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Modelling Generator Bidding Behaviour in the National Electricity Market

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This research examines the ways in which the dynamics of generator bidding behaviour can be captured in energy market modelling, to improve the usefulness of this modelling for forecasting and planning. Energy market modelling is essential for long-term planning and investment in the electricity industry, from both whole of system and commercial perspectives. This research presents results from market modelling using the Plexos market simulation software. Plexos is widely used in Australia and is currently being used by large organisational bodies including the Australian Energy Market Operator (AEMO) and the Australian Energy Market Commission (AEMC). The results of this modelling are informing decisions around a wide range of aspects of the development of the NEM and are used in studies including AEMO's Integrated System Plan. One of the key inputs in energy market modelling is the bidding behaviour of generators. The methodologies of modelling of bidding behaviour in an energy market model determine the dispatch of generators, competitive behaviours and price outcomes. This research presents the results and findings from an analysis of different methods of modelling bidding behaviour and examines the key factors of current bidding behaviours in the NEM, to understand what are the most important parameters that must be captured in energy market modelling.

Whilst there are a large number of studies examining the relative performance of competition models in energy market modelling (i.e. Bompard et al., 2010; David and Wen, 2000; Koschker and Most, 2016), these studies focus on the performance of the market under these models, rather than analysing how effective the models are in representing actual market outcomes with reference to a particular energy market. A comparison of competition models (Koschker and Most, 2016) was undertaken comparing a pure-competition model to the Cournot model, based on the German electricity market. This research found that the competition models resulted in significantly higher prices than actuals, especially in the Cournot model. However this may not be applicable to the NEM, as in the NEM there is a high concentration of generating resources and evidence of market power (EUAA, 2011).

To evaluate approaches to model competition, Plexos modelling was used to create energy market models. Three models were be developed, with different levels of complexity. Firstly a simplified model of 2-3 genereators in a single region, secondly a simiplified model of the NEM with a single generator per region per fuel type representing an aggregation of each category, and thirdly a full NEM model, based off the 2091 ESOO model published by AEMO. Each of the models will be configured using different approaches to modelling bidding behaviour as follows:

- SRMC/LRMC recover
- Nash-Cournot Competition
- Bertrand Competition
- Supply Function Equiliruim

The models will be modified to replicate market outcomes in a historic year, FY19 or FY20. The models will then be run over a range of years, including back-casting over historic years. The results will present how well each of the models replicate market outcomes, in particular price outcomes and generator dispatch outcomes. The root mean squared error in the price duration curve in each region will be calculated, for each year, as well as the error in the capacity factors of each generating unit.

The results will examine the limitations in the various methods of modelling bidding behaviour, and how these limitations constrain the usefulness of the model.

Preliminary findings include the patterns of bidding behaviour in the NEM. Bidding behaviour is very dependant on fuel type and short run marginal cost. Units can be classified as 'price setters' or 'price takers', depending on how often they change generation offer and how often they set the regional price. Figure 1 and Figure 2 illustrate the difference in bidding behaviour of a black coal unit and an open-cycle gas turbine unit in NSW, demonstrating the difference in bidding of a price setter and a price taker.

Figure 1: Diurnal bidding distribution, unit BW01 (black coal) - FY19

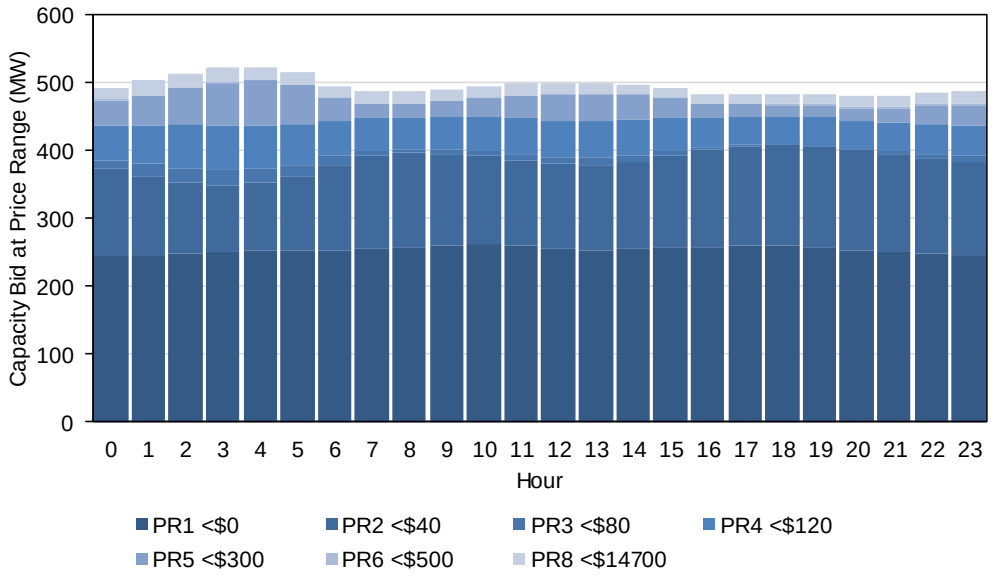

Figure 2: Diurnal bidding distribution, unit SITHE01 (OCGT) - FY19

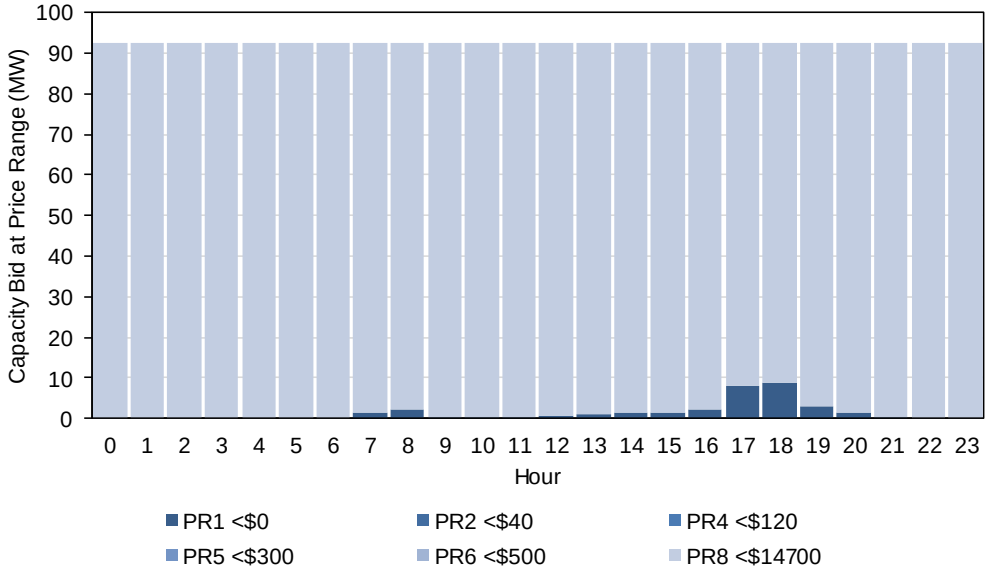

Figure 1 shows that the coal unit has roughly half of its capacity bid below $0, reflective of minimum operating levels, with the majority of remaining capacity bid below $120. The diurnal profile shows that the coal unit moves capacity to a higher price overnight to increase the market clearing price. Figure 2 shows the very different profile of the gas peaking plant. This unit has the majority of capacity bid out of

the market. The unit does not bid capacity in the range $0-$500, indicating that it is a price taker, always bidding either out of the market or below the market clearing price, and not setting price.

The finding of this research will demonstrate how well different approaches to modelling competition in Plexos are able to replicate market outcomes in the NEM. The results will also show to what extent these models are able to capture bidding behaviours, and quantify the comparative error in market price and generator dispatch as a results of the generator bidding modelling methodology.

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