Wholesale electricity market performance report 2018

Methods and assumptions

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AUSTRALIAN
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Contents

Background

The National Electricity Law (NEL)[1] requires the AER to monitor the wholesale market and report on its performance at least every two years. Particularly, the NEL[2] stipulates that the report must contain a discussion and analysis of the monitoring methodology applied and the results of indicators, tests and calculations preformed.

This methodology document contains a discussion of the analysis undertaken in our *Wholesale electricity market performance report 2018 (the performance report)* and aims to communicate how we have use data sources to form metrics as supporting evidence. It includes information on metrics we have had regard to in the performance report, the method we have applied, the data sources for our analysis, and references to the relevant figures in the performance report.

In addition, we have also published *Wholesale electricity market performance report 2018 - LCOE modelling approach, limitations and results* which sets out our approach in estimating the underlying costs for a range of new entrant generators in the long run. We also published the Statement of Approach[3] and 2018 Focus[4], which provide information on the general approach we have taken in the performance report.

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[1] National Electricity Law, Part 3 Division 1A
[2] The NEL, Section 18C(3)(d)
[3] AER, Wholesale electricity market performance monitoring, Statement of approach
[4] AER, Wholesale electricity market performance monitoring, 2018 Focus

1 Electricity generation by fuel source and renewable generation as share of total generation

What is this metric?

Electricity generation by fuel source is the total generation output in the NEM as a whole as well as each NEM region. It describes the proportion of output from each fuel type each financial year.

Renewable generation share of total generation is the total renewable generation output in the NEM as a share of total NEM generation output, particularly output from solar farms, wind and rooftop solar PV.

Where is the data from?

Other than rooftop PV, data is sourced from AEMO's Market Management System database. Rooftop PV data is sourced from other published datasets from AEMO[5].
The data is organised by financial year, with the exception of Rooftop PV prior to 2016–17. Calendar year data is used for Rooftop PV prior to 2016–17 (2015–16 uses 2016 data etc.).

Reference to figure in Wholesale electricity market performance report 2018

Figure 2.1 and figure 2.2

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[5] http://nemweb.com.au/#rooftop-pv-actual
http://forecasting.aemo.com.au/Electricity/AnnualConsumption/Operational

2 Volume weighted average price

What is volume weighted average price?

Volume weighted average (VWA) price is a measure of average wholesale electricity price for each NEM region. This metric is useful in showing trends in average prices in the market.

Quarterly VWA price is the sum of spot price multiplied by native demand in each region for every 30 minute trading interval in a financial quarter, then divided by the sum of all native demand in each region for every 30 minute trading interval in a financial quarter. Likewise annual VWA price is calculated on annual basis.

The contribution to VWA price by each price band is calculated by summing the product of spot price and native demand *only when* spot prices are within the defined bands, then divided by the sum of all native demands for *every* 30 minute trading interval in a financial quarter.

Where is the data from?

Spot price for each 30 minute trading interval in each region and native demand in each region are sourced from AEMO's Market Management System database.

What factors are considered?

- Resolution

The spot price data used is in 30 minute trading intervals (average of the last six 5 minute trading intervals). Demand data is in 30 minute trading intervals.

- Demand

The AER defines native demand as the sum of initial supply and total intermittent generation in a region.

- Price bands

The price bands used are prices less than or equal to $0; greater than $0 and less than or equal to $50; greater than $50 and less than or equal to $100; greater than $100 less than or equal to $200; greater than $200 and less than or equal to $300; greater than $300 and less than or equal to $1000; greater than $1000 and less than or equal to $5000; greater than $5000.

- Regions

VWA price is calculated for each NEM region.

Reference to figure in Wholesale electricity market performance report 2018

Figure 2.3, figure 2.4 and figure 2.6

3   Price setter by fuel type

What is price setter?

The price in the NEM for each region is set every five minutes. For each region, the highest priced offer needed to meet demand sets the price every 5 minutes (dispatch price). Every 30 minutes, the six dispatch prices are averaged to determine the spot price and generators that were dispatched are paid this price for the electricity they produce regardless of how they bid. There can be more than one unit contributing to setting the price. The market operators dispatch algorithm co-optimises energy and FCAS offers to come up with the cheapest option for supply to meet demand.

Price setter by fuel type shows which fuel type contributed to setting the price every five minutes in each NEM region.

Where is the data from?

Data is sourced from AEMO's Market Management System database.

How we determined who set price?

AEMO publishes data which identifies what contributed to setting the price every five minutes. This can contain units, constraints and interconnectors. It can also contain other markets, such as FCAS, that contributed to setting the price for energy.

We determined which units contributed to setting the price every five minutes. Then looked at what fuel source that unit used and gave it a count of one for that five minutes.

We then added up the counts of each fuel type and divided it by the number of five minute intervals in that period for each region to make it a percentage.

We also calculated the average price when each fuel type was setting price. This was done by adding the offer prices together of each fuel type then dividing it by the number of dispatch intervals in that period.

- Exclusions

We didn't include constraints or interconnectors as contributing to price setter as they don't have a fuel type.

We were only concerned with energy offers so we did not include when FCAS offers contributed to setting the price in the energy market.

- Assumptions

If there were two units setting a price both with the same fuel type, they were counted as one occasion for that fuel type each five minutes. If they were different fuel types setting a price then each fuel type would get a count for that five minutes. This is why the total can be more than 100 per cent.

Reference to figure in Wholesale electricity market performance report 2018

Figure 2.7, figure 4.2, figure 4.3 and figure 4.6

4   Local and global FCAS

What is local frequency control ancillary services (FCAS)?

When a region has to supply its own FCAS it is deemed to be local, the rest of the time it is global (NEM wide). This usually occurs at the ends of the network where the regions are only connected to a single region i.e., Queensland, South Australia and Tasmania.

Where is the data from?

Data is sourced from AEMO's Market Management System database.

How we determined local FCAS price?

If the price of a region differs from the NSW price (a proxy for the global price) and there is a local dispatch of FCAS in that region then we deemed it to be local.

Reference to figure in Wholesale electricity market performance report 2018

Figure 2.11 and figure 4.14

5 Market share by generation capacity

What is market share by capacity?

Market share by capacity represents the potential share that an organisation has to provide to the market. It does not reflect the actual generation or real time capacity of that organisation. Due to various factors, an organisation's market share by capacity may not be consistent with its generation market share due to factors such as plant outages, intermittent generation, and fuel supply.

Where is the data from?

Summer capacity of power generators is reported to AEMO by participants. This information is published by AEMO on their generation information page[6].

Information used to determine trading rights for each power station is from a range of publicly available sources, including company websites, annual reports, media statements and ASX announcements.

What factors are used in determining market share by capacity?

- Resolution

Market share by capacity is based on summer availability, for January of each year, except wind, which is adjusted for an average contribution factor.

- Interconnectors

Interconnector are not included in market share calculations, and are reported separately.

- Regions

Market share is calculated for each NEM region.

- Trading rights

Trading rights for each power station are attributed to the organisation that has control over the generation output. In the case of intermittent generation with Power Purchase Agreements (PPA), the trading rights are attributed to the organisation that receives the energy under the PPA, and not to the owner or operator of the generator.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.1

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[6] http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information

6 HHI by bid availability

What is HHI by bid availability?

HHI (Herfindahl-Hirschman Index) is a useful metric to summarise market concentration, by tallying the sum of squared market share percentages of all firms in a market. The index can range from close to zero (in a market with many small firms) to 10 000 (for a monopoly). In a financial year, a region in the NEM will have 105 120 HHI values representing each 5 minute dispatch interval in that year. It measures the degree of market concentration that accommodates the intermittency of all forms of generation, due to, for example, plant outages, fuel supply or other reasons.

Where is the data from?

The bid availability data is sourced from AEMO's Market Management System database.

Information used to determine trading rights for each power station is from a range of publicly available sources, including company websites, annual reports, media statements and ASX announcements.

What factors are used in determining HHI by bid availability?

- Resolution

Bid availability for an organisation in each NEM region is obtained for each 5-minute dispatch interval over a specific time period.

- Regions

HHI is calculated for the NEM as a whole and each NEM region.

- Trading rights

Trading rights for each power station are attributed to the organisation that has control over the generation output. In the case of intermittent generation with PPA, the trading rights are attributed to the organisation that receives the energy under the PPA, and not to the owner or operator of the generator.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.3 and figure 3.4

7 Regional interconnector flows

What is regional interconnector flows?

Interconnectors allow transfer of generation between NEM regions. Most of the time, energy flows from lower priced regions to higher priced regions, which allows competition to occur across regions. Regional interconnector flows looks at flows into and out of each NEM region through interconnectors and sums up total energy import and export.

Where is the data from?

Interconnector flows are sourced from AEMO's Market Management System database.

What factors are used in determining regional interconnector flows?

- Resolution

Flows across each interconnector in the NEM are measured every five minutes by AEMO in MW, and then converted to MWh to determine the energy imported into or exported from the region. Total quarterly import and export energy for a region is presented by summing all five minute measurements.

- Regions

Quarterly total energy import and export are calculated for each NEM region.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.8

8 Price alignment across regions in the NEM

What is price alignment?

Price alignment between regions occurs when dispatch price in all regions are set by one or more generators at the same price. However prices may vary slightly from region to region to account for transmission losses, depending on the distance between the price setting units to the region. When price alignment occurs, the generation capacity in the exporting regions (usually priced cheaper) offers competitive constraint in importing regions (usually with higher priced generation) to achieve most economic dispatch of electricity.

Where is the data from?

The occurrences of price alignment between regions can be calculated from interconnector flows and limits dataset. When the flow into a region on an interconnector is below its limit, an interconnector is said to be unconstrained. When this occurs, the dispatch prices in the two regions connected by the interconnector can be set by the next cheapest offer in the bid stack in those two regions (meaning prices will be aligned in the two regions). When a region has two or more interconnectors from the same neighbouring region, price alignment can occur as long as one interconnector is unconstrained, even if others may be flowing at their limits. Price alignment between regions can therefore be deduced by working out when interconnectors are unconstrained from flow and limit datasets.

The interconnector flow and limit data is sourced from AEMO's Market Management System database.

What factors are used in determining price alignment?

- Resolution

Interconnector flow and limit data is obtained for every 5-minute dispatch interval over a specific time period.

- Interconnectors

Data from all interconnectors in the NEM was used to calculate price alignment, including Queensland to NSW Interconnector, Terranora Interconnector, Victoria to NSW, Basslink, Heywood Interconnector and Murraylink.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.9 and figure 3.10

9 Residual Supply Index

What is Residual Supply Index?

Residual Supply Index (RSI) is the percentage of demand that can be met by all but the largest n participants in a region. An RSI-1 greater than 1 means demand can be fully met without dispatching the largest generator (n = 1) in a region. But an RSI–1 below 1 means the largest generator becomes pivotal to meeting demand. Various factors may cause the RSI–1 index to deteriorate over time, including a rise in demand, a decrease in available generation capacity, or an increase in the proportion of available capacity supplied by the largest generator.

Where is the data from?

The RSI calculation includes generator availability, regional demand and interconnector limits. These data is sourced from AEMO's Market Management System database.

Information used to determine trading rights for each power station is from a range of publicly available sources, including company websites, annual reports, media statements and ASX announcements.

How is RSI calculated?

- RSI calculation

The methodology used for the RSI is described below.

For RSI-n:

$$RS1-n = \frac{total\ region\ availability\ -\ region\ availability\ of\ n\ largest\ participants}{region\ demand}$$

where,

total region availability = availability offered to the market by generators for a given trading interval plus interconnector import limits, for a specified region.

region availability of largest participant = availability offered to the market by the participant with the largest availability for a given trading interval, for a specified region. Therefore, the 'largest participant' may be not be the same for all trading intervals.

region demand = Total Demand, as defined by AEMO, for a given trading interval, for a specified region. If an interconnector is forced to export from the given region, it is treated as additional demand in the region.

- Resolution

RSI is calculated for each trading interval over a specified time period.

- Interconnectors

Interconnector import limits are added to 'total region availability', as interconnector flows are additional MW that are available to meet demand within the region. Interconnector export limits are not considered in RSI calculation except for when interconnectors are forced to export.

- Regions

Residual Supply Index is calculated for each region.

- Trading rights

Trading rights for each power station are attributed to the organisation that has control over the generation output. In the case of intermittent generation with PPA, the trading rights are attributed to the organisation that receives the energy under the PPA, and not to the owner or operator of the generator.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.11, figure 3.12 and figure 3.13

10 Future contracts – monthly change in open interest

What is monthly change in open interest?

Monthly change in open interest is the change in the total number of open or outstanding future contracts in a month. It is an indication for liquidity in the future contracts market.

Where is the data from?

The open interest data for futures contracts is sourced from the Australian Securities Exchange (ASX)[7].

How is monthly change in open interest calculated?

Monthly change in open interest is calculated by summing daily changes in open interest for each month. Daily change is calculated by subtracting the previous days open interest from the current day open interest.

Reference to figure in Wholesale electricity market performance report 2018

Figure 3.14

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[7] https://www.asxenergy.com.au/

11 Average quarterly offers by threshold

What is an offer?

Participants can use up to ten different price bands to offer their capacity into the NEM. The price bands must be between the price floor -$1000/MWh and the price cap $14 500/MWh.

Where is the data from?

Data is sourced from AEMO's Market Management System database.

How is average quarterly offered by threshold calculated?

As participants can offer capacity at any price between the price floor (-$1000/MWh) and price cap ($14 500/MWh) we created price thresholds in order to effectively display the data. The thresholds were chosen on this occasion to highlight the changes in offers between $50 and $150/MWh which is where average prices have been in recent times.

The average quarterly offers are calculated by taking the offers for every half hour and summing up the total capacity offered in each threshold then dividing it by the number of trading intervals in that quarter.

- Assumptions

Fixed load is part of an offer which effectively gives AEMO a target that a unit must run at. We treat this as an offer priced less than $0/MWh as the unit has to be dispatched.

Reference to figure in Wholesale electricity market performance report 2018

Figure 4.1, figure 4.4, figure 4.7, figure 4.8 and figure 4.9

12 Fuel cost conversion

What is fuel prices?

Fuel prices can be given in different ways. For example, gas prices could be given in $/GJ or $/MWh. If we want to compare fuel costs to capacity offered then it needs to be in the same measure, in this case $/MWh.

Where is the data from?

Gas prices come from the STTM hubs and the Victorian declared wholesale gas market.

Coal prices come from globalCOAL and uses Newcastle coal price index as a reference price for spot thermal coal at Newcastle Port in NSW[8]. This data is in $US.

How is fuel costs conversion calculated?

- Gas

To turn the gas price which was collected in $/GJ into $/MWh we used the following formula.

$/MWh = gas cost ($/GJ) x heat rate (GJ/MWh)

For gas we used a constant heat rate of 8 GJ/MWh.

- Coal

To turn coal prices in $US/tonne in to AUD $/MWh we used the following formula.

$/MWh = Coal cost ($US/tonne) x exchange rate[9] (monthly average) x heat rate (GJ/MWh) / low heating value (GJ/tonne).

We used a constant heat rate of 9 $/GJ and a low heating value of 23 GJ/tonne

For more information on heat rates and fuel costs see the LCOE modelling approach, limitations and assumptions paper.

Reference to figure in Wholesale electricity market performance report 2018

Figure 4.2

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[8] The globalCOAL methodology is available at https://www.globalcoal.com/coalprices/newcindexmethodology.cfm

[9] Exchange rate sourced from Macrotrends, www.macrotrends.net

13 Late rebidding

What is late rebidding?

Under the National Electricity Rules a late rebidding period is defined as "In respect of a trading interval, the period beginning 15 minutes before the commencement of the trading interval" [10]. In other words any rebid made within 45 minutes from the end of a trading interval it is effective in is a late rebid.

Where is the data from?

Data is sourced from AEMO's Market Management System database.

How we determined a late rebid?

Participants can bid units one or many at a time (portfolio bid). As late rebidding is about giving others time to respond to a change we have included portfolio bids as one count because it is one change in conditions. For example, if a station has six units and four of these units were rebid at the same time then we count that as one rebid (not four).

AEMO publishes the time a rebid was submitted. We take that time and subtract it from the end time of the trading interval that the rebid is effective in. If the time is within 45 minutes then we count it as a late rebid and break that down into 5 minute increments from the end of the trading interval.

Reference to figure in Wholesale electricity market performance report 2018

Figure 4.13, figure A.1 and figure A.2

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[10] National Electricity Rules, Chapter 10

14 Short term physical withholding

What is short term physical withholding?

For this report short term withholding is where a participant has withdrawn all the capacity of a unit within the pre-dispatch time frame (after 12 pm the day before).

Where is the data from?

Data is sourced from AEMO's Market Management System database.

How we determined short term withholding?

We looked at rebids that were made within the pre-dispatch time frame and checked to see if the rebid reduced the availability of a unit to zero and, if so, then it got a count of one. We then classify the rebid based on the categories in our Rebidding and Technical Parameters Guideline[11] which should be in the rebid reason:

A – AEMO forecast or dispatch change

P – plant or physical change

F – financial or commercial change

E – rebid to address an error

As this is only in a guideline, the way participants place this in their rebid reason is not enforceable, and so we get many variants. We have developed IT systems to extract the category from the data set, but it is not always present and is not always able to be found even if present.

Reference to figure in Wholesale electricity market performance report 2018

Figure A.3

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[11] https://www.aer.gov.au/wholesale-markets/market-guidelines-reviews/rebidding-and-technical-parameters-guideline-2017