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Report to

AEMC

Analysis of rebidding activity in the NEM

(Emc00024)

17 October 2014

VERSION HISTORY

Revision	Date Issued	Prepared By	Approved By	Revision Type
0.5	2014-09-09	Nick Culpitt	Ben Vanderwaal	Incomplete Draft – Stage 1 outline
0.6	2014-09-18	Nick Culpitt	Ben Vanderwaal	Incomplete Draft – Stage 1 outline with amendments
0.7	2014-09-24	Nick Culpitt	Todd Turner	Incomplete Draft – Additional reporting of Stage 2 outcomes
1.0	2014-10-08	Nick Culpitt	Ben Vanderwaal	First release
1.1	2014-10-17	Nick Culpitt	Ben Vanderwaal	Final Report

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1 INTRODUCTION

1.1 BACKGROUND

ROAM has been engaged by the Australian Energy Market Commission (AEMC) to undertake quantitative analysis of rebidding activity in the National Electricity Market (NEM). The objective of this analysis is to inform the AEMC on a range of matters relating to the nature of rebidding in the NEM. This information will be used to provide context in relation to the rule change request regarding the bidding in good faith provisions submitted by the South Australian Minister for Mineral Resources and Energy.

1.2 PURPOSE OF THIS REPORT

This report provides a detailed description of the methodology used to produce these outcomes and also to identify key observations in this data.

This report is structured as follows:

- Section 2 outlines the scope of this analysis;
- Section 3 details the methodology used to develop the descriptive statistical analysis provided in the data package;
- Section 4 presents illustrative example of Stage 1 outcomes;
- Section 5 summarises the bidding behaviour of Basslink;
- Section 6 details the methodology and outcomes of analysis to determine the significance of relationships between bidding behaviour and market observations;
- Section 7 provides a detailed analysis of the price outcomes related to bidding behaviour;
- Section 8 summarises the outcomes and provides recommendations for potential further analysis.

2 SCOPE

The AEMC requested ROAM to provide both descriptive statistical analysis of rebidding in the NEM and to outline statistically significant relationships between bidding behaviour and market parameters such as pool prices and demand. This analysis covers the period between 1 January 2007 and 1 August 2014. The scope of works is divided into two stages.

2.1 STAGE 1

In Stage 1, ROAM has processed all of the bidding data submitted by generators and Scheduled Network Service Providers (Basslink). This bidding data is used to develop descriptive statistics which illustrate:

- The frequency of rebidding by each DUID[1] on a yearly, monthly and time of day basis;
- The frequency with which rebids are submitted that represent a movement of capacity to higher or lower price bands;
- The timing of rebids with respect to the dispatch intervals that the bid applies to;
- The frequency with which bids are submitted for dispatch intervals during that trading interval.

This report does not describe the outcomes of all of the Stage 1 analysis. ROAM has provided data to the AEMC throughout this project. A brief overview of the Stage 1 results is presented in Section 4.3. These results are intended to illustrate the range of outcomes that have been provided to the AEMC.

2.2 STAGE 2

Stage 2 uses the data collected in Stage 1 to examine the potential for statistically significant relationships between observations as to the nature of rebidding and other factors such as:

- Regional demand;
- Import headroom;
- Forced outages;
- Transmission constraints binding;
- Pre-dispatch forecasts.

ROAM has applied statistical techniques to determine the presence of these relationships. Where these relationships have been observed, this report provides illustrative case studies which demonstrate these effects for historical periods.

A particular focus of the Stage 2 analysis relates to investigating the relationship between bidding behaviour and pool price outcomes. This analysis has been presented in detail in Section 7.

3 METHODOLOGY FOR PROCESSING BIDDING DATA

This section describes the process applied in developing aggregated statistics from the vast collection of bids submitted by all DUIDs to AEMO.

[1] A DUID is a Dispatchable Unit ID. All generators submit bids at the DUID level. A DUID can represent many physical units but more commonly refers to a single physical unit.

3.1 BIDDING IN THE NEM

Analysing bidding data in the NEM is a complex exercise. Each DUID submits bids on a daily basis with potentially many subsequent rebids. As a result, the volume of bidding data for all DUIDs over an extended period is substantial. ROAM has used the "yestbid" source for all bidding data.

The first step of this analysis was to distil the vast collection of information into a single data set which represents only "valid, unique rebids". This process is described in detail in this section. It is important to determine which bids are considered valid and unique so that the outcomes of the statistical analysis are not clouded by duplicate data and bids that could never have applied. For example, a unit may submit many rebids where there is no change to energy offers; these bids should clearly not be considered as rebids as they represent no change for the market. Similarly, invalid rebids, for example those that are submitted after the gate closure for a given DI, should also not contribute to inferences about the materiality of rebidding in the NEM.

The general approach is to prepare a list of the valid, unique rebids for each dispatch interval and for each DUID that would have applied in that dispatch interval (either that the bid did apply, or would have applied had a subsequent rebid not been made).

Bidding in the NEM is on the basis of a "trading day" which starts and ends at 4:00 am.

Figure 3.1 illustrates how rebids submitted through time are determined to apply for a given DI. In the figure, the three coloured bars refer to three alternative energy market offers which apply over different time periods. These three offers were submitted at various times in the lead up to the DI of interest. For each DI, we determine a number of statistics that relate to the frequency with which bids were submitted that applied for that DI.

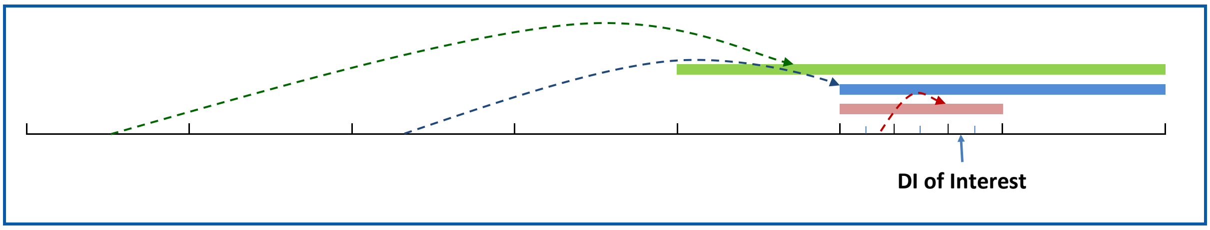

Figure 3.1 – Illustration of bids that apply for a given DI

3.2 DISPATCH INTERVALS/TRADING INTERVALS

The NEM is dispatched every five minutes. These five minute periods are called "dispatch intervals" (DIs). Each half-hourly "trading interval" (TI) is comprised of six DIs. TI outcomes (such as dispatch quantity, regional prices etc.) are determined by averaging the six DI outcomes. All financial settlements in the NEM energy market are based on TI outcomes.

Of critical importance to this analysis is that bids are also submitted on a TI basis. Each rebid submitted to the market defines the quantity that a DUID is prepared to offer at each of its ten price bands in each TI of the day.

Therefore, to submit a bid that will only apply for a subset of the DIs in any TI requires that a rebid be submitted, during the TI, for that TI. As a result, the number of valid, unique rebids for the last DI in a trading interval must have either an equal, or greater number of rebids than all preceding DIs in the TI.

3.3 DETERMINING WHETHER A BID IS "VALID"

A valid bid in this analysis is defined as a bid that was applied in a given DI or would have applied had a subsequent rebid not been made. The conditions that are required for a rebid to be "valid" are summarised in the following:

- The bid is found within the yestbid[2] file.

- The DI is within the TI the bid applies for.

  For example, if a bid applied for the 14:30 TI[3], this is only a valid bid for the DIs 14:05, 14:10, 14:15, 14:20, 14:25 and 14:30.

- The bid was submitted before the start of the DI.

  In fact, gate closure for a DI in the NEM is approximately 1 minute before the start of a DI. Therefore, for the DI ending 10:25, a bid would need to have been submitted for the 10:30 TI before approximately 10:19 for the bid to be valid.

  The "First Dispatch" field in the yestbid dataset is used to identify that a bid has been successfully submitted to the market. The first dispatch field shows the first DI that a bid could have applied from.

3.4 CONSIDERATIONS FOR "UNIQUENESS"

A bid submitted to the market is comprised of more than simply the energy market price and quantity offers. These bids also contain:

- Information related to operation within ancillary service markets;
- Ramp rates;
- Maximum availability;
- Fast start inflexibility profile parameters.

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[2] Yestbid (Yesterday's Bid) files are raw bidding data files provided by AEMO and are available through the Market Management System (MMS) and can be found on the AEMO website. Yestbid files are provided shortly after 4 am each day and contain all the bidding data for the previous trading day.

[3] All references to TIs and DIs are TI ending and DI ending respectively.

The focus of this analysis is limited to the operation of the NEM's energy market. Physical parameters such as ramp rates and fast start inflexibility profiles are not the focus of the rule change which relates specifically to generator bidding.

In determining whether a rebid for a given DI is unique, we consider whether the bid changes any of the quantities offered in the ten bid bands.

3.5 Determining whether a bid is "Unique"

There are many instances where a DUID is observed to resubmit a bid in which there is no change in any of its offers to either the energy market or to the ancillary service markets. Where this is observed to occur, we discard that rebid as being not unique.

It is important to note than a single offer can be a unique rebid for one DI, and not unique for another. Consider the following illustration in Figure 3.2, where the colours blue and green represent two alternative valid arrangements of capacity between the ten bid bands. For the DI 10:15, the second offer is not different from the first, and would therefore be discarded as a valid, but not unique rebid for this DI. However, for the 11:00 DI, the second bid offer did represent a change, and would therefore be included in the dataset as a valid, unique rebid for that DI. All consideration of validity and uniqueness are for each distinct DI.

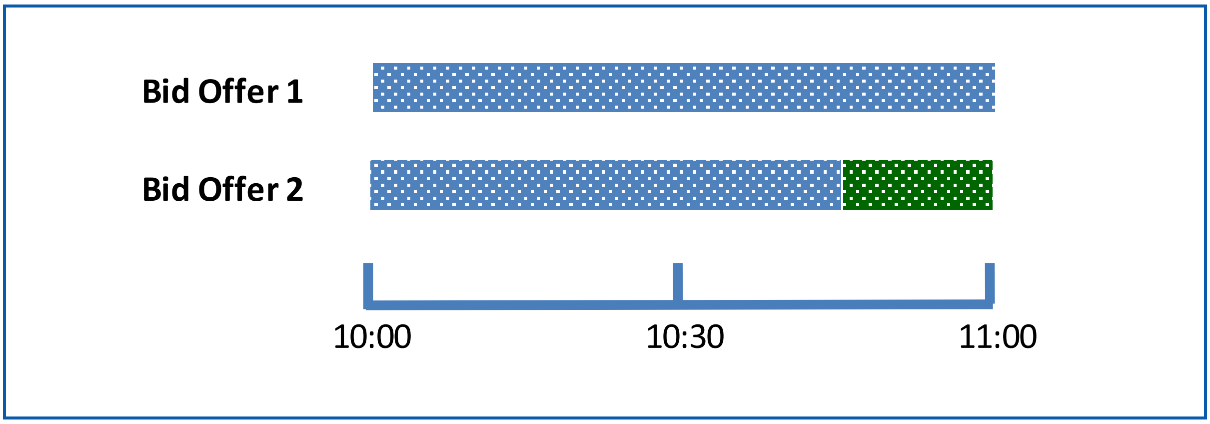

Figure 3.2 – Illustration of Unique Rebids

3.5.1 Treatment of Changes to Availability

For many units, availability (offered in the "MaxAvail" field) represents the maximum physical capability of the unit at any point in time. The expectation of the availability of a unit in any DI can change regularly in the hours before that DI. For some DUIDs, this manifests in frequent rebidding which alters the availability, sometimes by as little as 1 MW.

In early analysis during this study, it was found that these minor changes in availability were "swamping" the remainder of the rebidding data such that the total frequency of rebids was dominated by units that regularly adjusted their availability. It has therefore been determined that for many units, a change in availability should not be considered as a rebid.

There are some units however, that are observed to generally offer their capacity as unavailable, and only offer their capacity as available when they wish to operate. ROAM has identified these units and applied an alternative procedure such that changes in availability at these units are considered as rebids.

Consider Hunter Valley Gas Turbine as an example. For the vast majority of periods, the DUID bids its availability at 0 MW. When it wants to run, it will increase its offered availability from 0 MW; this is shown in Figure 3.3. During this period, the energy offers of the plant could be anything, ranging from bidding all its rated capacity at low prices (e.g. $0/MWh) to bidding no capacity at all. In the hypothetical case that the generator was bidding its capacity at $0/MWh and then wanted to run, by offering availability the unit would essentially be rebidding its capacity into the market. For DUIDs that operate in this manner, it is appropriate that a change in availability represents a valid, unique rebid.

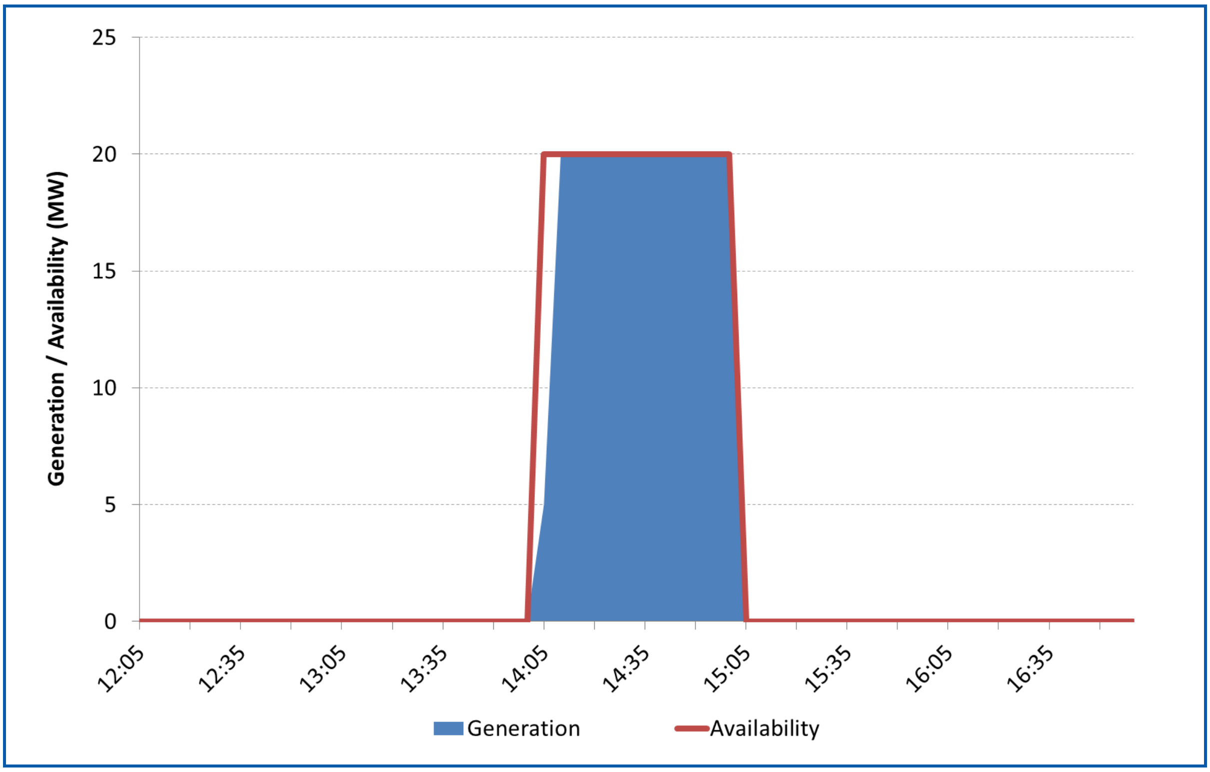

Figure 3.3 – Hunter Valley Gas Turbine Dispatch Example

In contrast, Figure 3.4 illustrates the generation and availability over a single day for Braemar Unit 1. This figure shows that the unit was available before, during and after its period of generation. It is also evident that availability is adjusted in small increments throughout the day. This is an example of a unit where changes in availability that coincide with no change in energy market offers are not considered as rebids.

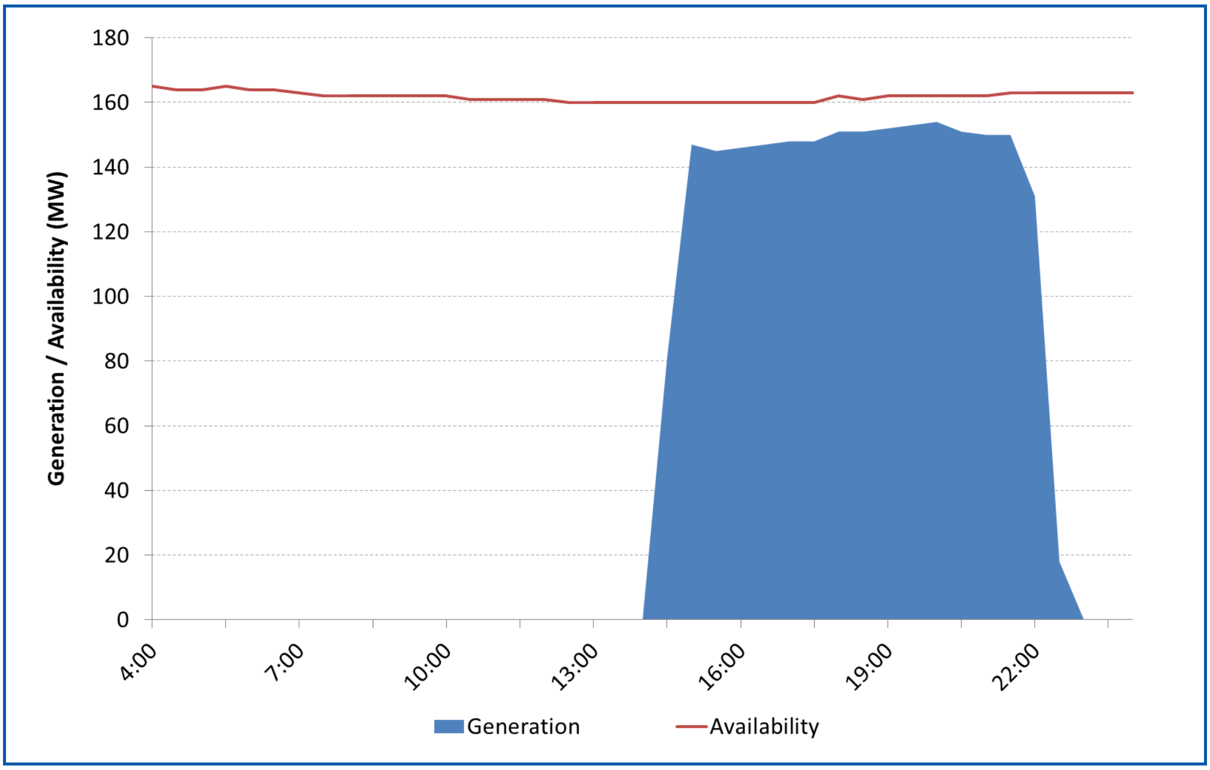

Figure 3.4 – Braemar 1 Dispatch Example

In determining the list of DUIDs that this should apply for we have given consideration to two factors:

- Is the generator low utilisation?
- When the generator is not operating, is its availability usually zero?

3.5.2 Methodology for Removing Rebids

There are two stages for removing rebids that are not unique.

For DUIDs that are not classified in the category of units that regularly bid unavailable when not operating (detailed in Section 3.5.1), the following process is applied to the list of valid bids:

1. Remove all bids that represent no change in any of the ten energy/quantity offers.
2. Cap the capacity in the ten quantity bands such that the sum of quantity offers equals the offered availability. Generators often submit energy market bids in which the total quantity offered across the ten price bands exceeds the offered availability.
3. Repeat the removal of duplicates.[4]
4. Divide all price bands by the Marginal Loss Factor (MLF) that would have applied in that period.

[4] This second duplicate removal is required as the total quantity offered across the ten bid bands can exceed max avail. After capping at availability, two bids that appear to have different energy offers, may in fact be identical.

By removing duplicates before capping the bids, rebids that changed only the availability offered will not be added to the final dataset of valid, unique rebids.

For the units that are in the category detailed in Section 3.5.1, the following process is applied to the list of valid bids:

1. Cap the capacity in the ten quantity bands such that the sum of quantity offers equals the offered availability.
2. Remove all bids that represent no change in any of the ten energy quantity offers.
3. Divide all price bands by the Marginal Loss Factor (MLF) that would have applied in that period.

By capping the bids as the first step, a change in availability will impact on the energy offers in the ten quantity bands, and therefore qualify as a unique rebid.

3.6 *CLASSIFYING REBIDS*

In addition to identifying the volume of rebids, the descriptive statistics are also intended to illustrate the nature of rebidding in the NEM. Each rebid is therefore categorised according to:

- The time it was offered relative to the DI that it was applied to;
- Whether the rebid represents a movement of capacity to higher or lower price bands.

3.6.1 Timing of Rebids

The timing of rebids with respect to the DI that they are applied is of particular interest in this analysis as demonstrated by the discussion in the submissions to the rule change request. In particular, there is considerable interest in rebidding activity that occurs at the last possible moment, where there is the possibility that other participants will not be able to respond to the impact of these rebids on the market.

The identification of the timing of bid offers has been used to determine a number of aggregates for each DUID and for each DI. These are as follows:

- The number of bids submitted less than 60 minutes before the start of a DI;
- The number of bids submitted less than 30 minutes before the start of a DI;
- The number of bids submitted less than 10 minutes before the start of a DI;
- Whether a rebid was submitted such that the first time the bid was applied was for that DI. Generally this means that the bid was submitted within 1 to 6 minutes (approximately) before the start of the DI. This is a TRUE/FALSE identifier rather than a count of the number of bids within this time interval.

3.6.2 Capacity offered at low/high price bands

A number of options were considered for determining whether a rebid represents a movement to higher or lower price bands. Ultimately, it was decided that the relatively simple approach of testing whether additional volume was offered at prices below \$300/MWh was most appropriate for this analysis; this is particularly true given the focus on “price spikes”, where prices can reach up to the Market Price Cap, \$13,500/MWh since 1st July 2014.

The choice of \$300/MWh as a price threshold is somewhat arbitrary but does have some relevance given the price of standard cap contracts. \$300/MWh is also higher than the Short Run Marginal Cost (SRMC) of all generators in the NEM other than a small number of liquid fuel plant. Other price thresholds were considered. We analysed the outcomes using a number of other factors and found that the general outcomes were relatively robust to the choice of price threshold.

The method is as follows:

1. For each valid, unique bid, determine the total capacity offered at price bands below \$300/MWh.
2. Determine whether this quantity has increased, decreased or remained the same as the rebid before (the initial bid is not classified in these categories).
3. For each DI, count the number of rebids that fall into these categories.

The primary benefit of this approach is that it is relatively simple to implement and to interpret. More sophisticated approaches were found to have implementation issues. For example, any approach based on the weighted average of capacity offers is heavily influenced by movements of capacity into high price bands.

The weakness of this approach is that it fails to capture more subtle movements of capacity, for example from \$30/MWh to \$250/MWh. This could also however be considered a strength of the method in that bids are classified as a movement to higher/lower bid bands if they represent a significant change in the effective capacity offered at low prices. For example, movement of capacity in bids from \$20/MWh to \$22/MWh do not cloud the analysis.

The two classifications of bids can be combined. For example, to illustrate the proportion of bids that occur in the 10 minutes prior to the start of a DI that are moving capacity to lower price bands.

The classifications presented throughout the data provided to the AEMC are as follows:

- Below 300: Additional capacity has been offered below \$300/MWh, adjusted for MLF;
- Neutral 300: A rebid did not change the MW of capacity offered below \$300/MWh, adjusted for MLF;
- Above 300: Less capacity was offered below \$300/MWh, adjusted for MLF.

4 STAGE 1 RESULTS

4.1 INTRODUCTION

As a result of the Stage 1 analysis, a comprehensive set of bidding data has been provided to the AEMC. This section provides an overview of the outcomes that constitute this dataset. We have also presented high level results for some categories as an illustration of the data supplied.

4.2 PRESENTATION OF STAGE 1 OUTCOMES

4.2.1 Time Classification of Rebidding Outcomes

The data provided to the AEMC provides a suite of results that are based on a particular aggregation of rebids. These are as follows:

Yearly

The yearly analysis averages rebidding outcomes over each calendar year of the study period. This is primarily used to provide an overview of rebidding across regions, DUIDs etc. and to illustrate how these outcomes have changed over time.

Monthly

The monthly analysis averages all periods in each month. This provides a more detailed view of movements in rebidding patterns over time. The monthly analysis also provides a means of illustrating seasonality.

DI in TI

For a given calendar year, the DI in TI analysis presents bidding statistics for the six DIs within any TI. This data is primarily used to illustrate changes in the frequency or type of rebidding that occurs during the TI.

DI

The DI analysis shows the average rebidding statistics in each of the 288 DIs of the day in each calendar year. This is particularly useful for illustrating time of day trends. The DI analysis can also be used to illustrate patterns of bidding behaviour in small periods, such as within a single TI.

4.2.2 Aggregation and Presentation of Data

ROAM has provided both raw data and aggregated analysis to the AEMC. In illustrating the frequency of rebidding (and/or different types of rebidding), we have used an average frequency, per DI and per DUID.

The data provided allows aggregation at the following levels:

- DUID
- Power Station
- Portfolio
- Regional
- Mainland
- NEM

Averaging over the number of DIs allows a comparison between portfolios and regions of different sizes.

All of the types of aggregation described above are able to be viewed for either a single calendar year, all calendar years in comparison, or all calendar years aggregated into a single result.

Each dataset contains all information relating to the frequency of particular types of rebidding (for example, Below 300, Neutral 300 and Above 300).

4.3 *ILLUSTRATIVE STAGE 1 OUTCOMES*

Figure 4.1 shows the average rebidding frequency across all DUIDs in each region on a calendar year basis. In general, it is evident that the average number of valid, unique rebids that have applied in each DI has been decreasing through time since 2007. Tasmania has the highest frequency of rebidding given the regular modifications made by Hydro Tasmania in operating its fleet of hydro generators, particularly in balancing hydrological and FCAS requirements. Of the mainland states, Queensland generally has the highest frequency of rebidding.

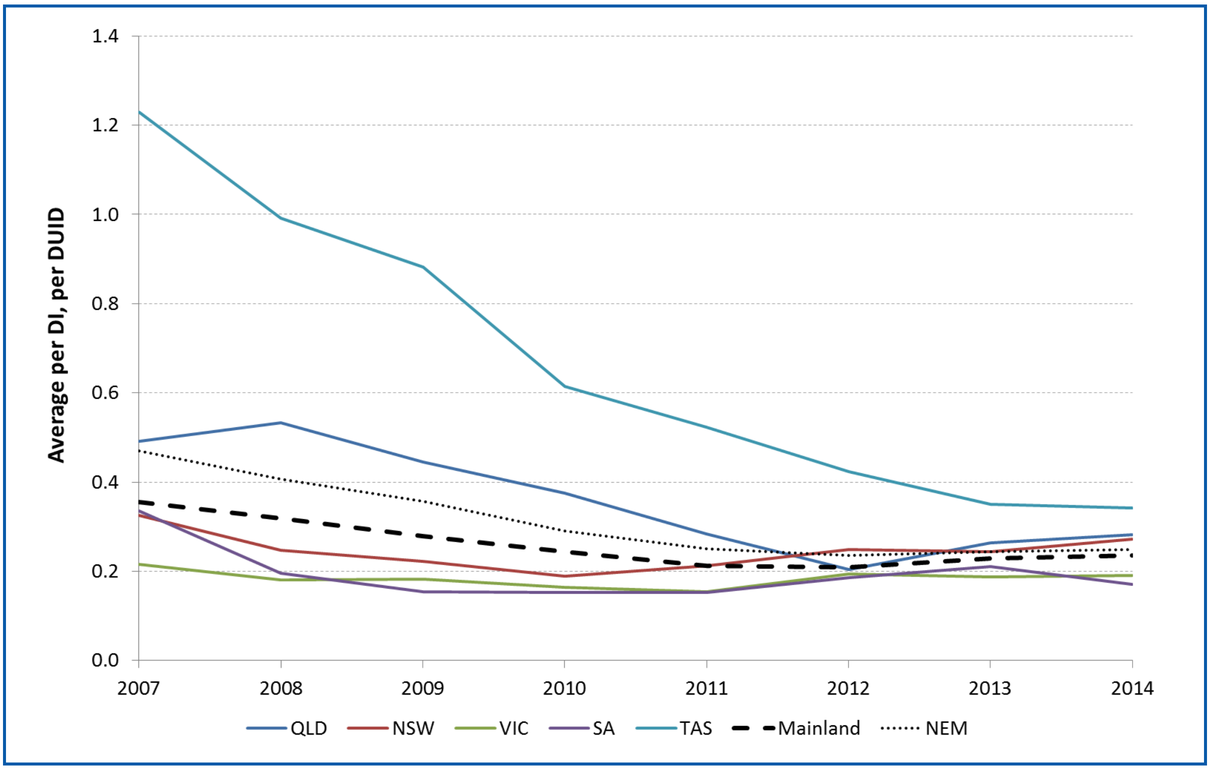

Figure 4.1 – Year Rebidding Frequency

Figure 4.2 shows the average monthly frequency of rebids submitted within the last DI of the TI in South Australia during the 2013 calendar year. The stacked areas show the breakdown of rebidding frequency between the three categories. This illustrates that the frequency of these late rebids was significantly higher during the May and June. The figure also presents the average monthly South Australian pool prices during the 2013 calendar year. These relationships will be examined in greater detail in Stage 2.

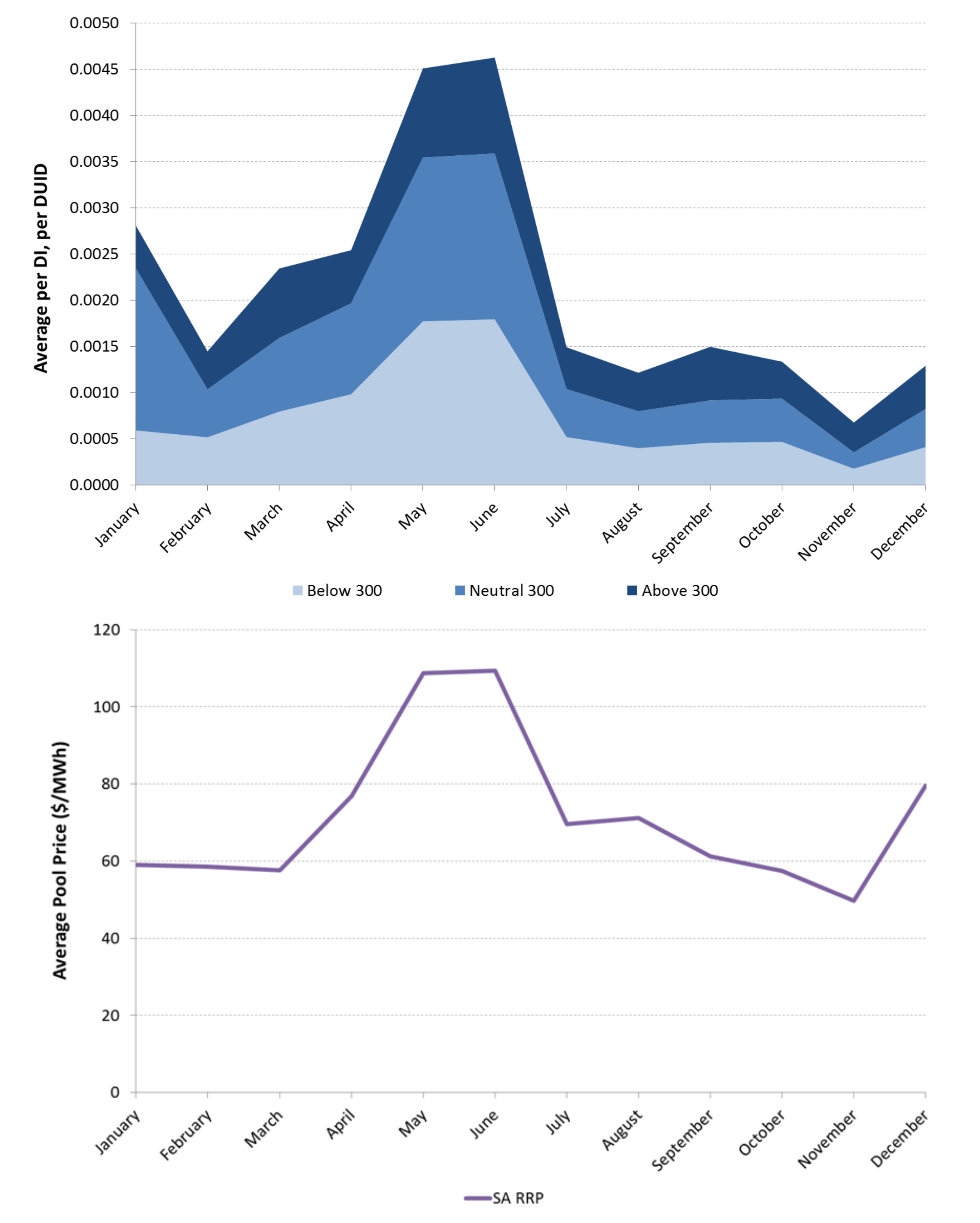

Figure 4.2 – Monthly Late Rebidding Frequency by Type – South Australia 2013

An important facet of this analysis is to determine whether there is a relationship between frequency and type of rebidding and the DI that a bid is applied to. In particular, the AEMC is interested in analysing the behaviour of generators towards the end of the trading interval. Figure 4.3 shows the increased frequency in late rebidding in 5th and 6th DIs for Queensland during the 2014 calendar year.

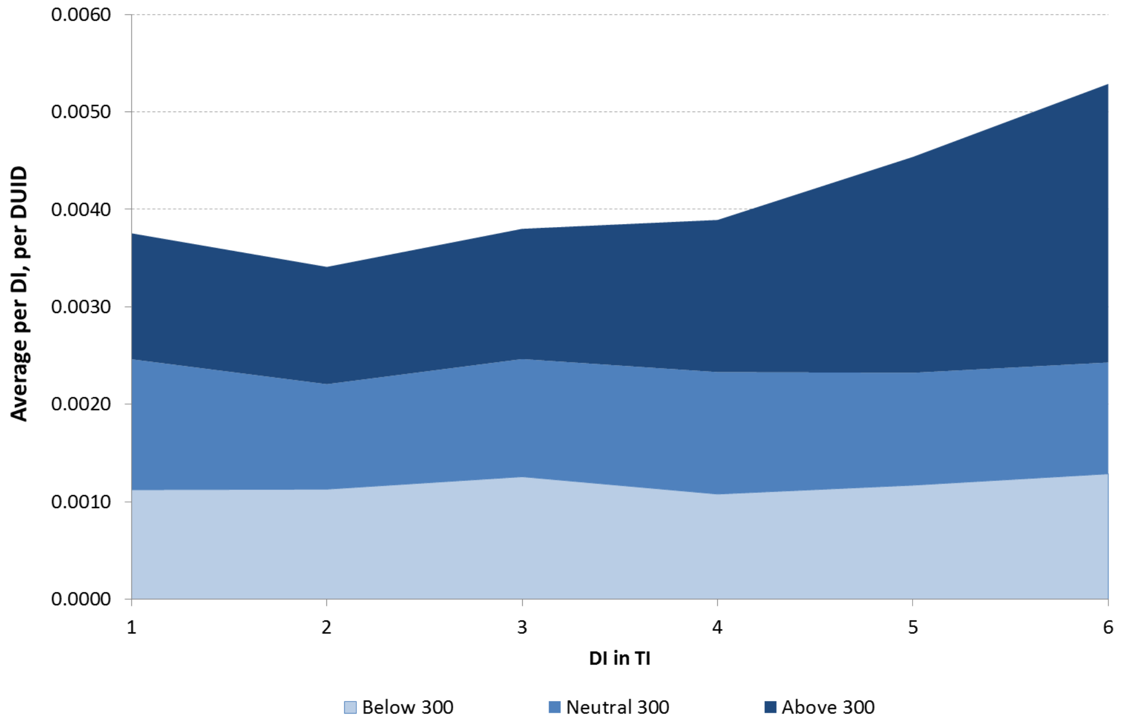

Figure 4.3 – Late Rebidding for DI in TI – Queensland 2014

Figure 4.4 shows the breakdown of mainland generators rebidding over the entire period. This figure illustrates the time of day trends in rebidding in the NEM. The 'sawtooth' effect illustrates the cumulative DI in TI effect. The step in midnight is an outcome of normal behaviour as generators submit bids for the trading day (4am-4am) on midnight, 4 hours ahead of time. The general time of day shape illustrates that rebidding activity is generally highest during the afternoon/evening peak demand periods.

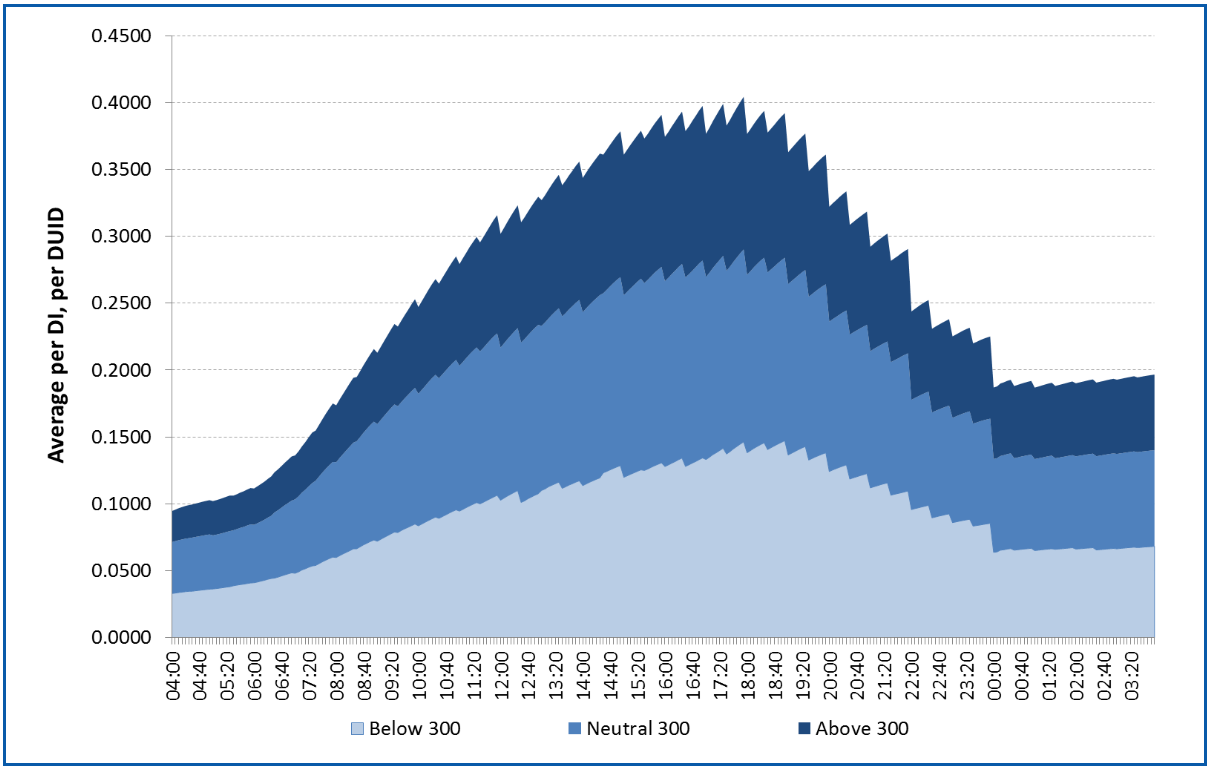

Figure 4.4 – Rebidding by Time of Day – Mainland – All Years

5 BASSLINK BIDDING BEHAVIOUR

Basslink is the only MNSP operating in the NEM. MNSPs are required to submit bids to AEMO. Basslink submits bids as two links; BLNKTAS and BLNKVIC. The two links represent the injection of energy into each region.

We have conducted an analysis of the frequency of the bidding behaviour of Basslink. We have found that Basslink does not frequently rebid and that generally, rebids that have occurred are concentrated over relative short periods.

Figure 5.1 shows the average rebidding by Basslink. The majority of the rebidding occurred in the 2009 and 2013 calendar years. Rebidding is more frequent on the Victorian end of the interconnector.

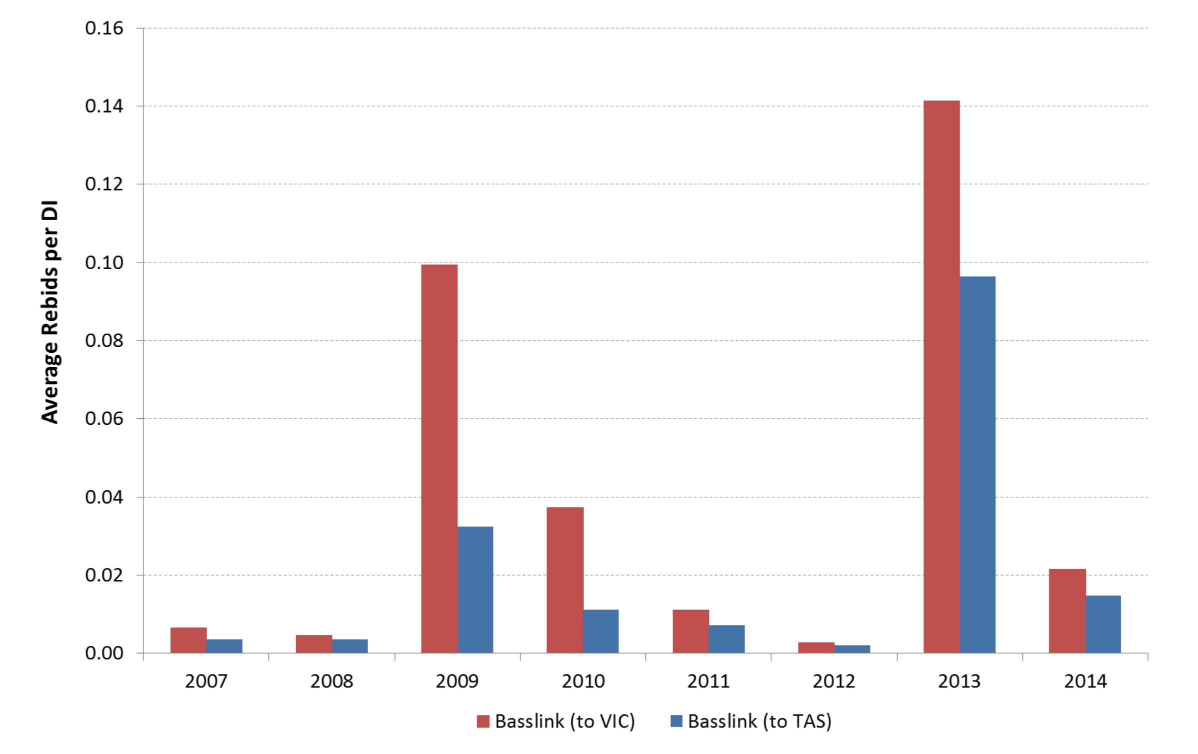

Figure 5.1 – Basslink Rebids – Annual

The concentration of rebidding is clearly evident in Figure 5.2. This figure shows average monthly rebidding. Rebidding during the 2009 calendar year was dominated by a high frequency of rebidding in January. Rebidding during the 2013 calendar year was more consistent. However, this 2013 rebidding appears to be the result of an isolated event as this relatively high frequency has not continued into the 2014 calendar year.

In general, rebidding that has occurred for Basslink over this time period has been the result of changing availability of the link. There are limited instances where Basslink has rebid available capacity at different price bands.

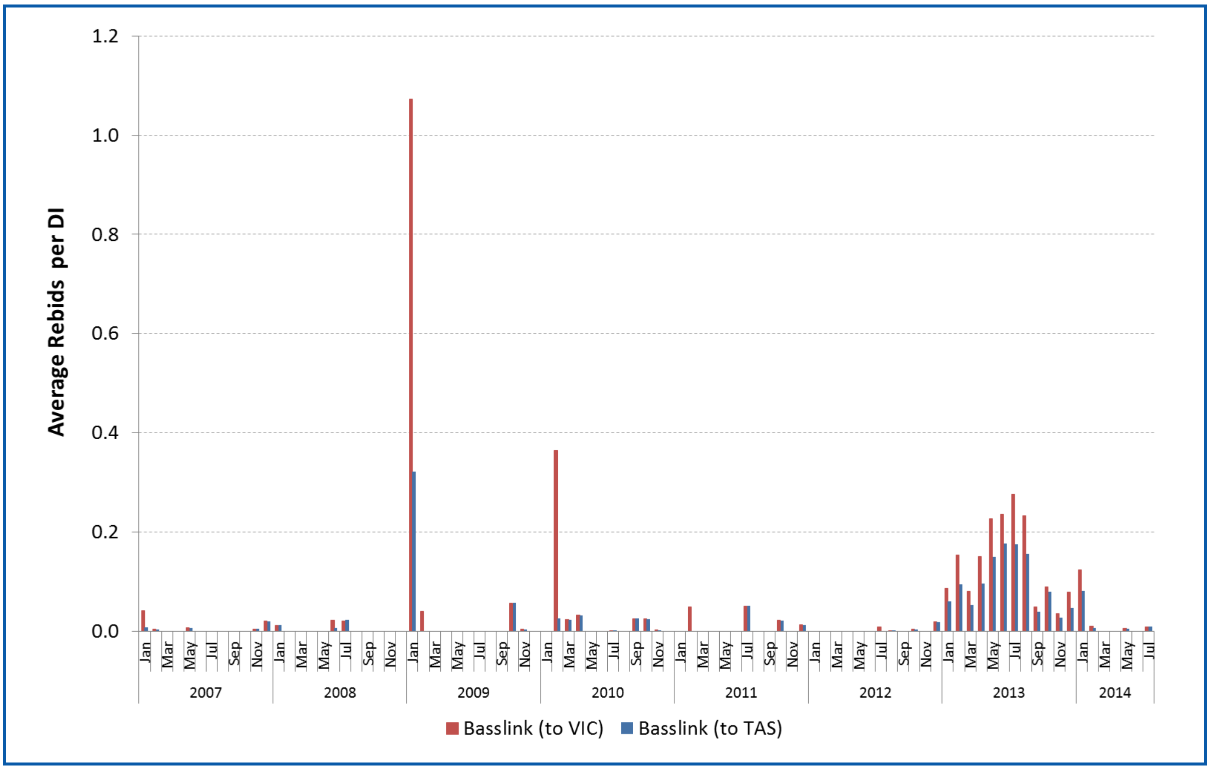

Figure 5.2 – Basslink Rebids – Monthly

The bidding results also show that the frequency of late rebidding by Basslink is very low. This can be seen in Figure 5.3.

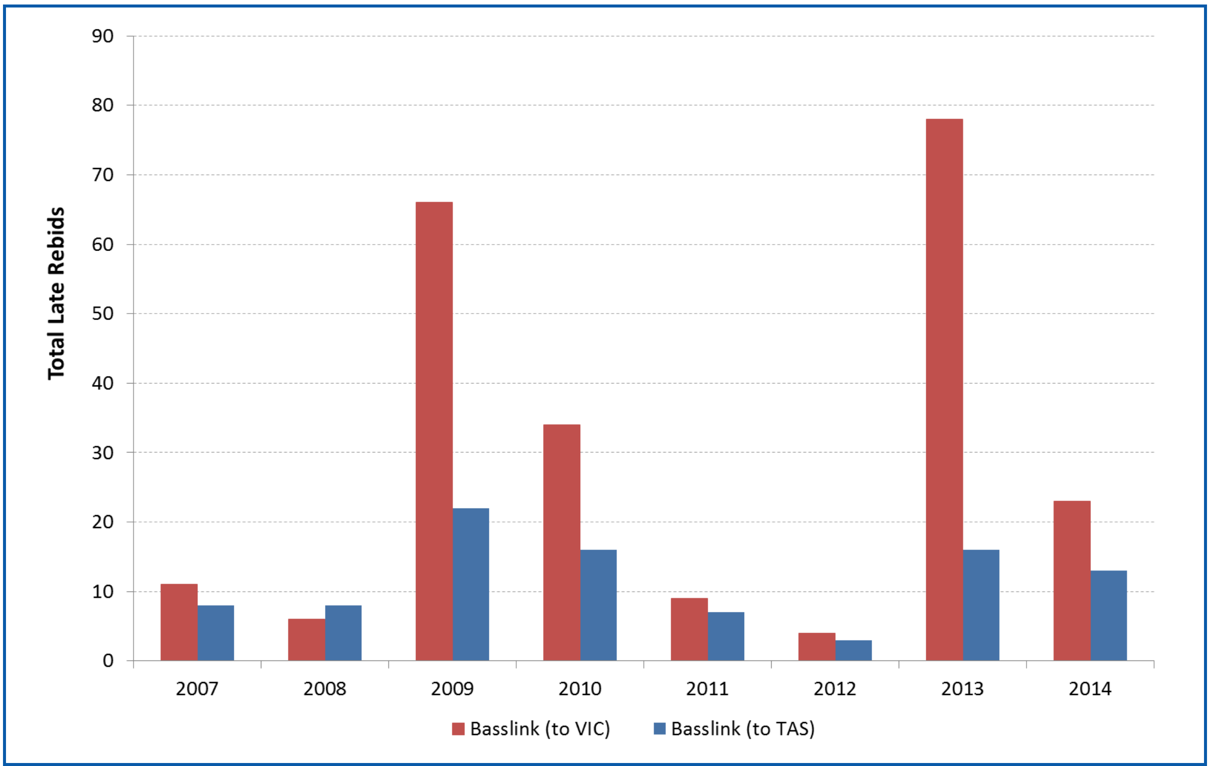

Figure 5.3 – Basslink Late Rebids – Annual

6 Stage 2 – Impact of Market Observation on Bidding Behaviour

The objective of Stage 1 was to produce aggregate data which summarised rebidding behaviour. As an interim step in this procedure, ROAM produced bidding statistics for each DI for all DUIDs. This DI data is used as an input into the Stage 2 analysis. The purpose of the Stage 2 analysis is to analyse the potential relationships that may exist between bidding behaviour and market variables such as demand, pre-dispatch forecasts, pool prices etc.

We have applied statistical techniques to determine the strength of the relationships between bidding behaviour and market observations. This statistical analysis is based predominantly on linear models that use DI level measures of bidding behaviour and DI level market observations in each calendar year.

The relationships that we have examined are summarised below:

- The relationship between the type of rebidding and the DI within the TI;
- The impact of market variables such as regional demand and import headroom on bidding behaviour;
- The relationship between bidding behaviour and the incidence of high regional pool prices;
- Determining the effect of generator forced outages and binding transmission constraint equations on bidding behaviour through case studies;

- The potential for pre-dispatch forecast outcomes to influence bidding behaviour over a short period.

For these relationships, we have looked at the effect of both the frequency and type of both 'all rebids' and 'late rebids'. Late rebids are generally defined in this analysis as the frequency of rebids that were submitted within the last DI (see Section 3.6.1). For some relationships, we have also considered an alternative definition of late rebidding being the frequency of rebids submitted 30 minutes before the start of the DI.

The majority of the relationships examined consider bidding behaviour at the regional level. Regional bidding behaviour is determined by adding the bidding frequencies across all categories for all DUIDs within the region. All DUIDs are therefore given equal weighting in this analysis.

The metrics used for bidding behaviour include both frequencies of rebids and also a categorisation of the type of rebid. For the Stage 2 analysis, examination of the type of rebidding refers to the likelihood that a rebid represents a movement of capacity to higher or lower bid bands (see Section 3.6.2). Rebids that represent no change in the capacity offered below $300/MWh are ignored for this analysis as a means of simplifying the interpretation of the outcomes. The two categories are called 'Above 300' and 'Below 300'.

Only relationships that have a level of significance below 10% are provided in the results for Stage 2. The relationships are illustrated in tables which indicate the direction of the relationship and the strength of the relationship. The symbols and colours used to represent the relationships are shown in Table 6.1.

Table 6.1 – Illustrations of Significance

Inference	**Symbol**	Direction	Significance Level
Mildly Significant	↗	Positive	10%
Moderately Significant	↗	Positive	5%
Highly Significant	↗	Positive	1%
Mildly Significant	↘	Negative	10%
Moderately Significant	↘	Negative	5%
Highly Significant	↘	Negative	1%

Grey boxes signify that the input variable has no observations in that year. For example, if a constraint equation did not bind in the 2008 calendar year, it is not possible to determine the significance of a relationship between the constraint binding and bidding behaviour.

This section focuses on market variables that influence bidding behaviour at the regional level. Section 7 considers the impact of different types of bidding behaviour on market pool price outcomes.

6.1 DI IN TI

6.1.1 Approach

We analysed the potential relationships that may exist between the DI within the TI and the types of rebids that are submitted. This analysis was performed separately considering all rebids and late rebids. Using all rebids results in consideration of all rebids that were submitted before the start of the TI for each DI. By analysing late rebidding, only rebids that are submitted during the trading interval are considered.

The general approach of this analysis is to determine whether the likelihood of bids being to higher or lower bid bands increases or decreases throughout the TI.

6.1.2 Results

Table 6.2 provides the results of the analysis determining the significance of the relationship between the type of rebids and DI within the TI.

Table 6.2 – DI in TI and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300							↗	↗
	Below 300							↘	↘
New South Wales	Above 300								
	Below 300								
Victoria	Above 300								
	Below 300								
South Australia	Above 300								
	Below 300								
Tasmania	Above 300								
	Below 300								

It is evident that the relationship between DI in TI and rebidding type is generally very weak or otherwise negligible. This is primarily the result of the fact that the majority of rebidding is submitted prior to the start of the trading interval. Therefore, the distribution of rebidding type is unlikely to change significantly during the trading interval. The only relationships that were found to be significant were in Queensland, which indicated that in 2013 and 2014, later DIs within the trading interval tended to be characterised by a higher likelihood of rebids that represented a movement of capacity to higher bid bands. Given that only rebids that increase or decrease the capacity offered below $300/MWh are considered in this analysis (i.e. neutral rebids are ignored), any variable that has a significant relationship with 'Above 300' will have an opposite and equally significant relationship with 'Below 300'.

A corresponding analysis which determines the relationship between the type of late rebidding and DI within the TI is presented in Table 6.3.

Table 6.3 – DI in TI and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300								↗
	Below 300								↘
New South Wales	Above 300				↗			↗	
	Below 300				↘			↘	
Victoria	Above 300								
	Below 300								
South Australia	Above 300	↗			↗	↗		↗	
	Below 300	↘			↘	↘		↘	
Tasmania	Above 300	↗					↘		↘
	Below 300	↘					↗		↗

The relationships between the DI within the TI and late rebidding were significantly stronger than those observed when considering all rebids. In all regions other than Tasmania, when a significant relationship was observed, the relationship indicated that late rebidding was more likely to withhold additional capacity for later DIs in the TI. The relationship shows in Queensland in 2014 fits well with descriptive result provided in Figure 4.3; this figure demonstrated that the proportion of rebids to higher bid bands was significantly higher in the 5th and 6th DIs.

The above results do not imply that when a significant relationship exists that a late rebid is more likely to be to higher bid bands than lower bid bands in a late DI within the TI. Rather, the results suggest that the likelihood of a rebid moving capacity to high bid bands is greater for a DI later in the TI in comparison to a DI earlier in the TI. It is also important to recognise that materiality of this effect is also related to the frequency of any late rebidding during the trading intervals. This frequency of late rebidding for mainland regions is illustrated in Figure 6.1.

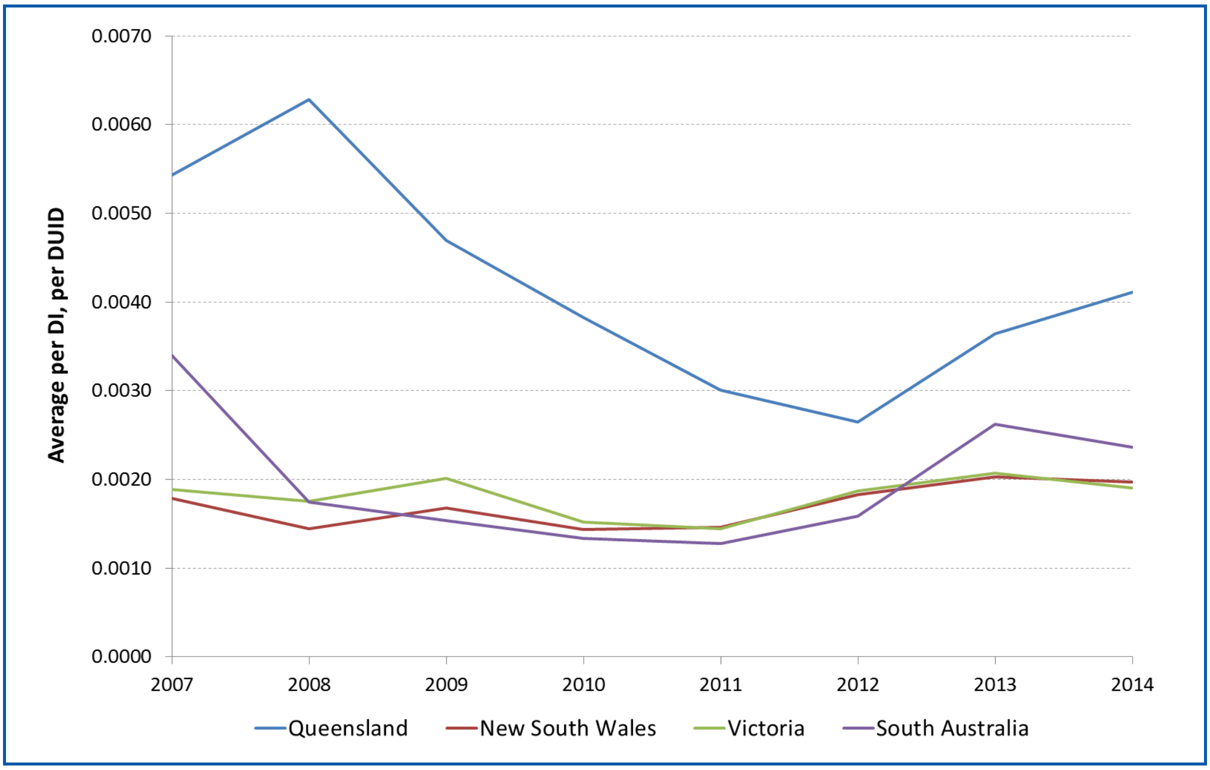

Figure 6.1 – Frequency of Late Rebidding for Mainland Regions

6.2 EFFECT OF DEMAND ON BIDDING BEHAVIOUR

We have investigated the impact of regional demand on bidding behaviour. The time of day figure provided earlier in Figure 4.4 is suggestive in that rebidding frequency is significantly higher during the middle of the trading day. This is also true of demand. The analysis of the impact of demand considers the impact of other factors which may influence bidding behaviour and the interaction effects between these observations.

Table 6.4 and Table 6.5 illustrate demand has a highly significant relationship with both rebidding and late rebidding frequency respectively in all regions. In the four mainland regions, demand is always positively correlated with rebidding and late rebidding frequency. The effect is more mixed in Tasmania as rebidding frequency is highly variable in that region as a result of the high concentration of hydro units and interaction with FCAS provision. The bidding behaviour of these hydro units is often related to other factors such as water management, ancillary services etc. rather than responding to regional demand.

Table 6.4 – Demand and All Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
New South Wales	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
Victoria	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
South Australia	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Rebid freq.	↗	↗	↗	↘	↘	↘		↗

Table 6.5 – Demand and Late Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
New South Wales	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
Victoria	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
South Australia	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗

The outputs in the tables above are consistent with the frequency of rebidding and late rebidding on a time of day basis. Figure 6.2 shows the average frequency of late rebids by time of day for each region, averaged over all years of the study. It is evident that rebidding frequency is generally higher during the day and early evening. Demand is generally higher over this period.

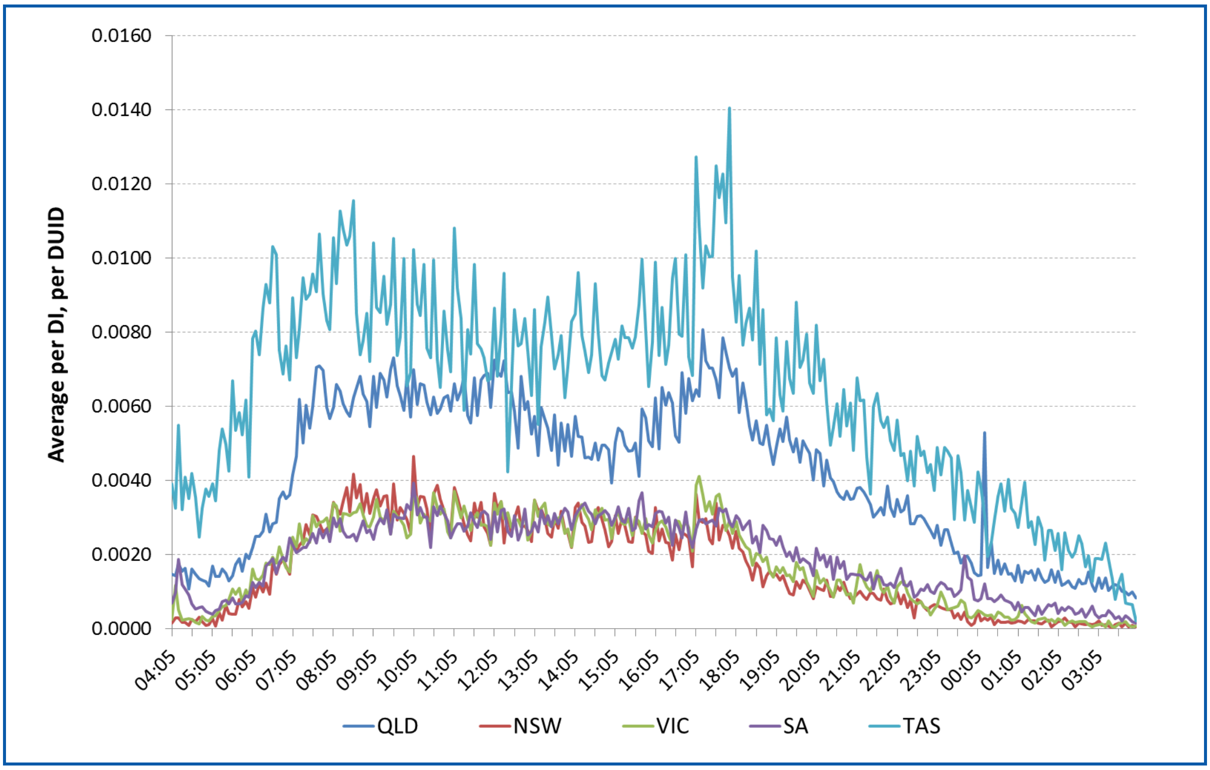

Figure 6.2 – Rebidding by Time of Day – All Regions – All Years

Regional demand also influences the likelihood that rebids are movements towards higher or lower bid bands. The results of this analysis are provided in Table 6.6. In South Australia and Victoria, higher demand is always significantly related to an increased likelihood that rebids will represent movements of capacity to bid bands below $300/MWh.

The effect of demand on rebidding type is more variable in Queensland, New South Wales and Tasmania; in these regions there are numerous calendar years in which high demand has a significant relationship with rebidding to higher bid bands. This is particularly true in Queensland, and also in the recent years in New South Wales.

Table 6.6 – Demand and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300		↗	↗	↗	↗	↘	↘	↗
	Below 300		↘	↘	↘	↘	↗	↗	↘
New South Wales	Above 300	↗	↘	↘	↘	↘	↗		↗
	Below 300	↘	↗	↗	↗	↗	↘		↘
Victoria	Above 300	↘	↘	↘	↘	↘	↘	↘	↘
	Below 300	↗	↗	↗	↗	↗	↗	↗	↗
South Australia	Above 300	↘	↘	↘	↘	↘	↘	↘	↘
	Below 300	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Above 300	↘	↘	↘	↘	↘	↗	↘	↘
	Below 300	↗	↗	↗	↗	↗	↘	↗	↗

A similar relationship to that described for all rebidding is observed in Table 6.7 which illustrates the relationship between demand and the type of late rebidding. There are a number of calendar years across all regions (with the exception of South Australia) where the relationship was not found to be significant.

When there is observed to be a significant relationship, the impact on the type of rebidding is consistent with that described above. In all regions other than Queensland, when the relationship between demand and late rebidding type is significant, the analysis indicates that higher demand results in an increased likelihood of late rebidding into lower bid bands.

In Queensland, higher demand generally results in an increased likelihood of capacity being moved to bid bands higher than $300/MWh.

Table 6.7 – Demand and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300	↗	↗	↗	↗	↗	↘		↗
	Below 300	↘	↘	↘	↘	↘	↗		↘
New South Wales	Above 300				↘	↘	↘	↘	
	Below 300				↗	↗	↗	↗	
Victoria	Above 300		↘		↘	↘	↘	↘	↘
	Below 300		↗		↗	↗	↗	↗	↗
South Australia	Above 300	↘	↘	↘	↘	↘	↘	↘	↘
	Below 300	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Above 300					↘			
	Below 300					↗			

Figure 6.3 shows a comparison between the proportion of late rebids submitted to higher or lower bid bands for all years of the study. Average time of day South Australian demand is also presented in this figure. It is evident that during the period from approximately 8:30am and 10:00pm, South Australian demand is generally high on average. Over this period, the proportion of the late rebids that are bid to prices below $300/MWh is significantly higher than the proportion to higher bid bands. This comparison is only indicative as the figure shows only the average rebidding and demand for each time of day. Therefore, this comparison does not consider the relationship

between late rebidding and demand within the averaging that is occurring in these figures.

For comparison, Figure 6.4 shows the same relationship in Queensland for 2014. In this figure, the period of the day with high average demand is generally correlated with a higher proportion of rebids to prices above $300/MWh.

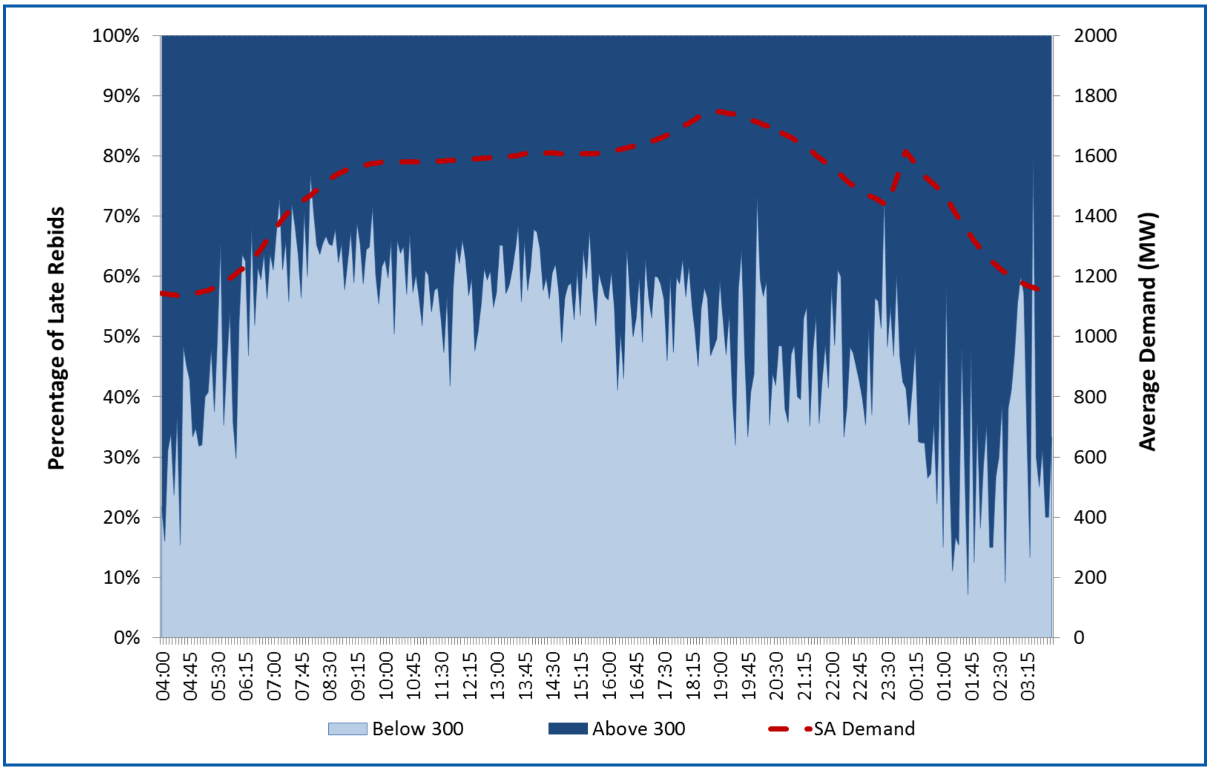

Figure 6.3 – Rebidding Type and Demand by Time of Day – South Australia – All Years

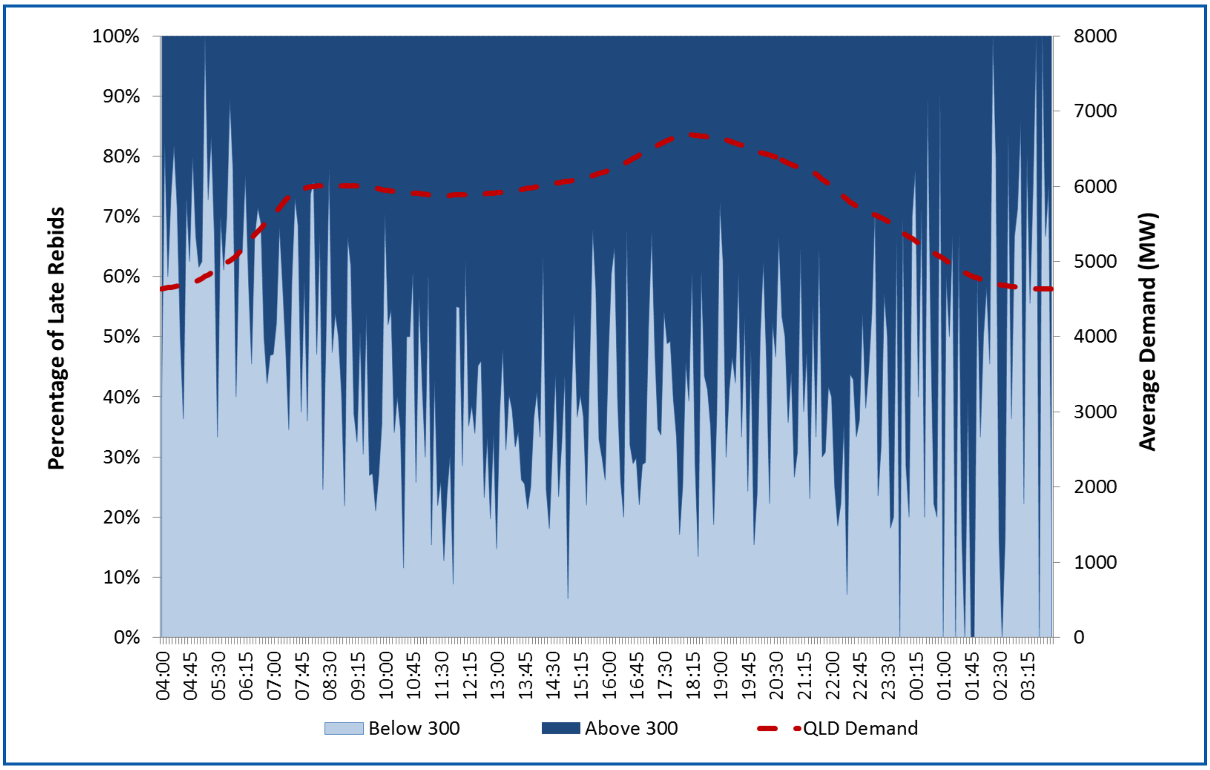

Figure 6.4 – Rebidding Type and Demand by Time of Day – Queensland – 2014

6.3 Effect of Import Headroom on Bidding Behaviour

Import headroom refers to the spare capacity available for interconnectors to import energy. Low import headroom is often a factor in high regional prices and is also commonly used in rebid explanations submitted to AEMO. We have therefore quantitatively assessed the effect of low import headroom on bidding behaviour; headroom considers the combined import across potentially multiple interconnectors. Low import headroom has been expressed as a being below 150 MW. The tables below refer to the impact of low import headroom on bidding behaviour. The analysis considers both the impact of demand on bidding behaviour and the interaction between demand and import headroom in determining whether the impact of low headroom is significant in its own right.

Table 6.8 shows that low import headroom often has a statistically significant relationship with an increase in rebidding frequency. There are occasional instances where low import headroom has a negative relationship with rebidding frequency. It is import to recognise that this analysis does incorporate the impact of demand. This inference therefore does not mean that there is not a positive correlation between low import headroom and rebidding frequency on a standalone basis. Rather, the analysis concludes that in considering other factors, import headroom does not further increase the expected frequency of rebids in some calendar years.

Table 6.8 – Import Headroom and All Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.	↗	↘		↗	↗	↗	↗	↗
New South Wales	Rebid freq.			↗	↗	↘	↘	↗	
Victoria	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↘
South Australia	Rebid freq.	↗	↘	↗	↗	↗	↘	↗	
Tasmania	Rebid freq.	↘	↘	↗	↘	↘	↘	↘	↗

As with rebidding frequency, low import headroom is observed in Table 6.9 to often have a positive, highly significant relationship with the incidence of late rebidding. This is particularly evident in Queensland and South Australia where all significant relationships have a positive direction.

Table 6.9 – Import Headroom and Late Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late rebid freq.	↗	↘		↗	↗	↗	↗	↗
New South Wales	Late rebid freq.	↘		↗	↗	↗		↗	↗
Victoria	Late rebid freq.	↗	↗		↗	↗	↗	↗	↘
South Australia	Late rebid freq.			↗	↗	↗		↗	↗
Tasmania	Late rebid freq.	↘	↘	↗	↗	↗		↗	↗

We have also considered the relationship between low import headroom and the type of rebidding (Table 6.10) and late rebidding (Table 6.11). Low import headroom is more often observed to have a significant impact on rebidding frequency in comparison to late rebidding frequency. In regions other than New South Wales, low import headroom generally results in a higher frequency of rebids to higher price bands. Low import headroom can indicate the possibility for portfolios to utilise market power to increase pool prices. This is potentially why low import headroom tends to result in portfolios withdrawing capacity to higher price bands.

In contrast, low import headroom into New South Wales tends to result in capacity moving to lower price bands.

Table 6.10 – Import Headroom and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300	↗	↗	↗	↘	↗	↗	↗	↗
	Below 300	↘	↘	↘	↗	↘	↘	↘	↘
New South Wales	Above 300	↘	↘	↗	↘	↘			↘
	Below 300	↗	↗	↘	↗	↗			↗
Victoria	Above 300		↘	↗	↘			↗	↗
	Below 300		↗	↘	↗			↘	↘
South Australia	Above 300		↗	↗	↗	↗	↗	↘	↘
	Below 300		↘	↘	↘	↘	↘	↗	↗
Tasmania	Above 300	↗	↗	↗	↘	↗	↗	↗	↘
	Below 300	↘	↘	↘	↗	↘	↘	↘	↗

Queensland has the most significant relationship between low import headroom and the type of late rebidding. Low import headroom consistently results in an increased frequency of rebids which withdraw capacity above $300/MWh.

Table 6.11 – Import Headroom and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300		↗		↗	↗	↗	↗	↗
	Below 300		↘		↘	↘	↘	↘	↘
New South Wales	Above 300			↘					↘
	Below 300			↗					↗
Victoria	Above 300				↘				
	Below 300				↗				
South Australia	Above 300	↗						↘	↘
	Below 300	↘						↗	↗
Tasmania	Above 300					↗	↗		
	Below 300					↘	↘		

6.4 EFFECT OF FORCED OUTAGES ON REGIONAL BIDDING BEHAVIOUR

ROAM also considered the impact of events such as forced outage on both regional bidding behaviour and bidding behaviour at the portfolio level (see Section 6.5). For this analysis, we considered a case study in each mainland region. We used historical dispatch data to determine where forced outages may have occurred.[5] We have then considered the bidding behaviour for the six DIs (30 minutes) which immediately follow the forced outage. The units chosen for the case studies are:

- Kogan Creek in Queensland;
- Mount Piper (both units) in New South Wales;
- Loy Yang B (both units) in Victoria;
- Pelican Point CCGT in South Australia.

Table 6.12 indicates that Queensland is the only region in which forced outages consistently increase the frequency of rebidding (noting that this analysis accounts for the impact of regional demand and import headroom). No significant effect is observed in South Australia. In Victoria and New South Wales, the impact of forced outages is inconsistent between calendar years. This may be influenced by the relatively low sample size for forced outages in this dataset.

Table 6.12 – Forced Outages and All Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.	↗	↗		↗		↗	↗	
New South Wales	Rebid freq.	↘	↗		↘	↘			
Victoria	Rebid freq.		↗	↘	↗			↘	↘
South Australia	Rebid freq.								

[5] ROAM used a method which examined where dispatch fell from high levels to 0 MW within a 10 minute as a means of determining forced outage events. These rapid reductions in generation could possibly have resulted from taking a unit off for a planned outage. Similarly, forced outages may have occurred which did not fit this criteria.

A more consistent result is observed for the influence of a forced outage on late rebidding. When significant, the relationship between forced outages and late rebidding frequency is always positive. As with rebidding, the strongest relationship is observed in Queensland.

Table 6.13 – Forced Outages and Late Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late rebid freq.	↗	↗	↗	↗	↗	↗	↗	
New South Wales	Late rebid freq.		↗		↗		↗		↗
Victoria	Late rebid freq.				↗	↗			
South Australia	Late rebid freq.							↗	

Although there are a number of exceptions, Table 6.14 indicates that forced outages generally increase the likelihood of rebidding to lower price bands. This is particularly true of late rebidding (see Table 6.15).

Table 6.14 – Forced Outages and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300		↗			↘			
	Below 300		↘			↗			
New South Wales	Above 300		↘			↘		↗	
	Below 300		↗			↗		↘	
Victoria	Above 300	↗				↘		↘	↘
	Below 300	↘				↗		↗	↗
South Australia	Above 300						↘		
	Below 300						↗		

Table 6.15 – Forced Outages and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300	↘			↘		↘	↘	
	Below 300	↗			↗		↗	↗	
New South Wales	Above 300								
	Below 300								
Victoria	Above 300					↘			↘
	Below 300					↗			↗
South Australia	Above 300								
	Below 300								

6.5 Effect of Forced Outages on Portfolio Bidding Behaviour

The impact of forced outages on bidding behaviour within the portfolio that owns the generating unit is likely to be different to the influence on other generating units. Where there is little possibility of a significant wholesale market impact, it would be expected that forced outages would increase rebidding frequency within the portfolio but may not significantly affect bidding of other units. Furthermore, forced outages could alter the type of rebids that a unit within the portfolio would submit in comparison to a unit outside the portfolio.

The case study considers the portfolio that owns the generation units listed above (i.e. CS Energy (Kogan Creek), Delta Energy (Mount Piper), GDF Suez Victoria (Loy Yang B) and GDF Suez South Australia (Pelican Point). The structural makeups of the CS Energy portfolio and the Delta Energy portfolio changed significantly during this time period. We have applied CS Energy as the arrangement since the restructure on 1 July 2011. Delta Energy consists of the configuration before the gentrader agreements on 1 March 2011).

Table 6.16 shows the influence of forced outages on rebidding for units within the portfolio and for other units within the region. In most instances, forced outages have a positive, significant relationship with rebidding frequency within the portfolio. This impact is more mixed on generation outside the portfolio.

Table 6.16 – Forced Outages and All Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland - CS Energy	Rebid freq.					↗	↗	↗	
Queensland - Other	Rebid freq.						↗		
New South Wales - Delta	Rebid freq.		↗	↘	↘				
New South Wales - Other	Rebid freq.	↘	↗		↘	↘			
Victoria - GDF Suez	Rebid freq.		↗		↗		↗		
Victoria - Other	Rebid freq.		↗	↘	↗			↘	↘
South Australia - GDF Suez	Rebid freq.			↗			↘		
South Australia - Other	Rebid freq.			↘					

This effect is more evident in late rebidding, with forced outages more consistently related to an increased frequency within the portfolio, while rarely impact on late rebidding outside the portfolio. This is seen in Table 6.17.

Table 6.17 – Forced Outages and Late Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland - CS Energy	Late rebid freq.					↗	↗	↗	
Queensland - Other	Late rebid freq.						↗	↗	
New South Wales - Delta	Late rebid freq.		↗	↗	↗				
New South Wales - Other	Late rebid freq.								
Victoria - GDF Suez	Late rebid freq.			↗	↗	↗			
Victoria - Other	Late rebid freq.					↗			↗
South Australia - GDF Suez	Late rebid freq.								
South Australia - Other	Late rebid freq.							↗	

In general, the results presented in Table 6.18 and Table 6.19 suggest that forced outages only occasionally affect the type of rebids submitted by units both within the portfolio and from other units. This is also evident for late rebidding which shows very few significant relationships with forced outages.

Where relationships are observed to exist within the portfolio, the impact is consistent in that forced outages result in a movement of capacity to lower bid bands. Contrastingly, the directions of the relationships for units outside the portfolio are more mixed.

Table 6.18 – Forced Outages and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland - CS Energy	Above 300						↘		
	Below 300						↗		
Queensland - Other	Above 300					↘	↗	↘	
	Below 300					↗	↘	↗	
New South Wales - Delta	Above 300		↘						
	Below 300		↗						
New South Wales - Other	Above 300		↘			↘			
	Below 300		↗			↗			
Victoria - GDF Suez	Above 300				↘	↘			
	Below 300				↗	↗			
Victoria - Other	Above 300	↗		↘					
	Below 300	↘		↗					
South Australia - GDF Suez	Above 300			↘					
	Below 300			↗					
South Australia - Other	Above 300			↗					
	Below 300			↘					

Table 6.19 – Forced Outages and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland - CS Energy	Above 300						↘	↘	
	Below 300						↗	↗	
Queensland - Other	Above 300								
	Below 300								
New South Wales - Delta	Above 300								
	Below 300								
New South Wales - Other	Above 300								
	Below 300								
Victoria - GDF Suez	Above 300					↘			
	Below 300					↗			
Victoria - Other	Above 300								
	Below 300								
South Australia - GDF Suez	Above 300								
	Below 300								
South Australia - Other	Above 300								
	Below 300								

6.6 EFFECT OF BINDING CONSTRAINTS ON REGIONAL BIDDING BEHAVIOUR

We have considered two case studies to investigate the impact of binding transmission constraints on bidding behaviour. These case studies are:

- Q>>NIL_855_871 in Queensland;
- N>>N-NIL__S in New South Wales.

These transmission constraint equations were chosen as they were observed to have a high impact on wholesale market outcomes over an extended period. For both these transmission constraint equations, the underlying network limitations have since been alleviated through network investment.

The impact of the transmission constraint equations on bidding frequency is provided in Table 6.20. Similarly, the impact on late rebidding is shown in Table 6.21. Binding transmission constraint equations have a significant relationship with rebidding frequency in all years. This relationship is positive in New South Wales in both years and positive in Queensland for the 2012 and 2013 calendar years.

Table 6.20 – Binding Constraints and All Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.		↘	↘	↘	↘	↗	↗	
New South Wales	Rebid freq.			↗	↗				

Table 6.21 – Binding Constraints and Late Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late rebid freq.		↘	↘	↘	↘	↗	↗	
New South Wales	Late rebid freq.			↗	↗				

The relationship is in the negative direction in Queensland between 2008 and 2011. This negative relationship is the result of accounting for other factors such as demand and import headroom, which are both highly related to the incidence of the constraint binding. A comparison of demand between periods of the constraint binding and periods where the constraint is not binding in 2011 is shown in Figure 6.5.

This box-and-whisker plot below shows the full range of observations of demand in periods where the constraint is and is not binding. The black diamond shows the median outcomes in these two data sets. The blue box shows the range of the middle 50% of observations.

This figure illustrates that demand is generally high during periods of the constraint binding. Therefore, it is likely that the frequency of rebids (and late rebids) would be at a high level, irrespective of whether the constraint was binding. In the years where the relationship between the constraint binding and rebidding (late rebidding) is negative, the incidence of the binding constraint decreases the expected frequency of rebids and late rebids given the level of demand and import headroom.

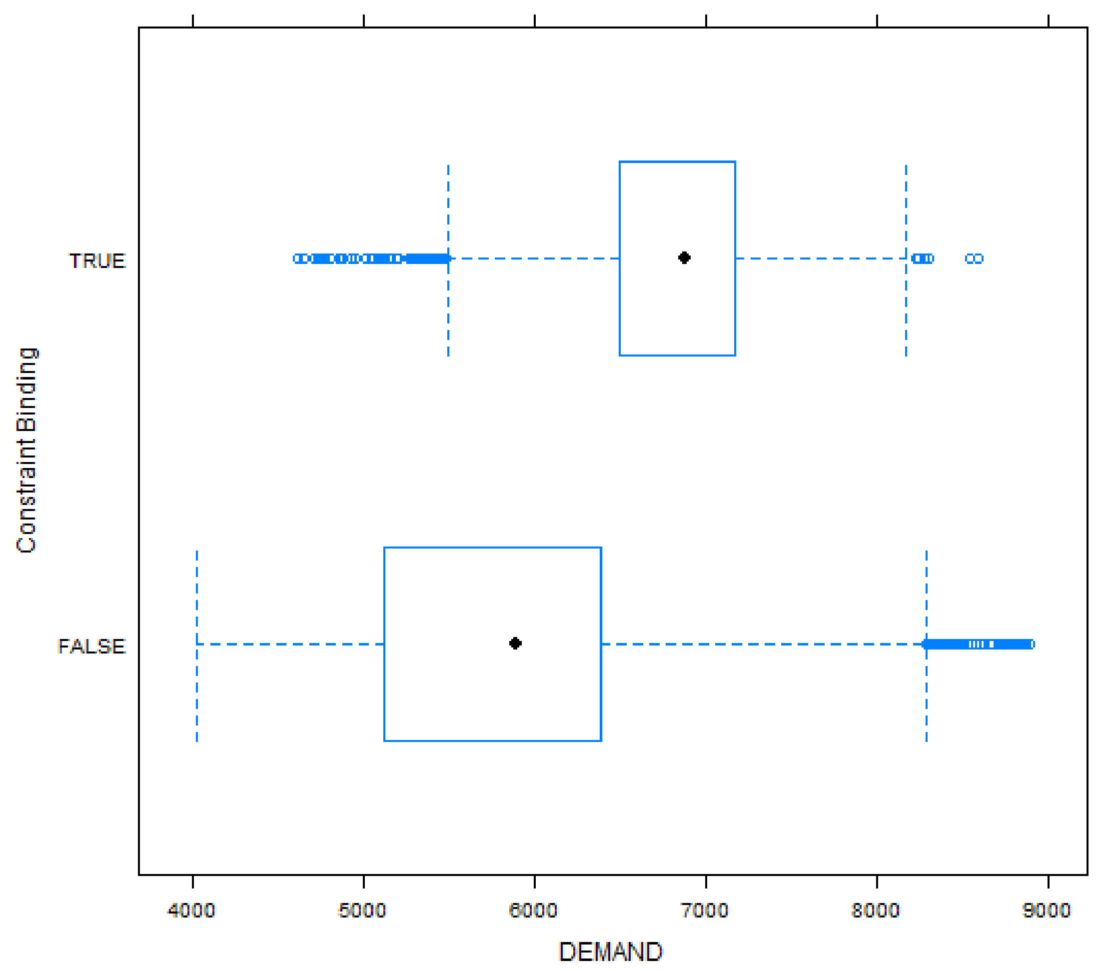

Figure 6.5 – Queensland Demand during Constraint Binding Periods

The binding transmission constraint is shown in Table 6.22 to generally result in an increased likelihood in generation withholding capacity to higher price bands. This is also true of late rebidding. However the relationships are not observed with the same regularity (see Table 6.23).

Table 6.22 – Binding Constraints and All Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300		↗	↗	↘		↗	↗	
	Below 300		↘	↘	↗		↘	↘	
New South Wales	Above 300			↗					
	Below 300			↘					

Table 6.23 – Binding Constraints and Late Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300					↗		↗	
	Below 300					↘		↘	
New South Wales	Above 300								
	Below 300								

6.7 PRE-DISPATCH PRICE FORECAST

Pre-dispatch forecasts are provided by AEMO in advance of dispatch to provide market participants with an independent forecast of market outcomes. These pre-dispatch forecasts use short-term demand forecasts in conjunction with bidding data submitted by market participants. Many market participants use pre-dispatch forecasts as an input into developing bidding strategies in the short-term. This is evident in the rebid explanations provided to AEMO.

This section considers the impact of high pre-dispatch price forecasts on bidding behaviour. We have considered the influence of the pre-dispatch forecast which is 30 minutes in advance of each DI. We then consider the bidding behaviour of all generation during that 30 minute interval.

Table 6.24 shows the relationship between a pre-dispatch price spike (>$300/MWh) forecast on rebidding frequency. Generally, this relationship is highly significant and positive, although there are some exceptions to this assertion, particularly during the 2013 and 2014 calendar years. As with all relationships examined in this section, these relationships do consider the impact of other factors that influence bidding behaviour.

Table 6.24 – Pre-dispatch Price Spike Forecast and Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.	↗	↗	↗	↗	↗	↘	↘	↘
New South Wales	Rebid freq.	↗	↗	↗	↗	↗	↗		
Victoria	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↘
South Australia	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Rebid freq.	↗	↗	↗	↗	↘		↗	↗

Consider for example Figure 6.6 which shows the distribution of bidding frequency in periods with and without price spikes in the pre-dispatch forecasts for Queensland in 2014. This relationship was described in the table above as having a negative relationship. This figures demonstrates the critical impact of the models considering other factors, significantly in this case, demand, in determining the true effect of each variable. In many of the models analysed here, the explanatory variables (such as demand, headroom, constraints binding, high pre-dispatch price forecasts) are all correlated with each other. Therefore, all relationships would appear significant in isolation. It is by using the statistical power of linear models that we have been able to determine where a market variable has significantly influenced bidding behaviour.

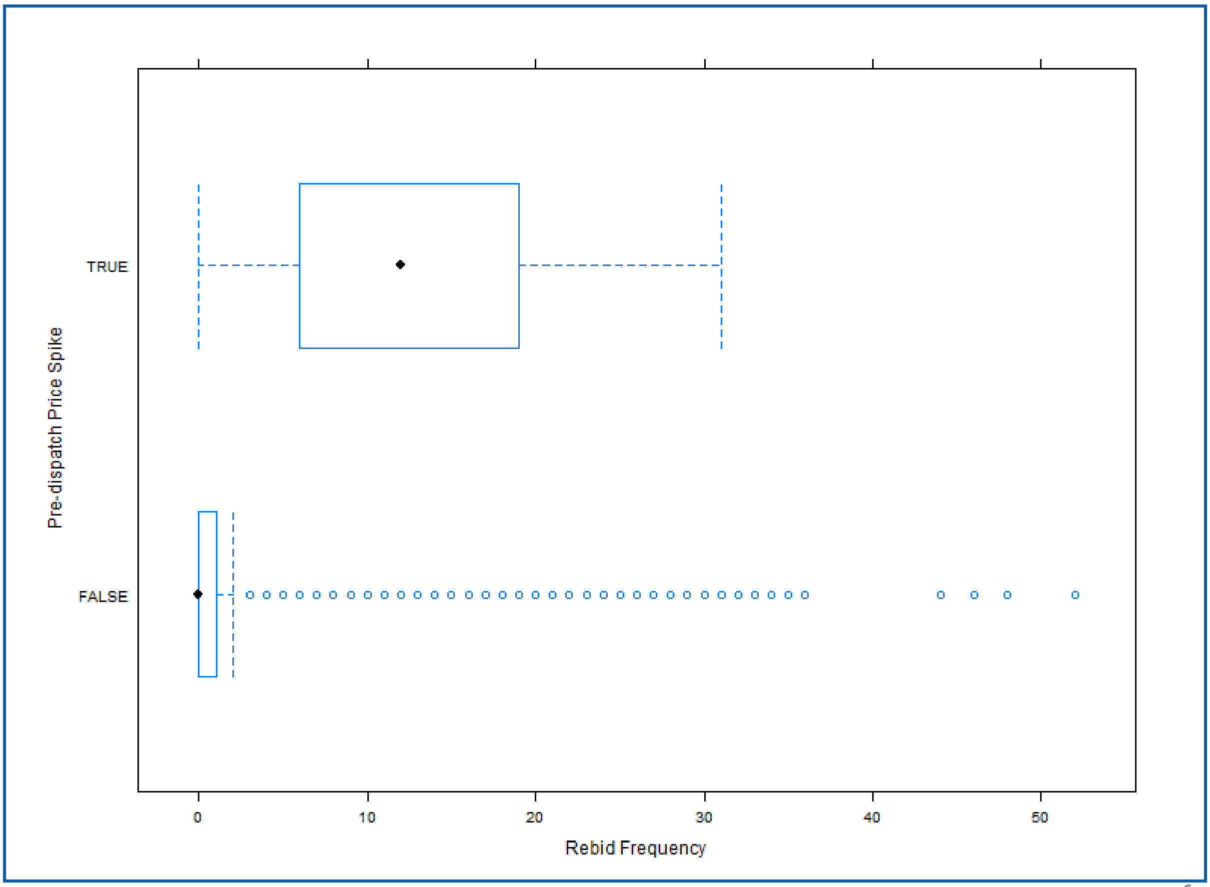

Figure 6.6 – Pre-dispatch Price Spike and the impact on rebidding – Queensland 2014[6]

The impact of a pre-dispatch price spike forecast on the type of rebids submitted during the 30 minute interval is presented in Table 6.25. With the exception of New South Wales, high pre-dispatch forecasts consistently result in an increased likelihood of generators submitting bids to lower price bands. This indicates an efficient response to the market signal that the region is short of low cost capacity in the near future. This bidding behaviour could indicate responses such as gas turbines starting to prepare their units to generate.

Table 6.25 – Pre-dispatch Price Spike Forecast and Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300	↘	↘				↘	↘	↘
	Below 300	↗	↗				↗	↗	↗
New South Wales	Above 300	↗	↘	↗	↗	↗	↗		
	Below 300	↘	↗	↘	↘	↘	↘		
Victoria	Above 300	↘	↘		↘		↘	↘	↘
	Below 300	↗	↗		↗		↗	↗	↗
South Australia	Above 300	↘	↘	↘	↘	↘	↘	↘	↘
	Below 300	↗	↗	↗	↗	↗	↗	↗	↗
Tasmania	Above 300	↘		↘	↘	↘		↘	↘
	Below 300	↗		↗	↗	↗		↗	↗

[6] See Section 6.6 for a description of box-and-whisker plots

Table 6.26 investigates the impacts of this response. Given a pre-dispatch price spike has been forecast, the table shows the impact of rebidding to lower price bands on the probability that the resulting actual pool price will also be a price spike. In general, this response decreases the likelihood of a price spike actually occurring.

Table 6.26 – Probability of Price Spike given frequency of rebids to low price bands after pre-dispatch price spike forecast

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Low Late freq.	↗			↗	↘	↘		
New South Wales	Low Late freq.	↘	↘	↘					
Victoria	Low Late freq.		↗	↘		↘		↘	
South Australia	Low Late freq.					↘	↘	↘	↘
Tasmania	Low Late freq.	↘	↘						

This is evident from the results provided in Table 6.27 that show the probability of a pool price spike where a price spike was predicted in pre-dispatch. It is particularly evident in the last three calendar years that price spikes forecast in pre-dispatch have a relatively low probability of actually occurring. This is in general agreement with the results presented above which indicate a significant relationship between high pre-dispatch forecasts and a generation response of moving capacity to low price bands.

Table 6.27 – Probability of Price spike given pre-dispatch price spike forecast

	Queensland	New South Wales	Victoria	South Australia	Tasmania
2007	58%	71%	59%	37%	32%
2008	54%	67%	33%	77%	0%
2009	42%	64%	47%	71%	56%
2010	29%	65%	41%	47%	39%
2011	52%	77%	58%	60%	61%
2012	0%	17%	38%	19%	#N/A
2013	53%	54%	13%	20%	3%
2014	12%	25%	32%	56%	26%

6.8 LOW IMPORT HEADROOM FORECAST IN PRE-DISPATCH

The expectation of low import headroom can also be used as a justification for rebidding. We have analysed the impact of a low headroom forecast (<150 MW) on bidding behaviour. The 30 minute window applied above has been replicated for this assessment.

Table 6.28 demonstrates that a low import headroom forecast is likely to increase the frequency of rebidding across all regions.

Table 6.28 – Pre-dispatch Low Import Headroom Forecast and Rebidding Frequency

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Rebid freq.	↗		↗	↗	↗	↗	↗	↗
New South Wales	Rebid freq.	↗	↘	↗	↗		↗	↗	↗
Victoria	Rebid freq.	↗	↗	↗	↗	↗	↗	↗	
South Australia	Rebid freq.	↗	↗	↗	↗	↗		↗	↗
Tasmania	Rebid freq.	↘	↘	↗		↗		↗	↗

An analysis of the impact of a low import headroom forecast on the type of rebids submitted during the 30 minute interval is provided in Table 6.29. The results in Queensland show that the forecast of low import headroom is often observed to significantly increase the likelihood of rebids submitted that move capacity above $300/MWh. However, this has not been the case over the two most recent calendar years. In comparison, the impact in other regions is that generally, low import headroom forecasts have a significant relationship with an increased likelihood of bids that add capacity at low prices.

Table 6.29 – Pre-dispatch Low Import Headroom Forecast and Rebidding Type

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Above 300	↗	↗		↗	↗	↗		↘
	Below 300	↘	↘		↘	↘	↘		↗
New South Wales	Above 300			↘			↘	↗	↘
	Below 300			↗			↗	↘	↗
Victoria	Above 300		↘		↘	↘			↘
	Below 300		↗		↗	↗			↗
South Australia	Above 300				↘		↘	↘	↘
	Below 300				↗		↗	↗	↗
Tasmania	Above 300				↘	↗	↗		
	Below 300				↗	↘	↘		

7 PRICE IMPACTS OF REBIDDING

7.1 INTRODUCTION

A critical purpose of this study is to investigate the interaction between generator bidding behaviour and wholesale pool price outcomes. We have applied statistical techniques to determine the potential relationships that exist between bidding behaviour and regional pool prices.

It is important to note that this approach cannot quantify the impact of rebidding or late rebidding on pool price outcomes. Rather, the approaches documented here seek to determine whether there are statistically significant relationships between observed bidding behaviour and market outcomes.

7.2 METHODOLOGY AND DATA MEASURES

The approaches applied in this analysis are similar to those applied in Section 5. The focus of this analysis is determining the impact of bidding behaviour on market outcomes as opposed to the influence of other factors on bidding behaviour.

Market outcomes are represented by two different pool price metrics:

- Regional pool prices (in $/MWh);
- Regional price spike, i.e. if pool price exceeds $300/MWh.

We have applied a number of measures of bidding behaviour to test their significance with pool price outcomes. These include:

- Frequency of rebids;
- Proportion of rebids to higher/lower price bands;
- Frequency of rebids within the last DI;
- Proportion of rebids within the last DI to higher/lower price bands;
- Frequency of rebids within 30 minutes prior to the DI;
- Proportion of rebids within 30 minutes prior to the DI to higher/lower price bands.

All statistical analysis of pool price outcomes considers the impact of market measures such as demand and interconnector headroom on both pool prices and on bidding behaviour.

7.3 LIMITATIONS

There are a number of limitations of this assessment that result from the input data used and the method of analysis. The most significant limitation relates to the analysis being used to determine measures of correlation rather than causation. Only backcasting would allow a method whereby the impact of late rebids on pool prices could be accurately assessed. Periods of high pool prices may be strongly related to a high frequency of late rebidding. This analysis does not indicate whether price outcomes would have been materially different had this late rebidding not occurred.

There are also a number of limitations that relate to the input data used. The analysis presented in this section is regional. Therefore, all DUIDs are equally weighted. Pool price outcomes may in reality be driven by the actions of a small group of units or only one DUID. These periods will not contribute heavily to a significant relationship in this analysis.

A further limitation relates to the means of determining and classifying rebids. No consideration is given to the size of the rebid in these measures. Rebids that result in the movement of large volumes of capacity are not clearly differentiated from rebids that may only impact low volumes.

7.4 Results

7.4.1 Impact of Bidding Frequency on Pool Prices

The following two tables show the impact of rebidding and late rebidding (the tables supply both alternative measures of late rebidding) on pool price outcomes. Table 7.1 considers the impact on the probability of price spikes. Table 7.2 considers pool price outcomes as a numerical variable. The first table places a high emphasis on the difference in bidding behaviour between the relatively low volume of price spike DIs compared to the vast majority of DIs. The second table considers the range of all pool price outcomes.

It is evident that high pool price outcomes are strongly related with both the frequency of rebids and late rebids in Queensland. Of all regions, Queensland exhibits the strongest positive relationship. With the exception of the 2014 calendar year, South Australia also has a strong, positive relationship between rebidding frequency and high pool prices. Although the relationships are generally positive in New South Wales and Victoria, the significance of the relationship with pool price spikes has generally decreased in recent calendar years.

The majority of these results indicate that the frequency of all rebids is as strong, or often stronger, than the relationship with late rebids. The inter-relationship between late rebids and total rebids is also strong however and therefore, the interaction effects between these two variables are complex in the context of their distinct relationship with pool price outcomes.

Table 7.1 – Relationship between rebidding and late rebidding frequency and pool price spikes

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	All Rebids	↗	↗	↗	↗	↗	↗	↗	↗
	Late Rebids = Last DI	↗	↗	↗		↗	↗	↗	↗
	Late Rebids = 30 mins	↗	↗	↗		↗	↗	↗	↗
New South Wales	All Rebids	↗	↗	↗	↗		↗		↗
	Late Rebids = Last DI	↗		↗	↗	↗			
	Late Rebids = 30 mins	↗		↗	↗	↗	↗		
Victoria	All Rebids	↗	↗	↗	↗	↗	↗	↗	
	Late Rebids = Last DI	↗	↗	↗				↗	
	Late Rebids = 30 mins	↗	↗	↗		↘		↗	
South Australia	All Rebids	↗	↗	↗	↗	↗	↗	↗	↘
	Late Rebids = Last DI	↗	↘		↗	↗	↗	↗	↗
	Late Rebids = 30 mins	↗	↘	↘		↗	↗	↗	↗
Tasmania	All Rebids	↗		↗			↗	↗	↗
	Late Rebids = Last DI	↗	↗	↗			↗	↗	↗
	Late Rebids = 30 mins		↗	↗		↘	↗	↗	↗

Table 7.2 – Relationship between rebidding and late rebidding frequency and pool prices

		2007	2008	2009	2010	2011	2012	2013	2014
Queensland	All Rebids	↗	↗	↗	↗	↗	↗	↗	↗
	Late Rebids = Last DI	↗	↗	↗		↗	↗	↗	↗
	Late Rebids = 30 mins	↗	↗	↗	↘	↗	↗	↗	↗
New South Wales	All Rebids	↗	↗	↗	↗	↗	↗	↗	↗
	Late Rebids = Last DI			↗	↗		↗		
	Late Rebids = 30 mins	↘	↘	↗	↗	↘	↗	↗	
Victoria	All Rebids	↗	↗	↗	↗	↗	↗	↗	↗
	Late Rebids = Last DI	↗	↗	↘	↘	↘	↗	↗	↗
	Late Rebids = 30 mins	↗	↗	↘	↘	↘			↘
South Australia	All Rebids	↗	↗	↗	↗	↗	↗	↗	↗
	Late Rebids = Last DI	↗	↘	↘	↘	↗	↗	↗	↗
	Late Rebids = 30 mins	↗	↘	↘	↘	↘	↗	↗	↗
Tasmania	All Rebids	↗	↗	↗		↘	↗		↘
	Late Rebids = Last DI		↗	↗		↘	↗		↗
	Late Rebids = 30 mins	↘	↗		↘		↗		↗

Each of these tables considers the relationship between bidding behaviour and pool price outcomes within each calendar year. Figure 7.1 and Figure 7.2 further illustrate the extent of late rebidding behaviour and the materiality of the impact on pool prices. The correlation between annual late rebidding behaviour (shown by the frequency of bidding within 30 mins prior to the DI in Figure 7.1) and high pool prices is weak in the early years of this study; the earlier years of this study were characterised by higher levels of general volatility that related to a much tighter supply demand balance than has been observed in recent years. There is some evidence of a recent increase in both high price eventss and late rebidding in Queensland and South Australia.

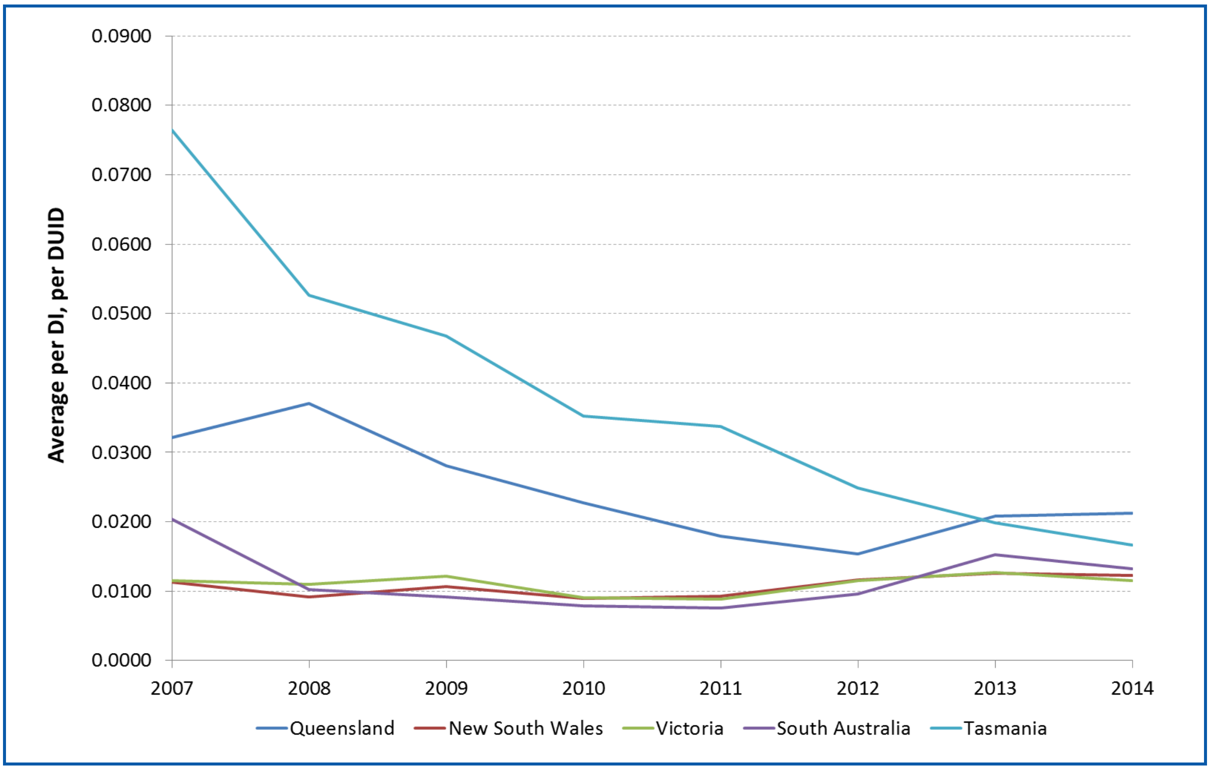

Figure 7.1 – Frequency of rebidding within 30 min prior to DI

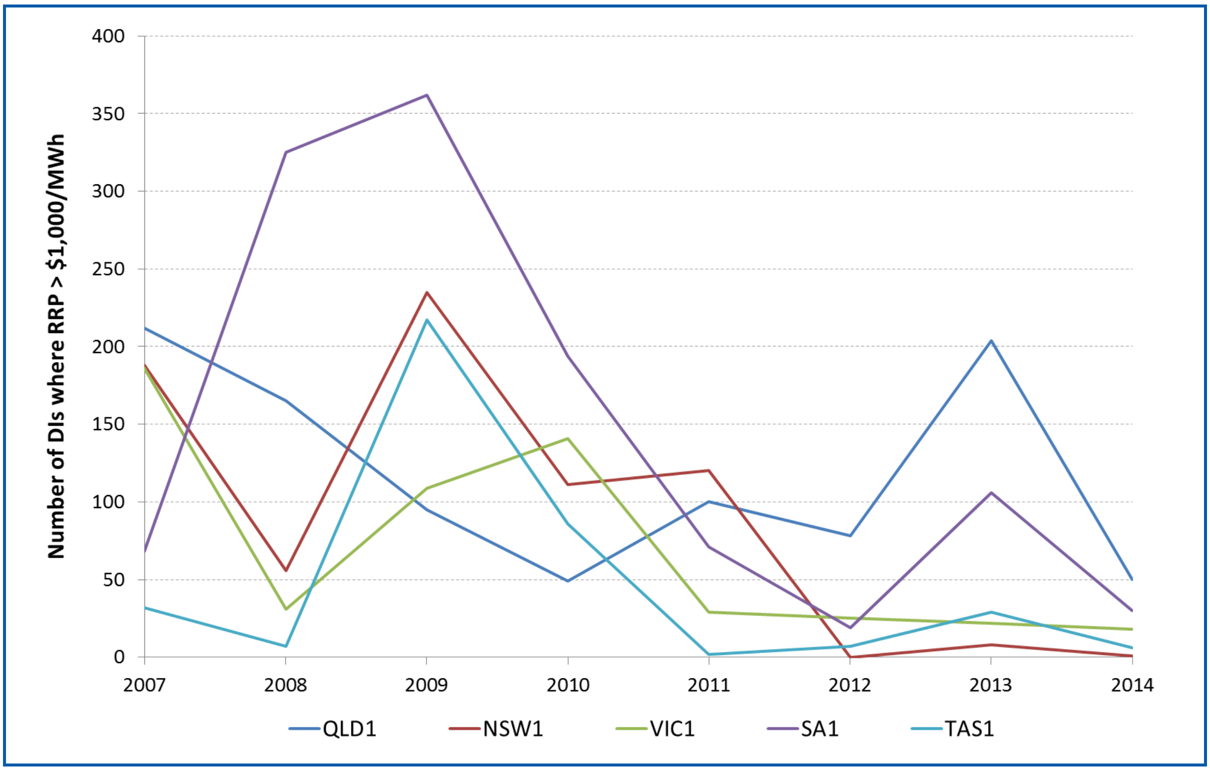

Figure 7.2 – Frequency of Pool Prices > $1,000/MWh

7.4.2 Impact of Late Rebidding Type on Pool Prices

Table 7.3 and Table 7.4 investigate the impact of the type of late rebidding on the probability of price spikes and on pool prices respectively. These results suggest that the relationship between the type of late rebidding and pool price outcomes is highly variable and not consistently significant. These tables show that a higher proportion of late rebids to price bands above $300/MWh can have both a positive or negative relationship with pool prices. Movements to higher bid bands may be reflective of the cause of price volatility. Similarly however, late rebidding to lower price bands may be a response by generators to market volatility.

The strongest relationships that indicate that a higher proportion of late rebids to high price bands increases the likelihood of high pool prices are in South Australia in 2013 and Queensland in 2014.

Table 7.3 – Relationship between late rebidding type and pool price spikes

	% Bids to Above 300:	2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late Rebids = Last DI	↘							↗
	Late Rebids = 30 mins	↘	↗		↘		↗		↗
New South Wales	Late Rebids = Last DI			↘	↘	↘			
	Late Rebids = 30 mins				↘			↗	
Victoria	Late Rebids = Last DI								
	Late Rebids = 30 mins	↘		↗			↗		
South Australia	Late Rebids = Last DI	↘	↘	↘	↘			↗	
	Late Rebids = 30 mins	↘		↘	↘			↗	
Tasmania	Late Rebids = Last DI	↗							
	Late Rebids = 30 mins	↗		↘	↘				↗

Table 7.4 – Relationship between late rebidding type and pool prices

	% Bids to Above 300:	2007	2008	2009	2010	2011	2012	2013	2014
Queensland	Late Rebids = Last DI	↘				↗			
	Late Rebids = 30 mins	↘		↗	↗	↗			
New South Wales	Late Rebids = Last DI			↘	↘	↘	↘		
	Late Rebids = 30 mins			↘			↘		
Victoria	Late Rebids = Last DI								
	Late Rebids = 30 mins	↘	↘	↗					
South Australia	Late Rebids = Last DI		↘	↘	↘			↗	
	Late Rebids = 30 mins	↘	↘	↘	↘	↗		↗	
Tasmania	Late Rebids = Last DI	↗				↗			
	Late Rebids = 30 mins	↗		↘					

An analysis of the two calendar years (SA in 2013, QLD in 2014) identified above exhibit a similarity in that both years were characterised by a relatively high proportion of price spikes occurring in the last DI of the trading interval. Figure 7.3 shows the percentage or price spikes that have occurred in the 6th DI for each region in each calendar year.

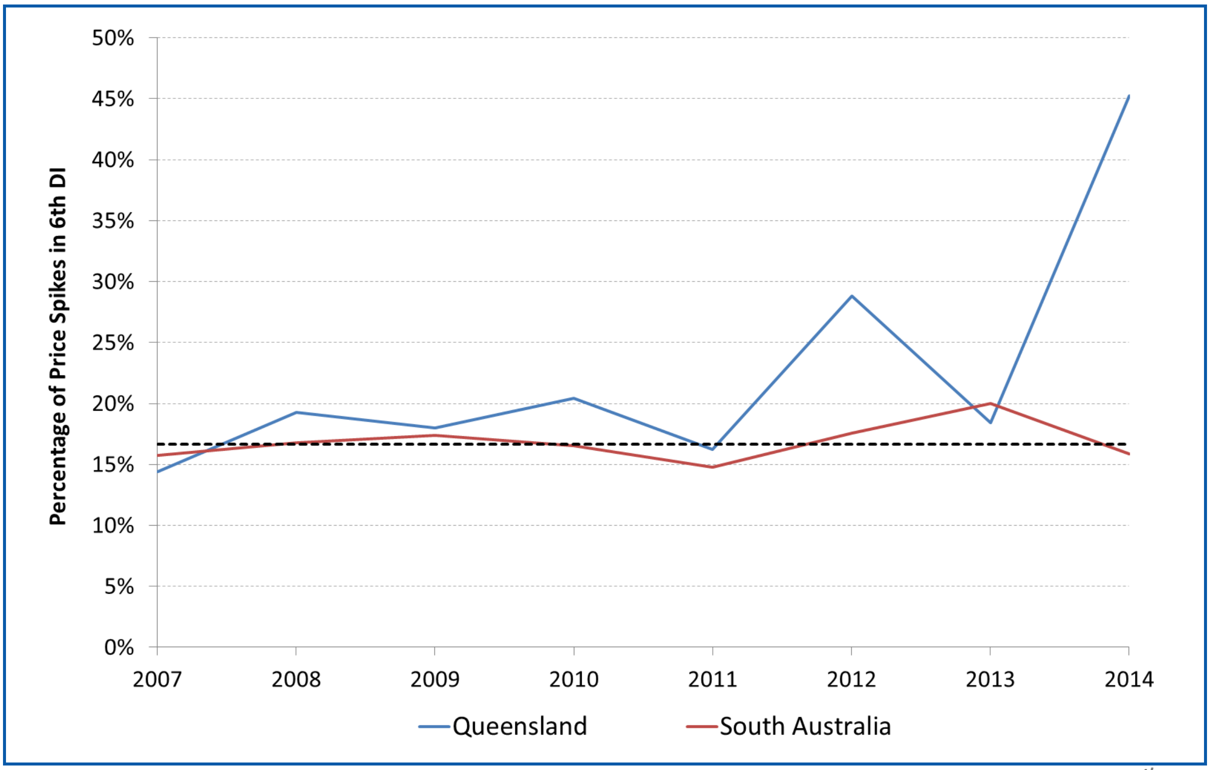

Figure 7.3 – Percentage of price spikes in 6th DI

It is evident that for Queensland, the 2014 calendar year has shown a particularly high frequency of price spikes in the 6th DI. The absolute frequencies are provided in Figure 7.4.

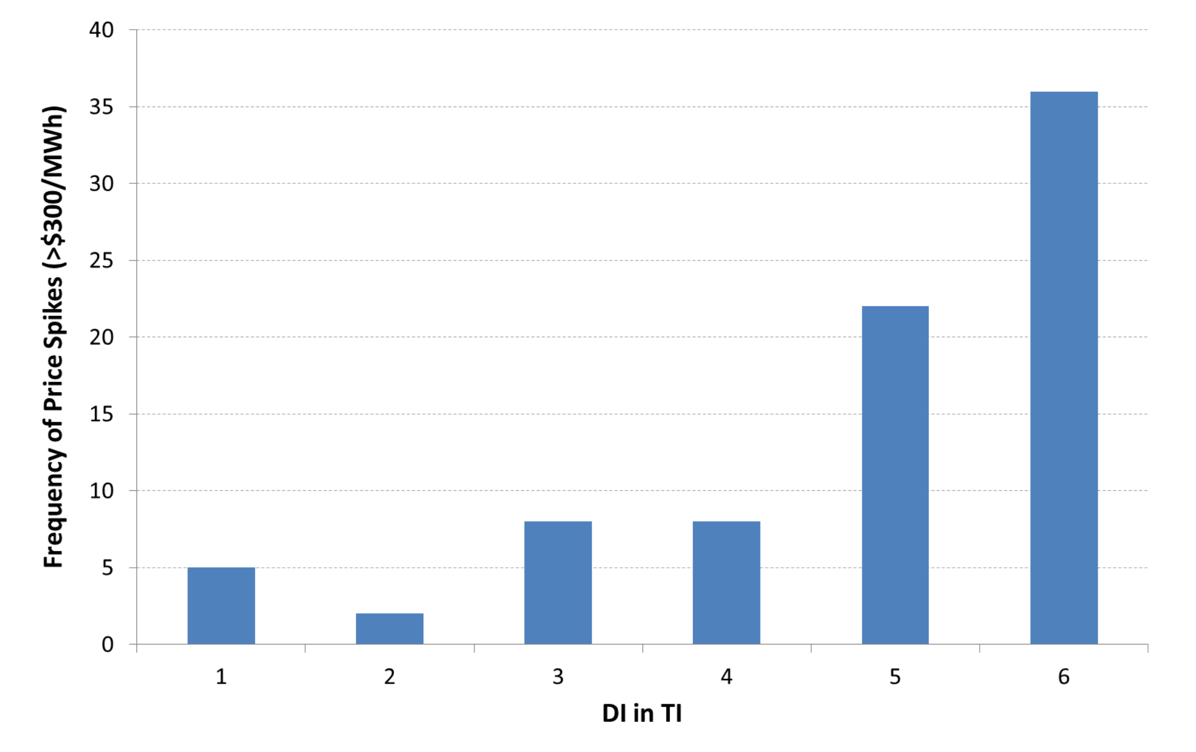

Figure 7.4 – Price Spikes in Queensland – January–July 2014

A representation of the late bidding behaviour for Queensland in 2014 was provided in Figure 4.3. From this figure it was evident that both the frequency of late rebids, and in particular the frequency of late rebids bidding to higher prices was increasing throughout the TI. It is therefore clearly evident how the relationships between late rebidding and high prices during this period have been found to be highly significant.

For comparison, Figure 7.5 shows the frequency of price spikes during the trading interval between 2007 and 2011 in Queensland. This figure shows that price spikes were less likely to occur in the last DI over this period. Therefore, the bidding behaviour which is contributing to price spikes in the last DIs of the TI in Queensland is a relatively recent trend. Furthermore, this trend is not clearly identifiable in other regions, with the possible exception of South Australia in the 2013 calendar year.

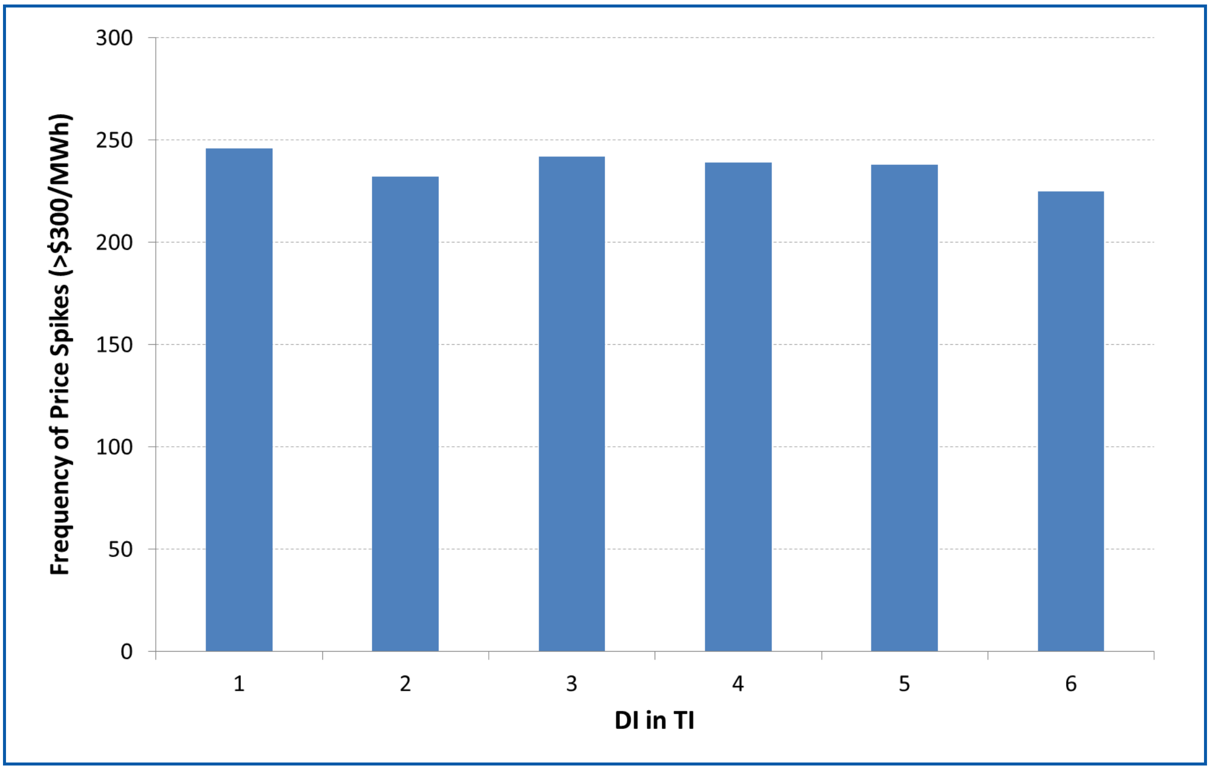

Figure 7.5 – Price Spikes in Queensland – 2007 to 2011

It is important to recognise that this analysis is focused on a single direction; the impact of late rebidding on high prices. Section 6.7 for example demonstrates the opposing side of this story where late rebidding represented the response of generation to high pool price forecasts, and may have reduced price volatility.

8 CONCLUSIONS AND RECOMMENDATIONS

ROAM has provided the AEMC with a comprehensive data package that contains descriptive statistical outputs that illustrate the nature of rebidding in the NEM. This data package summarises details related to the quantity, type and timing of rebidding at the regional, portfolio, station and DUID level.

We have also provided a range of outputs of statistical analysis that investigated the impact of market variables on rebidding frequency and type. The report summarises the key findings of that analysis. Generally, it was found that key market variables such as demand and regional import headroom had a significant impact on bidding behaviour. Across all regions and in all years of the study, it was generally found that higher demand and low import headroom increased the frequency of rebidding and late rebidding. The impact of demand on the type of rebidding differed between regions, with Queensland in particular showing that higher demand was often related with an increased frequency of rebids that withheld additional capacity to above $300/MWh.

Analysis also indicated that there is a trend in Queensland during 2013 and 2014 of generation withholding capacity to higher price bands later in the TI. We have considered the relationship between this relationship and the high frequency of price spikes in the 5th and 6th DIs over this period.

An important relationship was found in examining the impact of pre-dispatch forecasts on bidding behaviour. The results indicate that generation generally responds to high price forecasts in pre-dispatch, indicating that late rebidding may play a critical role in responding to anticipated market volatility.

A critical result of this assessment related to the impact of bidding behaviour on pool price outcomes. These results found that there was a strong, positive relationship between both rebidding and late rebidding and periods of high price in the majority of years and across all regions of the NEM. Further analysis showed that significant relationships between particular types of late rebidding and high pool prices were far less common. We have provided a more detailed investigation of these few instances.

The analysis above indicates that rebidding, and particularly late rebidding, has strong relationships with both high pool prices and a response to forecast high pool prices. These relationships only suggest that the variables are correlated and cannot determine whether there is any causal relationship between rebidding and price outcomes.

Further studies could be conducted that examine the impact of an earlier gate closure over the historical period. It should be acknowledged however that this backcasting would rely on the assumption that bidding before gate closure did not change from the historical observations, whereas if a longer gate closure was in effect in the market then generation may behave differently. Generation portfolios may simply move their “late” rebidding to the last minute before gate closure and thereby still restricting the ability of other participants to respond[7]. Such behaviour may remove any perceived benefit of an earlier gate closure.

Although this modelling may not be reflective of behaviour in a market with earlier gate closure, the results would provide a strong indication of the actual market impact of late rebidding over the historical period.

[7] Except for perhaps the demand side, and non-scheduled generation.