2015 ESOO METHODOLOGY

Methodology for the Electricity Statement of Opportunities

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AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

AEMO has prepared the 2015 Electricity Statement of Opportunities (ESOO) to provide technical and market data and information which can be used to assess opportunities in the National Electricity Market, as at the date of publication. This paper provides more detail about the methodology used in the 2015 ESOO, and modelling results.

AEMO publishes the ESOO in accordance with clause 3.13.3(q) of the National Electricity Rules.

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Acknowledgement

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CHAPTER 1. INTRODUCTION

The purpose of this document is to provide further information on the following:

- The methodology used to develop the 2015 Electricity Statement of Opportunities (ESOO).
- The detailed modelling results that accompany the 2015 ESOO.

AEMO continues to improve the focus and clarity of its planning publications, presenting succinct key points in the main document, and publishing detailed accompanying information, including the methodology, separately.

AEMO has used the same time-sequential model which was used in the 2014 ESOO. This model performs optimised electricity dispatch for every hour in the modelled horizon.

CHAPTER 2. ESOO MODELLING

2.1 Aims and scope

The ESOO assesses the adequacy of existing and committed supply to inform stakeholder decision-making. It highlights opportunities for generation and demand-side investments.

In 2015, assessing supply adequacy for the ESOO involved detailed computer modelling that simulated the behaviour of the system at hourly resolution, including the following:

- The availability of generation capacity, accounting for planned and unplanned outages.
- Demand-side participation activity.
- The impact of network limitations and congestion.
- The intermittent nature of wind and rooftop solar installations.
- Electricity demand projections under both moderate and extreme weather conditions.[1]

Simulation outputs are compared against the system reliability standard (explained below). The assessment is conducted over a 10-year outlook period, with results presented on a regional basis.

In the context of the NEM, reliability refers to the likelihood of having sufficient supply to meet demand. It is measured in terms of accumulated unserved energy over time, and is expressed as a percentage of the total energy requirement over the same timeframe.

The Reliability Standard established by the Australian Energy Market Commission (AEMC) Reliability Panel defines the minimum acceptable level of reliability to be met in each region, and places a limit on the amount of expected unserved energy. The NEM Reliability Standard states that, over the long term, the maximum expected unserved energy in any region should not exceed 0.002% of the region's total annual energy consumption.

A low reserve condition (LRC) point indicates a year when unserved energy is projected to exceed the Reliability Standard. An LRC point does not necessarily signify that load shedding will occur, but continued operation with low reserve indicates the system may not meet the Reliability Standard over the long term.

[1] Represented in the 2015 ESOO as 50% probability of exceedance (POE) and 10% POE demand conditions.

2.1.2 Inter-regional reserve sharing

The LRC points are presented on a regional basis, but take into account the scope for reserve-sharing by neighbouring regions, since the modelling is conducted on a NEM-wide basis. The amount of capacity that can be contributed between regions via interconnectors mainly depends on the demand diversity between regions, network losses within regions, and transmission network limitations such as interconnector power transfer capability.

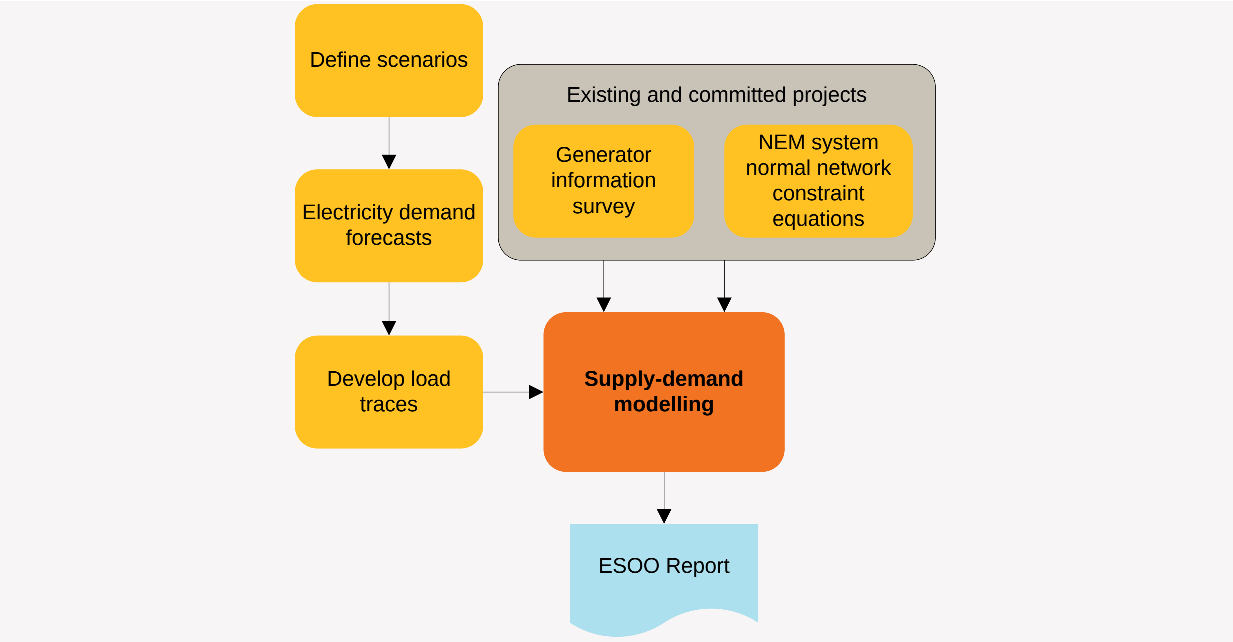
Demand diversity is the extent to which demand varies between regions. For instance, if one region had a high level of demand while a neighbouring region concurrently had a low level of demand, there would be a high level of demand diversity. Reserve-sharing allows a region's supply-demand outlook to be optimised so that regions with excess available capacity can support neighbouring regions that are unable to meet their reserve requirements locally.

2.2 Inputs

Supply adequacy results are particularly sensitive to aspects of the power system that change over time, such as demand diversity, the location and reliability of installed generation capacity, and significant transmission network augmentations.

Figure 1 shows the key inputs to the supply-demand modelling. Inputs are updated as new information becomes available.

Figure 1 ESOO modelling inputs and outputs



Each of the inputs in Figure 1 is described in further detail below.

- **Define scenarios.** AEMO undertook scenario-based modelling in the ESOO, with each scenario representing a narrative of how future environmental, political, and economic conditions may change. These narratives were used to create detailed assumptions that govern the growth of demand over time. AEMO and the industry-based Scenarios Working Group developed three scenarios representing high, medium and low energy consumption for both gas and electricity from centralised sources.[4] The same scenarios were used for 2015 National Electricity Forecasting Report (NEFR) modelling.

- **Electricity demand forecasts**. These are published in the NEFR each year. Section 2.3.1 provides detail on how demand is reflected in the ESOO modelling.
- **Develop load traces**. See Section 2.3.1 and step one of the modelling methodology in Section 2.3.
- **Generator information survey**. AEMO surveys generators each year to obtain the latest information on generation forecasts, including information on the status of committed and proposed projects. The results from this survey are summarised on the Generator Information page on AEMO's website.[5]
- **NEM system normal network constraint equations.** A representative set of system normal network constraint equations for the NEM was developed and input into the model to ensure system security.

2.3 Methodology

The steps for the ESOO modelling methodology using the time-sequential model were as follows:

1. The annual energy and maximum demand forecasts were fitted to profiles to create demand traces for each probability of exceedence (POE) studied. A detailed description of the trace development process used for AEMO's planning studies is available from the Planning Assumptions webpage.[6]
2. The time-sequential model was run over the 10-year outlook period reported in the ESOO. The output from the model included the regional unserved energy (USE), enabling assessment of the supply–demand balance.
3. The year in which the weighted unserved energy exceeds 0.002% was identified (see below for more information on weightings). The financial year in which weighted USE equals or exceeds the 0.002% reliability standard is the low reserve condition (LRC).

Weighting

AEMO's time-sequential modelling used weighted 50% and 10% POE demand conditions to determine USE. The following weights were applied to the USE:

- 30.4% for 10% POE.
- 69.6% for 50% POE.

See Section 4.1.3 of the 2013 Planning Consultation Methodology and Input Assumptions[7] document for further information on deriving weighting factors.

2.3.1 Modelling and reporting demand in the ESOO

For consistency across planning publications, operational consumption has been used in the 2015 ESOO unless specified otherwise.[8] However, as a result of the demand trace development process,

[4] AEMO. Available: http://www.aemo.com.au/Electricity/Planning/Related-Information/~/media/Files/Other/forecasting/2014_Planning_and_Forecasting_Scenarios.ashx Viewed 30 June 2015.
[5] AEMO. Available: http://www.aemo.com.au/Electricity/Planning/Related-Information/Generation-Information. Viewed 30 June 2015.
[6] AEMO. Demand Trace Development for the 2012 National Transmission Network Development Plan, 12 June 2013. Available: http://www.aemo.com.au/Electricity/Planning/Related-Information/~/media/Files/Other/planning/Demand_Traces_Development.ashx. Viewed 30 June 2015.
[7] AEMO. 2013 Planning Consultation Methodology and Input Assumptions. 12 June 2012. Available: http://www.aemo.com.au/Electricity/Planning/Related-Information/2013-Planning-Assumptions. Viewed 19 June13.
[8] For instance, as described in Section 3.2.1, the wind contribution to peak demand calculations used total demand, not operational consumption. Where operational consumption has not been used, it has been specified.

adjustments were made to the NEFR demand projections to align the demand forecasts with supply assumptions made in the modelling process.

The NEFR published a list of power stations used for operational and annual energy demand forecasts in each state.[9] The list of generators used in operational demand for each region formed the basis of the generation and demand modelled in the ESOO. Angaston was included in the South Australian generators as it is a significant non-scheduled non-wind generator that has an impact on network constraint equations.

CHAPTER 3. ACCOMPANYING INFORMATION

The accompanying information derived from the 2015 ESOO modelling that is published on AEMO's website includes:

- The Prophet model database.
- The constraint workbooks for both Prophet and PLEXOS.
- A series of data files containing the modelling results.

The Prophet model database, containing a representation of all the input assumptions, is made available to stakeholders for use in modelling or as reference material.

The constraint equations modelled in the ESOO are published alongside the Prophet database in Excel format for use by stakeholders in other modelling tools. AEMO understands that market modelling is often completed in PLEXOS, and so has also released the constraints in the PLEXOS format.

AEMO continues to update and refine constraints through its modelling projects throughout the year, and welcomes feedback to incorporate into future studies where possible.

3.1 Modelling results

Five spreadsheets accompany the ESOO, one spreadsheet for each NEM region. Each spreadsheet contains the following figures and underlying data for each of the three economic growth scenarios (high, medium, and low).

- The chart shown in Section 4 of the ESOO for each region, which shows (and provides data for):
  - Yearly 10% and 50% POE maximum demand.
  - The percentage of USE against the 0.002% reliability standard.
  - The maximum "firm" generation capacity (see Section 3.1.1 for further detail).
  - Any LRC points within the outlook period.

  Section 3.1.1 provides a guide to interpreting this chart.
- A supply–demand chart for the region, presenting monthly energy modelling output in MWh of the following parameters:
  - Energy demand.
  - Generation by type (coal, hydro, gas, wind, other).
  - Import/export, where exports are shown below the x-axis, but equal to the additional energy generated within the region above the demand required.
  - Energy pumped to storage (where applicable), which represents the energy required to pump water for hydro generation.

[9] See Appendix E of the NEFR Methodology Information Paper. AEMO. Available: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report-2013/NEFR-Supplementary-Information-2013.

- A supply–demand chart for the region, presenting monthly modelling output in MW of the following parameters against a weighted 10% POE and 50% POE maximum demand (see Section 2.3):
  - Weighted maximum demand.
  - Import at weighted maximum demand.
  - Export at weighted maximum demand.
  - Unmet load at weighted maximum demand (USE).
  - Generation.
- An import/export chart depicting the total imports and exports from the region for each year.

3.1.1 Interpreting the ESOO adequacy chart

Figure 2 shows an example of the adequacy chart provided for individual NEM regions in the 2015 ESOO report. The chart summarises the results from the supply–demand modelling relevant to supply adequacy for that region over the 10-year outlook period. In particular, it highlights any USE for that region compared to the Reliability Standard as described in Section 2.1.1, which enables the LRC point (if any) to be derived. Several regions in the 2015 ESOO do not have an LRC point so no chart is provided.

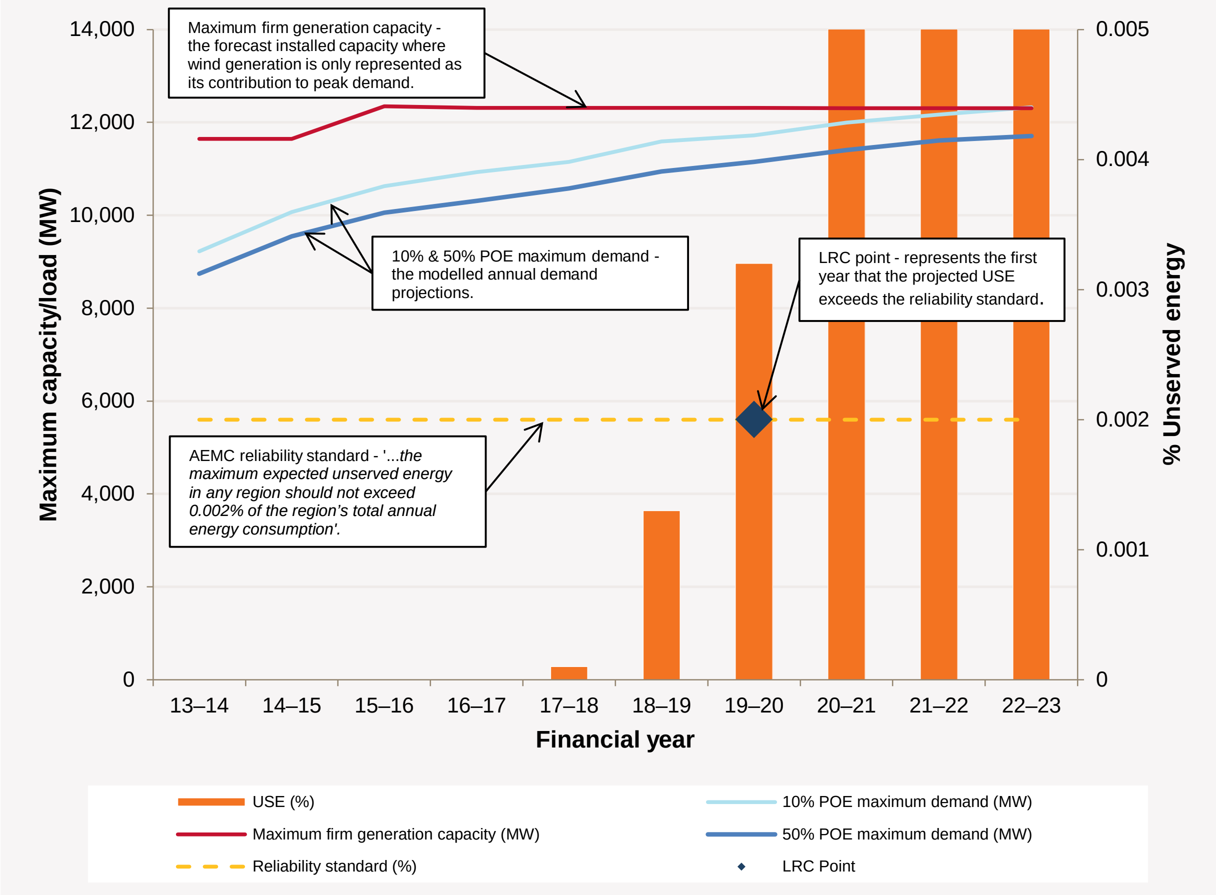
Of note, the maximum firm generation capacity figure shown only includes firm wind generation capacity for peak demand. For instance, if a region's scheduled and semi-scheduled generation capacity is 4,000 MW (excluding wind generation), there is 400 MW of additional installed wind capacity and an assumed wind contribution to peak demand of 7%[10], the maximum firm generation capacity represented in the chart would be:

4,000 + (400 x wind contribution to peak demand (7%)) = 4,028 MW.

There are times when the modelled wind output exceeds these firm generation capacities. The ESOO simulations assume houlry wind output profiles, derived from historical data. See section 4.7.1 of the 2013 Planning Consultation Methodology and Input Assumptions for further information on wind profiles.

[10] See Section 3.2.1 for further information on the methodology for developing the wind contribution to peak demand.

Figure 2 Example ESOO adequacy chart



3.2 NEM Historical Market Information report

The NEM Historical Market Information report[11] is included in the ESOO document suite, and provides historical demand, generation, inter-regional power flows, regional spot prices, inter-regional settlements residue, and wind contribution to peak demand.

3.2.1 Wind contribution to peak demand

The wind contribution to peak demand presented in the NEM Historical Market Information report is analysed for each region using historical generation data obtained from AEMO's systems. The analysis starts from the time at which each wind farm was fully installed and started transmitting energy to the NEM.

The top 10% of seasonal demand periods for each region is selected; summer refers to the period 1 November to 31 March, and winter refers to the period 1 June to 31 August for all regions.[13] The Tasmanian wind contribution to peak demand was recognised to have unique qualities among the regions, given that generators tend to respond to combined Tasmanian and Victorian demand, via Basslink (the Victoria–Tasmania interconnector). For this reason, wind contribution in Tasmania was measured during the top 10% of the combined Tasmanian and Victorian demand periods.

Non-scheduled wind farms in the NEM are generally treated as negative load elements when recording demand. This means that non-scheduled generators lower the total demand in the region by the

[11] Available: http://www.aemo.com.au/Electricity/Planning/Electricity-Statement-of-Opportunities.
[13] The standard definition of summer for Tasmania for the ESOO and electricity planning is usually 1 December to 28 February.

amount of electricity they generate. To adjust for this, and ensure that the total demand figures reflect actual demand levels, the total for each non-scheduled wind farm is added to the corresponding regional demand. For the abovementioned periods, the wind output as a percentage of the installed capacity for each region is then calculated and used to produce a frequency analysis.

The wind contribution factor is taken at the 85% confidence level. That is, it gives a percentage of installed capacity that can be expected to generate during high demand periods 85% of the time.

The Queensland region was not studied, as there was insufficient wind farm data available.

3.3 Changes from 2014

The ESOO methodology is unchanged since 2014 and the only major reporting difference is the reintroduction of the adequacy charts into the report.