will also consider the potential benefits of upgrading the Davenport to Cultana 275 kV transmission lines to further improve supply reliability and security to the Eyre Peninsula	200-300
3	Construct two single circuit 132 kV transmission lines following separated routes between Cultana and Port Lincoln	We will also consider the potential benefits of upgrading the Davenport to Cultana 275 kV transmission lines to further improve supply reliability and security to the Eyre Peninsula	200-350
4	Construct a double circuit 275 kV transmission line following a Cultana to Yadnarie and Yadnarie to Port Lincoln route	New lines to be operated initially at 132 kV  We will investigate the potential benefits of additional emergency restoration measures that may include network support  We will also consider the potential benefits of upgrading the Davenport to Cultana 275 kV transmission lines to further improve supply reliability and security to the Eyre Peninsula	280-380
5	Construct two single circuit 275 kV transmission lines following separated routes between Cultana and Port Lincoln	New lines to be operated initially at 132 kV  We will also consider the potential benefits of upgrading the Davenport to Cultana 275 kV transmission lines to further improve supply reliability and security to the Eyre Peninsula	400-550

## Planning outcomes

Our network planning accounts for a wide range of potential future developments. The table below summarises emerging limitations and their potential solutions across a range of areas.

Planning focus	Key outcomes
<b>Emerging system security issues (e.g. system inertia, system strength)</b>	<p>System security issues that may arise from low levels of system inertia and declining levels of system strength (as projected in AEMO's 2016 National Transmission Network Development Plan) could be addressed by:</p> <ul style="list-style-type: none"> <li>establishing a new interconnector between South Australia and the Eastern States to address emerging system security issues and provide net market benefits, as is being considered by the SA Energy Transformation RIT-T</li> <li>installing plant such as synchronous condensers.</li> </ul> <p>A grid-scale battery energy storage system is proposed for connection at Dalrymple to help improve system security and reliability</p>
<b>Connection points</b>	<p>The existing network support arrangement at Port Lincoln expires in December 2018</p> <p>A RIT-T has been commenced to determine the most cost effective way of continuing to meet the required reliability standard at Port Lincoln beyond that date. The outcome of this investigation could be significant network investment on the Eyre Peninsula (e.g. a new double circuit line from Cultana to Yadnarie to Port Lincoln) and/ or a new network support arrangement</p>
<b>Market benefit opportunities</b>	<p>A range of market benefit driven projects is proposed to reduce the impact of constraints and increase the capability of the transmission network, providing net market benefits</p>
<b>Maximum demand</b>	<p>South Australia's transmission network is projected to be adequate to supply forecast maximum demand for the duration of the planning period</p> <p>Augmentation may be needed to supply future significant individual load connections, particularly in the Upper North region, depending on their size and location</p>
<b>Minimum demand</b>	<p>As the minimum demand supplied by the transmission network is forecast to decrease, a series of 275 kV reactor investments (or similar) is needed to prevent voltage levels from exceeding equipment ratings if an unplanned contingency event was to occur at times of low demand</p>
<b>Maximum fault levels</b>	<p>Fault levels will remain within design and equipment limits for the duration of the planning period</p>
<b>Emergency control schemes</b>	<p>ElectraNet and AEMO are working together to develop a special protection scheme that will reduce the chance of islanding following a non-credible simultaneous loss of multiple generators within South Australia</p>

## RIT-T Consultations

There are two Regulatory Investment Tests for Transmission (RIT-Ts) currently active. In addition, there are several consultations that we are considering starting in the near future.

Project	Expected project commitment date	Consultation status
Managing Main Grid High Voltage Levels	Early 2018, for first stage completion in late 2018	Declining levels of minimum demand are forecast to reach levels from spring 2018 that may result in voltage levels on the Main Grid that exceed equipment ratings if a credible contingency event was to occur at low demand times  A PSCR is planned to be published in the second half of 2017
Eyre Peninsula Electricity Supply Options	2018, for completion by 2022	The current network support arrangement that enables ElectraNet to meet the ETC <sup>5</sup> category 3 reliability standard at Port Lincoln expires in December 2018, and significant portions of the conductor on the Eyre Peninsula 132 kV lines are in poor condition and need replacement  ElectraNet is currently considering the best way to continue to meet the ETC category 3 reliability standard at Port Lincoln and address the poor conductor condition  A PSCR was published in April 2017 and remains open for consultation until 21 July 2017 <sup>6</sup>
South Australian Energy Transformation	2018, for completion in 2022 or later	ElectraNet is investigating the feasibility of an additional interconnector between South Australia and the Eastern States, as outlined in the PSCR published in November 2016 <sup>7</sup>  A Project Assessment Draft Report (PADR) is planned to be published in the second half of 2017
Gawler East New Connection Point	2021, for completion in 2022	Application of the Regulatory Investment Test for Distribution (RIT D) is planned to begin with publication by SA Power Networks of a NNOR <sup>8</sup> for this project well before project commitment  Proponents of potential network support solutions will be encouraged to make a submission in response to the NNOR

<sup>5</sup> South Australian Electricity Transmission Code.

<sup>6</sup> Available from [electranet.com.au](http://electranet.com.au)

<sup>7</sup> Available from [electranet.com.au](http://electranet.com.au)

<sup>8</sup> Non-Network Options Report, which forms part of the Regulatory Investment Test for Distribution.

# Major Network Developments

## Completed Projects

During 2016-17 we completed the following major projects to remove network limitations and address deteriorating asset condition.

Project description	Region	Project Category	Asset in service
<p><b>Heywood interconnector upgrade</b></p> <p>The Heywood interconnector was incrementally upgraded to raise nominal transfer limits from <math>\pm 460</math> MW to <math>\pm 600</math> MW<sup>9</sup>. The upgrade included a third 500/275 kV transformer at Heywood terminal station (installed by AusNet Services in December 2015), series compensation<sup>10</sup> on the South East to Tailem Bend 275 kV lines, and reconfiguration of the existing 132 kV transmission system between Snuggery, Keith and Tailem Bend.</p>	Main Grid/ South East	Augmentation	July 2016
<p><b>SA Water Morgan-Whyalla Pump Station #3</b></p> <p>Rebuilt the Morgan to Whyalla pumping station #3 supply site to ensure continued supply reliability to critical water infrastructure.</p>	Riverland	Replacement	August 2016
<p><b>SA Water Morgan-Whyalla Pump Station #1</b></p> <p>Rebuilt the Morgan to Whyalla pumping station #1 supply site to ensure continued supply reliability to critical water infrastructure.</p>	Riverland	Replacement	September 2016
<p><b>Dalrymple Substation Upgrade</b></p> <p>Installed an additional 25 MVA 132/33 kV transformer and associated switchgear to meet ETC category 2 requirements.</p>	Mid North	Connection	November 2016
<p><b>Para SVC Secondary Systems</b></p> <p>Replaced Para SVC thyristor valves and valve cooling, protection and control systems that had reached their end of life, and installed and integrated a 50 Mvar switched 275 kV reactor, to ensure continued reliable voltage control on South Australia's 275 kV transmission system.</p>	Main Grid	Replacement	November 2016
<p><b>Tailem Bend – Keith #2 132 kV line insulator replacement</b></p> <p>All porcelain disc insulator assemblies that had reached end of life to ensure continued 132 kV line reliability.</p>	South East	Refurbishment	January 2017

<sup>9</sup> A market notice was issued on 5/08/2016 releasing a transfer limit of 600 MW. The next increment of 650 MW is on hold pending a review of frequency changes impacts.

<sup>10</sup> Series compensation reduces the "electrical distance" of a transmission line, thereby increasing the maximum possible power transfer over the line.

## Committed Projects

Committed projects are projects where the RIT-T has been completed (where required), and the ElectraNet board has given approval. ElectraNet is currently undertaking several committed projects which are expected to be completed in the near future.

Project description	Region	Project Category	Expected Service Date <sup>11</sup>
<b>SA Water Mannum-Adelaide Pump Station #2</b> Rebuild the Mannum to Adelaide pumping station #2 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	June 2017
<b>SA Water Morgan-Whyalla Pump Station #4</b> Rebuild the Morgan to Whyalla pumping station #4 supply site to ensure continued supply reliability to critical water infrastructure.	Mid North	Replacement	September 2017
<b>SA Water Mannum-Adelaide Pump Station #3</b> Rebuild the Mannum to Adelaide pumping station #3 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	September 2017
<b>Brinkworth – Mintaro 132 kV line remediation and insulator replacement</b> Porcelain disc insulator assemblies that have reached end-of-life will be replaced along with defective poles and cross arms, to ensure continued 132 kV line reliability.	Mid North	Refurbishment	November 2017
<b>Tailem Bend Substation Upgrade</b> Improve the circuit breaker arrangement to reduce constraints on the Heywood interconnector and improve network security and reliability.	Main Grid	Security / Compliance	November 2017
<b>SA Water Mannum-Adelaide Pump Station #1</b> Rebuild the Mannum to Adelaide pumping station #1 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	November 2017
<b>Para-Brinkworth-Davenport Hazard Mitigation</b> Replace load-releasing cross arms and all porcelain disc insulators, to ensure continued 275 kV line reliability.	Main Grid	Refurbishment	December 2018



<sup>11</sup> Subject to change – dates accurate at time of writing.

## Feedback

ElectraNet welcomes feedback on the Transmission Annual Planning Report, including suggestions for improving the value of the information provided in the future to all interested parties. Feedback can be provided to [consultation@electranet.com.au](mailto:consultation@electranet.com.au) or by calling us on +61 8 8404 7966.

Copies of the full document are available from [electranet.com.au](http://electranet.com.au)

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