



SOUTH AUSTRALIAN
TRANSMISSION
ANNUAL PLANNING
REPORT 2016

OVERVIEW

July 2016

 **ElectraNet**

Energy and infrastructure solutions
for a better world™

Introduction

The energy industry is changing at an increasing pace.

Customers now use, produce and value electricity services in different ways and are transforming electricity systems worldwide. Nowhere is this more evident than in South Australia where intermittent renewable energy penetration rates are the highest in the country and amongst the highest in the world.

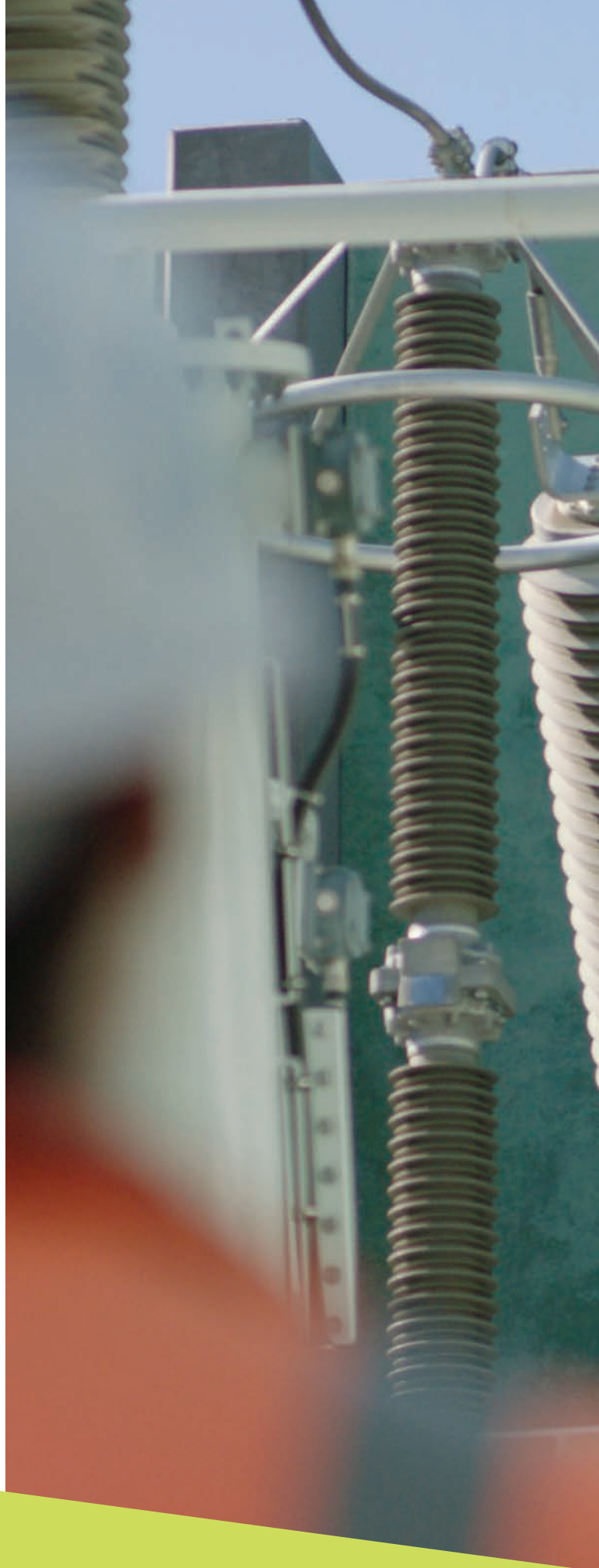
The closure of Northern Power Station in May this year and the continued growth of renewable generation, both wind and rooftop solar photovoltaics (PV), have dramatically altered the mix of electricity generation within South Australia. Strongly supportive Federal and State government policies are expected to drive further significant investment in renewable energy generation over the foreseeable future.

The transmission network continues to evolve to meet customers' changing needs and reflect new technology and supply options available at both the large and small scale, such as rooftop solar PV installations combined with battery storage.

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 for 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.

This year's Transmission Annual Planning Report has a heightened focus on responding to the increasing amount of intermittent renewable generation and the impact of reducing minimum demand forecasts.





Purpose of ElectraNet's South Australian Transmission Annual Planning Report

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

The report covers a ten year planning period and includes:

- Projections of electricity demand
- Emerging network limitations or constraints
- Information on completed, committed, pending, proposed and potential transmission network developments
- Information on what ElectraNet is doing to help address the increasing challenges of integrating high levels of renewable energy into the power system

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

This overview touches on key points which are explored in greater detail in the full document available from electranet.com.au.

Highlights in 2016



Integration of renewable energy

This year sees an increasing focus on the work we are doing to address the challenges posed by the continued increasing penetration of intermittent renewable energy.



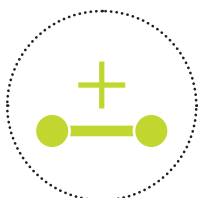
Demand forecasts

The Australian Energy Market Operator's (AEMO) 2015 National Electricity Forecasting Report (NEFR) included, for the first time, a forecast of minimum demand levels in South Australia. The forecast shows that minimum demand levels are expected to reduce dramatically over the forecast period. We have used AEMO's 2015 forecasts in our assessment of emerging network needs at times of low demand. Preliminary assessment of AEMO's 2016 forecasts shows that they may only have a slight impact on our plans.



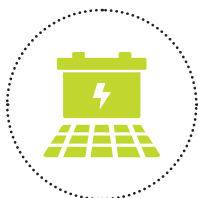
Impact of Northern Power Station closure

Northern Power Station ceased generation on 9 May 2016. As a result, we have identified a need for improved voltage control in the northern regions of South Australia. There is also significant interest in new generator connections in the area.



New interconnector feasibility study

Our pre-feasibility work shows that a new interconnector between South Australia and either New South Wales or Victoria may be economically and technically feasible. We intend to commence consultation on a range of interconnector options in September 2016.



Grid connected energy storage

We are applying for Australian Renewable Energy Agency (ARENA) funding to develop a large grid connected battery at Dalrymple, to provide a range of network and system security benefits. A funding decision from ARENA is expected in the second half of 2016.

Our role in supplying electricity

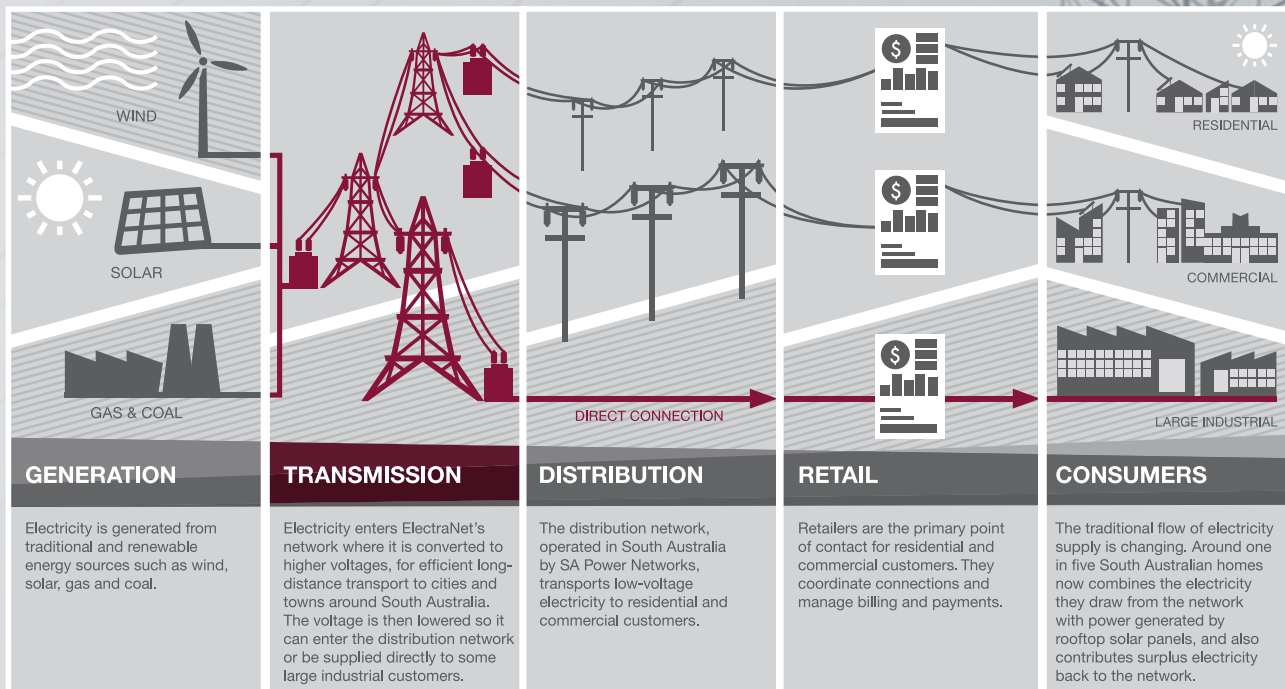
ElectraNet is the principal Transmission Network Service Provider in South Australia and operates in the National Electricity Market (NEM).

South Australia's electricity transmission network is the backbone of the electricity supply system that safely transports power generated from diverse local and interstate sources to metropolitan, regional and remote areas of demand.

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.

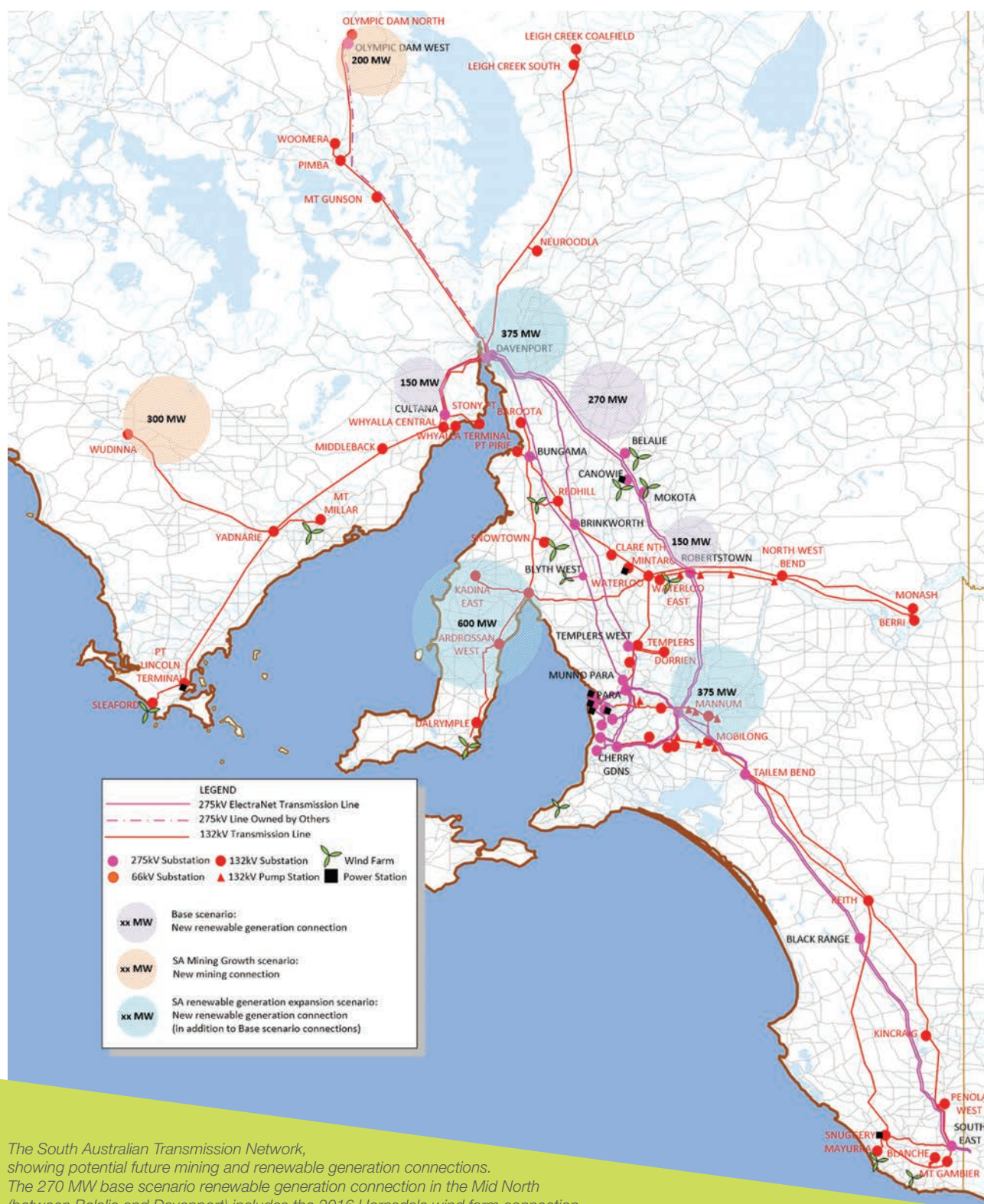
We are planning for the future – preparing for the changing way that electricity will be generated and used.

How electricity gets to you



The South Australian transmission network

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. It offers a range of opportunities for both new generator connections and resource-driven load developments.



The South Australian Transmission Network, showing potential future mining and renewable generation connections. The 270 MW base scenario renewable generation connection in the Mid North (between Belalie and Davenport) includes the 2016 Hornsdale wind farm connection.

Scenario planning outcomes

Network planning is increasingly challenging given the rate of change across the electricity supply system. The information and analysis presented in the 2016 TAPR is based on three planning scenarios, which represent differing assumptions about the future development of demand and generation in South Australia. The three scenarios are summarised in the table below.

For all scenarios, other key assumptions including generator plant retirements are unchanged from AEMO's 2015 National Transmission Network Development Plan.

Scenario	Description	Network reinforcement required (10-year planning outcomes)
Base	This is ElectraNet's central planning scenario.	Dynamic 275 kV reactive support at Davenport following the closure of Northern Power Station. Potential market benefits could be released with additional interconnector capacity.
SA Mining Growth	This scenario considers a number of potential mining loads, incorporating general information from connection enquiries that is generalised for long-term planning.	Dynamic 275 kV reactive support at Davenport following the closure of Northern Power Station. Significant network reinforcement in specific parts of the network, depending on actual mining developments driving this investment. Potential market benefits could be released with additional interconnector capacity.
SA Renewable Generation Expansion	This scenario represents a further possible expansion of SA wind generation, above that already included in the base scenario. It is based on connection enquiries, which have been generalised for long-term planning.	Dynamic 275 kV reactive support at Davenport following the closure of Northern Power Station. Moderate network reinforcement to avoid significant network congestion at maximum demand times. At low demand times, wind generation output may be limited by the ability to export power from South Australia. Potential market benefits could be released with additional interconnector capacity.

Demand forecasts

Transmission network planning is based on forecasts of maximum and minimum electricity demand¹, to ensure the network has sufficient capacity and flexibility to reliably supply electricity to all connection points across the full range of demand and supply 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 their 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 October 2015.

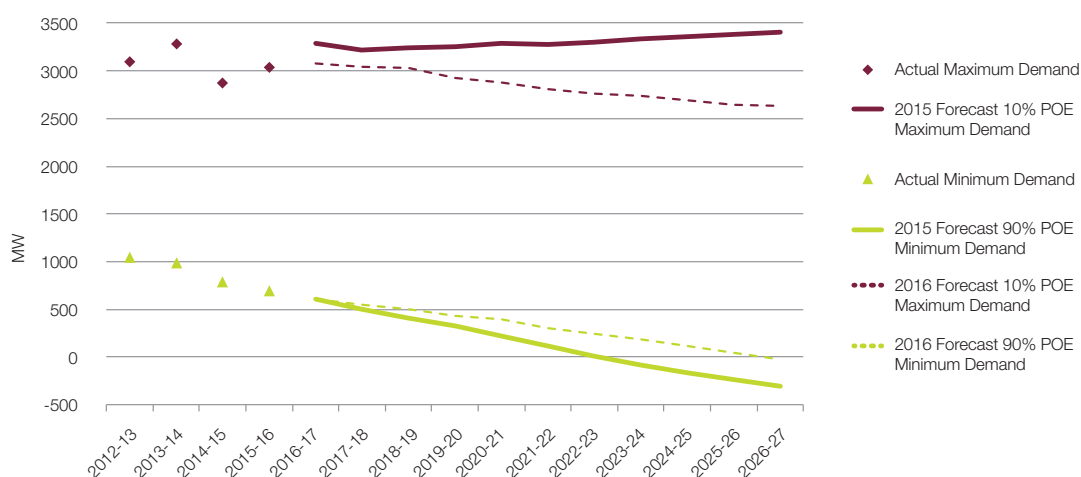
SA Power Networks and customers connected directly to the transmission network annually provide demand forecasts for their connection points to the transmission network. ElectraNet uses these forecasts to develop regional demand forecasts which are a key input to the planning and development of the transmission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

AEMO's 2015 NEFR forecast South Australian state-wide demand to increase modestly over the outlook period. More dramatically, it also included a forecast of minimum demand levels for South Australia, showing a forecast of zero net demand at times on the transmission network by 2023-24 (in the middle of sunny minimum demand days).

AEMO published the 2016 NEFR in June 2016, which has South Australian forecasts that differ significantly from those in the 2015 NEFR. 10% Probability of Exceedance (POE)² maximum demand is now forecast to reduce steadily to around 2,600 MW by summer 2028-29, and then remain steady for the rest of the 20 year forecast period. Minimum demand is forecast to continue to reduce rapidly, but at a slower rate than indicated in the 2015 NEFR. Zero net demand for the 90% POE forecast is now expected to be reached in summer 2028-29.

Despite the significant change in AEMO's minimum and maximum demand forecasts, we expect they will only have a minimal impact on our current plans. However, we will review the impact of the new forecasts before we submit our 2018-23 revenue proposal in January 2017.

2015 and 2016 NEFR operational demand³ forecasts



¹ Electricity demand is the amount of electrical power (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 10 years.

³ Operational demand is the amount of electrical power that is drawn from the transmission network at any given time. It does not include the demand that is supplied by embedded generation, eg rooftop solar PV.

An emerging challenge – integrating renewable energy

In recent years, renewable energy generation has increased as a proportion of the total generation mix across the NEM. However, South Australia has by far the highest intermittent renewable energy penetration of any NEM region and has world-leading penetration levels of renewable generation compared to demand. This has been driven by the quality of solar and wind resources available as well as supportive State Government policies.

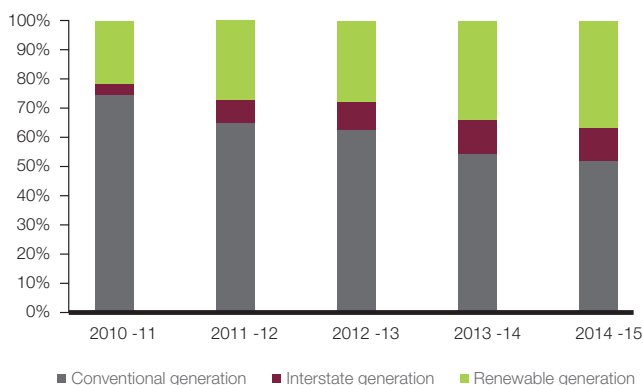
As the penetration of intermittent renewable generation has increased in South Australia, the contribution from conventional generators has reduced, as shown in the graph below, which draws on AEMO's 2015 South Australian Historical Market Information Report.

ElectraNet expects that strongly supportive current and future government policies will continue to influence renewable energy deployment and in particular drive ongoing investment in wind and solar energy generation.

South Australia may continue to attract a significant proportion of this investment due to the high quality of wind and solar resources available in the State, especially if a new interconnector can unlock the opportunity for more renewable energy to be exported to New South Wales or Victoria.

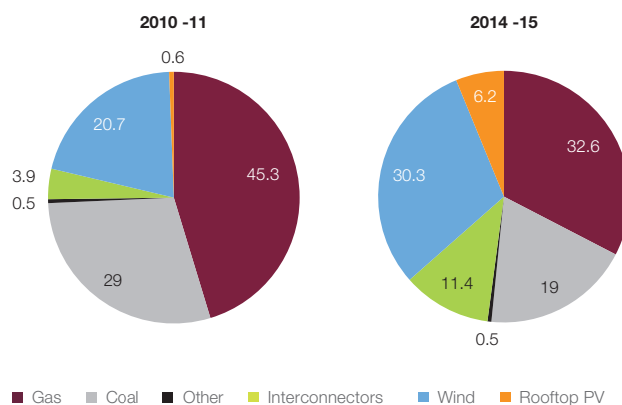
Energy generation patterns have changed significantly over the last five years.

Source: AEMO's 2015 South Australian Historical Market Information Report



Renewable energy from wind and rooftop solar photovoltaic systems has increased significantly over the last five years.

Source: AEMO's 2015 South Australian Historical Market Information Report





Impact of Northern Power Station closure

While providing a significant source of baseload supply, Northern Power Station (NPS) also performed an important transmission network voltage control service in the Upper North region of South Australia, until it ceased electricity generation on 9 May 2016.⁴ The withdrawal of NPS will create increasing challenges for transmission network voltage control in the Upper North and Eyre Peninsula regions during certain system operating conditions. We have performed system studies to identify potential network adequacy and security limitations resulting from the withdrawal of NPS. These studies, and a review of past operational experience, have revealed reactive power margin, voltage collapse and over-voltage limitations under certain credible demand and generation scenarios.

Improved voltage control in the northern regions of South Australia is needed, and we will initiate a Regulatory Investment Test for Transmission (RIT-T) to identify the most economic network or non-network solution that resolves the issue. There is interest from a number of proponents in developing new generation in the area, including large-scale solar thermal at Port Augusta.⁵



Additional interconnector capacity

We have undertaken a pre-feasibility assessment of the costs and likely benefits of increasing the level of interconnection between South Australia and the Eastern states that would also address system security concerns in South Australia.

The outcome of this work shows the potential for a new interconnector to be economically feasible. The South Australian government is contributing \$500,000 towards a detailed feasibility study.⁶

In the pre-feasibility assessment, we assessed the likely benefits of a new transmission link between Robertstown in South Australia and Darlington Point in New South Wales, with an estimated cost of about \$500 million in total, to be shared across the regions. The assessment indicated that such an interconnector would likely deliver sufficient market benefits to customers and producers of electricity, and warrants further investigation.

This will now be explored in more detail with TransGrid, the transmission network service provider for New South Wales, and AEMO as the planning authority for Victoria. It will also be subject to extensive consultation with electricity consumers and industry stakeholders.

We intend to commence a RIT-T consultation in September 2016. The RIT-T will consider a range of potential interconnector options to either New South Wales or Victoria, and also seek alternative solutions that might deliver similar market benefits. Expected market benefits include NEM wide fuel cost savings, capital investment savings and improved system security and reliability outcomes for customers in South Australia and elsewhere in the NEM. Any final investment decision will be subject to a rigorous regulatory process with oversight by the Australian Energy Regulator.

A potential new interconnector would further build upon the benefits provided by the upgrade of the existing South Australia to Victoria (Heywood) interconnector, that is nearing completion.



Grid connected energy storage

ElectraNet has examined the business case for medium to large scale (5–30 MW) non-hydro energy storage systems support intermittent renewable energy integration in South Australia, through the Energy Storage for Commercial Renewable Integration – South Australia (ESCRI-SA) project. This project has been partly funded by ARENA and was performed by a consortium consisting of AGL, ElectraNet and Advisian.

⁴ Alinta Energy news announcement on 9 May 2016, available at: <https://alintaenergy.com.au/about-us/news/augusta-power-station-ceases-generation>

⁵ <http://reneweconomy.com.au/2016/hewson-backed-company-plans-170mw-solar-thermal-baseload-power-plant-for-port-augusta-76729>

⁶ Department of State Development, State Budget 2016/17: Study into new interconnector, 14 June 2016, available at <http://www.statedevelopment.sa.gov.au/news-releases/all-news-updates/state-budget-2016-17-study-into-new-interconnector>

ESCRI-SA Phase 1 was completed in December 2015 with the final report suggesting a potential Phase 2 delivery and testing project involving a 10 MW, 20 MWh Energy Storage Device (ESD) located on the Yorke Peninsula and providing a range of network and market services. However, the business case for such an asset was poor.

The project was subsequently reconfigured as a 30 MW, 8 MWh battery and is being presented to ARENA for funding support.

We are confident that utility scale energy storage can play an effective role in addressing emerging system security concerns resulting from a high penetration of intermittent renewable generation and thereby be a key enabler of intermittent renewable energy on an interconnected power system.



Reduced minimum fault currents (system strength)

System strength is related to fault current, which is the electrical current that flows when a fault occurs on the system – that is, when one or more electrical conductors contact the ground or each other. The contact could be direct or through a mediating material such as a tree branch. If allowed to continue, fault currents present a safety risk to people and equipment. Protective devices are installed throughout the system to mitigate any risk by quickly disconnecting any part of the system where a fault occurs.

These protective devices require a minimum level of fault current to detect fault conditions and operate as designed.

Conventional generators generally contribute more fault current than existing intermittent renewable technologies such as wind turbines and solar PV farms. This means that fault currents are expected to decrease as conventional generation is displaced from the system by intermittent renewables. This may introduce several challenges into the electricity system.

ElectraNet is investigating the impacts of reduced system strength and considering whether:

- protective devices and power electronic devices on the transmission system and distribution network can continue to perform satisfactorily
- existing wind farms can continue to ride through disturbances without being disconnected
- reactive plant, such as reactors and capacitors, can continue to be switched without exceeding sudden voltage change limits.

Preliminary results indicate that existing wind farms will still be able to ride through disturbances without being affected, and reactive plant connected to the transmission network will still be able to be switched without exceeding sudden voltage change limits.

However, there may be a significant number of transmission lines where protective devices will be unable to detect all faults at times of low fault current. We are currently determining whether this could be fixed by replacing or upgrading the relevant protective devices. Alternatively, a more substantial investment, such as the installation of large synchronous condensers in strategic network locations, could help to maintain suitable levels of minimum fault currents as well as providing additional benefits to system security.

We plan to provide a further update on this work in the second half of 2016.

RIT-T Consultations

There are no Regulatory Investment Tests for Transmission (RIT-Ts) ⁷ currently active. However, ElectraNet completed one RIT-T consultation in the last year, and there are several consultations that we are considering starting in the near future.

Project	Project timing	Consultation status
Baroota Connection Point Upgrade Install a second transformer to meet ETC ⁸ reliability standard for category 2.	2017	<p>Application of the RIT-T indicated that the available network and non-network options were unable to provide a positive net market benefit.</p> <p>As proposed by ElectraNet, the Essential Services Commission of South Australia (ESCOSA) amended the ETC to remove the requirement for Baroota connection point to be upgraded to meet the category 2 reliability standard.</p>
Energy Storage for Commercial Renewables Integration in South Australia Install a large grid connected battery at Dalrymple to improve reliability and provide market benefits.	2018	<p>If this project is funded by ARENA, ElectraNet will prepare a project specification consultation report (PSCR) for planned issue towards the end of 2016.</p> <p>Proponents of potential non-network solutions will be encouraged to make a submission in response to the PSCR.</p>
Eyre Peninsula Supply Arrangements Continue to meet ETC reliability standard for category 3 at Port Lincoln, and address poor condition on the Eyre Peninsula 132 kV lines.	2018-22	<p>The current network support arrangement that enables ElectraNet to meet the ETC category 3 reliability standard at Port Lincoln expires in June 2018.</p> <p>ElectraNet will be consulting on the best way to continue to meet the reliability standard, and to address poor conductor condition on the Eyre Peninsula 132 kV lines.</p> <p>We plan to issue a PSCR in the second half of 2016. Proponents of non-network solutions will be encouraged to make a submission in response to the PSCR.</p>
Gawler East New Connection Point Establish a new 132 kV connection point for SA Power Networks.	2019	<p>Application of the Regulatory Investment Test for Distribution (RIT-D) ⁹ is planned to begin with publication by SA Power Networks of a NNOR ¹⁰ for this project before the end of 2016.</p> <p>Proponents of potential non-network solutions will be encouraged to make a submission in response to the NNOR.</p>
Northern SA Voltage Control Improve voltage control in the northern region of South Australia following the closure of Northern Power Station.	2019	<p>ElectraNet is currently preparing a PSCR, planned for issue in July 2016.</p> <p>Proponents of potential non-network solutions will be encouraged to make a submission in response to the PSCR.</p>
South Australia New Interconnector Investigate the potential of a new interconnector to provide market benefits and improve South Australian system security.	~2023	<p>ElectraNet is currently preparing a PSCR, planned for issue in September 2016.</p> <p>Proponents of potential non-network solutions will be encouraged to make a submission in response to the PSCR.</p>

⁷ The public economic benefit test administered by the Australian Energy Regulator that must be undertaken for all distribution augmentation projects with economic options estimated to cost more than \$5 million.

⁸ The public economic benefit test administered by the Australian Energy Regulator that must be undertaken for all transmission augmentation projects with economic options estimated to cost more than \$6 million.

⁹ South Australian Electricity Transmission Code

¹⁰ Non-Network Options Report, which forms part of the Regulatory Investment Test for Distribution

Major Network Developments

Completed Projects

During 2015-16 we completed the following major projects to remove network limitations and address deteriorating asset condition.

Project description	Region	Project category	Asset in service
Neuroodla 132/33 kV connection point replacement Rebuilt the substation within the existing substation site to ensure continued supply reliability to this part of the Upper North region.	Upper North	Replacement	July 2015
Munno Para New 275/66 kV connection point A new 275/66 kV 225 MVA connection point substation was built at Munno Para, to address limitations on SA Power Networks' distribution network.	Metropolitan	Augmentation	August 2015
Robertstown – North West Bend #1 and #2 132 kV line uprate Increased the line rating by providing increased conductor clearances.	Riverland	Augmentation	October 2015
South East additional 275 kV circuit breakers Improved the circuit breaker arrangement to reduce constraints on the Heywood Interconnector and improve network security and reliability.	Main Grid	Security and compliance	December 2015
Para Unit asset replacements Replaced poor condition 275 kV, 132 kV and 66 kV secondary systems along with associated telecommunications systems, control buildings and selected primary plant at the Para substation.	Metropolitan	Replacement	March 2016
Davenport Under-voltage Load Shedding Implemented an under-voltage load shedding scheme on the Olympic Dam exit at Davenport substation as a short term measure to mitigate risk of voltage collapse following closure of Northern Power Station.	Main Grid	Security and compliance	April 2016
SA Water Morgan-Whyalla Pump Station #2 Rebuilt the Morgan to Whyalla pumping station #2 supply site to ensure continued supply reliability to critical water infrastructure.	Riverland	Replacement	May 2016

Committed projects

Committed projects have received all internal and external approvals, including the RIT-T, where required. We are currently undertaking the following major committed projects.

Project description	Region	Project Category	Expected Service Date ¹¹
SA Water Morgan-Whyalla Pump Station #3 Rebuild the Morgan to Whyalla pumping station #3 supply site to ensure continued supply reliability to critical water infrastructure.	Riverland	Replacement	July 2016
Heywood interconnector upgrade Incrementally upgrade Heywood interconnector from a nominal transfer limit of ± 450 MW to ± 650 MW. The upgrade includes installation of a third 500/275 kV transformer at Heywood terminal station (installed by AusNet Services in December 2015), series compensation on the South East to Tailem Bend 275 kV lines, and reconfiguration of the 132 kV transmission system between Snuggery, Keith and Tailem Bend.	Main Grid/ South East	Augmentation	July 2016 ¹²
SA Water Morgan-Whyalla Pump Station #1 Rebuild the Morgan to Whyalla pumping station #1 supply site to ensure continued supply reliability to critical water infrastructure.	Riverland	Replacement	September 2016
Dalrymple Substation Upgrade Install an additional 25 MVA 132/33 kV transformer at Dalrymple substation and associated switchgear to meet ETC category 2 requirements.	Mid North	Connection	November 2016
Tailem Bend – Keith #2 132 kV line insulator replacement Replace porcelain disc insulator assemblies that have reached end of life to ensure continued 132 kV line reliability.	South East	Refurbishment	November 2016
SA Water Morgan-Whyalla Pump Station #4 Rebuild the Morgan to Whyalla pumping station #4 supply site to ensure continued supply reliability to critical water infrastructure.	Mid North	Replacement	November 2016
Brinkworth – Mintaro 132 kV line remediation and insulator replacement Replace porcelain disc insulator assemblies that have reached end-of-life and defective poles and cross arms, to ensure continued 132 kV line reliability.	Mid North	Refurbishment	November 2016
Para SVC Secondary Systems Replace Para SVC thyristor valves and valve cooling, protection and control systems that have reached end of life, and install and integrate a 50 Mvar switched 275 kV reactor, to ensure continued reliable voltage control on South Australia's 275 kV transmission system.	Main Grid	Replacement	November 2016

¹¹ Subject to change – dates accurate at time of writing

¹² Following installation of the series compensation by this date, testing will be undertaken and be followed by the gradual release of additional interconnector capacity by AEMO.

Project description	Region	Project Category	Expected Service Date
SA Water Mannum-Adelaide Pump Station #3 Rebuild the Mannum to Adelaide pumping station #3 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	May 2017
Tailem Bend Substation Upgrade Improved the circuit breaker arrangement to reduce constraints on the Heywood Interconnector and improve network security and reliability.	Main Grid	Security / Compliance	June 2017
SA Water Mannum-Adelaide Pump Station #2 Rebuild the Mannum to Adelaide pumping station #2 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	July 2017
SA Water Mannum-Adelaide Pump Station #1 Rebuild the Mannum to Adelaide pumping station #1 supply site to ensure continued supply reliability to critical water infrastructure.	Eastern Hills	Replacement	July 2017
Para-Brinkworth-Davenport 275 kV Hazard Mitigation Replace load-releasing cross arms and all porcelain disc insulators, to ensure continued 275 kV line reliability.	Main Grid	Refurbishment	September 2017





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 or by calling us on +61 8 8404 7966.

Copies of the full document are available from electranet.com.au

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The purpose of this document is to provide information about ElectraNet's assessment of the transmission system's likely capacity to meet demand in South Australia over the next ten years. It also provides information about ElectraNet's intended plans for augmentation of the transmission network. This document is not to be used by any party for other purposes, such as making decisions to invest in further generation, transmission or distribution capacity. This document has been prepared using information provided by, and reports prepared by, a number of third parties.

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