Generator operating earnings approach and limitations

Wholesale electricity market performance report 2020

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1 Introduction

To inform the AER's assessment of wholesale electricity market performance, one factor we must consider is whether participants hold a reasonably sustainable position in the market.[1] In our *Wholesale electricity market performance report 2020* (the performance report) we modelled generator operating earnings to inform our assessment.

This technical paper is complementary to the analysis in the performance report. While the performance report contains the results of the analysis and calculations performed, this document summarises the method and assumptions applied in our modelling.

1.1 Background

The National Electricity Law (NEL) requires the AER to monitor the wholesale market and report on its performance at least every two years.[2] We are required to identify and analyse whether:

- there is 'effective competition' within the relevant wholesale market, as defined in the NEL,
- there are features of the market that may be detrimental to effective competition within the market,
- there are features of the market that may be impacting detrimentally on the efficient functioning of the market and the achievement of the national electricity objective.

This monitoring and reporting role supports the efficient operation of the wholesale electricity market as it allows early detection of issues affecting market performance.

1 NEL, Section 18B (a).

2 National Electricity Law, Part 3, Division 1A.

2 We modelled the relationship between operating costs and potential earnings for generators

We modelled the relationship between the operating costs and potential earnings of generation technologies in the National Electricity Market (NEM). In particular we have focused on mainland regions where technology options for generators are most diverse. In addition to earnings from the spot market alone, we have included simplified contracting models to replicate common generator contracting behaviour (Chapter 3). The use of contracts to provide revenue certainty and support generation is a common practice by all generators.

Our assessment covers the 6 year period from 2014-15 to 2019- 20 and relies on publicly available information.[3] This includes:

- Spot market generation and regional spot price data from AEMO's Market Management System database (MMS).
- Generator specific information, such as operating and maintenance costs and performance characteristics from AEMO's national transmission planning studies, the *Integrated System Plan* (ISP) and *National Transmission Network Development Plan* (NTNDP).
- Fuel prices for each region from gas spot market data and international coal price sources such as globalCOAL
- ASX Energy contract prices and other contracting information, which we used to inform the contracting strategies and contract revenue adjustments.

Using public data to determine the financing strategies and arrangements for all participants is challenging as individual participants will have different operating costs and potential earnings. The results presented by our analysis cannot therefore be seen as representing the profitability or viability of any individual participant or participant group.

2.1 What did we model?

We modelled spot revenue, generator operating earnings and generator operating costs.

In this analysis we refer to revenue and operating earnings as 2 separate concepts. For the purposes of this analysis, revenue is total income earned from generation before costs, while operating earnings is revenue less operating costs. In addition, we have modelled 2 variants of revenue. Spot revenue is income earned only from the spot market. Contract adjusted revenue accounts for generators engaging in risk management through contracting, and adjusts spot revenue with simple contracting assumptions.

2.2 Which generators did we include?

While our analysis considered most generators in the NEM, we excluded some generators to avoid potentially distorting our results (Table 1).

In our analysis we included generators registered in the market scheduled, market semi-scheduled and market non-scheduled categories. We excluded generators classified as non-market, non-scheduled as there are only a few of them and their behaviour may be governed by factors external to market operations. For the report, we aggregated our analysis by generation technology.

AEMO's MMS reports output from some generators before they are fully operational. For example, generators undergoing commissioning may operate at low levels for extended periods to verify or test their systems. So, to avoid potentially distorting our results, we excluded generators that were in the process of commissioning, or that were mothballed in a particular financial year from the 'by fuel type' analysis.

[3] The NEL requires us to use public information in the first instance.

Table 1 Generators excluded from our analysis

Generation Technology	
Brown coal	Excluded any plant that was mothballed in a year for example, Anglesea, Morwell
Black coal	Excluded any plant that was mothballed in a year, for example Wallerwang
Natural gas (CCGT)	Does not include Queensland Nickel, Sithe and Yarwun as their operational decisions may be governed by other factors outside of electricity market operations.
Natural gas (OCGT)	Does not include dual-fuelled OCGTs, this excluded Oakey, Hallet.
Wind	Commissioning plant was excluded in the year it was being commissioned
Solar	Commissioning plant was excluded in the year it was being commissioned

3 Methodology

As we are required to use publicly available information in the first instance, we have largely relied on information published by AEMO. A full list of our input assumptions and sources is in Appendix A.

3.1 Spot revenue and contract revenue calculation

We modelled spot revenue, as well as contract-adjusted revenue for all technologies. For contract-adjusted revenue we modelled generator revenue using base and cap contracts as well as power purchase agreements (PPA).[4]

For each, we performed the following calculations:

- Spot revenue = Generation as dispatched * Spot price * Marginal Loss Factor
- Base contract revenue = Spot revenue + (VWA base price – average spot price) * contracted capacity
- Cap contract revenue = Spot revenue + (VWA cap price – final cap price) * contracted capacity
- PPA contracts = PPA price * dispatch volume of relevant year

Where:

- VWA base price = sum of (trade volume * trade price) / total traded volume, this was calculated separately for each region from quarterly base futures for that region.
- VWA cap price = sum of (trade volume * trade price) / total traded volume, this was calculated separately for each region from quarterly caps for that region
- The VWA is for every trade over the period that the product is traded.

To determine the revenue per megawatt hour (MWh) for a generation technology, we divided the revenue by that technology's total output for a financial year.

3.2 Contract market data and setting contract levels

Contracting behaviours affect a generators ultimate revenue.

We modelled contract adjusted revenues for each generation technology using ASX Energy data, applying assumptions around the level and type of contracts sold.[5] These assumptions include:

- Generators contract for about 80% of the total energy traded in the NEM
- 75% of all contracts are base swaps, and the remainder are cap contracts.
- Different technologies prefer different contracts. For example, black coal generators sell base contracts, OCGT generators sell cap contracts.
- Different technologies prefer to contract for different proportions of their total generation. For example, black coal generators sell contracts to cover a larger percentage of their output than hydro.
- Vertically integrated participants contract to a lesser degree, reflecting internal hedging arrangements.

[4] Base contracts are base load quarter futures. The ASX defines a base load contract unit as 1 megawatt (MW) of electrical energy per hour based on a base load profile. Where the base load profile is defined as the NEM base load period from 00:00 hours Monday to 24:00 hours Sunday (AEST) over the duration of the contract quarter. The size in MWh of each contract quarter will vary depending on the number of days and base load hours within the quarter.

. Cap contracts are ASX Energy Base load quarter $300 cap futures

PPAs refer to electricity buyers contracting to buy power from a renewable energy project (currently solar or wind farms) at a fixed price over a longer term.

[5] Available at www.asxenergy.com.au

3.3 Cost data

To assess the operating costs for each mainland generator in the NEM we have used the public data available in the ISP and NTNDP. However, as the purpose of this data is to forecast to plan future transmission developments we have supplemented ISP data where possible.

We sourced the following components from AEMO's *2020 Integrated System Plan*:

- Fixed operating and maintenance costs (FOM)—AEMO defines FOM as the recurring annual cost that occurs regardless of the variation of quantity (output) of a generator.[6] Does not include depreciating and finance cost.
- Variable operating and maintenance costs (VOM) —AEMO defines VOM as the cost occurs relating to the variation of quantity (output) of generator (for example, labour costs, operation and maintenance costs).[7]
- Heat Rate—the measure of how much electricity is produced for each unit of fuel.
- Marginal Loss Factors (MLF) —represents the average losses incurred by a generator to get its power to the regional reference node.
- Auxiliary load—the amount of energy used in the power station to support the generation of electricity.

For generators not listed in the ISP, such as those that retired earlier than 2020, we drew assumptions from other publications such as the NTNDP. In some instances we saw that methodology changes cause unexplained differences in values between the ISP and NTNDP. In these cases, we adjusted costs to be more consistent with the values in the ISP.

AEMO developed ISP and NTNDP fuel price data for NSW coal and natural gas for the purpose of long term forecasting. But the forecast prices did not always reflect actual outcomes. So where appropriate, we used spot market fuel prices instead of ISP or NTNDP forecasts. For each region:

- The price for NSW coal was based on monthly prices from the Newcastle coal price index sourced from globalCOAL, and coal prices for AGL Energy's Bayswater and Liddell power stations were further adjusted in line with the ratio of ISP fuel prices for these stations and other NSW coal generators.[8]
- Victorian coal price information is sourced from the 2020 ISP.
- Daily gas spot prices from the Brisbane, Sydney and Adelaide Short Term Trading Markets and the Victorian Declared Wholesale Gas Market is used to represent the opportunity cost to fuel power stations that use natural gas in each region.

We determined the total cost of operation for each generator for each trading interval using the following formula:

- Total cost = FOM + VOM + Fuel cost (heat rate * fuel price * MLF)

To determine the cost per megawatt hour (MWh) for a generation technology, we divided the total cost by that technology's output for a financial year.

3.4 Generator operating earnings calculation

To calculate generator operating earnings, we subtracted modelled generator operating costs from potential revenue.

6 AEMO, 2020 ISP inputs and assumptions

7 AEMO, 2020 ISP inputs and assumptions

8 The GlobalCOAL Newcastle coal price index is a reference price for spot thermal coal at Newcastle Port in NSW. The GlobalCOAL data and methodology is available at www.globalcoal.com/coalprices/newcindex.cfm

4 Limitations

This analysis uses simplified models and public data to estimate generator potential revenues, operating costs and earnings. However, to avoid misinterpretation, it is important to understand the various limitations:

- The ISP cost data does not account for capital expenditure, financing costs, asset values and depreciation for existing generators.
- While public information on fixed operations and maintenance provides a guide over time, in practice it is more likely to be lumpy and plant specific. When this occurs to an aged generator it may complicate decisions regarding investment to extend its life.
- The price for black coal in NSW and natural gas in each region are based on fuel spot market prices. While individual generator fuel costs are likely to also be affected by factors such as storage levels and longer term contracts, fuel spot market prices provide a reasonable proxy for a generator's maximum marginal fuel cost.
- Only revenue from the energy market has been included in our model, and we excluded revenues from frequency control ancillary service markets, directions, and network support agreements.
- Each generator only sells a single contract type and the contracted percentage of a generator's total output was fixed for every year. In practice generators sell various contract types and target contracted levels may change based on prevailing conditions. Similarly, contract quantity is based on broad and simple estimates, and may not accurately represent the complex contracting behaviour of a generator with variations in its generation portfolio.
- The majority of wind and large-scale solar generators have PPAs, but details of these contracts are confidential. Some public information is available on ACT Government PPA prices, which we used as a general proxy. A single PPA price for wind and large-scale solar is not necessarily realistic as the price of these contracts change from year to year.

Appendix A—Input assumptions

Table 2 Parameters, assumptions and sources

Parameter	Assumption	Data source and description
Generator and load dispatch data	None	30 minute metered generator/load dispatch data for each registered unit from AEMO MMS.
Regional electricity spot prices	None	30 minute spot price data for each region from AEMO MMS
FOM, VOM, heat rate, MLF, auxiliary load	Fixed values for all years (2015 to 2020)	AEMO 2020 ISP inputs and assumptions data.[9] AEMO 2016 NTNDP planning studies—additional modelling data and assumptions summary.[10] For generators that retired before 2019-20, we sourced costs information from NTDNP reports.
Fuel prices	NSW black coal price based on Newcastle export black coal price	globalCOAL—NSW coal price information sourced from globalCOAL, information on their data is available www.globalcoal.com We then discounted the coal prices applied to Bayswater and Liddell power stations in proportion to ISP values (that is by the same proportion they were different to other NSW black coal stations using ISP values).
	AEMO fuel cost data for Queensland black coal and Victoria brown coal	AEMO 2020 ISP inputs and assumptions data.[11] AEMO 2016 NTNDP Planning Studies—additional modelling data and assumptions summary.[12]
	Spot gas price	Brisbane, Sydney and Adelaide Short Term Trading Market prices. Victorian Declared Wholesale Gas Market prices.
Black coal, brown coal, CGGT contract volume and price	Black coal: 18,400MW (60% contracted) Brown coal: 4,700MW (75% contracted) CCGT: 2,500MW (45% contracted)	Regional quarterly ASX Energy flat strip contract price. Prices for futures contracts from ASX Energy, available at www.asxenergy.com.au

9 AEMO, 2020 ISP inputs and assumptions

10 AEMO, 2016 NTNDP database

11 AEMO, 2020 ISP inputs and assumptions

12 AEMO, 2016 NTNDP database

Parameter	Assumption	Data source and description
OCGT and hydro contract volume and price	OCGT: 4,500MW (35% contracted) Hydro: 4,900MW (45% contracted)	Regional quarterly ASX Energy cap contract price. Prices for cap contracts from ASX Energy, available at www.asxenergy.com.au
Wind and large-scale solar contract volume and price	100% contracted PPA wind: $50 per MWh PPA large-scale solar: $60 per MWh	The PPA values are constant over the reporting period. Most PPA price information is not publicly available, for our model the values are generalised based on information published by the ACT Government for its PPA auctions.[13]

[13] Information on the ACT Government's 'Next generation renewables' investment program is available on their website. Additional information on the value of PPAs across Australia is available from RenewEconomy (M Marzengarb, ACT secures two big batteries for Canberra and a record low price for wind, 8 September 2020)