March, 2017

5-Minute Settlement

Assessing the Impacts

Report Prepared for
Australian Energy Council

RUSS SKELTON & ASSOCIATES

Executive summary

This paper has been prepared on behalf of the Australian Energy Council (Energy Council). The Energy Council is the industry body representing 21 electricity and downstream natural gas businesses operating in the competitive wholesale and retail energy markets.

The purpose of this paper is to contribute to the discussion regarding the proposed rule change to introduce 5-minute settlement for the National Electricity Market being considered by the AEMC.

The AEMC is seeking to determine if the introduction of 5-minute settlement will materially improve the efficiency of the electricity market. In considering this, the historical choices that led to the current design are irrelevant and in effect are "sunk". The question is; will the value of the improved ability of the market to meet the NEO materially exceed the costs of implementing this change?

We have sought to assist the AEMC in their deliberations by assessing:

1. The magnitude of the issues provoking the consideration of 5-minute settlement.
2. The possible benefits of introducing 5-minute settlement.
3. The expected costs of introducing 5-minute settlement.
4. The likely price effects.
5. The impact of other rule changes on the outcomes.

Given the difficulties and costs of undertaking an extensive modelling exercise to quantify the benefits we have adopted the approach of examining a representative sample of high priced events and sought to understand how the behaviour of generators would be influenced by a change to 5-minute settlement.

Based on the analysis completed we have come to the following conclusions:

1. The market is working like a market with a complex interaction of many variables resulting in reasonable outcomes. There is no evidence of material inefficiencies – particularly at times of high prices.
2. The observed response of generators to price spikes occurring in dispatch intervals 5 and 6 clearly demonstrates that introducing 5-minute settlement is unlikely to improve incentives for generators and result in improved efficiency.
3. There is no evidence of the need to improve incentives to attract alternative technologies such as batteries.
4. As a result, the benefits of introducing 5-minute settlement are unlikely to exceed the significant costs associated with its introduction which we estimate to be in excess of $250 million.
5. The introduction of 5-minute settlement would result in material price increases for electricity consumers.
6. Not considering the 5-minute settlement rule change in conjunction with other related rule changes will create additionality problems where there is a risk of double counting perceived benefits.

7. The prospects of improving dispatch efficiency by implementing other current rule change proposals and by improving the accuracy of AEMO's 5-minute pre-dispatch forecast are much more likely to have a material impact on market efficiency at lower cost and risks than introducing 5-minute settlement.

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Introduction

This paper has been prepared on behalf of the Australian Energy Council (Energy Council). The Energy Council is the industry body representing 21 electricity and downstream natural gas businesses operating in the competitive wholesale and retail energy markets. These businesses collectively generate the overwhelming majority of electricity in Australia and sell gas and electricity to over 10 million homes and businesses.

The purpose of this paper is to contribute to the discussion regarding the proposed rule change to introduce 5-minute settlement for the National Electricity Market. This rule change is currently being considered by the AEMC.

Background

In December 2015 Sun Metals requested the AEMC to consider implementing 5-minute settlement for the National Electricity Market.[1] The issues that Sun Metals seek to address are:

- Lack of incentives for fast start generation because of the averaging of 5-minute prices under 30-minute settlement.
- The difficulty of loads experiencing an increase in price compared to forecast after choosing to consume at the forecast price. This occurs if the price spike occurs in the later dispatch intervals of a trading interval. Under these circumstances, loads are, in effect, being subject to "retrospective price increases". This again occurs because of the price averaging process.
- When the risk of these "retrospective price increases" is high, loads being forced to restrict consumption.
- The change to 5-minute settlement would also reduce the incentive for generators to rebid late in the trading interval which appears to have been the cause of some of the late price spikes.

Since receiving the rule change request the AEMC has undertaken analysis of dispatch outcomes and how they may be affected by the introduction of 5-minute settlement and has actively consulted with industry on this potential change to the rules. Some of their considerations are:

- Whether 30-minute settlement is creating distortions and inefficiencies in the dispatch process that could be corrected by introducing 5-minute settlement.
- How generators would respond to the changed incentives.
- What other forms of generation and demand side response could emerge because of this change. One area of interest has been whether this change would help support the entry of faster response generators that can respond within 5-minutes to price spikes – such as batteries.
- How the change to 5-minute settlement could be practically implemented.

[1] *Sun Metals rule change request - http://www.aemc.gov.au/getattachment/6a518011-533d-49dd-bb27-e6e8175bcabd/Rule-change-request.aspx*

A benefit that a range of stakeholders identify of introducing 5-minute settlement is that it is also seen as a way of moving to a more "ideal" market design. The matching of the timing of dispatch pricing and settlement is generally seen as more ideal than the current arrangements. Reviewing documentation from the time of the beginning of the market it is clear that settlement and dispatch would have been aligned other than for technology difficulties that prevented this occurring at the time.

In addition to the 5-minute settlement rule change a wide range of other rule changes that would also have an impact on the dispatch process and its efficiency have been under consideration by the AEMC. One of which has been implemented. A summary of these rule changes is:

a. A change to the good faith rebidding provisions of the rules. This change, which was made on 10 December 2015, came into force on 1 July 2016. This now requires participants to *"not make an offer, bid or rebid that is false misleading or is likely to mislead"* and to require participants who make a rebid during or less than 15-minutes before the trading interval to "*make a contemporaneous record in relation to the rebid"*[2]

b. Rule change submitted by Snowy Hydro seeking market loads greater than 30 MW, which are or intend to be price responsive, to be registered as scheduled loads and being required to submit bids and follow dispatch instructions.[3]

c. Rule change submitted by ENGIE seeking to include non-scheduled generating units between 5-30 MW in the central dispatch process.[4]

d. Rule change submitted by AGL seeking the introduction of a NEM-wide Inertia Ancillary Services market.[5]

e. A package of rule changes proposed by the South Australian Government to make rule changes so that *"the regulatory framework supports competitive and efficient provision of ancillary services necessary to manage emerging security challenges such as high rate of change of frequency"* [6]

As all of these rule changes are likely to impact on the efficiency of the dispatch process it would be helpful to consider their impact as part of assessing the 5-minute settlement rule change.

[2] *AEMC Final Rule Determination - http://www.aemc.gov.au/getattachment/815f277c-a015-47d0-bc13-ce3d5faaf96d/Final-Determination.aspx*
[3] *Snowy Hydro - rule change request - http://www.aemc.gov.au/getattachment/0b9688b8-dc3c-49b1-8bf8-df587ca8ed53/Rule-change-request.aspx*
[4] *GDF Suez (now Engie) – rule change request - http://www.aemc.gov.au/getattachment/4219ffd9-f0f1-4690-84a8-555282d44374/Rule-change-request.aspx*
[5] *AGL – rule change request - http://www.aemc.gov.au/getattachment/bacba344-8989-4107-ae2a-480427c9c9f9/Rule-change-request.aspx*
[6] *SA Government rule change request - http://www.aemc.gov.au/getattachment/cd295d50-46a0-4c1e-a988-2453ebc07f0c/Rule-change-request.aspx*

Overall approach to assessing merits of 5-minute settlement

The overall approach we will use to assess the merits of introducing 5-minute settlement is:

1. Assess the magnitude of the issue and hence the magnitude of the potential benefits by examining:
   a. Historical price spikes.
   b. Possible impact on costs to consumers.
2. Examine the range of possible benefits from introducing 5-minute settlement including:
   a. Improving the market design.
   b. Improving the ability of customers to make more efficient consumption decisions.
   c. Creating more effective incentives for generators that will result in lower production costs. This will be done be examining a sample of high priced events to seek to understand how current incentives are working and how these may change if 5-minute settlement is introduced.
   d. Creating incentives to attract alternative technologies.

   Based on this analysis form a view on the materiality of the potential benefits of introducing 5-minute settlement.
3. Assess the costs of introducing 5-minute settlement – these costs include:
   a. Costs of re-negotiating long dated electricity contracts.
   b. Costs to businesses, AEMO and third parties of the introduction of 5-minute settlement.
   c. Increases in ongoing costs.
4. Examine the expected price impacts of the introduction of 5-minute settlement.
5. Review the impact of other rule changes being considered on expected outcomes.
6. Draw some conclusions from this analysis and make a number of recommendations.

Magnitude of issue

Clearly in considering the potential benefits of the introduction of 5-minute settlement it is important to seek to quantify the magnitude of the possible efficiency gains. Two indicators of this magnitude examined were:

1. The historical frequency and duration of price spikes.

   This was examined as the introduction of 5-minute settlement is likely to have the greatest impact on dispatch efficiency when price spikes are occurring as this is when the risk of inefficient outcomes is greatest.
2. A static comparison of aggregate costs to consumers of 5-minute compared to 50-minute settlement.

Frequency and duration of price spikes

We conducted an analysis of the duration of historical price spikes. The analysis is for the period 2012 to 2016 and counts price spikes per dispatch interval (DI) in sequence, i.e. price spikes above $1,000 that persisted for 1, 2, 3 or up to 20 DI's. It is clear from Figure 1 that by far most price spikes only last 1 DI. In fact, 98% of all price spikes above $1,000 last for no more than 6 dispatch intervals. The proportions for various durations as shown in the Table 1.

Figure 1: Frequency count of dispatch interval sequences, >$1,000, 2012 to 2016

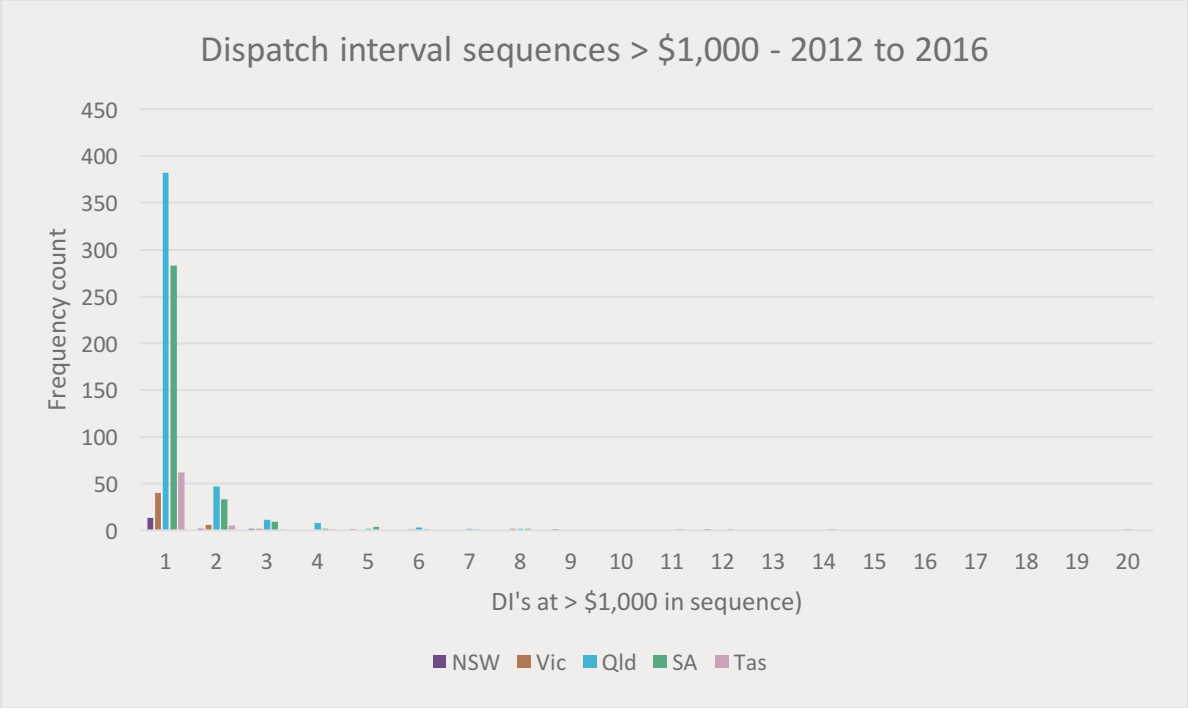


Table 1: Proportions of price spike durations

No of dispatch intervals in spike	1	2	3	4	5	6
Proportion of all spikes	83.2%	9.9%	2.7%	1.2%	0.7%	0.5%

In considering the magnitude of the potential efficiency gains it is important to note that over the 5 years of data summarized that the dispatch intervals where the price was greater than $1,000 only comprise 0.18% of the total dispatch intervals over the period.

Static analysis

The AEMC undertook an initial analysis of the difference between the total payments by customers that would have occurred, using 5-minute settlement, from 2000 to 2016. They conclude that *"the difference between 5-minute settlement and 30-minute settlement is typically less than 0.1% of total payments through the pool"*[7]

[7] *AEMC – Five Minute Settlement Working Group: Working Paper No: 1 – 6 October 2016 – page 9*

We undertook essentially the same analysis as detailed below:

1. We calculated the total cost to customers for the total demand for the period from 2002 to September 2016 using both the published 30-minute and 5-minute prices.
2. For the NEM the total cost using 30-minute settlement was $131,973,182,955 and for 5-minute settlement was $132,095,199,794.
3. If 5-minute settlement had occurred this would have resulted in a cost increase to customers $122,016,639 over the almost 14 years – a difference of 0.09%

This is essentially the same result as the AEMC and clearly indicates that on a purely static basis there is no material difference between 5 and 30-minute settlement.

The key question is seeking to assess whether the introduction of 5-minute settlement will change incentives for generators and that this will lead to materially different efficiency outcomes.

The AEMC has attempted to quantify the magnitude of efficiency changes that could result from the changed incentives introduced by 5-minute settlement.

The approach they adopted to do this was:

1. Define three terms:

- "Overs" – the value of the dispatch price minus the trading price, when the dispatch price exceeds the trading price.
- "Unders" – the value of trading price minus the dispatch price, when the trading price exceeds the dispatch price.
- "Variation" – the sum of overs and unders, which is equivalent to the absolute value sum of the difference between the dispatch price and the trading price.

2. Then use these to determine an average historical "variation" – which ranges from around $5 per MWh but as high as $35 per MWh in South Australia in 2016 YTD – based on this analysis they conclude that there is a material *"distortion to efficient prices introduced by 30-minute settlement"*[8]

In our view the AEMC's analysis does not represent the magnitude of the potential efficiency gains from introducing 5-minute settlement.

The static analysis, which assumes no change in dispatch outcomes or market prices, conducted by both us and the AEMC suggests impact would be immaterial – approximately a 0.1% increase in the cost of wholesale spot purchases. The AEMC points out that analysing outcomes under 5-minute settlement should ideally account for changed incentives, i.e. a dynamic assessment.[9] Despite this, the AEMC's analysis of variations, without any real basis, concludes that gross variations in static pricing outcomes imply material changes to dynamic outcomes. We disagree with this position and suggest that the AEMC should either have stopped at the static analysis stage or have conducted a robust dynamic analysis, the 'half way house' presented is unhelpful and potentially misleading.

[8] *AEMC – Five Minute Settlement Working Group: Working Paper No: 1 - page 17*
[9] *AEMC – Five Minute Settlement Working Group: Working Paper No: 1 - page 8*

Possible benefits of introducing 5-minute settlement

Improving the market design

As outlined above, a view expressed by a range of stakeholders is that the introduction of 5-minute settlement would improve the design of the market by making it closer to the ideal.

However, this is not the question that the AEMC needs to consider. The question rather is will the proposed rule change improve the ability of the current market to achieve the National Electricity Objective (NEO):

"to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers with respect to:

a. *price, quality, safety, reliability and security of supply of electricity; and*

b. *the reliability, safety and security of the national electricity system."*

The question in effect becomes will the value of the proposed change to improve the ability of the market to meet the NEO exceed materially the costs of implementing this change. The historical choices that led to the current design are irrelevant and in effect are "sunk". In other words, will the benefits when quantified exceed the costs taking into account the risks of seeing the expected costs and benefits being realised.

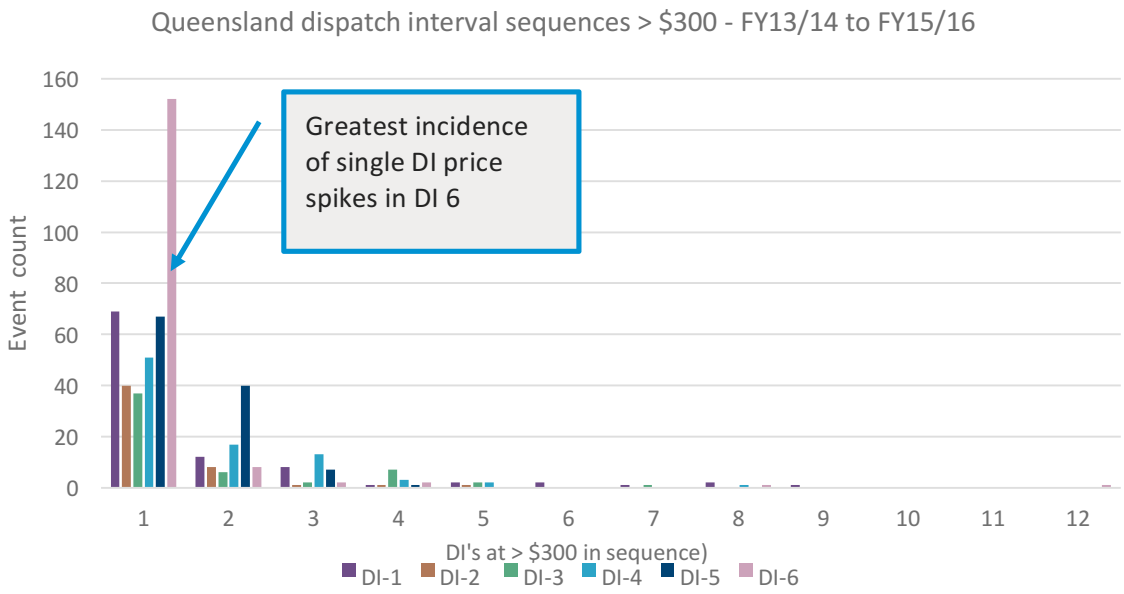
Improving ability of customers to make consumption decisions

As outlined above a key reason for Sun Metal's introducing this rule change was to improve their ability to make effective production and consequently electricity consumption decisions. Their ability to do this has been limited by the relatively frequent occurrence of price spikes in the last dispatch interval. This has the effect of retrospectively increasing prices that apply to previous DI's.

To illustrate this effect, if the spot price for the half hour is $50, Sun Metals' production costs are approximately $3,150 for the half hour, assuming an average load of $63MW. However, if the price spikes to the market price cap of $14,000 in the last dispatch interval Sun Metals' production costs increase to approximately $148,000 – an increase of over 1,000%. It is worth noting that 83% of this increase is applied retrospectively – after Sun Metals had made a production decision based on the forecast spot price.

The prevalence of price spikes in the last dispatch interval is shown in Figure 1 below. This graph covers the period of financial year 2013-14 until the introduction of the revised rebidding in good faith rule. This was brought into effect on 1 July 2016.

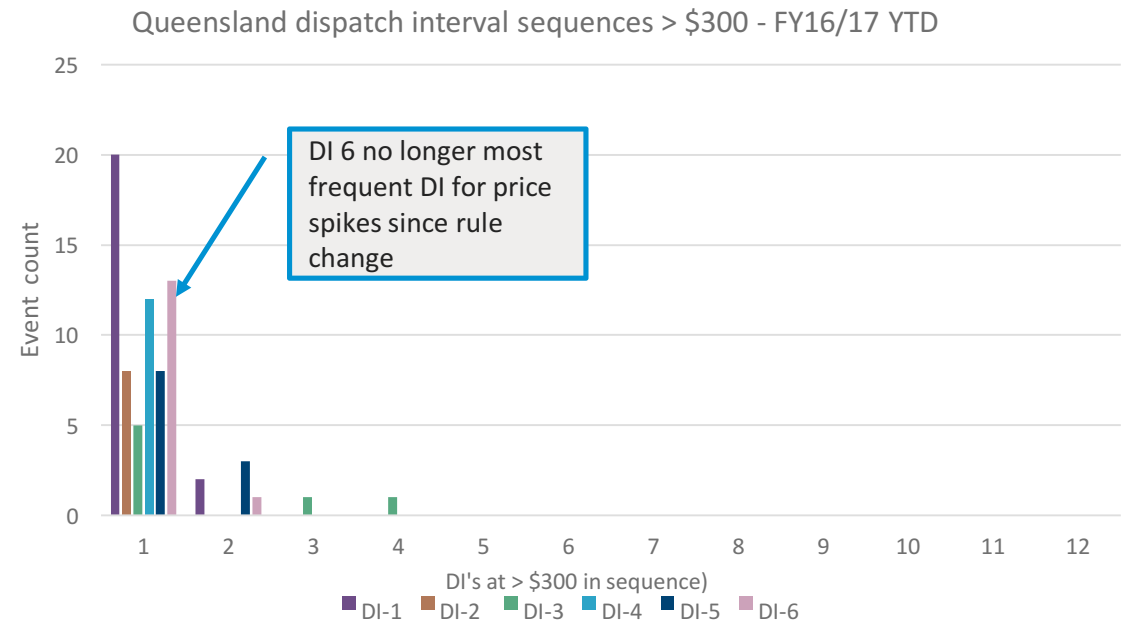
Figure 2: Incidence of price spikes – prior to Rule change



The rule change was targeted at reducing the incentive for very late rebidding which was seen as a significant cause of the high incidence of price spikes in the last dispatch interval.

At this stage, it is difficult to assess the long-term impacts of the effectiveness of this rule change given that the rule change has only been in effect for a little over 6 months. However, as Figure 3 below indicates, to date the rule change seems to have been effective. This is indicated by the incidence of last dispatch interval price spikes compared to other dispatch intervals. There are no longer significantly more price spikes in DI 6.

Figure 3: Incidence of price spikes – after Rule change



Graphs for all States are included in Appendix 1.

Based on this data it appears that there would be no material incremental benefit in terms of reducing incidence of last dispatch interval price spikes from introducing 5-minute settlement as the recent rule change has greatly reduced this behaviour since implementation.

Creating incentives that will reduce the costs of production

The key questions in assessing the potential benefits of the proposed rule change is whether it will create incentives that will induce changed behaviour in existing and future generators that will materially reduce the costs of producing electricity.

5-minute settlement could improve efficiency by:

1. Incentivising incumbents to produce during DI's with high prices - productive efficiency improvement with regard to "overs" identified by AEMC
2. Incentivising incumbents to not produce during DI's with low prices - productive efficiency improvement with regard to "unders" identified by AEMC
3. Incentivising new entrants that can respond more quickly and address #1 above – a dynamic efficiency improvement with regard to "overs" identified by AEMC

Given the complexity of how the spot market operates forming a view on whether 5-minute settlement would improve efficiency is challenging. Even more challenging is to quantify the magnitude of the potential benefits.

One approach would be to undertake an extensive modelling exercise, using a model such as Frontier Economics' *SPARK* market model to seek to identify changes in behaviour resulting from the changed incentives and quantify the shifts in costs. To do this however would require major modifications to *SPARK* before undertaking the modelling exercise. This would be both expensive and time consuming.

The alternative approach we have adopted is to examine a reasonably sized sample of high priced events that have occurred in recent years. Then seek to identify the likely causes for the price spikes that are occurring, the range of behaviours being demonstrated by both generators and customers, what incentives they might be responding to and then postulate how the introduction of 5-minute settlement would change these incentives and modify the behaviour.

To do this we examined a sample of high priced events from 2016. The sample represented about 30% to 40% of the high-priced events that occurred.

As part of this analysis it is important to appreciate that the incentives that generators would be exposed to under 5-minute settlement would be very similar to the incentives that they are exposed to currently when price spikes occur in DI 6. This is because the price outcome for the DI does not flow onto subsequent DI's as is the case if the spike occurs in earlier DI's in a trading interval. Consequently, there is no incentive for a generator to seek any benefit from higher prices in following DI's as there is none.

The analysis undertaken, identifies examples of generators responding to price spikes in DI's 5 and 6. Generator behaviour in interval 5 and 6 is likely to indicate the response to 5-minute settlement.

To help examine these events we prepared detailed graphs of each incident and produced a summary of these events. The summary table is attached as Appendix 2 and the graphs as Appendix 3. The graphs focus on the reactions of peaking generators to these incidents.

Causes of price spikes

As noted above the duration of most prices spikes is brief – often no more than 1 or 2 dispatch intervals. The analysis indicates that there is a diversity of reasons for these prices spikes occurring including:

- Network outages
- Transmission constraints
- Inter-connector constraints
- High demand
- Generator original bids that change at the beginning of a trading interval
- Generators re-bidding
- Reductions in generation – such as falling wind generation

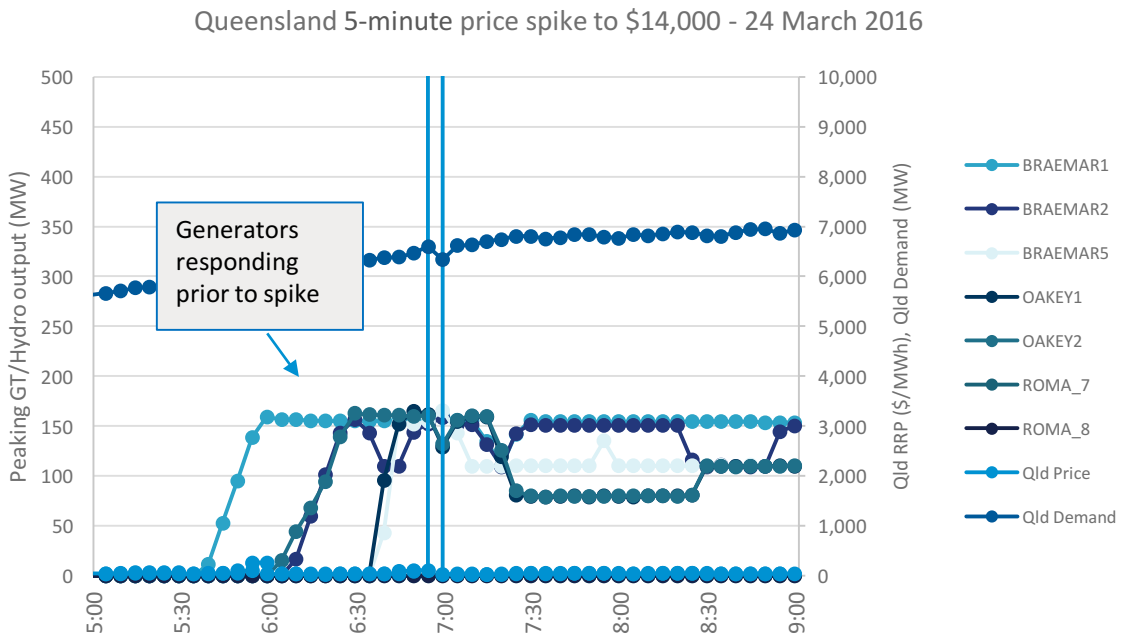
In reviewing the likely causes of price spikes in Appendix 2 it is interesting to note many of the causes were not because of supply demand balances.

Generator responses to price spikes

There is a wide range of responses from generators to the price spikes including:

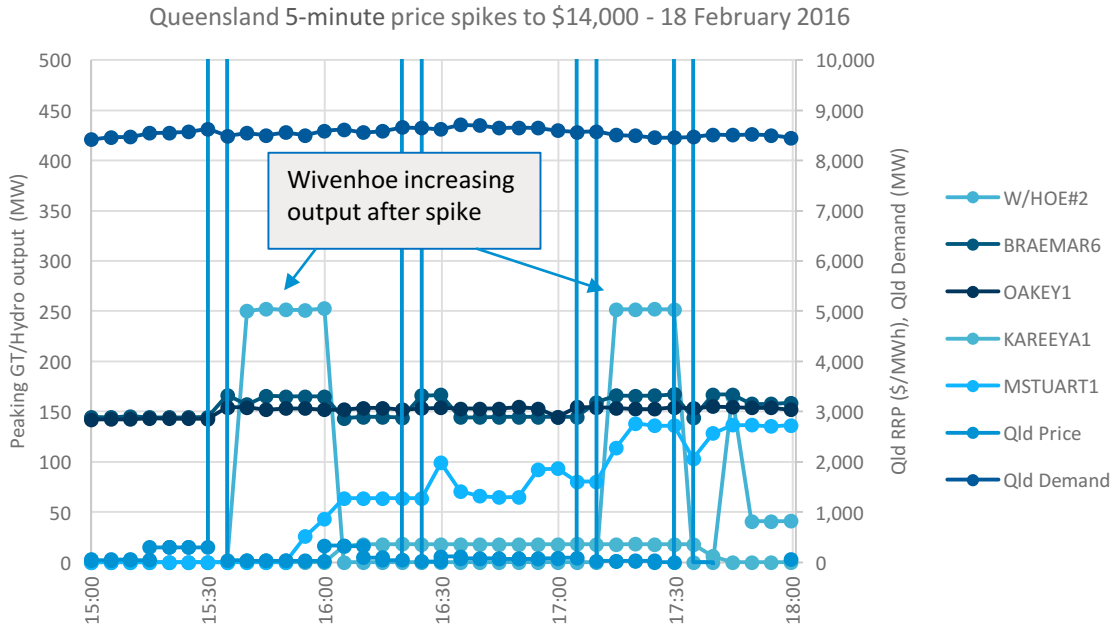
1. Generators being able to anticipate the emergence of a price spike and increase output before the price spike occurs. Examples of this are in SA on 1 March 2016 where both Hallet Power Station and Ladbroke Grove Power Station anticipated the spike, in Qld on 24 March 2016 where a number of generators anticipated the spike and in Qld on 31 December 2016 where Braemar Power Station anticipated the spike (Figure 4 for 24 March 2016 is below).

Figure 4: Market Outcomes – 24 March 2016



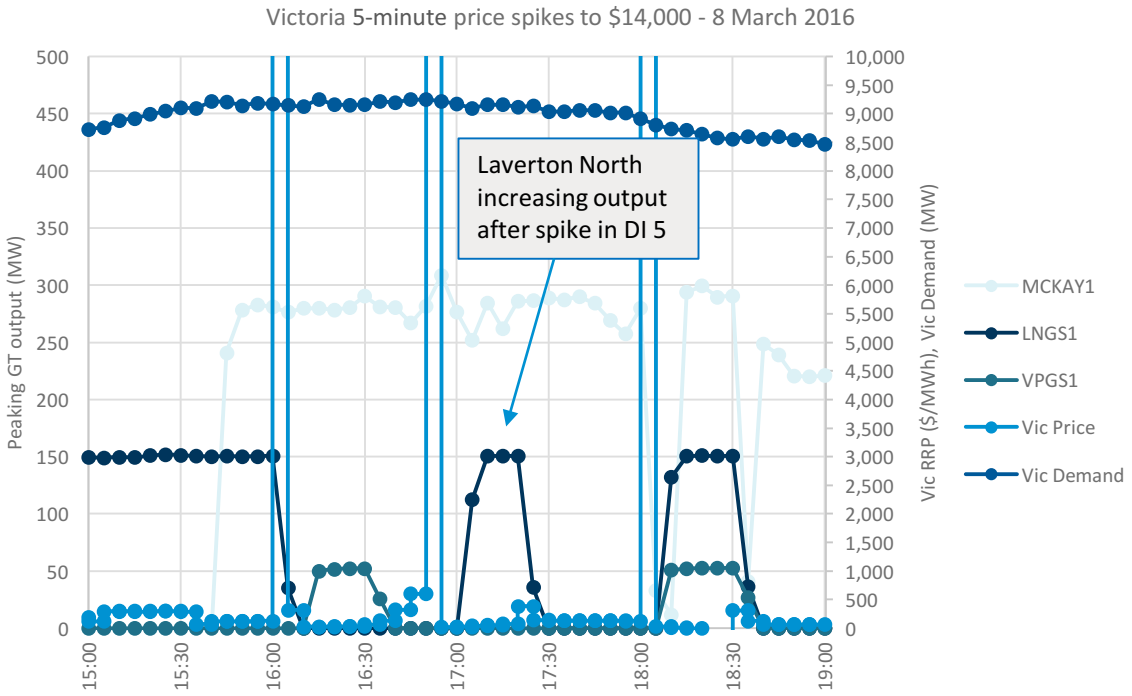
2. Where the price spike occurs early in the trading interval some generators increase output for the balance of the trading interval only. Examples of this are in Qld on 18 February 2016 where Wivenhoe Power Station responded only for the balance of the trading interval (Figure 5 for 18 February 2016 is below). Also in SA on 14 November 2016 and 10 December 2016 a range of power stations responded mainly during the balance of the trading interval.

Figure 5: Market outcomes – 18 February 2016



3. Where the price spike occurs late in the trading interval, for example in DI 5 or DI 6 generators increase output. This output increase however only occurs in the following trading interval. As a result, the generator that increases output derives none of the increased spot revenue that occurs in trading interval that the spike occurred in. Examples of this are in Victoria on 8 March 2016 where Laverton North Power Station increased output in the trading interval beginning 17:00 in response to a price that occurred in DI 5 in the previous trading interval (Figure 6 for 8 March 2016 is below). In Qld on 17 February 2016 Townsville Gas Turbine (YABULA on Figure 7) increased output in two trading intervals immediately after prices spikes in DI 6 in the previous trading intervals (Figure 7 for 17 February is below).

Figure 6: Market Outcomes – 8 March 2016

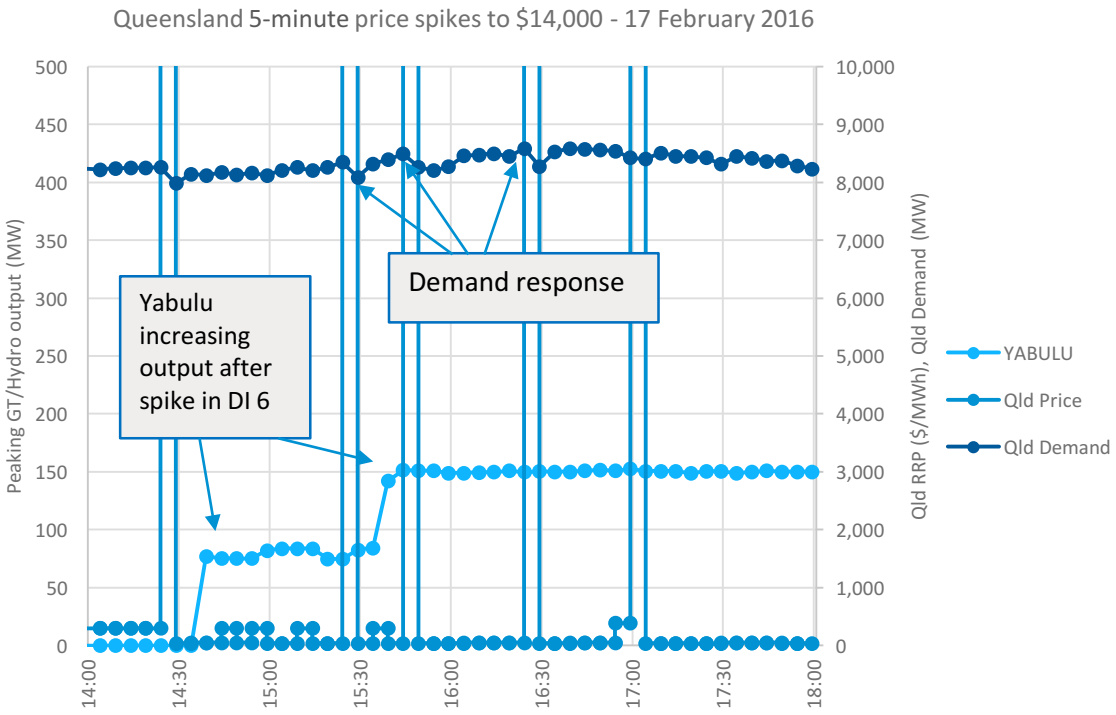


Given as we pointed out previously that a spike DI 5 or 6 is close to a spike that occurs at any time under 5-minute settlement this behaviour by generators is a strong indicator as to how they will respond with 5-minute settlement.

Demand response to price spikes

Often there is a demand side response to price spikes. This response is clearly evident in Queensland and to a lesser degree in South Australia. Examples of this are in Qld on 17 February 2016 (see Figure 7), in SA on 1 March 2016 and on 7 July 2016.

Figure 7: Market Outcomes – 17 February 2016



Why price spikes are not sustained

The brevity of most price spikes raises the question as to why they are not sustained for longer. There are a range of interacting factors that cause the spikes including:

- The nature of the supply curve – the supply curve has become much more "digital" in its shape over recent years. By "digital" we mean that there is capacity offered at -$1,000 to ensure minimum generation levels are achieved, then capacity at modest prices roughly equivalent to short run costs and the balance at the market price cap of $14,000. Consequently, a small reduction in supply or a small increase in demand can result in the price spiking very quickly and then reverting to normal equally as quickly – in effect the price outcome is more "digital". As a result, if there is a modest demand or supply response to a price spike the price reverts to normal very rapidly – generally within 1 or 2 dispatch intervals.
- The generators response to a price spike which can occur as a result of a rebid to offer more capacity at lower prices when the spike becomes evident or having previously offered a fast start inflexibility profile and prices to AEMO and this being activated by AEMO. In both instances this would result in dispatch instructions for the generators to increase their output.
- As a result of rapid responses from both demand and generators the price spike will end quickly, particularly if as outlined above the bids are "digital".
- Pre-dispatch fails to consistently predict either price spikes themselves or the low prices that often occur as a consequence of the market responding.

Are current market outcomes inefficient?

In seeking to reach a view as to whether the current market outcomes are inefficient it is worth considering each of the types of responses by generators and demand discussed above.

1. Where generators re-bid to create a spike in DI 6 to increase value of generation already supplied in previous DI's this would be inefficient particularly as demand and other generators cannot effectively respond to the price signal.

2. Where generators only respond for the remainder of the trading interval in response to a price spike early in the trading interval – this may be inefficient. However, it may also simply be a response to the high price from a risk management perspective. Also, it is important to consider that at least part of the reason the price spike is no longer present is because the generators have increased supply to the market and this has resulted in lower prices for customers than otherwise would have occurred. Both responses would be efficient as generators are appropriately responding to a price signal. It is not at all possible to be confident that the only reason that generation is producing is to capture the high average spot price for the trading interval created by the early price spike.

3. When responding to a price spike in DI 5 or DI 6 the only reasonable explanation is that generators are responding to price spikes from a risk management perspective and thus increasing supply and reducing prices – this is an efficient response as they are again appropriately responding to the price signal. This response would reinforce the observation that generators responding to early DI prices is likely a risk management response.

4. The demand side response is a logical response to the price signal.

Impact of 5-minute settlement on incentives and behaviour

Given the complexity of what is driving the current market outcomes when price spikes occur it is very difficult to be definitive as to what the effect of introducing 5-minute settlement would be on incentives for generators and what the resulting changes in behaviour and market outcomes would be.

However, some observations can be made.

1. The incentive to spike the price in DI 6 would be reduced from the perspective of gaining a "retrospective price increase" on production earlier in the trading interval. This would also resolve the concerns of Sun Metals regarding "retrospective price increases". However, the risk is that this creates the incentive for generators to spike the price more frequently to achieve their revenue objectives. If they can spike the price at present for 1 DI it is not clear why they could not do this more frequently if this was commercially beneficial. Additionally, it appears that the Bidding in Good Faith rule change has significantly changed behaviour in the market such that the incremental impact of moving to 5-minute settlement is greatly reduced.

2. Given the characteristics of the current peaking GT's with 5-minute settlement they will not be able to start fast enough to capture the value of a high priced DI. It is not clear how they can change their performance to respond to a price spike within 5-minutes and as a result are less likely to respond to the price spike. This will lead to increased frequency of price spikes and a resultant increase in average spot prices and cap premiums.

Creating incentives to attract alternative technologies

One potential advantage of introducing 5-minute settlement is that it will attract investment in alternative forms of fast response generation such as batteries.

The key issues in considering this are:

1. Do the current market rules create a barrier to entry for alternatives such as batteries?
2. What the costs of these alternative technologies are compared to existing technology and therefore whether the current level of entry is a result of the relative costs and not a barrier created by the rules.

Barriers to entry

Two indicators of the presence of barriers to entry would be:

1. Whether batteries, particularly distributed batteries, are already entering the market and what current trends, absent 5-minute settlement, are. To assess this we sought the advice of SUNWIZ who provide industry advice on trends in solar PV and battery markets. In their view, based on wide ranging discussions within the industry, there is a strong rate of growth in the installation of batteries. They are predicting at least a 3 fold increase in battery sales for 2017 compared to 2016. This suggests that 30-minute settlement is not acting as a material barrier to entry for battery storage.
2. Whether the revenue that a battery can earn is materially affected by 5-minute settlement compared to the existing 30-minute settlement and as a result 30-minute settlement is creating a barrier to entry for batteries.

To examine this, we looked at the example of a battery installed in a customer's premises with the following characteristics:

- A discharge capacity of 5 kW and able to discharge at this rate for at least 30 minutes
- Electricity stored in the battery being sourced from solar PV's at zero marginal cost or from off peak electricity at cost of 12 cents per kWh

It was assumed that a price spike occurred for 1 dispatch interval and the price for the spike was $14,000/MWh. For the 30-minute settlement scenario it was assumed that the prices for the other dispatch intervals were $50/MWh. It was also assumed, for the purpose of the analysis, that the battery would respond immediately to the price spike.

The margin that this battery would generate was calculated for 5-minute settlement, where the battery would only need to discharge for 1 DI and then for 30-minute settlement where the battery would discharge for the DI when the price spike occurred and the remaining DI's in the trading interval.

The results of this comparison are shown in the table below. (The values quoted are total $'s of margin earned for the single event):

	5-minute settlement		30-minute settlement		
	Energy source		Energy source		Ratio 30 min:5 min
DI of spike	Solar PV	Off peak	Solar PV	Off peak	
1	$5.83	$5.78	$5.94	$5.64	102%
2			$4.95	$4.70	85%
3			$3.96	$3.76	68%
4			$2.97	$2.82	51%
5			$1.98	$1.88	34%
6			$0.99	$0.94	17%
Average	$5.83	$5.78	$3.46	$3.29	59%

Obviously, the margin that a battery earns under 30-minute settlement is a function of the DI in which the price spike occurs. However, if the distribution between dispatch intervals over time is even, the average margin is 59% of what would have been earned under 5-minute settlement.

It is clear that battery installers and operators would prefer 5-minute settlement but it is far from clear that the margins that 5-minute settlement would generate relative to 30-minute settlement are necessary for either customers to invest in batteries or operate them once installed. In discussions with representatives of the battery industry they have confirmed that this is the case.

From this analysis, it is clear that there are no barriers that are preventing batteries entering the market and therefore there is no need to introduce 5-minute settlement to improve the incentives to attract batteries to the market.

Relative costs

In addition to considering whether additional incentives are required for small scale batteries as discussed above it is useful to consider the relative costs of available technologies to assess whether introducing 5-minute settlement is beneficial in terms of attracting lower cost technologies. The available technologies and their relevant costs are:

- Batteries – LRMC ~ $450/MWh if source of energy is residential off-peak and ~$350/MWh if the source of energy is wholesale off peak
- Gas peaking GTs - LRMC ~$540/MWh, SRMC ~$100/MWh[10]

Given these relative costs it is not efficient to seek to displace low cost, existing technologies with higher cost options. This is particularly the case when comparing new batteries with LRMC's of $450/MWh to $350/MWh to gas peaking GTs that are already installed with a SRMC of $100/MWh.

[10] *Frontier Economics cost estimates based on current wholesale prices and retail tariffs.*

Impact on availability of caps

An important risk management product, particularly for 2nd tier retailers are price caps. Historically these caps have been provided by peaking generators. With the entry of batteries and the resulting displacement of peaking generators it is important to consider the impact on the availabilty of caps. It is not clear how the reduced availablity of caps from traditional suppliers will be replaced by battery operators. If the total availability of caps is reduced this will sigificantly reduce the ability of 2nd tier retailers to compete in the retail market.

Conclusions on potential benefits of 5-minute settlement

Our conclusions based the above analysis are:

1. Without extensive and detailed modelling, it is very difficult to be definitive about the magnitude of the benefits of introducing 5-minute settlement.
2. That generators respond to price spikes for a range of reasons, and that managing risk under uncertainty appears to dominate a desire to game the basis of settlement. This suggests that there may only be limited changes to dispatch under 5-minute settlement. 5-minute settlement will not improve the market's ability to anticipate price spikes and neither will it materially change generators responding to manage the risk of an enduring spike with the result that generators will commit to service and produce into low prices in subsequent DI's. As a result, it is unlikely that dispatch and market price outcomes will materially change and the impact of moving to 5-minute settlement is not likely to be materially net beneficial.
3. The high-level analysis that we have undertaken clearly indicates that any benefits in addition to the already implemented rebidding in good faith rule change are uncertain and likely to be very small in magnitude.
4. Similarly, our analysis and discussions with the battery industry suggest that the incremental incentives for batteries entry are likely to be small as batteries are entering the market in any case and can earn decent returns during price spikes under 30-minute settlement.

Costs of introducing 5-minute settlement

There will be significant costs associated with the introduction of 5-minute settlement. These will occur in a range of areas for the industry.

Costs of re-negotiating ISDA based and other contracts

If 5-minute settlement is introduced there is the potential that a significant number of both ISDA and other contracts that will need to be re-negotiated.

We sought advice from Graeme Dennis of HWL Ebsworth on the implications of the proposed introduction of 5-minute settlement. His conclusions are that the introduction of 5-minute settlement will result in:

1. *Basis risk exposure – Introducing the contemplated Rule Change would, at the very least, be likely to introduce a basis risk exposure for participants on existing contracts, in that the prices which they pay or receive to and from the NEM spot market will become different than*

the average half-hourly spot price currently provided as the reference price in their hedge and futures contracts.

2. *Re-pricing risk – Where the "Spot Price" as currently defined in OTC contracts disappears or the basis of its calculation is materially changed, a "Market Disruption Event" is likely to arise, requiring a renegotiation of the price so that the replacement reference price that is adopted for remaining calculation periods under the hedge is reflective of the original intent to reflect the average price of all energy delivered at the regional reference node in that half-hour.*

   If the parties cannot agree a replacement price methodology within 5 Business Days after the change is implemented, then under most hedge contracts it will require the appointment of an independent expert to calculate the floating price for all future periods under the hedge.

3. *Termination risk – If the parties cannot agree on a replacement price or methodology, and the independent expert does not produce a replacement price or methodology within 30 days of the change being implemented, the whole hedge contract terminates and a cash settlement amount for the present value of the hedge is payable by one party to the other.*

Further Graeme notes that:

Although exchanged-traded contracts have short terms, and some OTC hedge contracts are entered only for terms of up to 2 or 3 years, there are many OTC hedge contracts extending for much longer terms, particularly those hedge contracts supporting the entry of renewable generation under the Renewable Energy Target.

The AEMO registration list presently shows about 162 renewable generators currently registered. Of these, we estimate more than 50% (that is, 80-90) would have long-term power price hedge contracts extending to the end of the Renewable Energy Target in 2030.

There are also long-term power price hedge contracts in place in relation to large loads such as smelters and refineries.

The full advice is included as Appendix 4.

Based on this advice and discussions with market participants we have estimated the number of contracts that will need to be re-negotiated. We have only taken into account contracts with terms of greater than 3 years. It should be noted that the feedback from participants indicated that a high proportion of these contracts are for terms of more than 10 years.

We have divided the contracts into 3 categories:

1. Standard contracts – contracts that use the standard ISDA terms and conditions. These would require a small amount of work to re-negotiate. This could be accomplished by applying changes recommended by AFMA. It is estimated that the cost each party to re-negotiate these contracts will be $5,000.

2. Be-spoke contracts – ISDA based contracts that have incorporated be-spoke terms and conditions. These would require a moderate amount of work to re-negotiate because of the be-spoke conditions. It is estimated that the cost to each party to re-negotiate these contracts will be $50,000.

3. Large contracts with a wide range of specific terms and conditions. Some of these may be ISDA based others will not be. An example of these would be electricity supply contracts for smelters. These would require a substantial amount of work to re-negotiate. It is estimated that the cost to each party to re-negotiate these contracts will be $300,000.

The estimated numbers of contracts in each category, and the costs associated with re-negotiation are summarised below:

Category	Standard	Be-spoke	Large
No of contracts	97	54	15
Cost per negotiation	$5,000	$50,000	$300,000
Cost of collective negotiation with AFMA	$600,000		
Total costs	$1,085,000	$2,700,000	$4,500,000

This would result in a total cost for all contracts of approximately $8.3 million.

Costs of changes to business systems

The introduction of 5-minute settlement will require major changes to market participant's business systems.

Typically, integrated businesses will require changes to:

1. Wholesale market trading systems.
2. Retail customer management systems.
3. Risk management and reporting systems.

We have sought input from a wide range of affected businesses and based on their preliminary cost estimates sought to develop an estimate of the overall cost to participants. The results of this analysis are summarized below:

System	Wholesale trading	Retail	Risk management
Range of cost estimates	From $1M to $15M	From $0.5M to $15M	From $0.1M to $5M
Total costs	$54M	$73M	$23M

The total transition cost for participants based on this is approximately $150 million. In addition to this there would be an increase in ongoing costs of operating business systems as result of increased license fees, maintenance costs and storage costs. This is estimated to be approximately $7 million per annum.

The present value of these costs over a 15-year life at a discount rate of 5% would be approximately $200 million.

Costs to AEMO

It would be expected that the costs for AEMO would be significant. An indicator would be the costs of implementing the demand response rule change – in the order of $10 million.

Costs to third party service providers

In addition to costs to participants there would also be costs to third party service providers who support electricity market participants. These would include:

1. Consultants that provide advice based on modelling of the electricity market.
2. The ASX will have to undertake changes to their futures contracts and trading systems.
3. Businesses that provide information services – such as real time market data – to the electricity market.

Total costs

Based on the above cost estimates it would be reasonable to conclude that the present value of the total costs over 15 years of the implementation of 5-minute settlement would exceed $250 million.

Price impacts

The introduction of 5-minute settlement would result in price increases to customers in several ways:

1. *Average spot price will increase* – As outlined above, based on the static analysis undertaken by AEMC and ourselves a small increase in average spot price would be expected. Based on historical outcomes customers in aggregate would be expected to pay on average 0.09% more – or around $17 million per annum.
2. *Premium for caps will increase* – Again, based on an analysis of historical data the fair value cap premium would be expected to increase by the amounts in the following table. This analysis is based on 5 and 30-minute price data for calendar years 2012 to 2017.

Region	NSW	Vic	Qld	SA
Increase	23%	39%	41%	59%

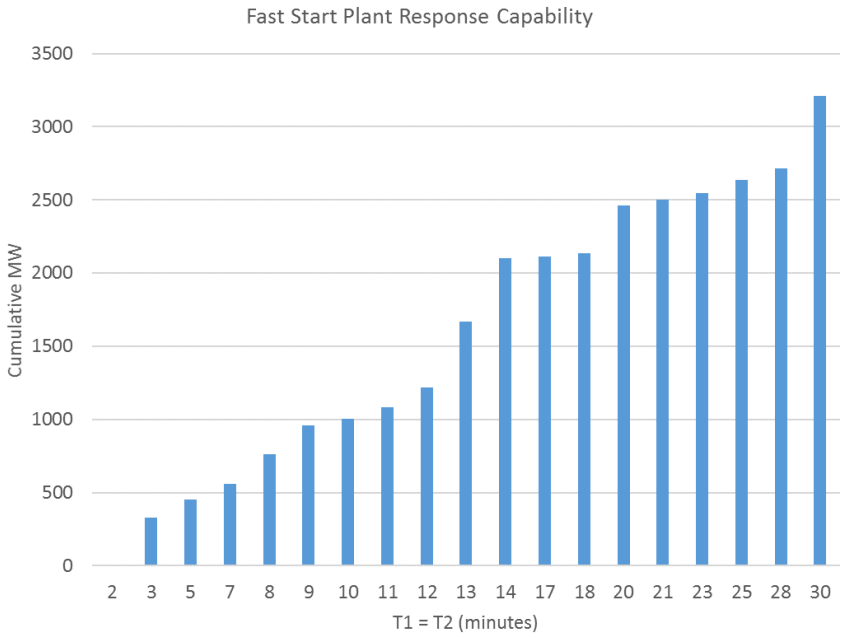
3. *Spot price volatility may increase* – Most of the current peaking capacity cannot respond within a 5 minute dispatch interval. Figure 8 below shows a typical response to a price spike that occurred on 15 June 2016.[11]. The introduction of 5-minute settlement will reduce the expected revenue that peaking generators will receive and consequently reduce the incentive for existing peaking generators to respond to price spikes. This will result in reduced response of generation at times of high prices and this would lead to increased volatility of the spot price. This would lead in turn to higher average spot prices and also cap

[11] *Engie submission to AEMC- 20 June 2016 - http://www.aemc.gov.au/getattachment/2cb0d0bf-1d98-4474-85ee-60c649052914/ENGIE-Received-20-June-2016.aspx*

premiums increasing by more than the amounts quoted above. It is possible that this increase in premiums could be significant.

4. The combination of increased cap premiums and higher spot price volatility will make it more difficult for 2nd tier retailers to manage their spot price risks and hence their ability to compete in the retail market. This reduced competition is likely to lead to higher retail prices than otherwise would have occurred.

Figure 8 –peaking generator response to price spike



Impact of other rule changes on outcomes

As outlined above the AEMC has already implemented a rule change related to good faith rebidding. The early indications are that this rule is having a material effect of the dispatch process.

In addition, a range of other rule changes are being currently considered by the AEMC which could have a material effect on the efficiency of the dispatch process. These rule changes and some observations on the likely impact are:

1. A rule change requiring market loads greater than 30 MW who wish to be price responsive to register, submit bids and follow dispatch instructions.

   Currently the demand response that is routinely demonstrated in the market is not visible ex ante to AEMO. This creates 2 problems for AEMO:

   - The dispatch engine cannot take the willingness of the load to respond to an increased price into account and therefore forecasts a higher price than it would if it was visible. This may result in AEMO giving a gas turbine with a fast start inflexibility profile an instruction to start. In addition, generators who see this price will respond and start their plant. When the demand response occurs the forecast demand and prices will not be achieved and the starting and dispatch of generation may prove to

have been unnecessary. As a result, costs that could have been avoided, will be incurred.

- AEMO is not able to take the magnitude of the demand response that will occur into account for the purposes of managing the security of the system.

On this basis, it would appear that this change could materially improve both the efficiency of dispatch and AEMO's ability to manage the security of the system.

It is acknowledged that this would create costs for loads however the benefit to them would be an expected reduction in prices and the ability to produce more product. Also, it would be worth considering mitigating these costs by creating a simpler regime for loads to bid into the market than what applies to generators.

2. A rule change reducing size of generators required to be scheduled by AEMO.

   Currently this generation is usually evidenced to AEMO as a reduction in demand. As is the case for loads this generation is not visible to AEMO ex ante. The problems of the generation not being visible and benefits to the market of subjecting more of this generation to dispatch are the same as for loads as outlined above.

3. Rule changes to introduce a market for inertia and other services required for system security.

   Currently there are no market mechanisms for AEMO to ensure that adequate levels of inertia and spinning reserve are available to the system. The introduction of additional ancillary services markets for these services will have an effect on how the dispatch process operates and has the potential to impact its efficiency.

All these rule changes, if implemented, will have an impact on the dispatch process. This creates a problem of additionality. It is entirely possible that benefits of one change may impact on the benefits of another. This could result in the same benefit being claimed more than once or alternatively the benefits of one being negated by the other. As a result, it is important that the AEMC consider all of these rule changes as a package and not in isolation from each other. The more explicitly this is done by the AEMC the better.

Other options for improving dispatch efficiency

In undertaking the research and analysis for this paper an issue that arose was the ability of participants to anticipate price spikes, in terms of both timing and duration, and to predict the market's response to price spikes. The accuracy of AEMO's 5-minute pre-dispatch forecast is critical to the market's ability to anticipate outcomes at the 5-minute level.

Currently AEMO produces a rolling 1 hour 5-minute pre-dispatch forecast in addition to the 30-minute balance of pre-dispatch forecast. AEMO does not include the full constraint set used in real time dispatch or the impact of fast start inflexibility profiles for fast start generators in the pre-dispatch runs. The anecdotal feedback from discussions was that the accuracy of the 5-minute forecast is not very good and cannot be relied upon to predict price spikes. This view is supported by our analysis of pre-dispatch outcomes where even 5-minutes out, pre-dispatch regularly fails to predict price spikes *and* the market's response to price spikes.

If AEMO could improve the accuracy of this forecast then both generators and customers could make better informed judgements and this would result in material improvements in dispatch efficiency. An obvious starting point would be to more accurately represent the expected impact of constraints in the pre-dispatch NEMDE run.

Conclusions and Recommendations

Based on the analysis undertaken in this report we have reached the following conclusions:

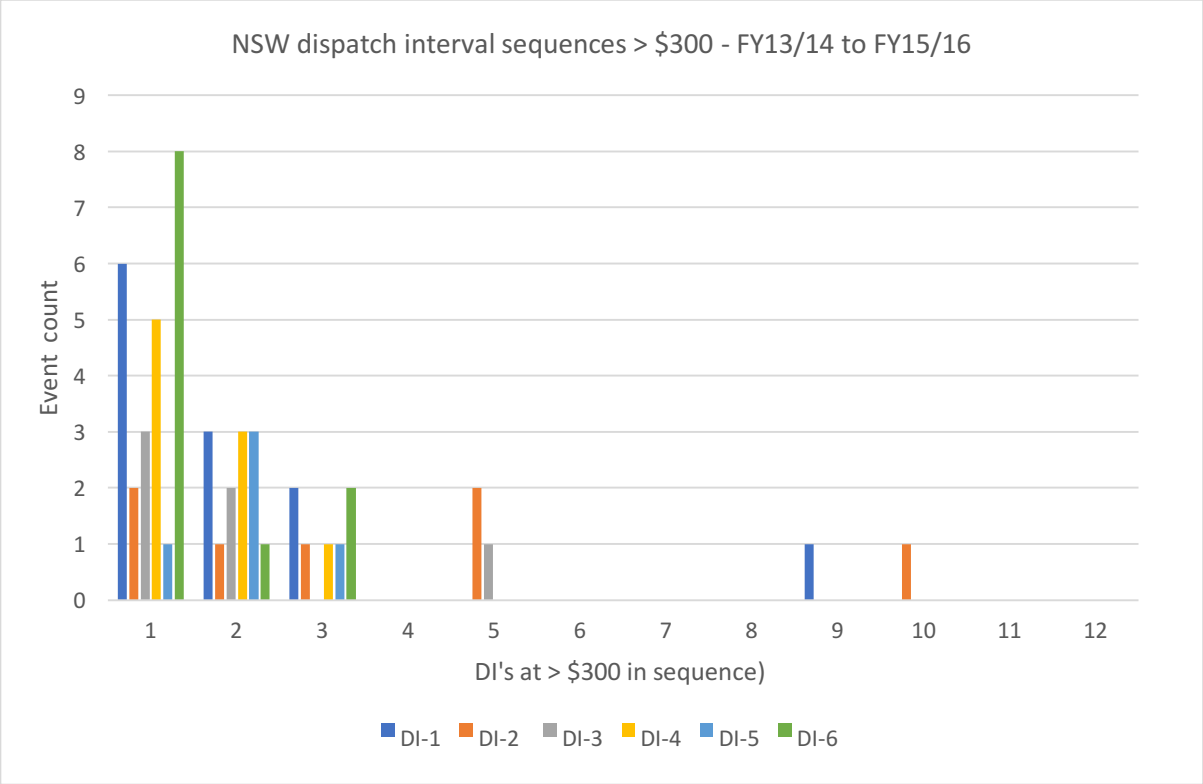
1. There is no real evidence that the magnitude of issue that has led to the consideration of 5-minute settlement is material.
2. One of the potential benefits of 5-minute settlement has already been largely realized as a result of the recent "rebidding in good faith" rule change.
3. There is no real evidence of material inefficiencies in the operation of the market during times of high prices. The market is working like a market with a complex interaction of many variables resulting in reasonable outcomes.
4. There is no real basis on which to conclude that the introduction of 5-minute settlement will make any material improvement in the efficiency of the market.
5. There is no need to further incentivise fast response generation such as batteries as investment in these is already occurring at an increasing rate and it is possible for battery operators to make profits without the introduction of 5-minute settlement.
6. Not considering the 5-minute settlement rule change with regard to other related rule changes will create additionality problems where there is a risk of double counting perceived benefits.
7. It appears that the prospects of improving dispatch efficiency would be greater if the rule changes to treatment of loads that can be dispatched and currently unscheduled generation were progressed rather than the 5-minute settlement change. They also have the advantage of being lower cost options.
8. Another material contribution that also could be made to dispatch efficiency would be to have AEMO improve the accuracy of the 5-minute pre-dispatch forecast to the point that it forecasts most price spikes.
9. The costs of moving to 5-minute settlement would be high given the broad nature of the rule change and its multiple impacts on the market, its participants and secondary stakeholders.

We would also make the following recommendations:

1. That before the AEMC proceed any further with progressing the 5-minute settlement rule change that it complete the necessary analysis to demonstrate with a reasonable degree of confidence the magnitude of the benefits of making this rule change. This analysis should be dynamic and consider responses of both existing participants and potential new entrants under the rule change compared to the status quo. Given the magnitude of the costs and the very real risk of unintended consequences it is imperative that the AEMC complete this analysis. The simplistic analysis undertaken to date is simply inadequate

2. That the AEMC explicitly consider all the rule changes and other expected rules changes that will relate to the dispatch process as a package. Identifying the interactions and trade-offs between these rules as well as ensuring benefits and costs are isolated and not double counted is important Where rule changes are closely interrelated the benefits and costs should be considered concurrently.
3. That the AEMC work with AEMO to improve the accuracy of the 5-minute pre-dispatch forecast.

Appendix 1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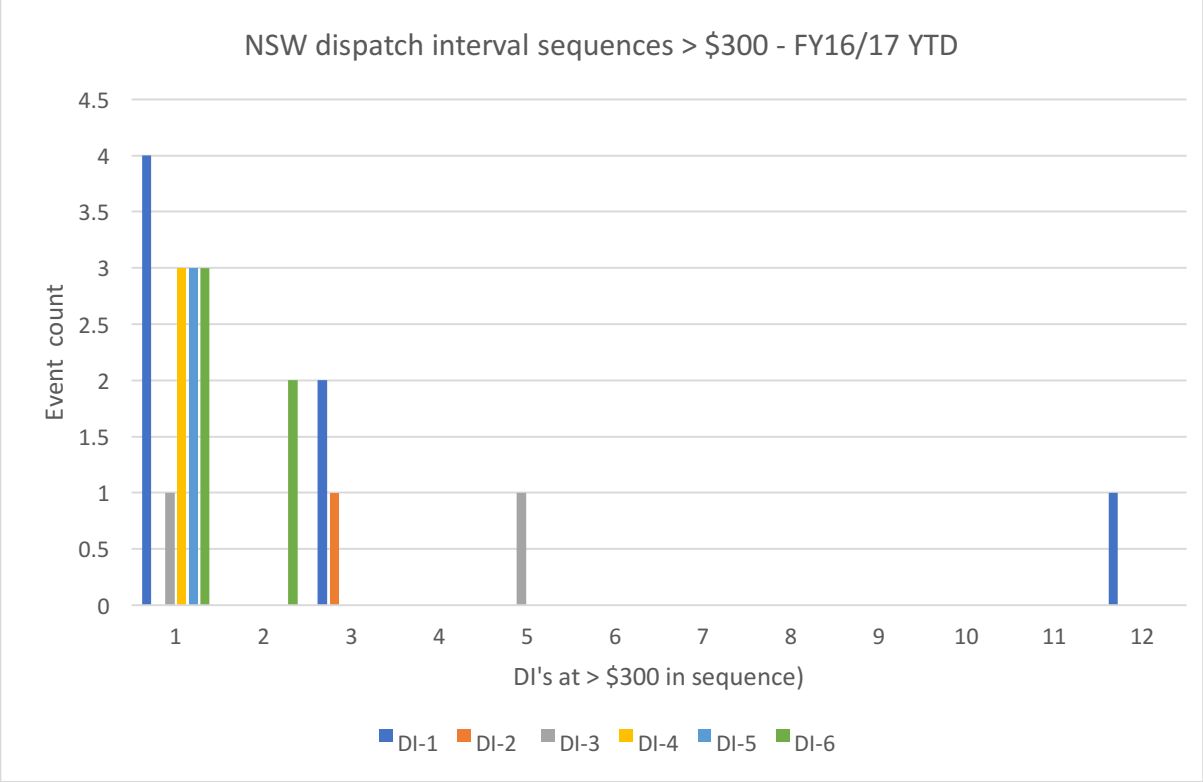
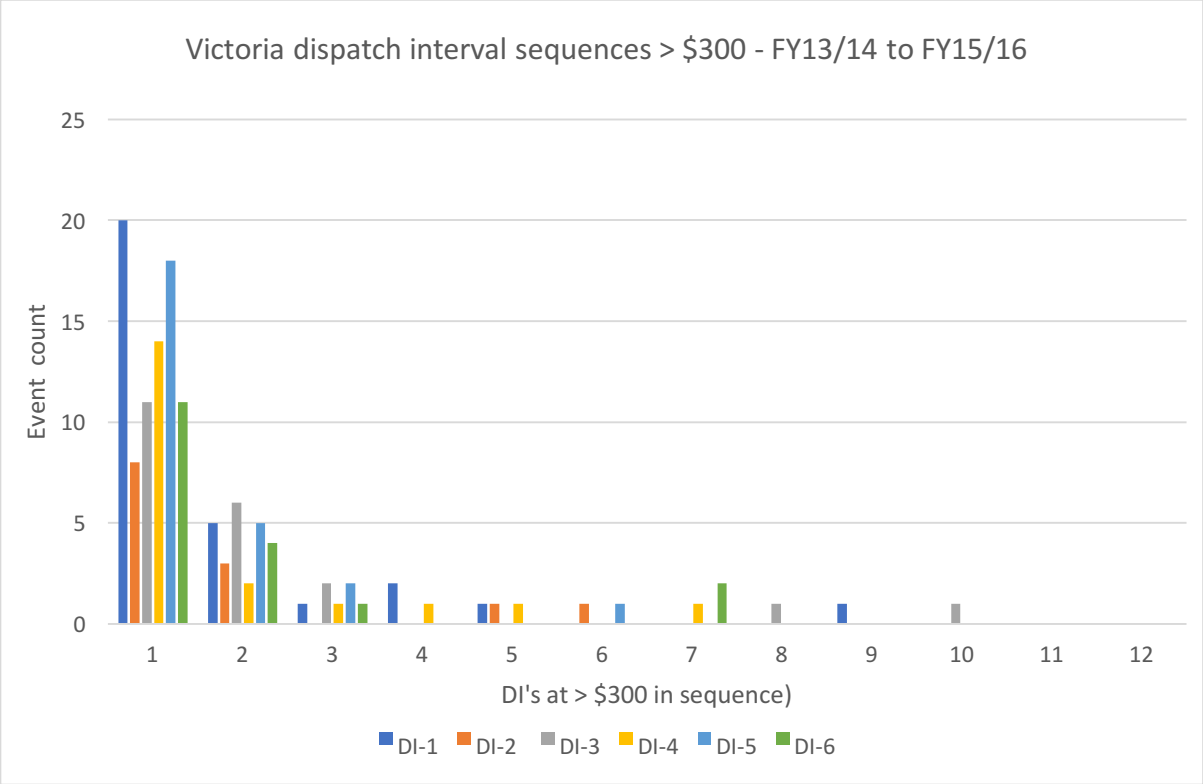
DI-2
DI-3
DI-4
DI-5
DI-6


NSW dispatch interval sequences > $300 - FY16/17 YTD
Event count
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6

Appendix 1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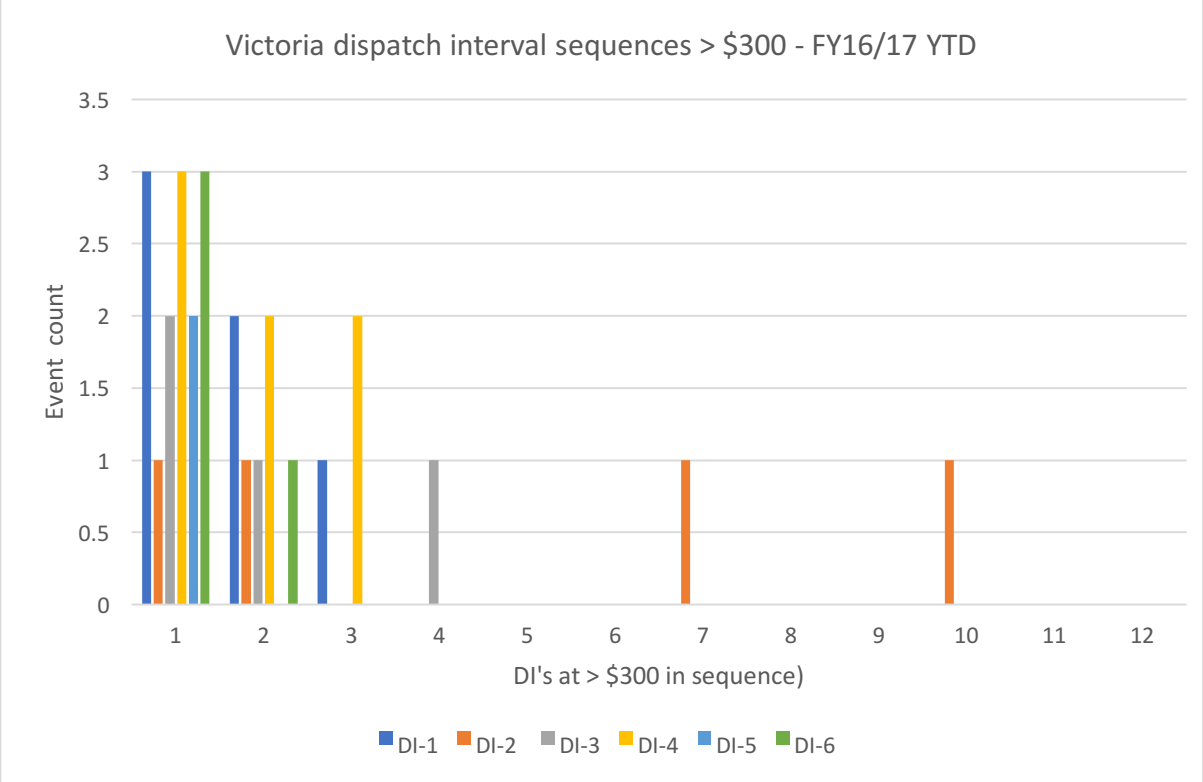
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6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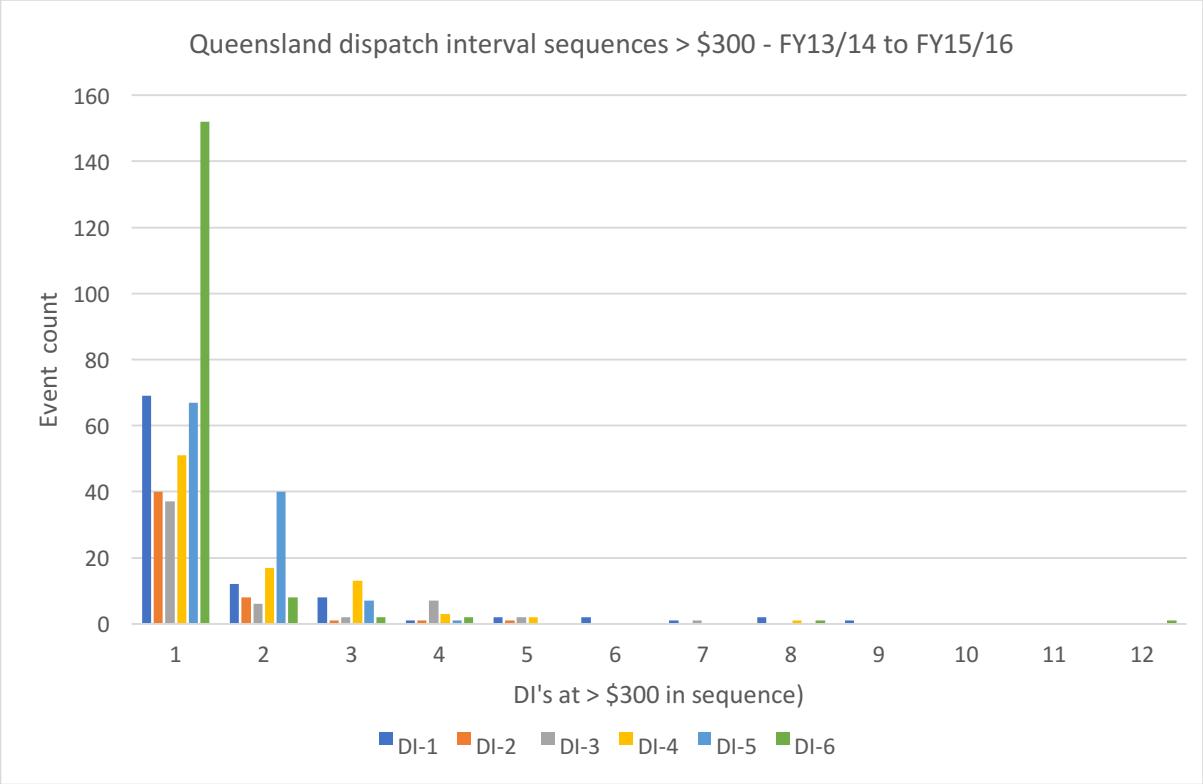
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7
8
9
10
11
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6

Appendix 1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Event count
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140
120
100
80
60
40
20
0
1
2
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4
5
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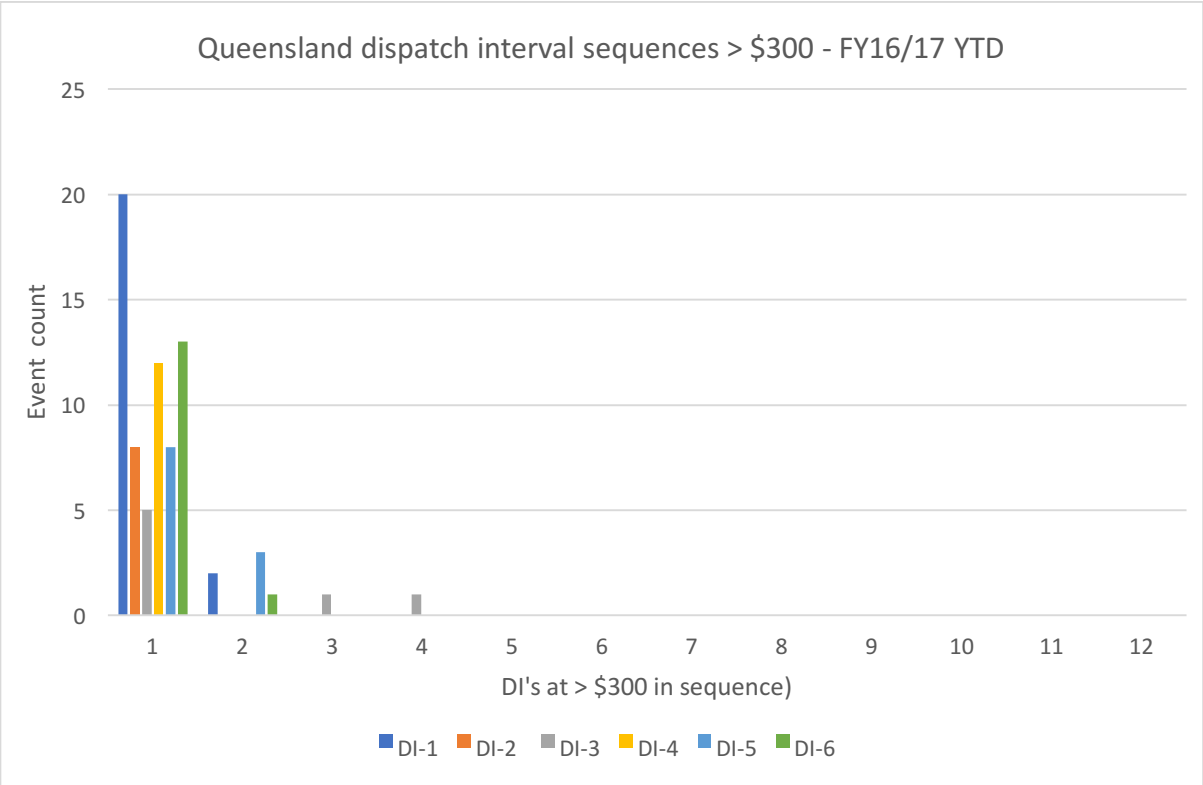
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6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Event count
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20
15
10
5
0
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2
3
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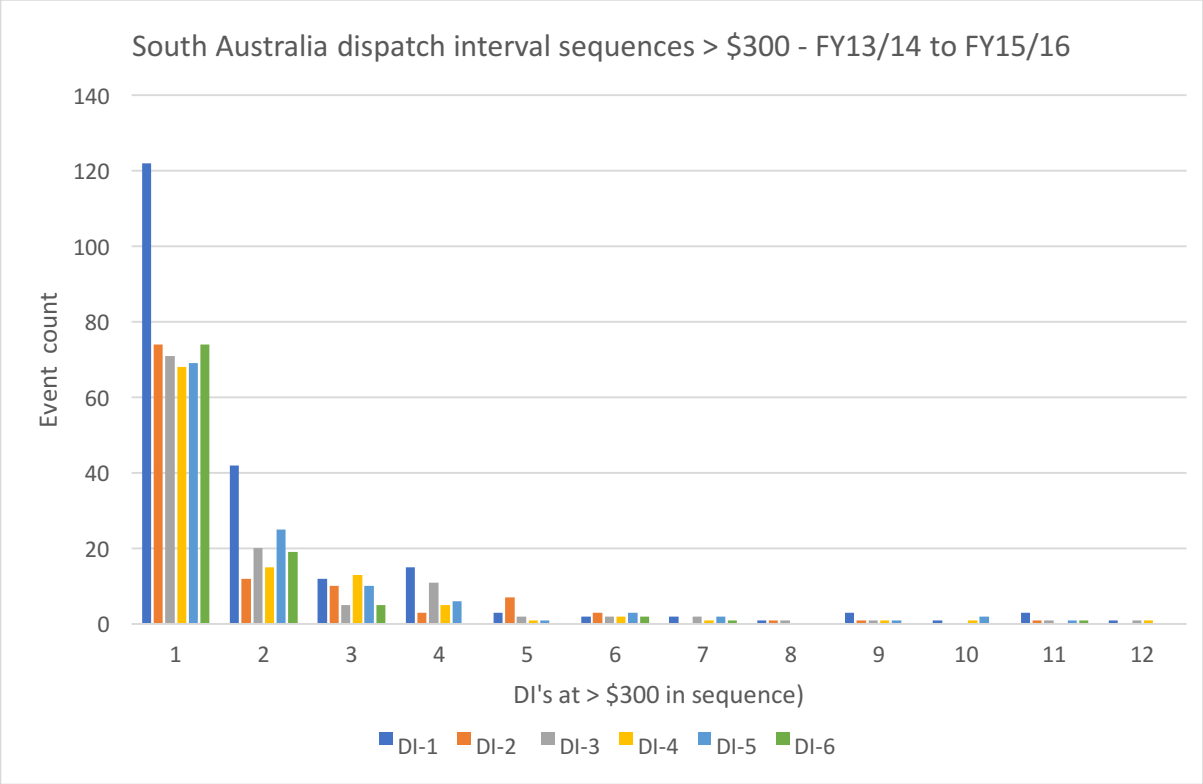
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6

Appendix 1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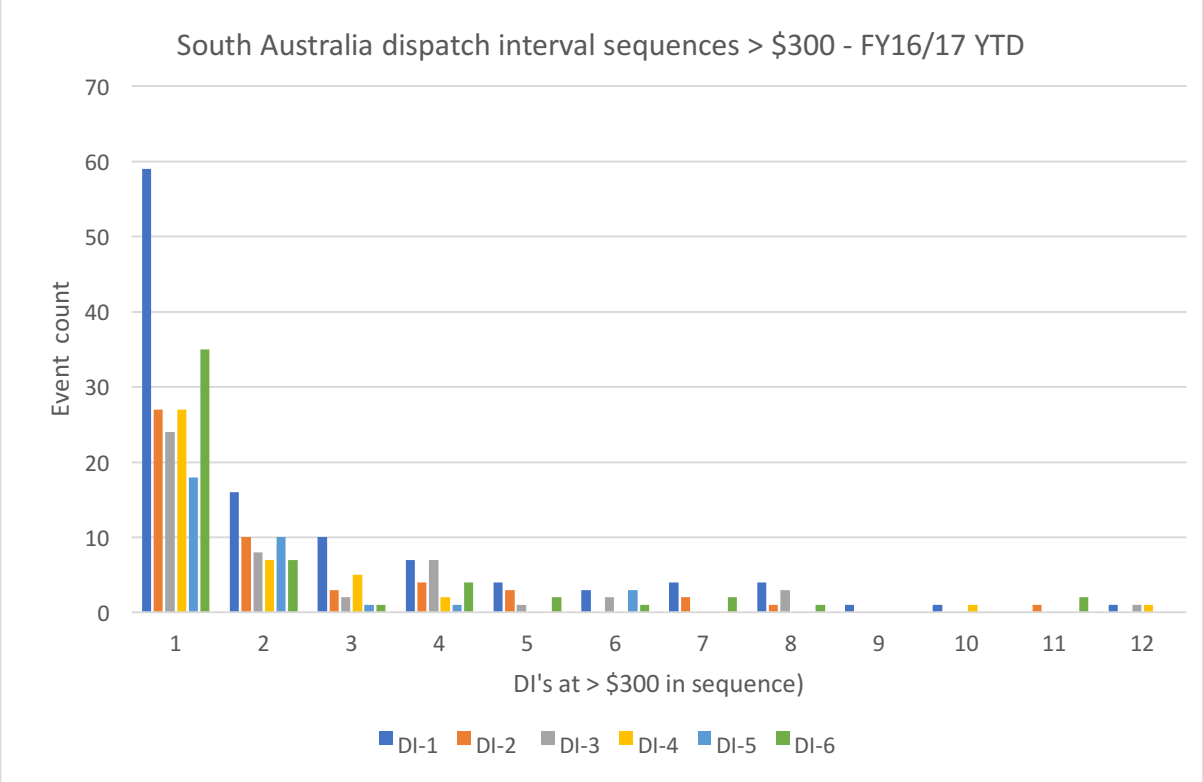
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6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Event count
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0
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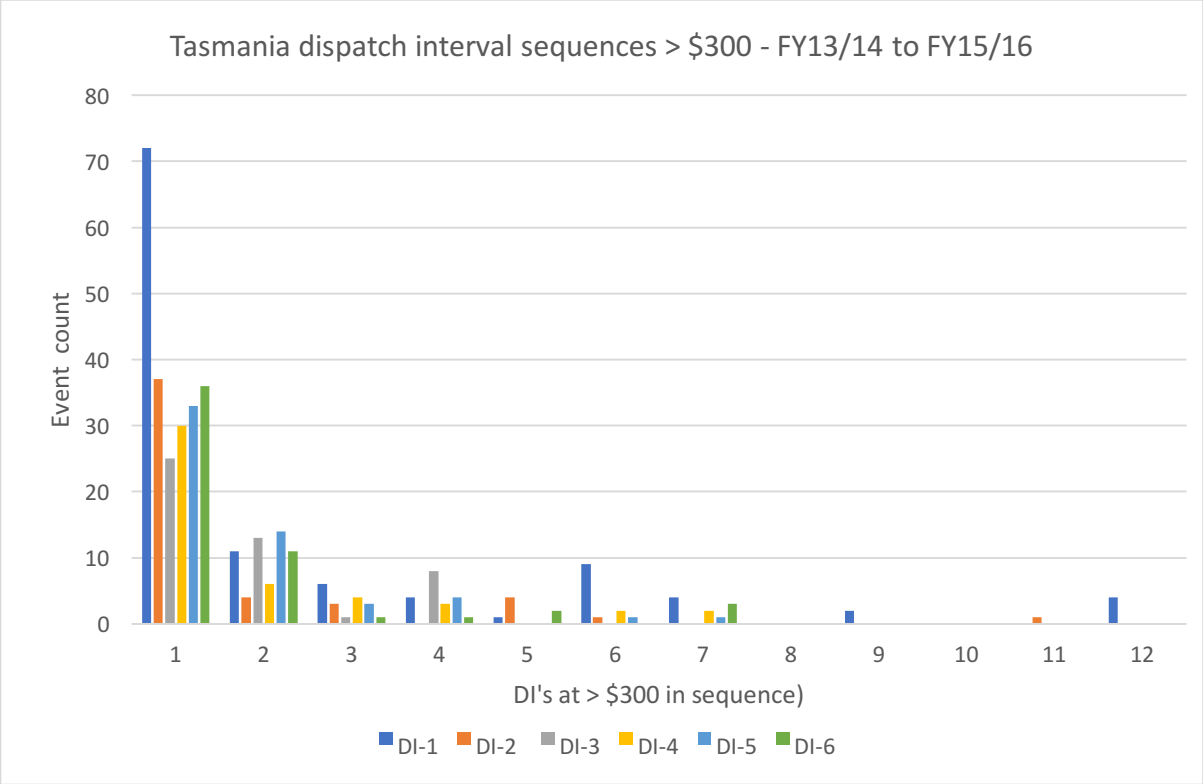
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6

Appendix 1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Event count
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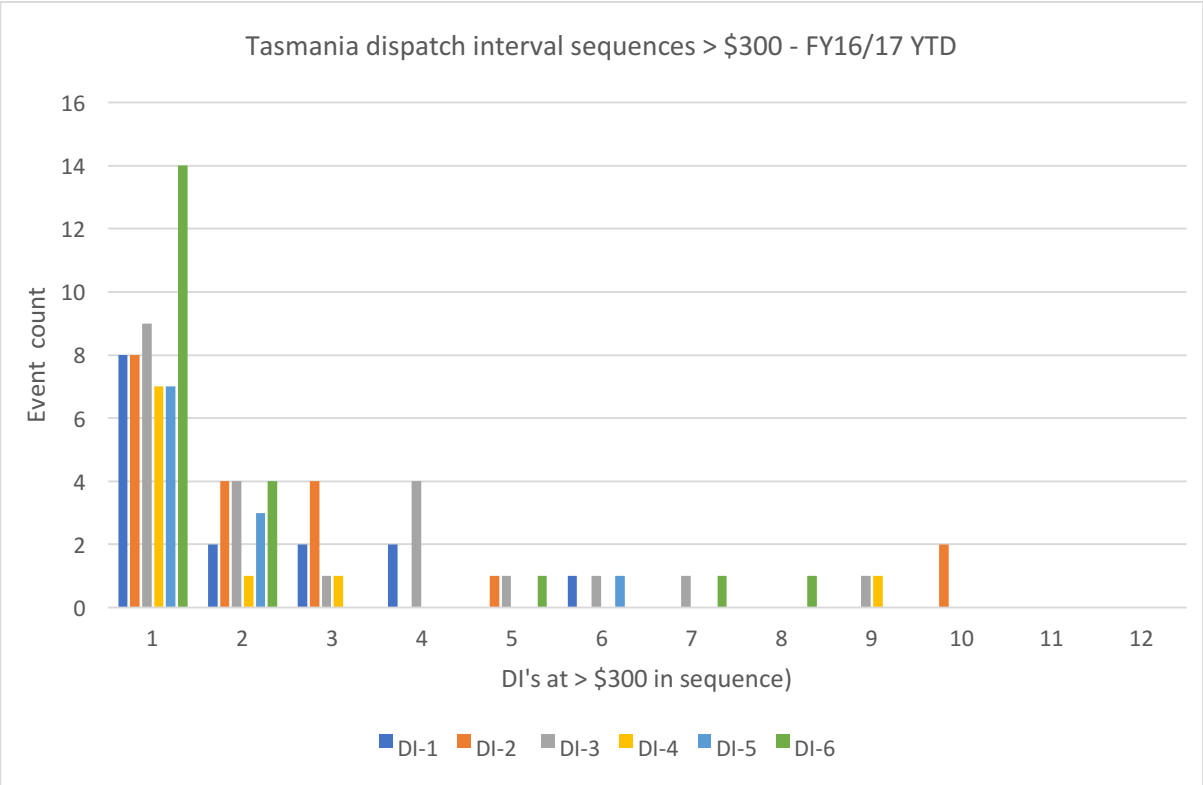
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6


Tasmania dispatch interval sequences > $300 - FY16/17 YTD
Event count
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
DI's at > $300 in sequence)
DI-1
DI-2
DI-3
DI-4
DI-5
DI-6

Appendix 2

Date	Trading Interval	Dispatch interval	Region	Price	Dem. side response	Generator response	Likely cause(s)
13-Jan-2016	15:30 16:00	DI-3 to 6 DI-1 to 3	Vic Vic/SA	>$10,000 >$10,000	37 nil/nil	Several FSG already i/s, AGL reduced Vic hydro due to Torrens Island rebid, JLA01 i/s 15:20, AGLSom, Lonsdale and AGLHal i/s 15:30, Dry Ck 1 i/s 15:45.	Network outages, transmission constraints in Victoria (lightning), capacity rebid by AGL (Torrens Island)
14-Feb-2016	17:00	DI-6	Qld	>$300	35	Several FSG already i/s including Roma 7 and 8, Oakey 2 i/s 17:05.	Interconnectors constrained northwards, high demand
15-Feb-2016	16:30 17:00 17:30 19:00	DI-6 DI-6 DI-5 & 6 DI-6	Qld	>$1,400 >$1,400 >10,000 >$1,400	61 147 293 30	Several FSG already i/s including Roma 7 and 8, Mt Stuart 1, 2 and 3 and Barcaldine.	Interconnectors constrained northwards, high demand and capacity rebids within TI 17:30 (CS, CPP and Millmerran)
16-Feb-2016	14:00 16:30 17:00 17:30	DI-4 to 6 DI-3 DI-1 & 3 DI-3	Qld	>1,400 >$10,000 >$10,000 >$10,000	44 nil nil neg	Several FSG already i/s including Roma 7 and 8, Mt Stuart 2. Mt Stuart 3 i/s 13:45. Mt Stuart 1 and Yabulu i/s 14:15, Kareeya 1, 2 and 3 i/s 16:00, Mackay i/s 16:45.	Interconnectors constrained northwards, high demand, high Brisbane temperature (37.5C) and capacity rebids within TIs 16:30, 17:00 and 17:30 (CS, CPP and Millmerran)
17-Feb-2016	06:30 07:00 14:30 15:30 16:00 16:30 17:30 19:00 19:30 20:00	DI-1 & 2 DI-6 DI-6 DI-6 DI-4 DI-6 DI-1 DI-1 DI-3 DI-5	Qld	>$300 >$1,400 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000	67 nil 278 259 223 309 22 nil 354 178	Several FSG already i/s including Roma 7 and 8, Barcaldine and Mt Stuart 2 (taken o/s 14:45). Kareeya 1, 2 and 3 i/s 14:30, Mt Stuart 3 i/s 15:35, Wivenhoe 2 i/s 15:55 and again at 17:10 and 18:40 and 19:15.	Interconnectors constrained northwards, high demand and capacity rebids (Stanwell, CS, CPP and Millmerran)
18-Feb-2016	16:00 16:30 17:30 18:00 19:00 19:30 20:00 20:30	DI-1 DI-5 DI-2 DI-1 DI-4 DI-2 DI-5 DI-1	Qld	>$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000	139 14 nil nil 206 neg neg neg	Several FSG already i/s including Roma 7 and 8, Barcaldine and Mt Stuart 2 and 3. Wivenhoe 2 i/s 15:35 and again 17:10, 17:40, 18:50, 19:10 and 19:55, Wivenhoe 1 i/s 15:40 and 17:10, Mackay GT i/s 17:15. Kareeya units i/s several times during the high priced periods.	Interconnectors constrained northwards, high demand and capacity rebids (CS, and Millmerran)

Appendix 2

Date	Trading Interval	Dispatch interval	Region	Price	Dem. side response	Generator response	Likely cause(s)
1 Mar-2016	15:00	DI-5	SA	>$13,000	131	Ladbroke 1 already i/s. AGL Hallett and Ladbroke 2 i/s 14:25, Angaston 1 and 2 and Lonsdale i/s 14:50, Quarantine 2 i/s 15:50.	Interconnectors constrained Vic to SA, high SA demand and falling wind generation (>100 MW from previous hour)
1 Mar-2016	19:00	DI-4	Qld	>$1,400	55	Roma 7 and 8 already i/s	Interconnectors constrained northwards, capacity rebids (CS, CPP and Millmerran)
8-Mar-2016	16:30 17:00 18:30	DI-1 DI-5 DI-1	Vic/SA	>$10,000 >$10,000 >$13,000	23/80 31/nil 48/nil	Several FSG already i/s including Jeeralang, McKay, Eildon 1 and 2, Ladbroke 1 and 2, Quarantine 1, 2, 3 and 5, Angaston 1 and 2, Lonsdale and Port Stanvac. Clover i/s 15:55, Dry Ck 2 and 3 i/s 16:00, Dry Ck 2 and Snuggery i/s 16:05, Valley 1, 3 and 4 i/s 16:10, Valley 5 and 6 i/s 16:15Port Lincoln 1 i/s 17:40, Port Lincoln 2 1/s 18:15	Interconnectors constrained NSW to Vic, high demand in Vic (Melbourne 40 degC), Laverton North GTs inter-TI bid transfer 16:00, capacity rebids in Vic and SA (Loy Yang, Origin and AGL)
13-Mar-2016	19:00	DI-3	Qld	>$13,000	345	Several FSG already i/s including Kareeya 2, 3 and 4 and Wivenhoe 2.	Interconnectors constrained northwards (planned outage), capacity rebids (CS only)
16-Mar-2016	07:00 08:30 09:00	DI-5 DI-6 DI-6	Qld	>$10,000 >$1,400 >$1,400	154 105 36	No FSG already i/s, Oakey 1 i/s 06:30, Braemar 2 i/s 07:35, Braemar 3 i/s 08:35, Mt Stuart 2 i/s 09:20	Interconnectors constrained northwards (planned outages), capacity rebids (CS, ERM and CPP)
23-Mar-2016	10:00	DI-6	Qld	>$13,000	354	Yabulu, Kareeya 2 and 3 already i/s. Yabulu loaded at 10:05, Barron 2 i/s 10:10	Interconnectors constrained northwards (planned outages), capacity rebids (Stanwell, CS, ERM and CPP)
24-Mar-2016	07:00	DI-6	Qld	>$13,000	262	Braemar 1, 2 and 5 and Oakey 2 i/s, Oakey 1 i/s 06:55, Braemar 3 i/s 07:20	Interconnectors constrained northwards (planned outages), Kogan o/s 05:45, capacity rebids (Millmerran, CS, ERM and CPP)
30-Mar-2016	07:30	DI-4	SA	>$13,000	11	Nil FSG already i/s. Angaston 1 and 2 and Lonsdale i/s 07:15, Port Stanvac and Dry Ck 3 i/s 07:20, Ladbroke 1 i/s 07:25 and AGL Hallet i/s 07:30	Interconnectors constrained Vic to SA and low wind generation. No evidence of capacity rebids to higher price bands.
5-May-2016	08:00	DI-4	Qld	>$10,000	340	Several FSG already i/s (Kareeya 2, 3 and 4) and Oakey 1 was i/s. Oakey 2 i/s 07:45, Braemar 1 and 6 , Wivenhoe 2 and Kareeya 1 i/s 07:50,	Interconnectors constrained northwards. No significant capacity rebids to higher price bands.

Appendix 2

Date	Trading Interval	Dispatch interval	Region	Price	Dem. side response	Generator response	Likely cause(s)
17-May-2016	18:30 19:30 24:00	DI-6 DI-3 DI-1	SA	>$10,000 >$10,000 >$10,000	43 44 nil	Several FSG already in service (AGL Hallett, Ladbroke 1 and 2, Mintaro, Angaston 1 and 2, Lonsdale and Dry Ck 3. Port Stanvac i/s 18:30.	Interconnectors constrained Vic to SA, low wind generation and capacity rebids by Snowy (Port Stanvac) and EA (AGL Hallett). Also 23:30 HWS load.
7-Jul-2016	09:00 09:30 13:30 14:00 14:30 15:00 16:00 16:30 17:00 17:30 18:00 18:30 19:00 19:30 20:00 20:30 21:00 21:30 22:00	DI-2 DI-1 DI-5 DI-4 DI-3 DI-3 DI-6 DI-2 DI-4 DI-5 DI-4 DI-1 DI-1 DI-1 to 5 DI-1 to 2 DI-2 DI-1 to 2 DI-1 to 2 DI-2	SA	>$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000 >$10,000	28 36 25 nil nil nil nil nil nil nil nil nil neg nil nil nil 43 neg neg	Most FSG i/s for day including AGL Hallett, Ladbroke 1 and 2, Quarantine 1, 2, 3, 4 and 5, Dry Ck 2, Mintaro and Snuggery. Angaston, Lonsdale and Port Stanvac i/s within the high price DI or the DI immediately following. Dry ck 1 i/s 14:20 and was committed several times following that time.	Tailem Bend West 175 kV bus on planned outage for upgrade, interconnectors constrained Vic to SA. Wind generation very low.
14-Jul-2016	09:00 10:00 10:30 11:00	DI-5 for 8 Dis DI-1 & 3 DI-1 to 2 DI-2	SA	>$600 >$10,000 >$10,000 >$10,000	neg. 10 22 29	Several FSG already i/s including AGL Hallett, Ladbroke 1 and 2, Quarantine 1, 2, 3, 4 and 5, Lonsdale, Dry Ck 2, Port Lincoln 3 and Mintaro. Angaston and Port Stanvac i/s 09:00	Tailem Bend West 175 kV bus on planned outage for upgrade, interconnectors constrained Vic to SA. Pelican Point o/s until 14:25. Torrens Island B4 on outage. Quarantine 1 and 2 taken o/s 09:10 due to low gas pressure.
1-Aug-2016	09:30	DI-2 to 3	SA	>$10,000	nil	Several FSG already i/s including AGL Hallett and Ladbroke 1 and 2. Dry Ck 2 i/s 08:55, Torrens Island B3 i/s 09:05, Angaston, Lonsdale, Port Stanvac and Dry Ck 3 i/s 09:15	Planned network outage, interconnectors constrained Vic to SA, Torrens Island A 1, 2 and 4, Torrens B 2 and 3 o/s.

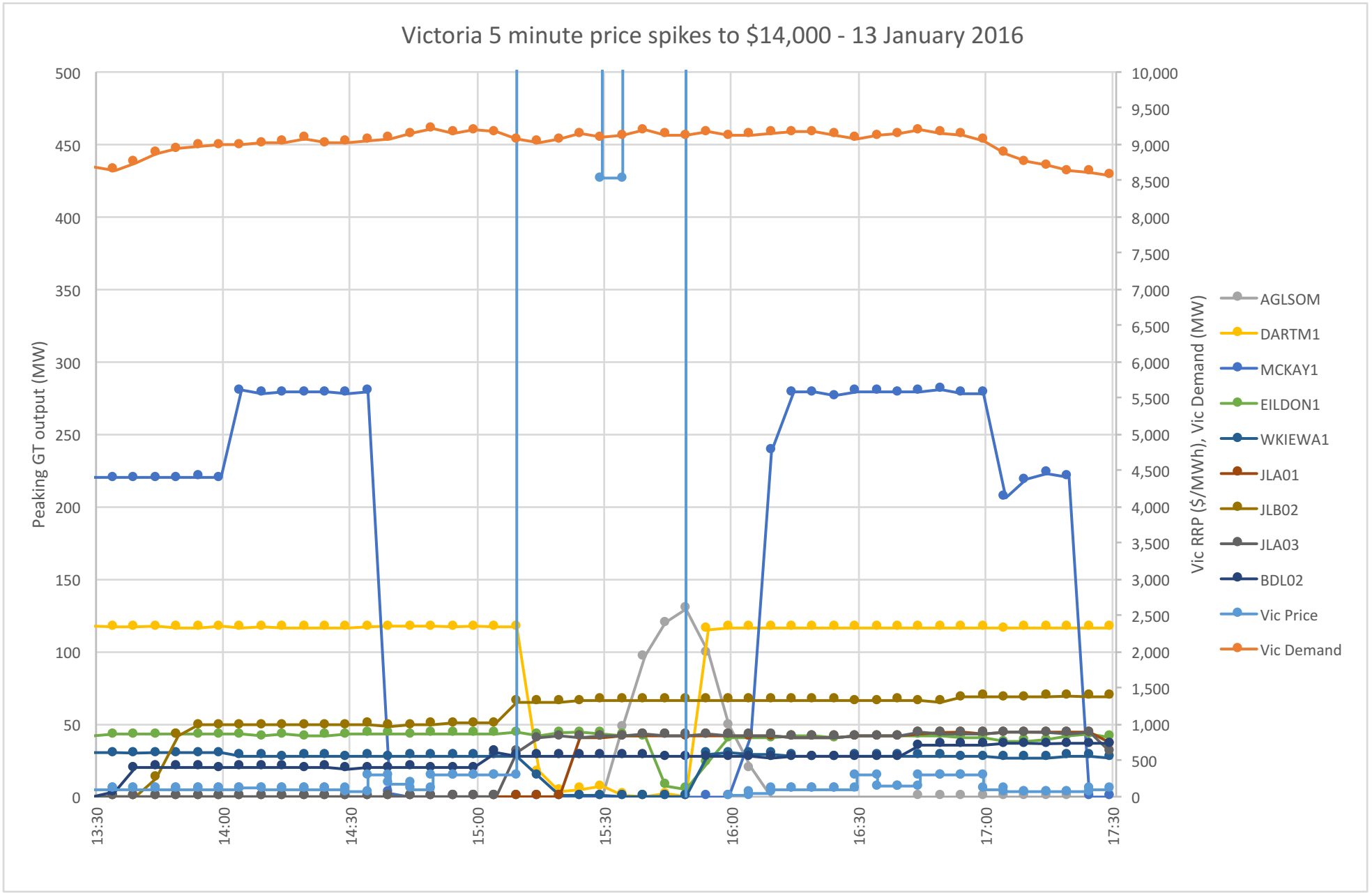
Appendix 2

Date	Trading Interval	Dispatch interval	Region	Price	Dem. side response	Generator response	Likely cause(s)
8-Nov-2016	15:30	DI-1	NSW & Qld	>$10,000	8/108	Several FSG already i/s including Shoalhaven, Barron 1, Kareeya1, 3 and 4, Barcaldine failed to start 15:00, Mt Stuart 1 and Roma 7 and 8. Mackay GT i/s 15:05, Mt Stuart 3 i/s 15:15. Braemar6 and 7 rts 15:10, Braemar 5 rts 15:20.	Eraring 1 to 4 and Bayswater 2 o/s. Constrained interconnectors Vic to NSW. Braemar 5, 6 and 7 tripped 14:05. Capacity rebids Origin (DDPS, MT Stuart and Uranquinty) and Millmerran.
14-Nov-2016	14:00	DI-1	SA	>$10,000	neg.	Quarantine 1 only FSG i/s. Dry Ck 3 and Snuggery i/s 13:35, AGL Hallett, Angaston, Lonsdale and Port Stanvac i/s 13:40, Dry Ck 2 i/s 13:45, Quarantine 4 i/s 13:55.	Interconnectors constrained Vic to SA due to low wind generation and capacity rebids by AGL (Torrens B) and EA (AGL Hallett)
18-Nov-2016	15:00 15:30 16:00	DI-2 DI-1 to 2, 4 to 6 DI-3	NSW	>$10,000 >$10,000 >$10,000	nil	Shoalhaven was i/s before the high price events started and remained i/s.	Interconnectors constrained Vic to NSW, high demand due to warm weather, Eraring 1, 2, 3 and 4 and Liddell 1 o/s and capacity rebids by AGL (Bayswater) and EA (Mount Piper.
5-Dec-2016	15:00	DI-5	NSW & Qld	>$1,400	nil/70	No FSG responded in NSW although Uranquinty 2 and 3 committed during the event. Several FSG already i/s in Queensland including Wivenhoe, Barron 1, Kareeya 2 and 3, Barcaldine Mt Stuart 3 and Roma 8. Kareeya 1 and 4 i/s 15:30.	Interconnector constrained Vic to NSW due to planned line outage and capacity rebids by EA (Mt Piper)
10-Dec-2016	24:00	DI-1	SA	>$13,000	26	No FSG i/s at time of high price event. Angaston, Lonsdale, Port Stanvac, Dry Ck 1 and Snuggery i/s 23:35, AGL Hallett and Dry Ck 2 i/s 23:40, Dry Ck 3 i/s 23:45.	Interconnectors constrained Vic to SA and capacity rebids by Snowy (Lonsdale and Port Stanvac) at time of 23:30 HWS load.
15-Dec-2016	17:00	DI-6	Qld	>$300	87	Several FSG already i/s including Kareeya 2 and 3, Wivenhoe 1 and Roma 7 and 8. No other FSG came i/s due to low range price.	Interconnectors constrained northwards due to stability limit and capacity rebids by Stanwell and ERM.
16-Dec-2016	06:30 08:30	DI-6 DI-1	Qld	>$13,000 >$1,000	382 143	No FSG i/s at time of high price events. Oakey 2 i/s 06:30, Braemar 5 and Oakey 1 i/s 08:05 and Braemar 3 i/s 08:10. Kareeya 2 i/s 09:00	Interconnectors constrained northwards due to stability limit. No significant capacity rebids were detected

Appendix 2

Date	Trading Interval	Dispatch interval	Region	Price	Dem. side response	Generator response	Likely cause(s)
31-Dec-2016	14:00	DI-1	Qld	>$13,000	269	The only FSG already i/s were Kareeya 2 and 3. Kareeya 2 o/s 13:30, Oakey 1 and 2 i/s 13:30, Braemar 5 and Wivenhoe 2 i/s 13:35, Braemar 2 i/s 13:40, Braemar 6 and Roma 7 and 8 i/s 13:45	Interconnectors constrained northwards due to stability limit, high demand and capacity rebids by Stanwell, CPP, ERM and CS.

Appendix 3



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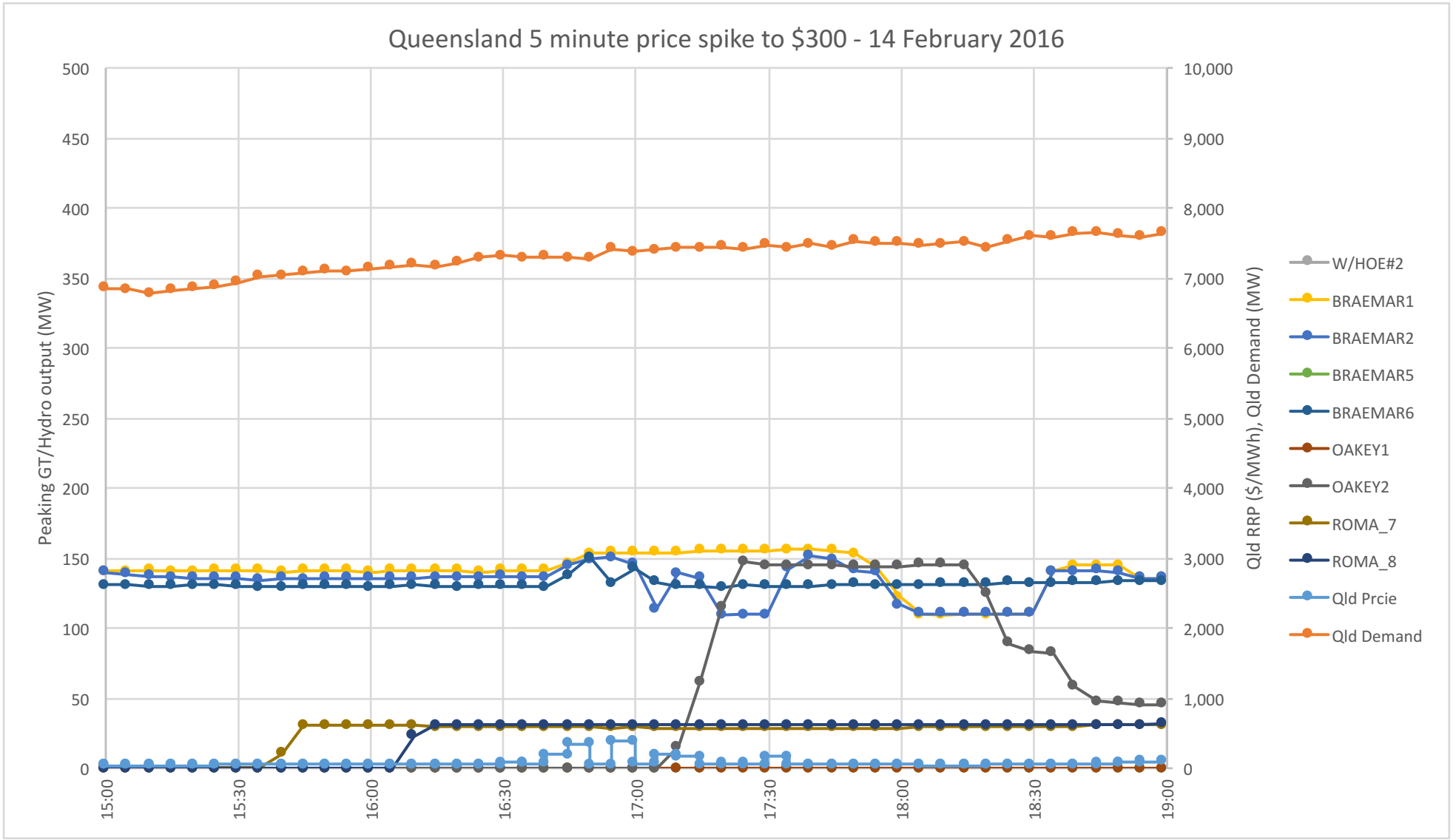

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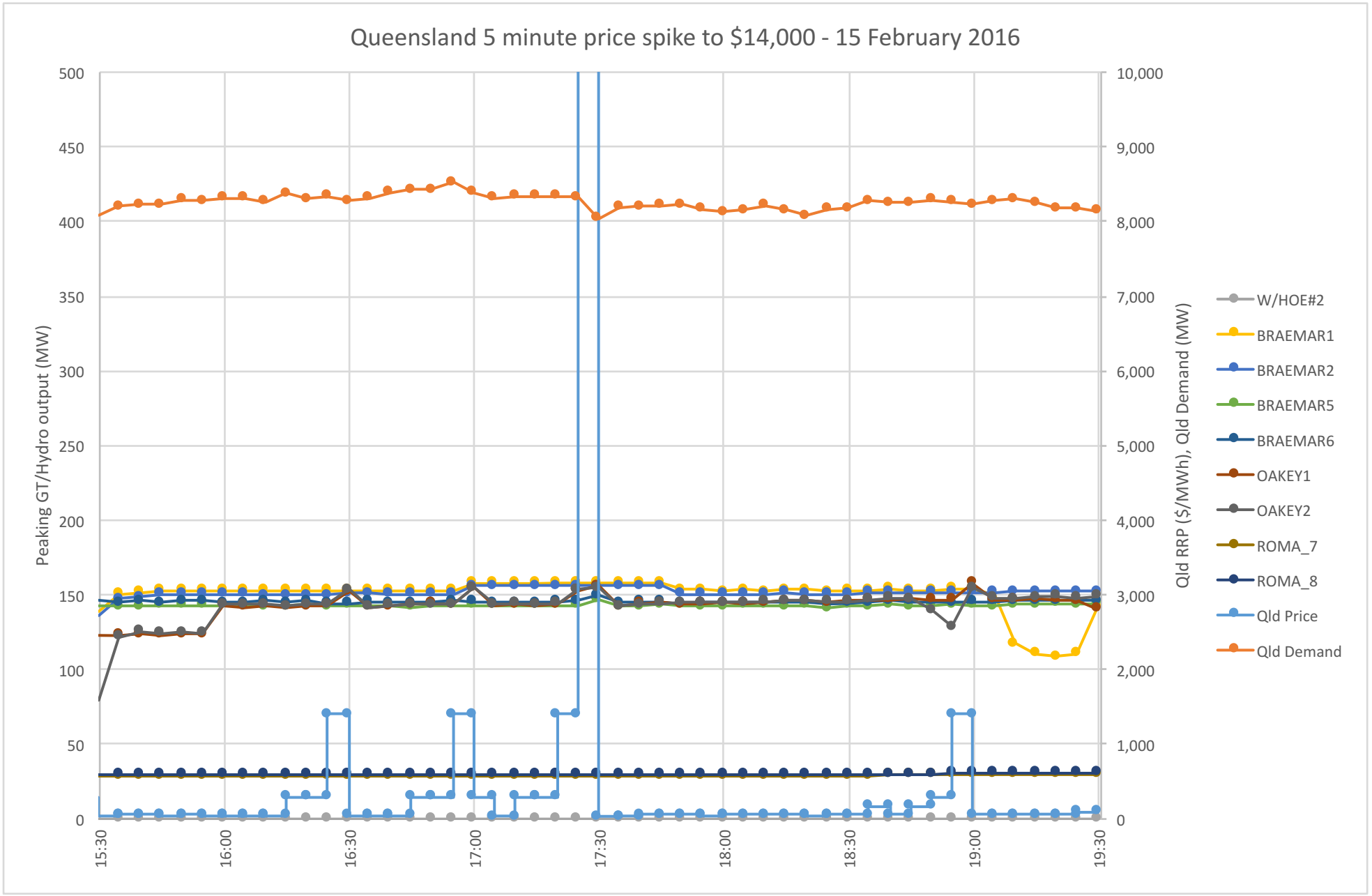

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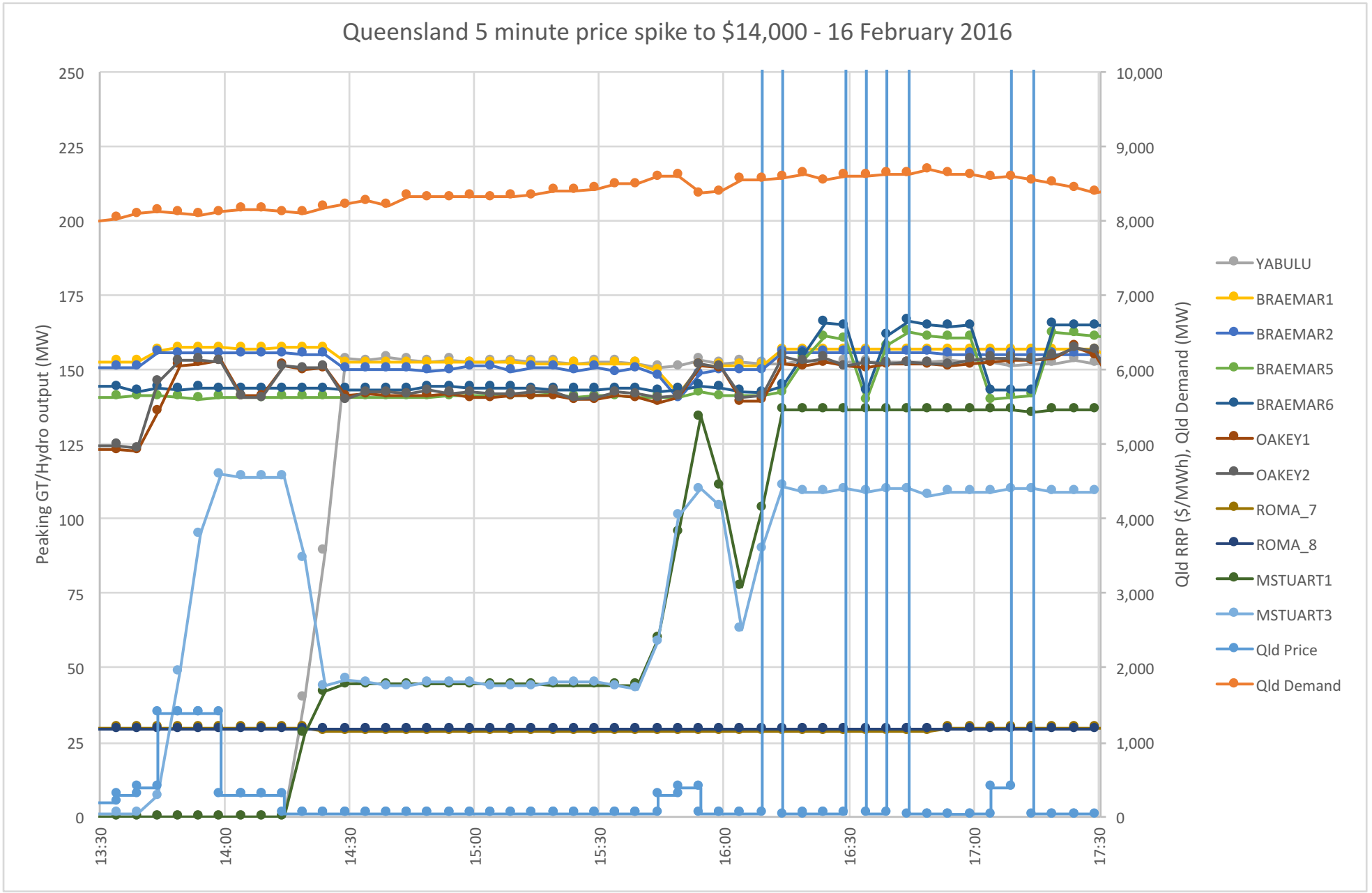

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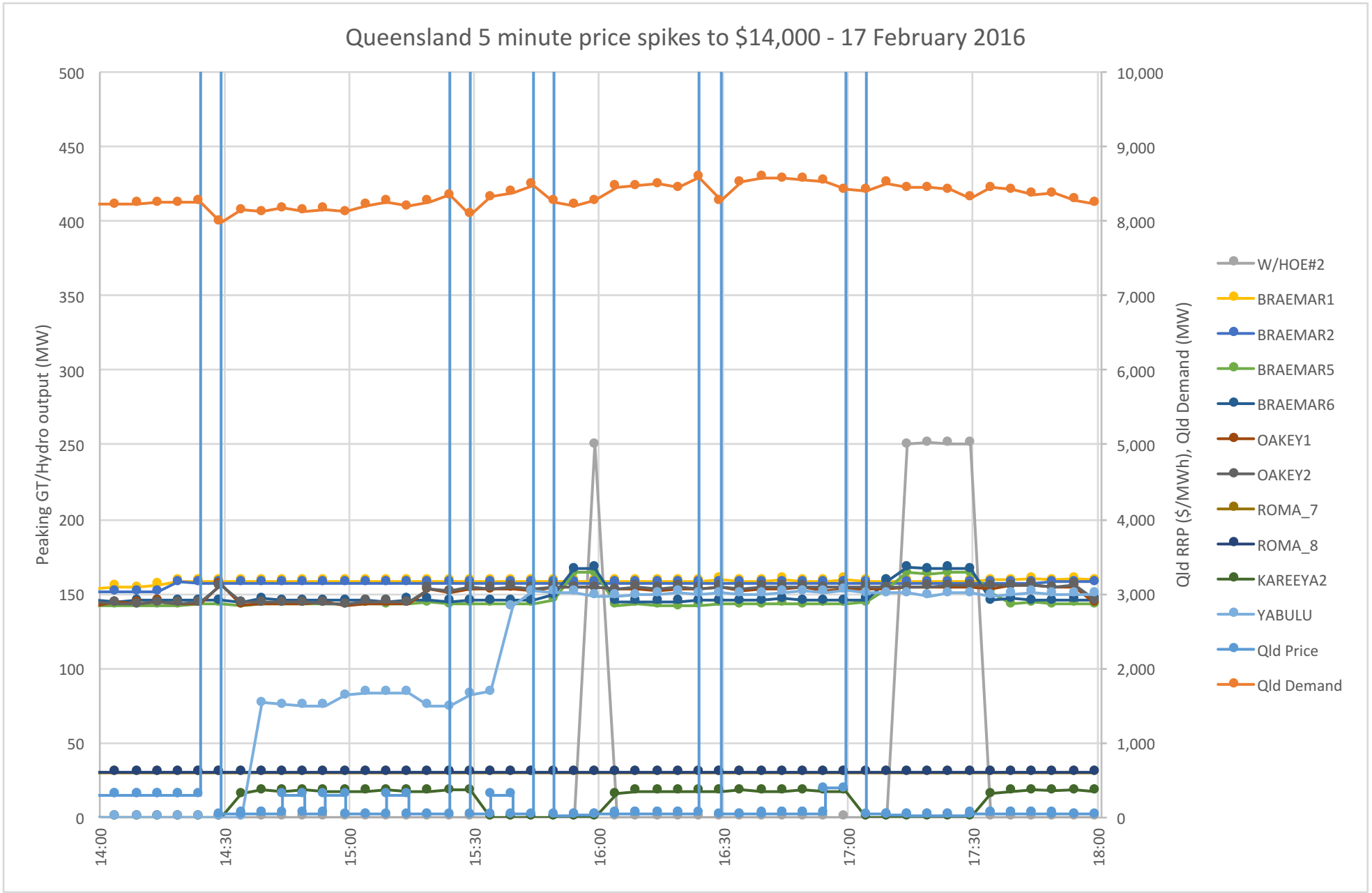

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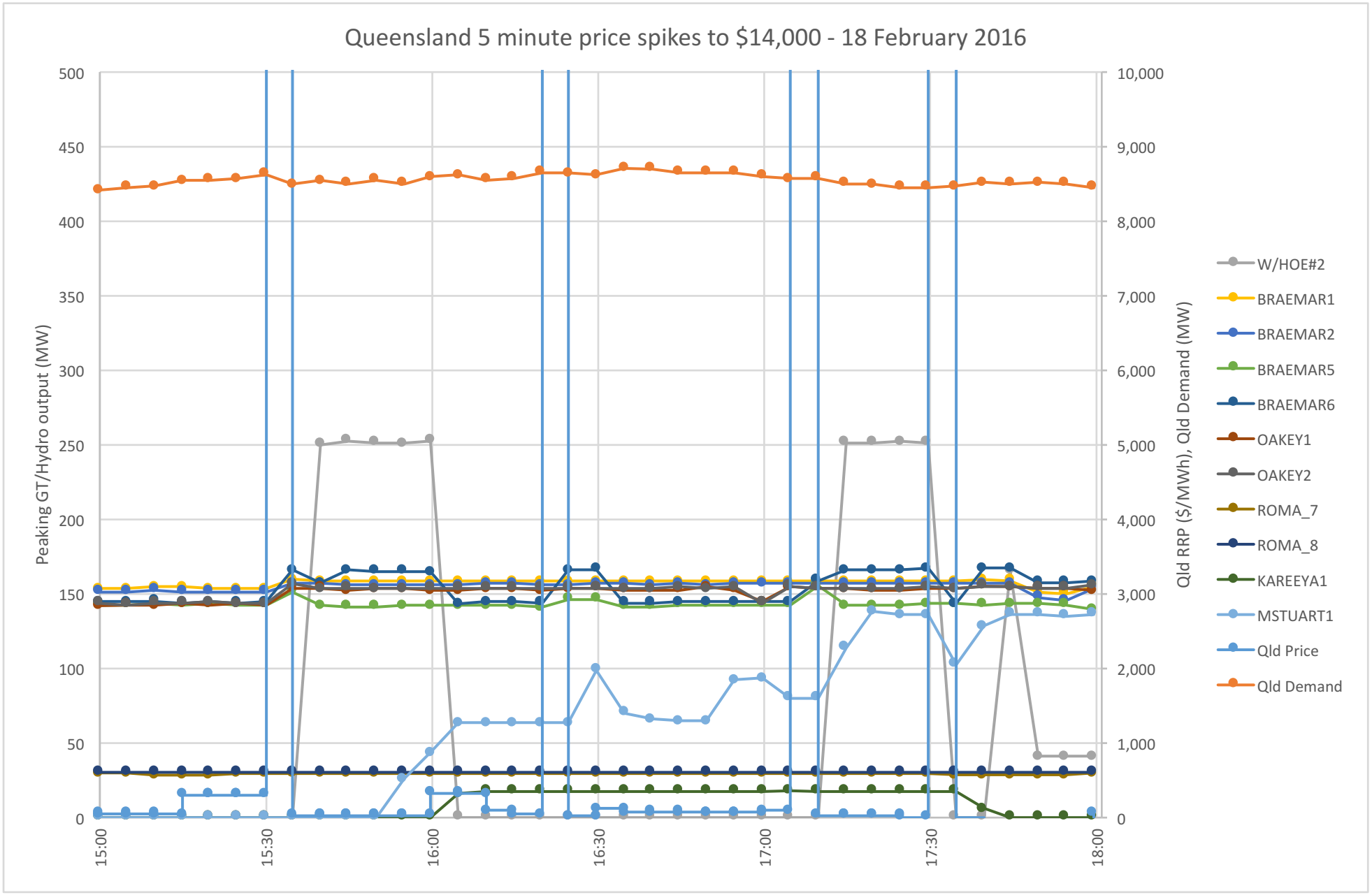

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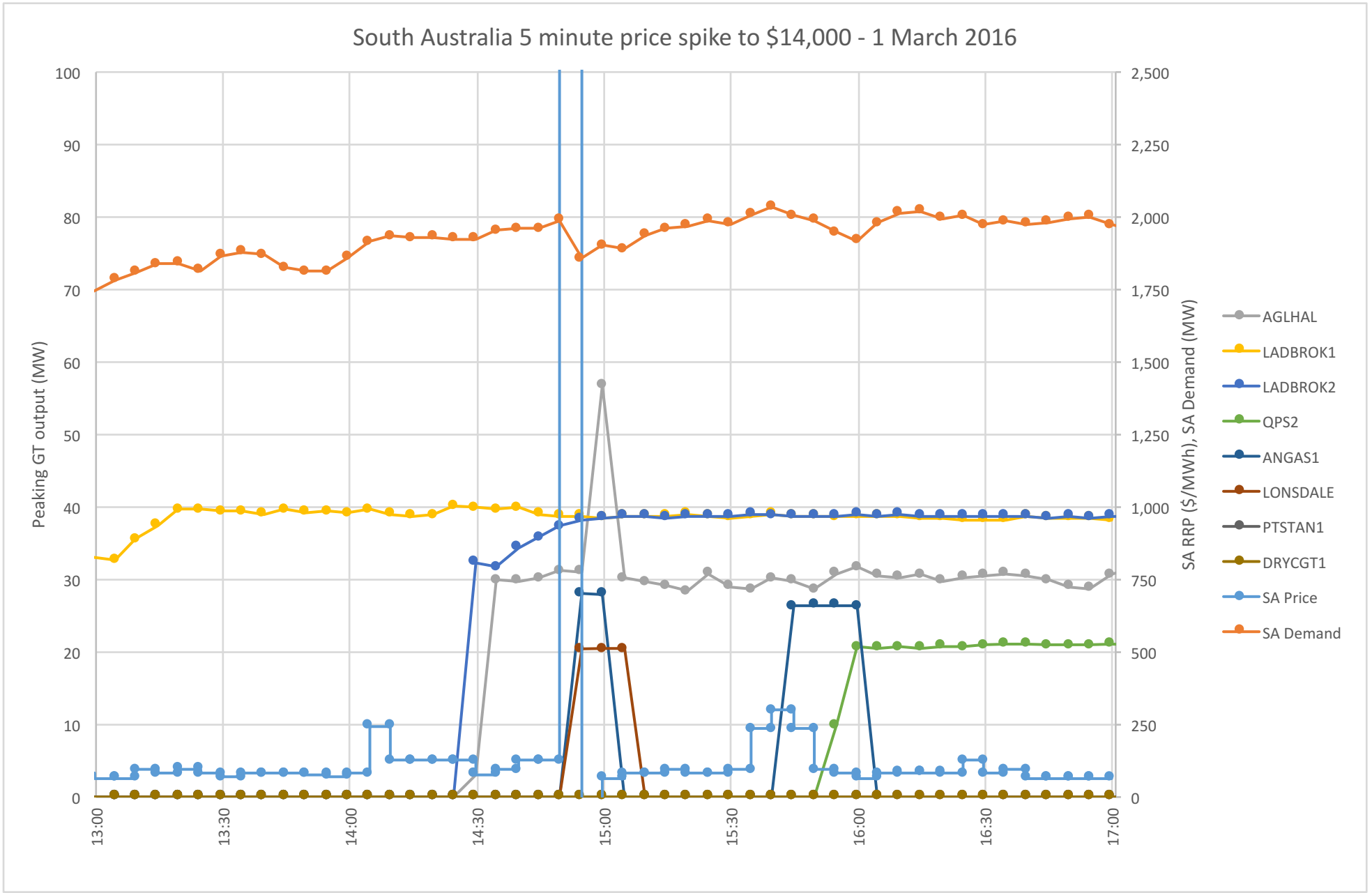

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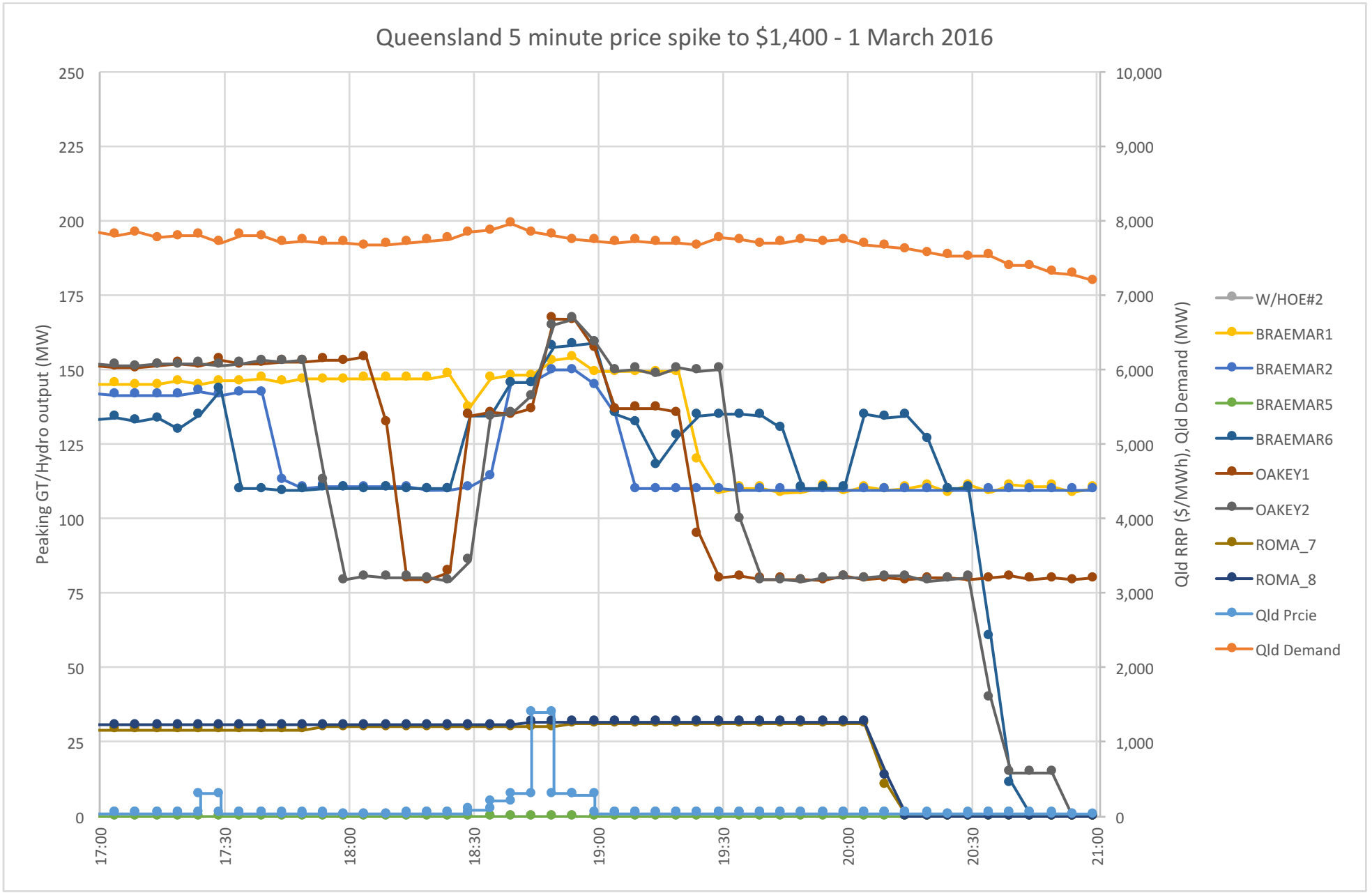

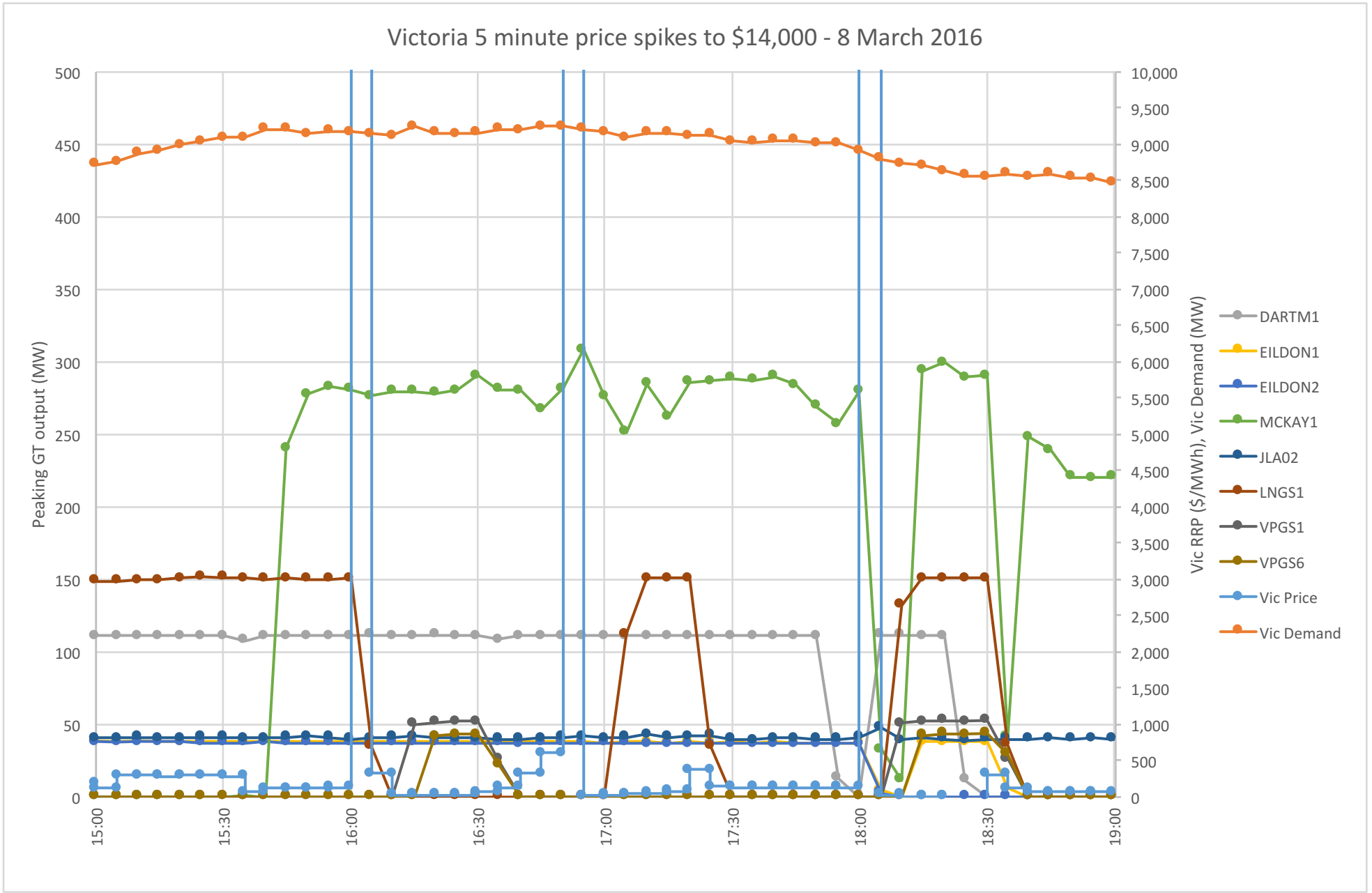

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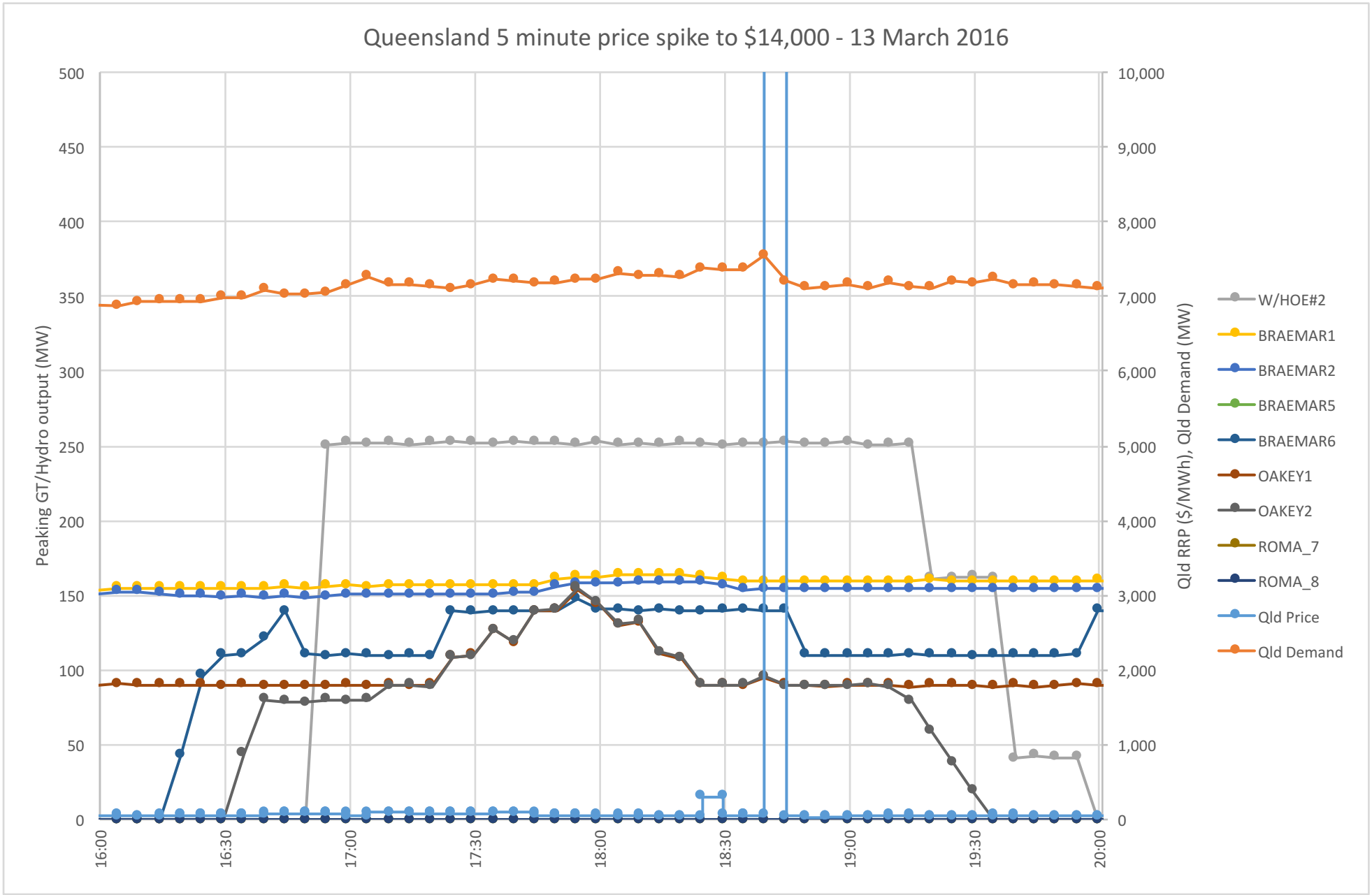

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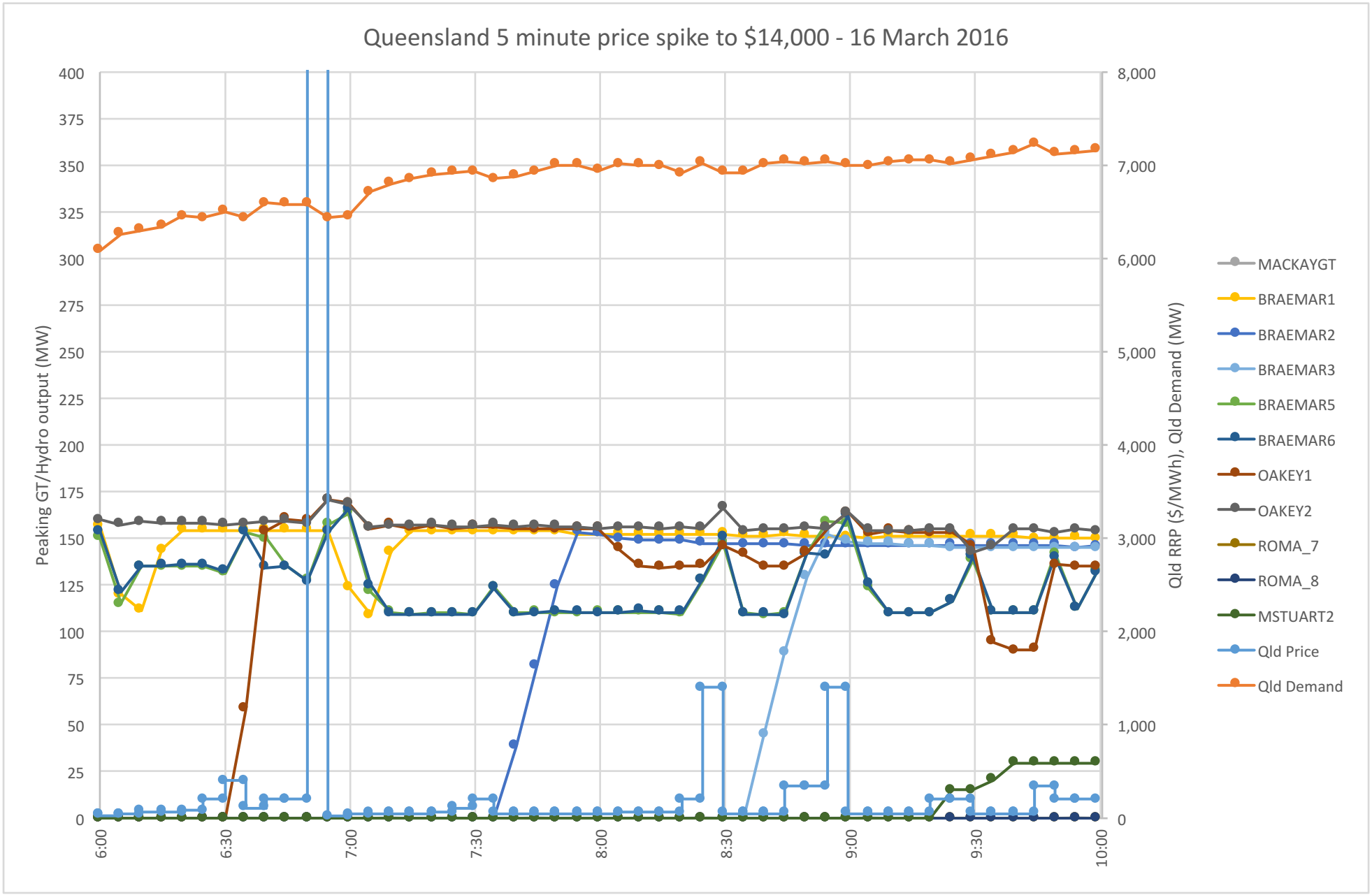

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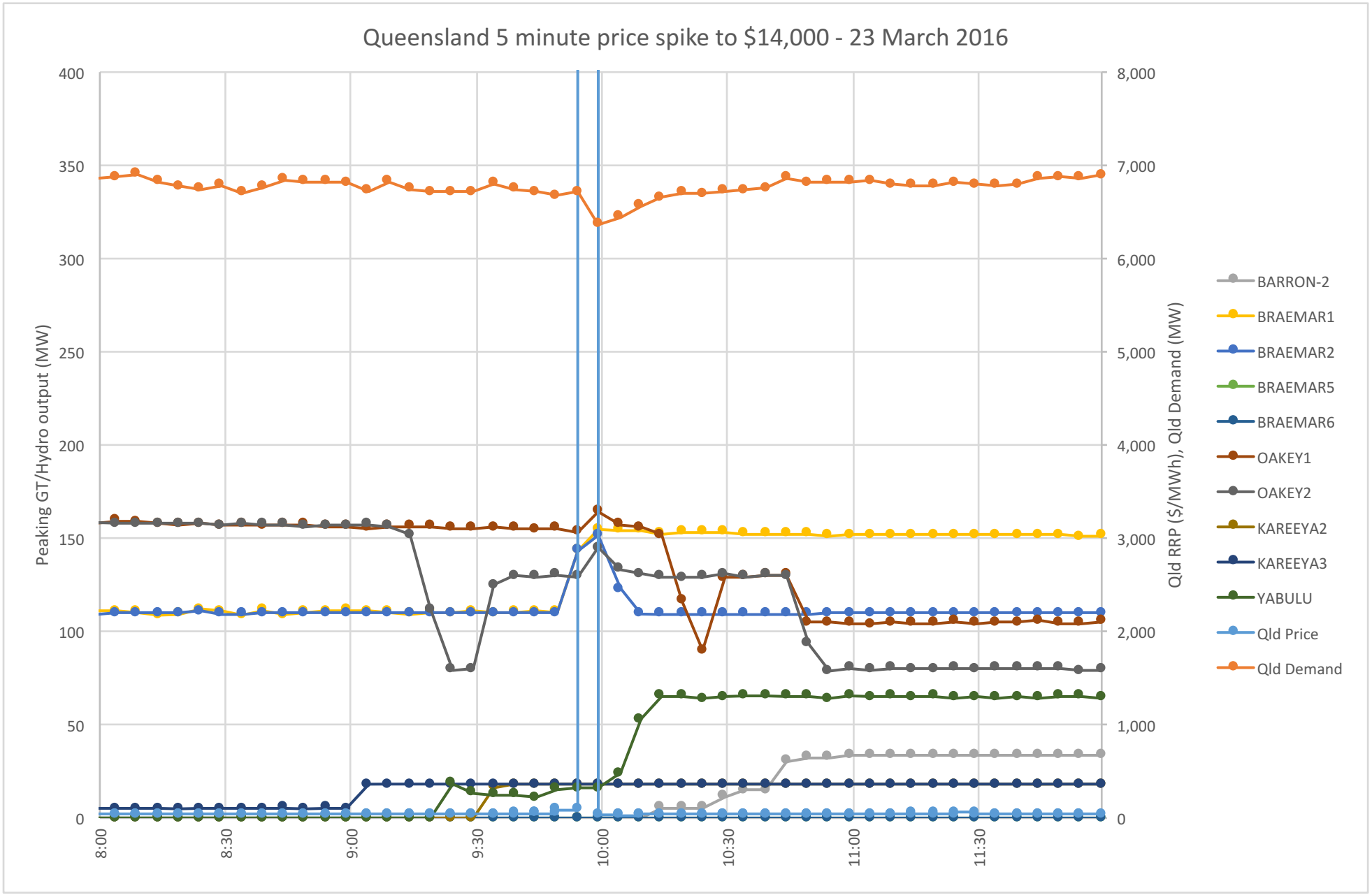

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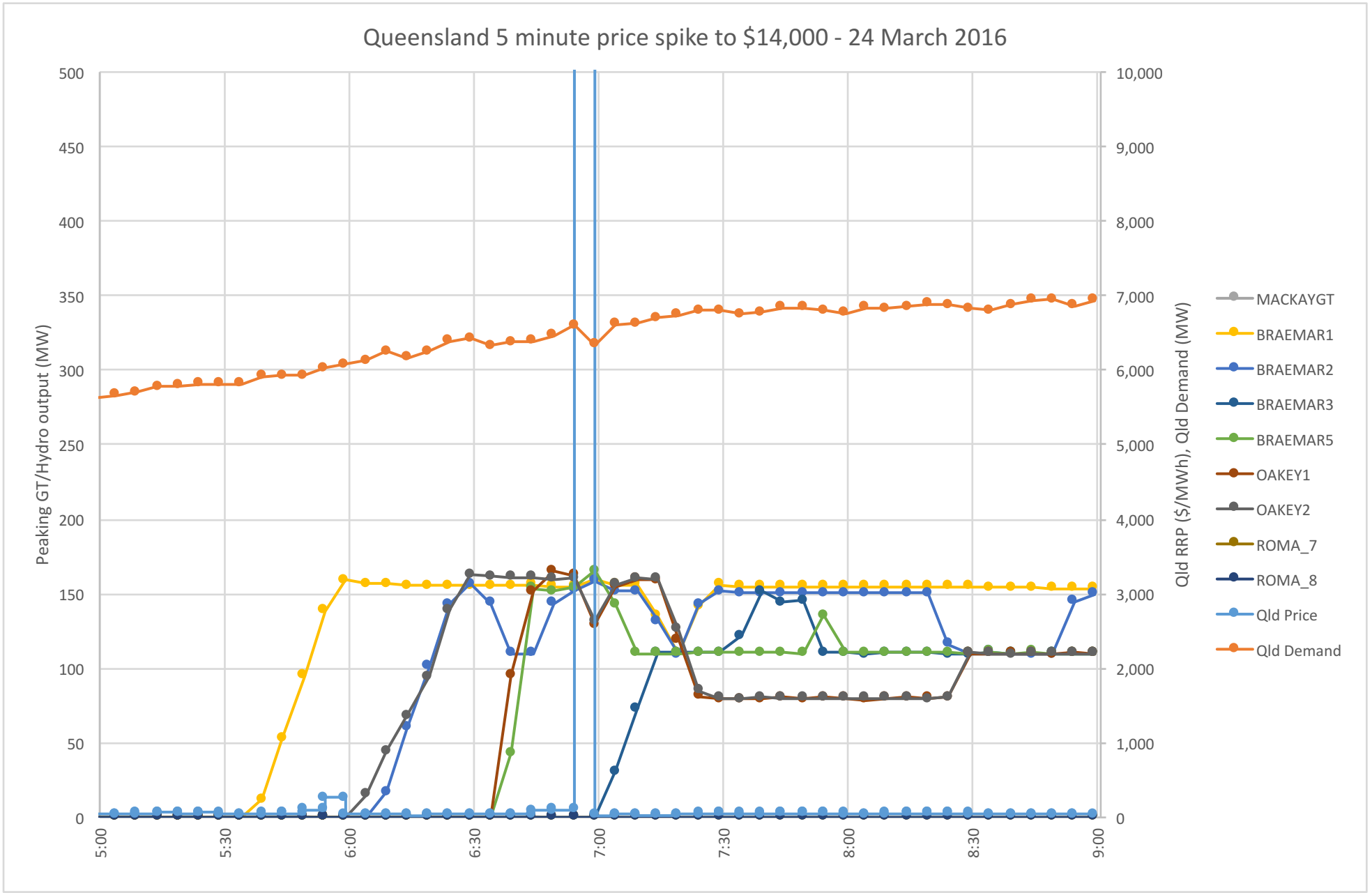

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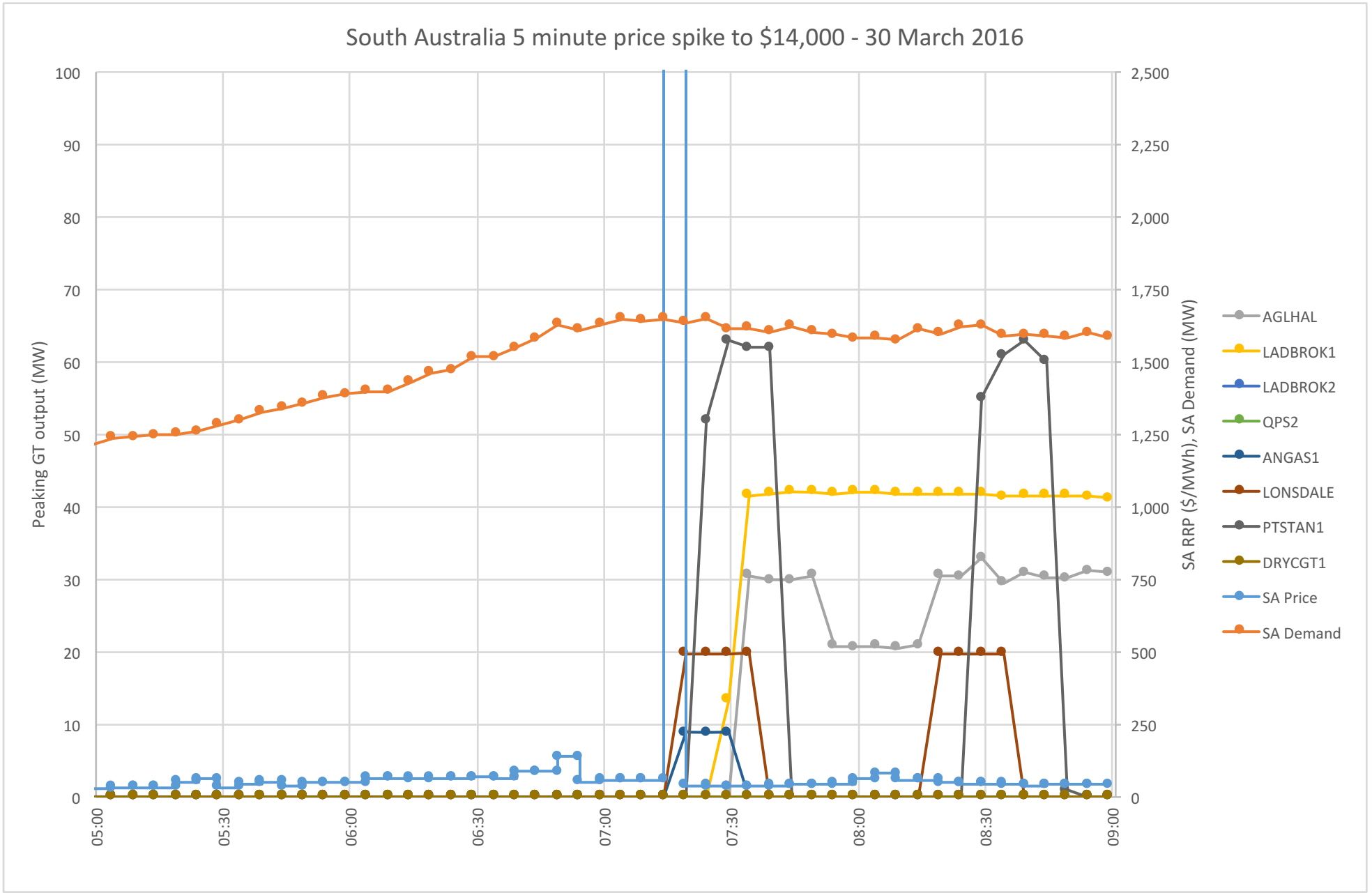

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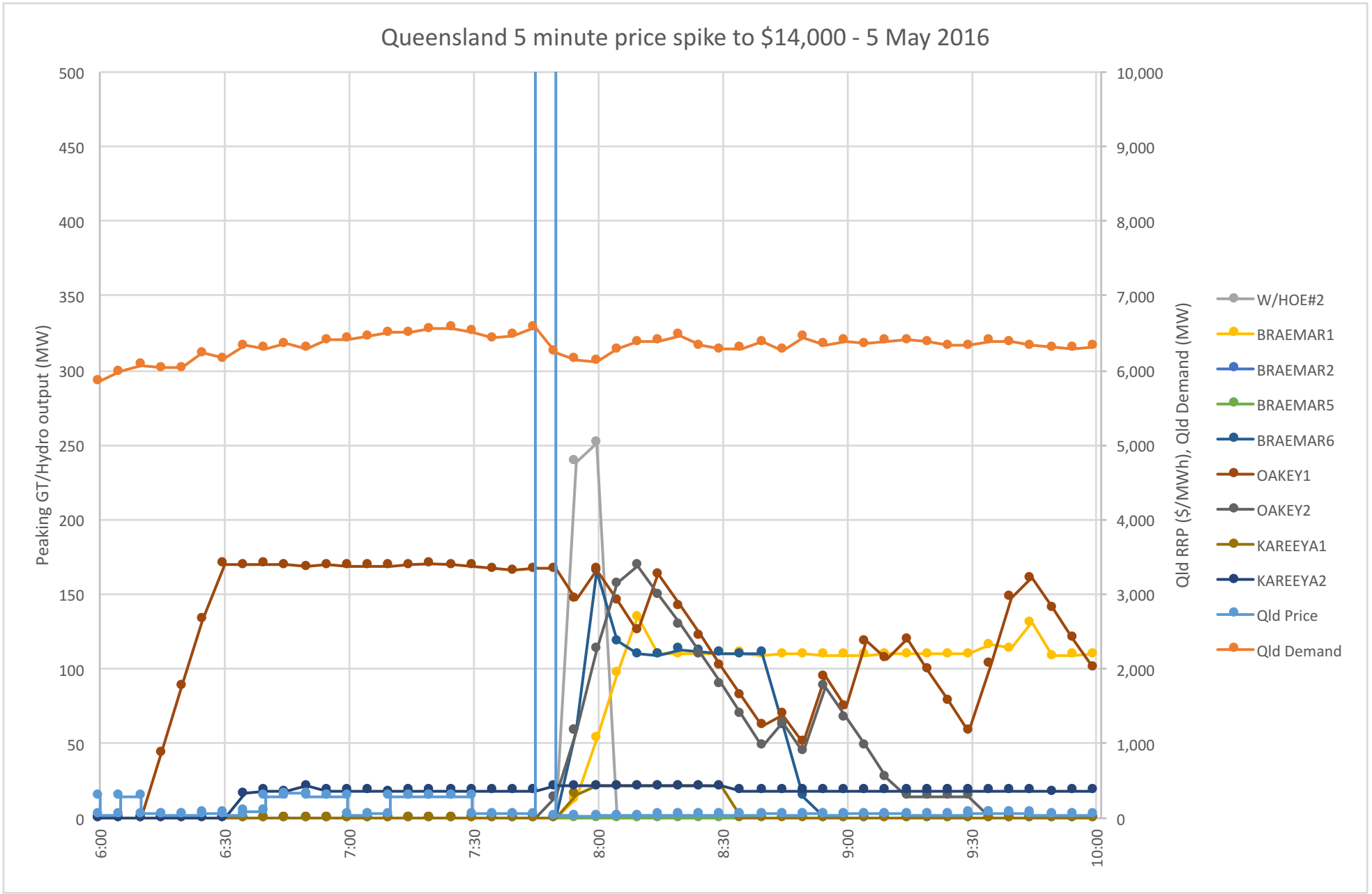

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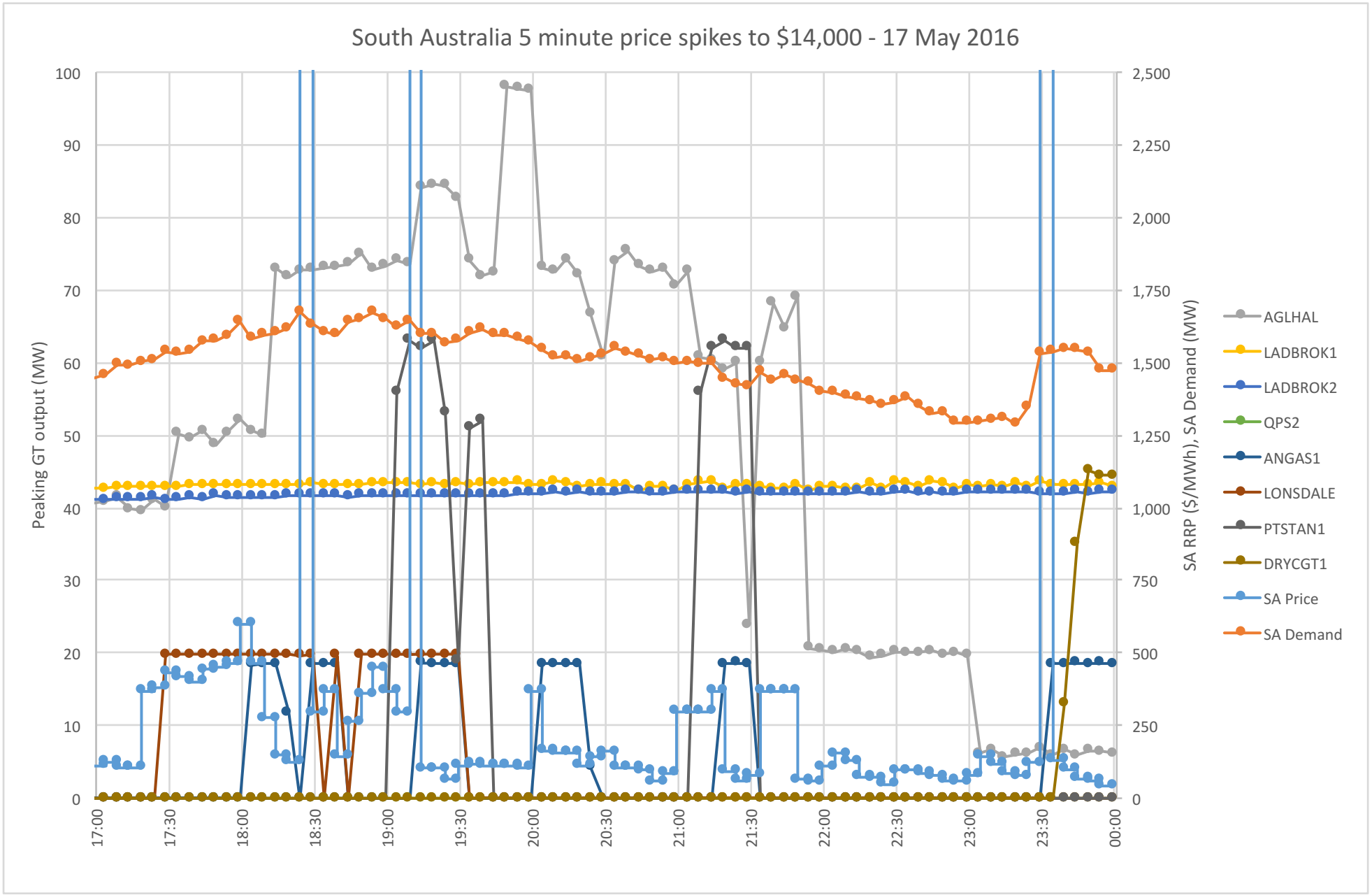

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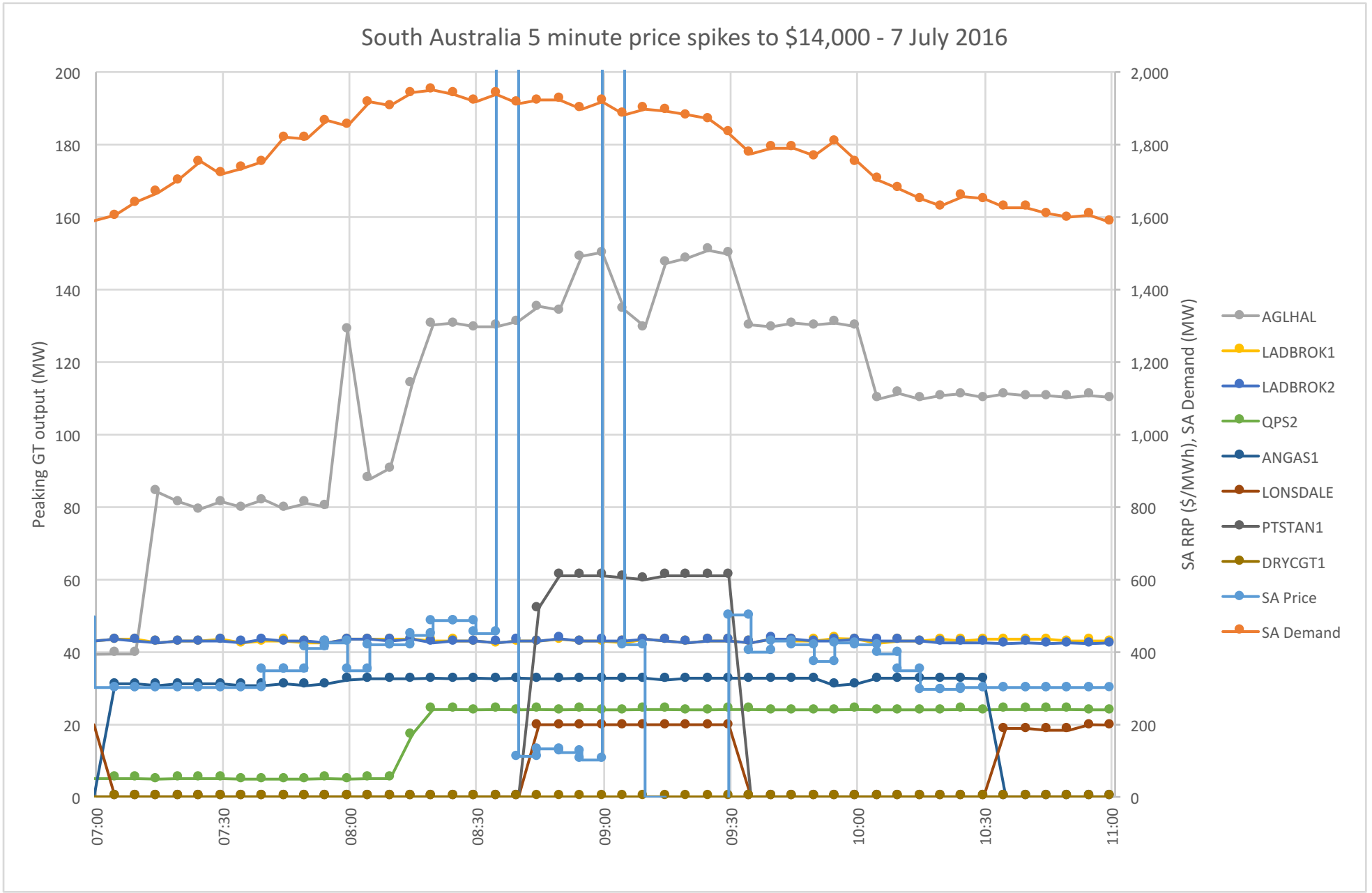

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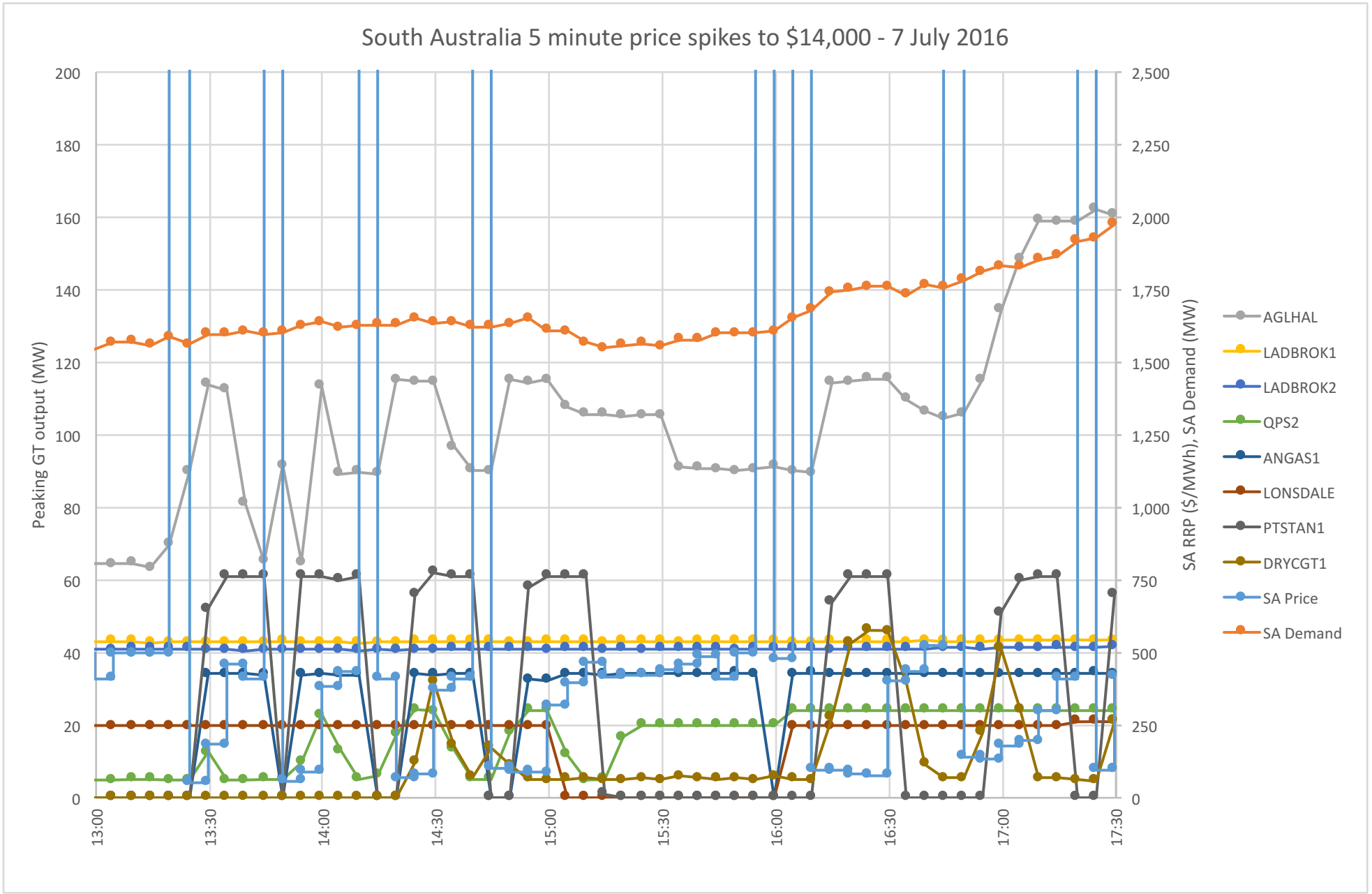

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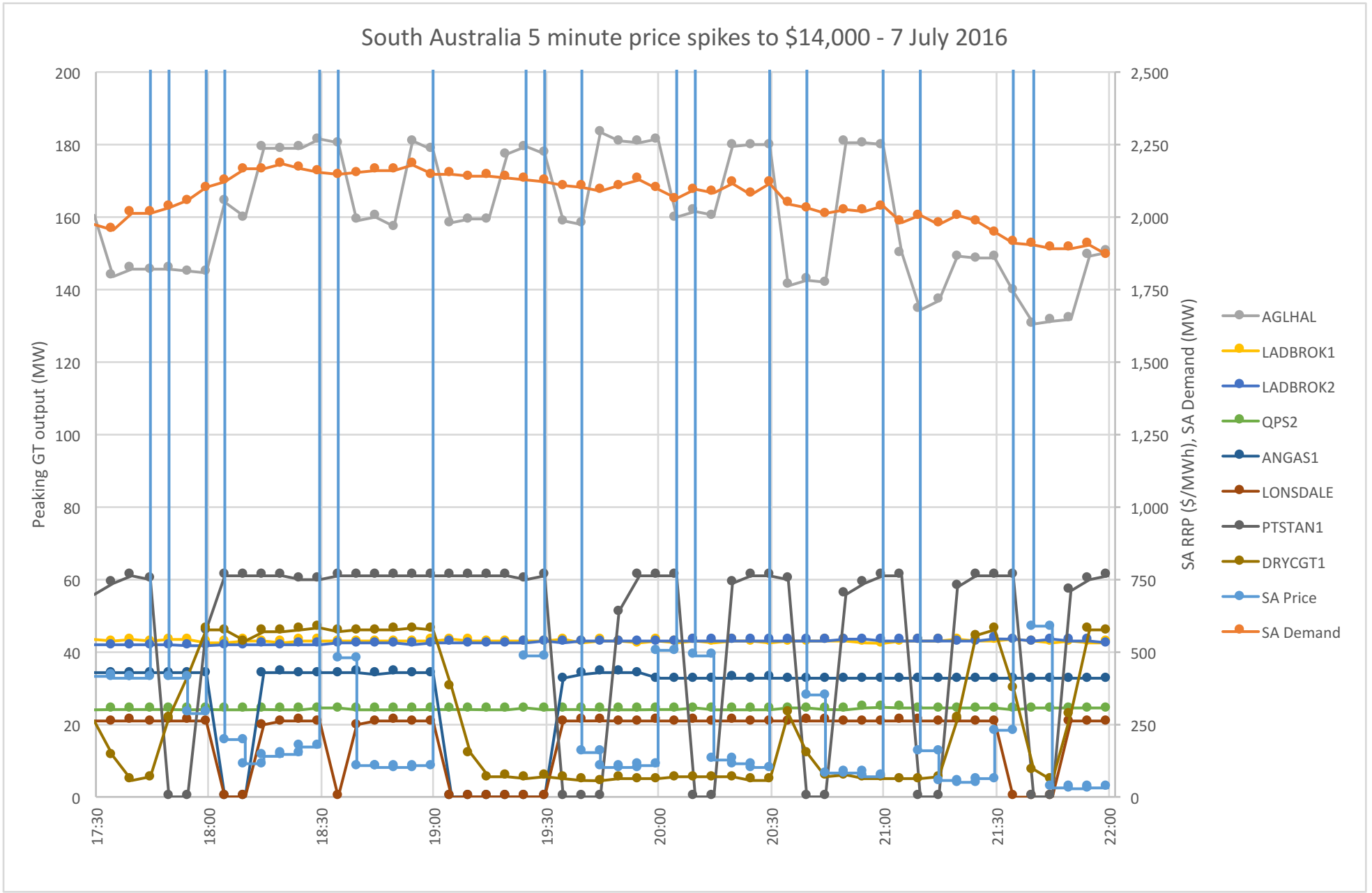

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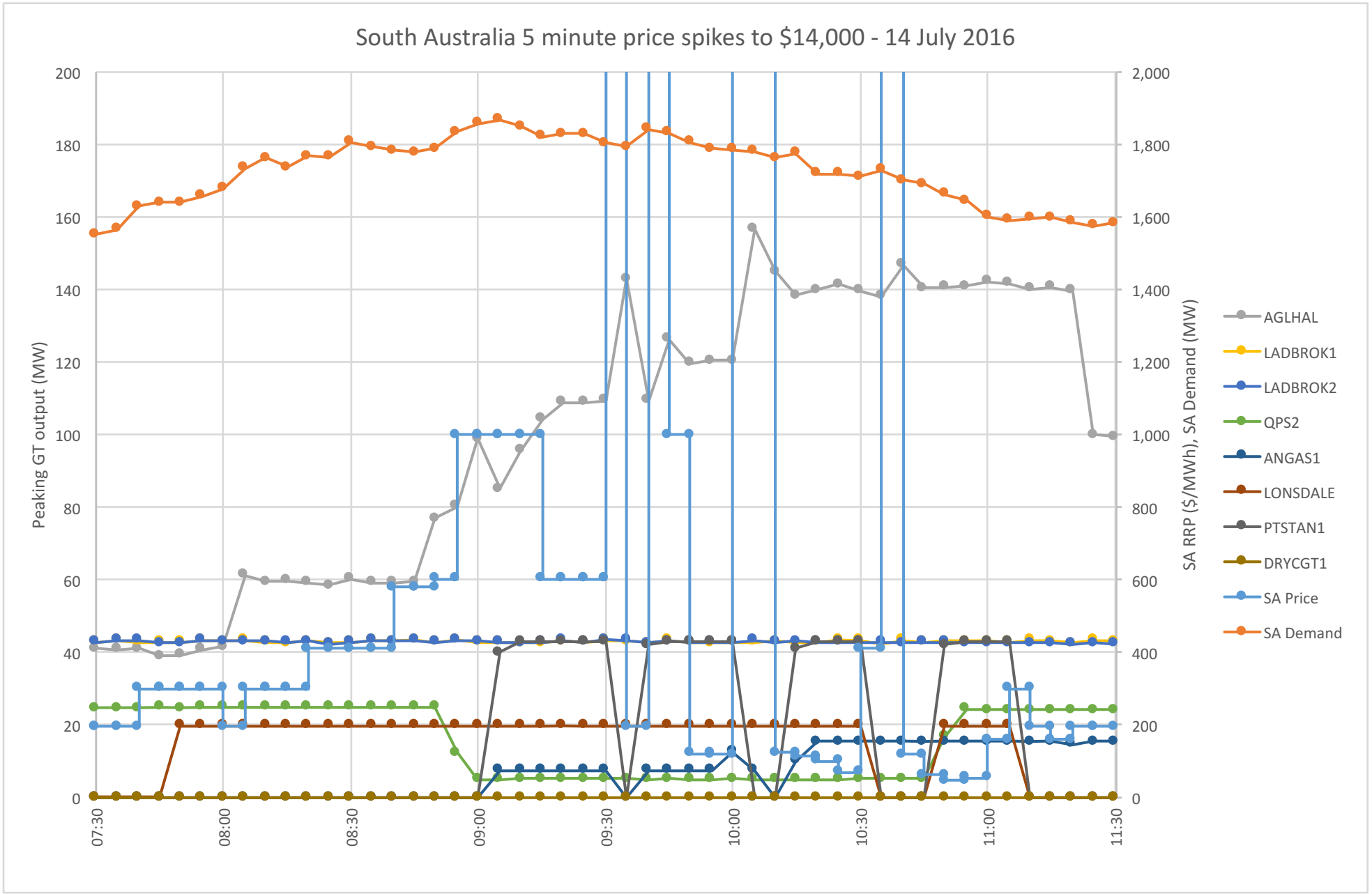

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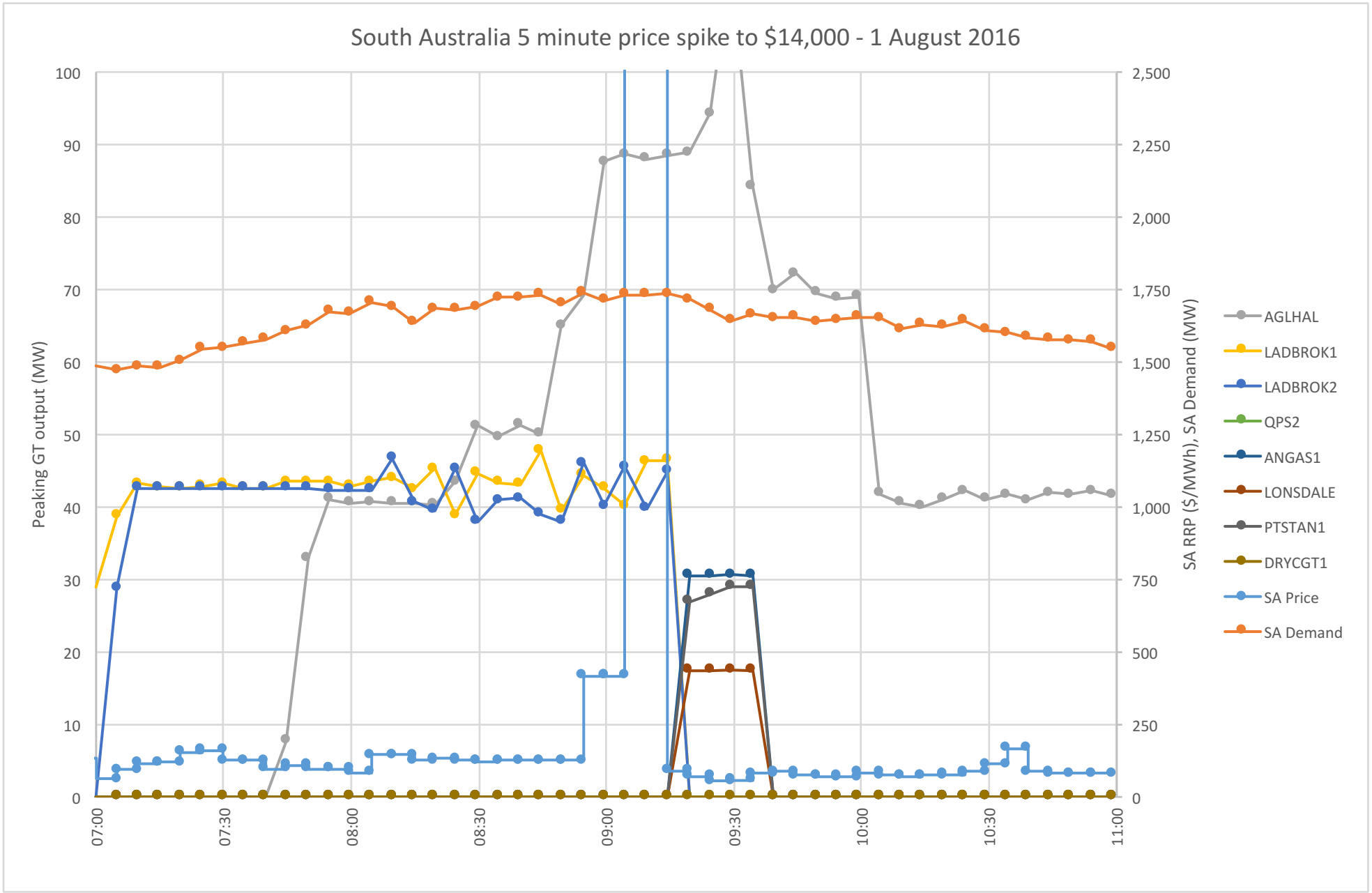

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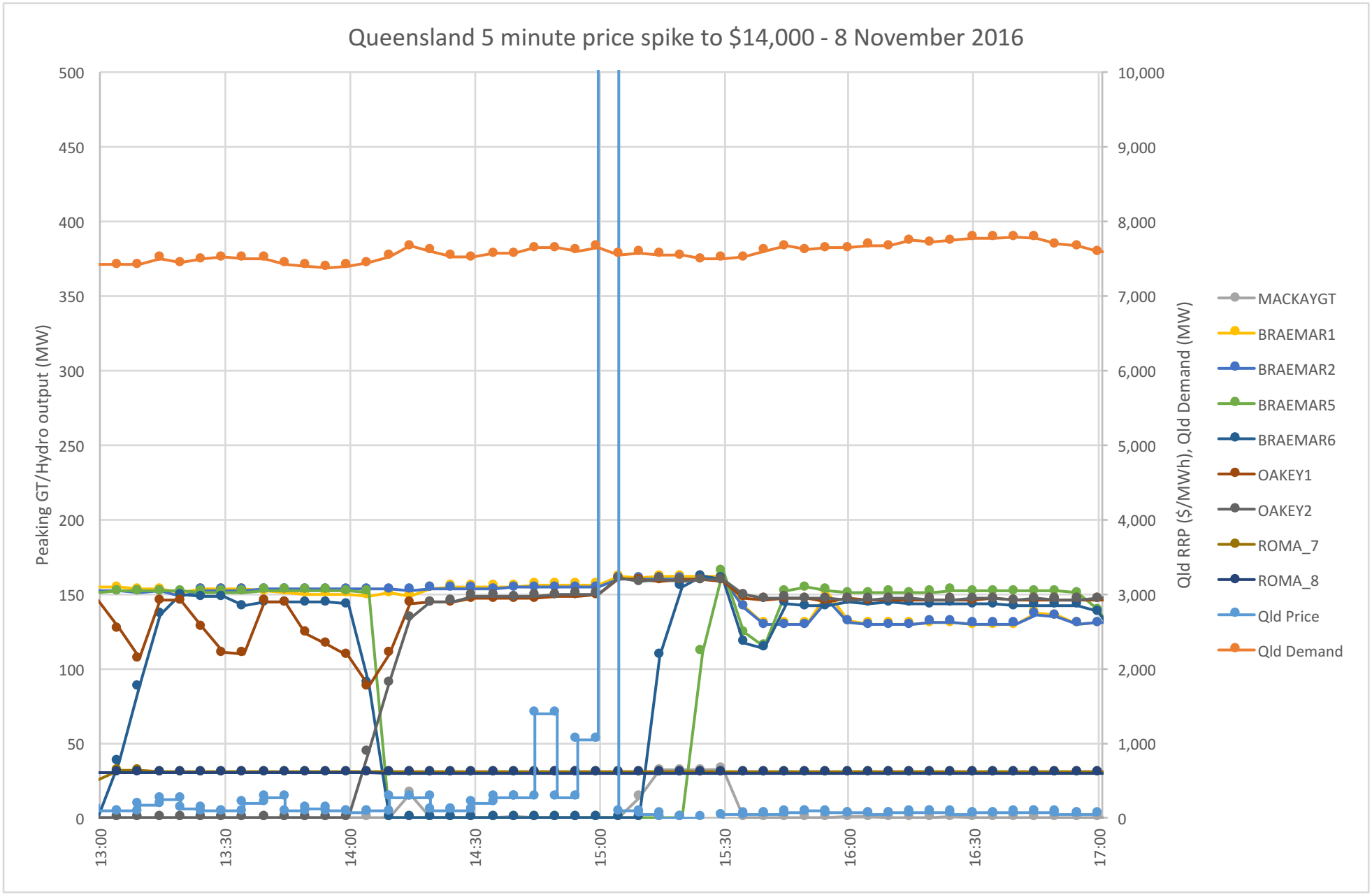

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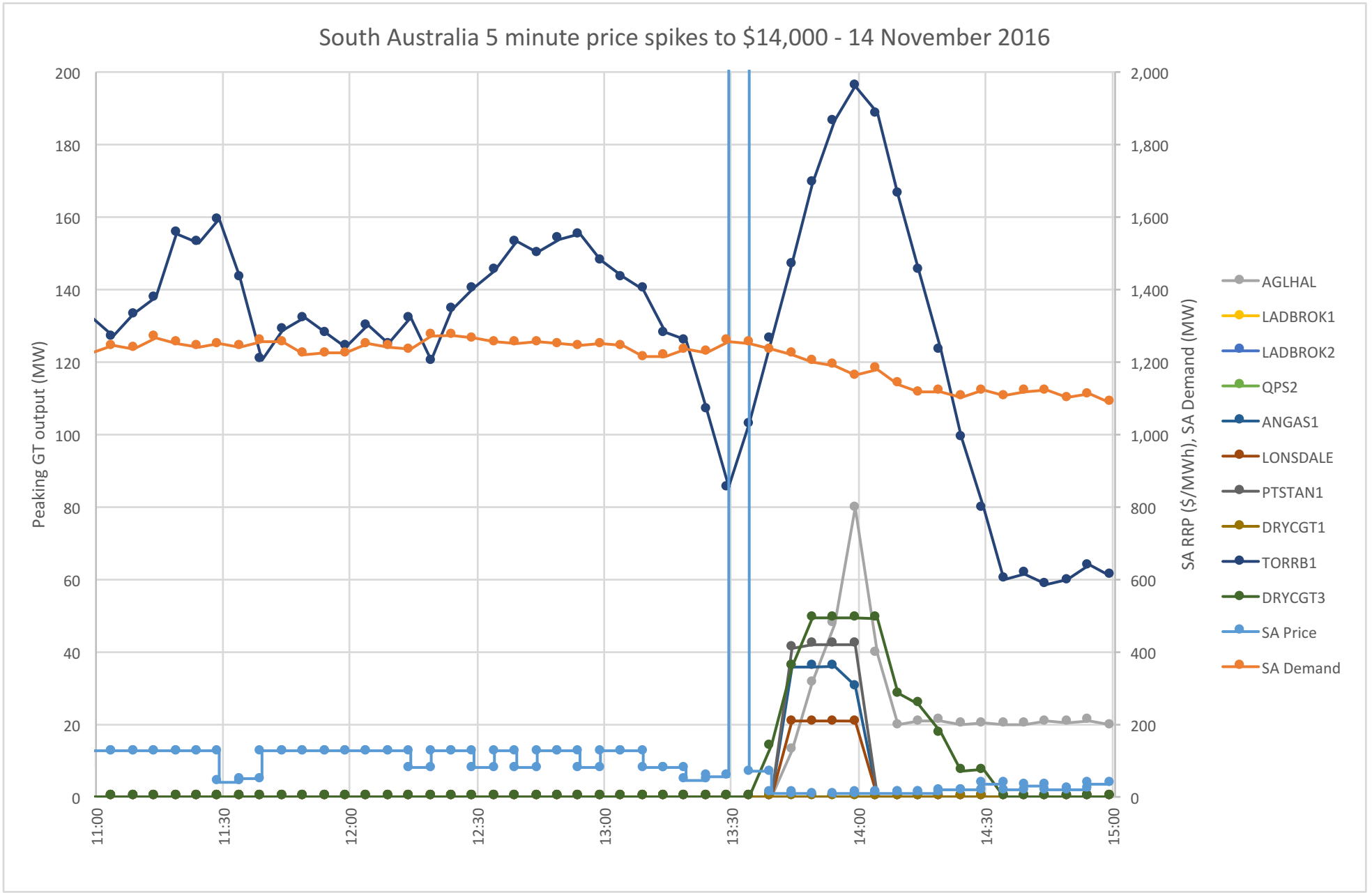

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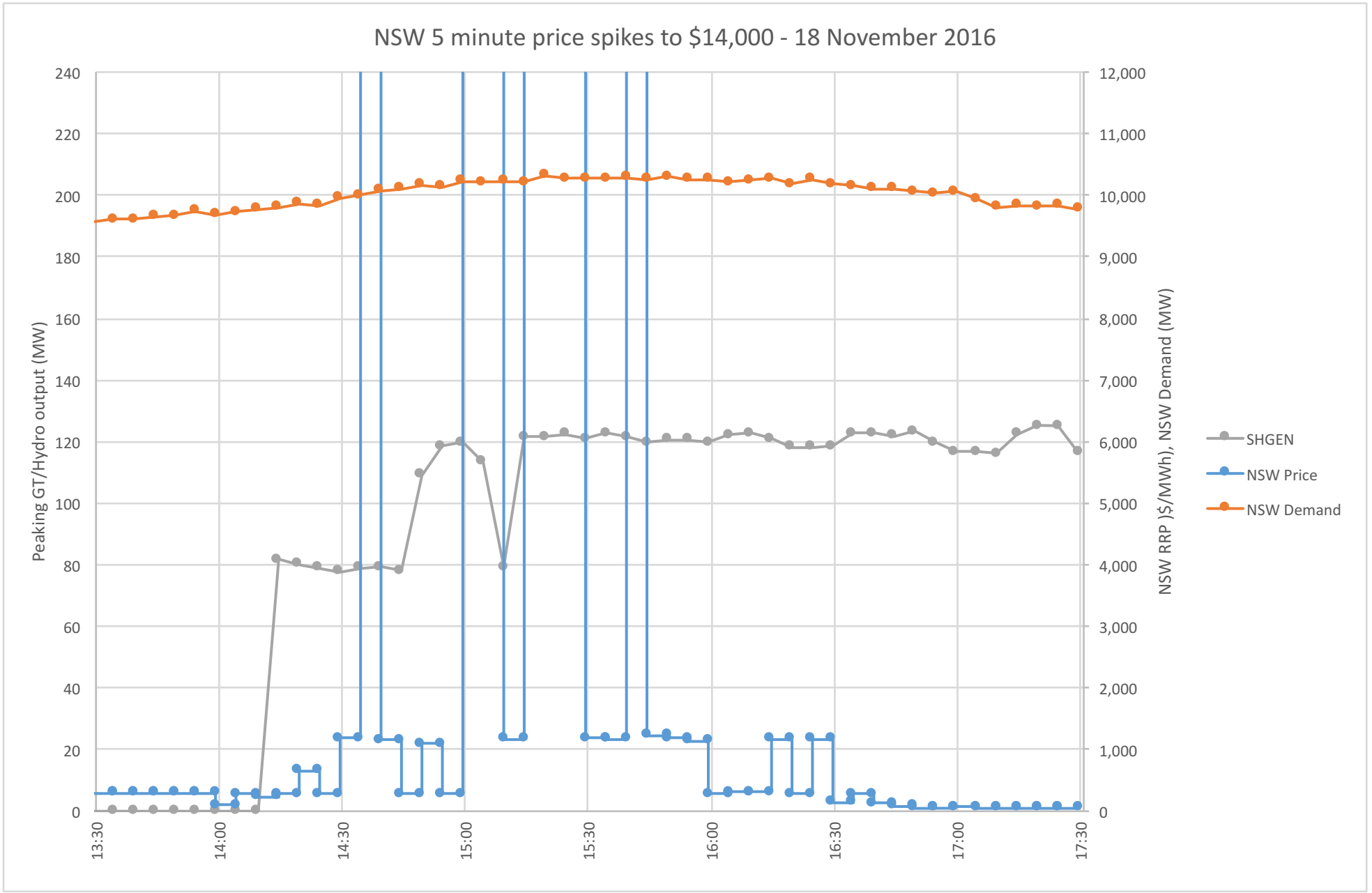

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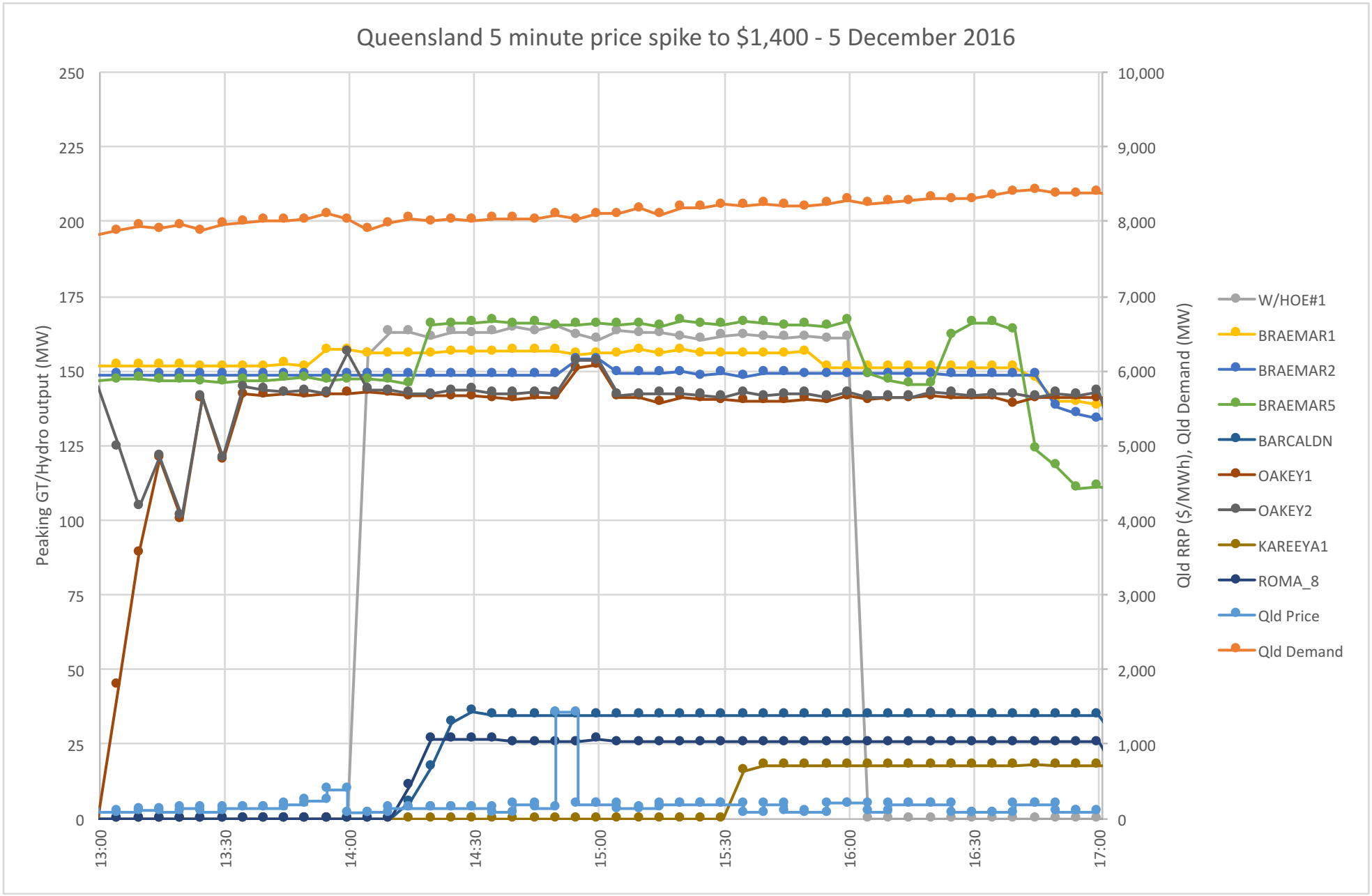

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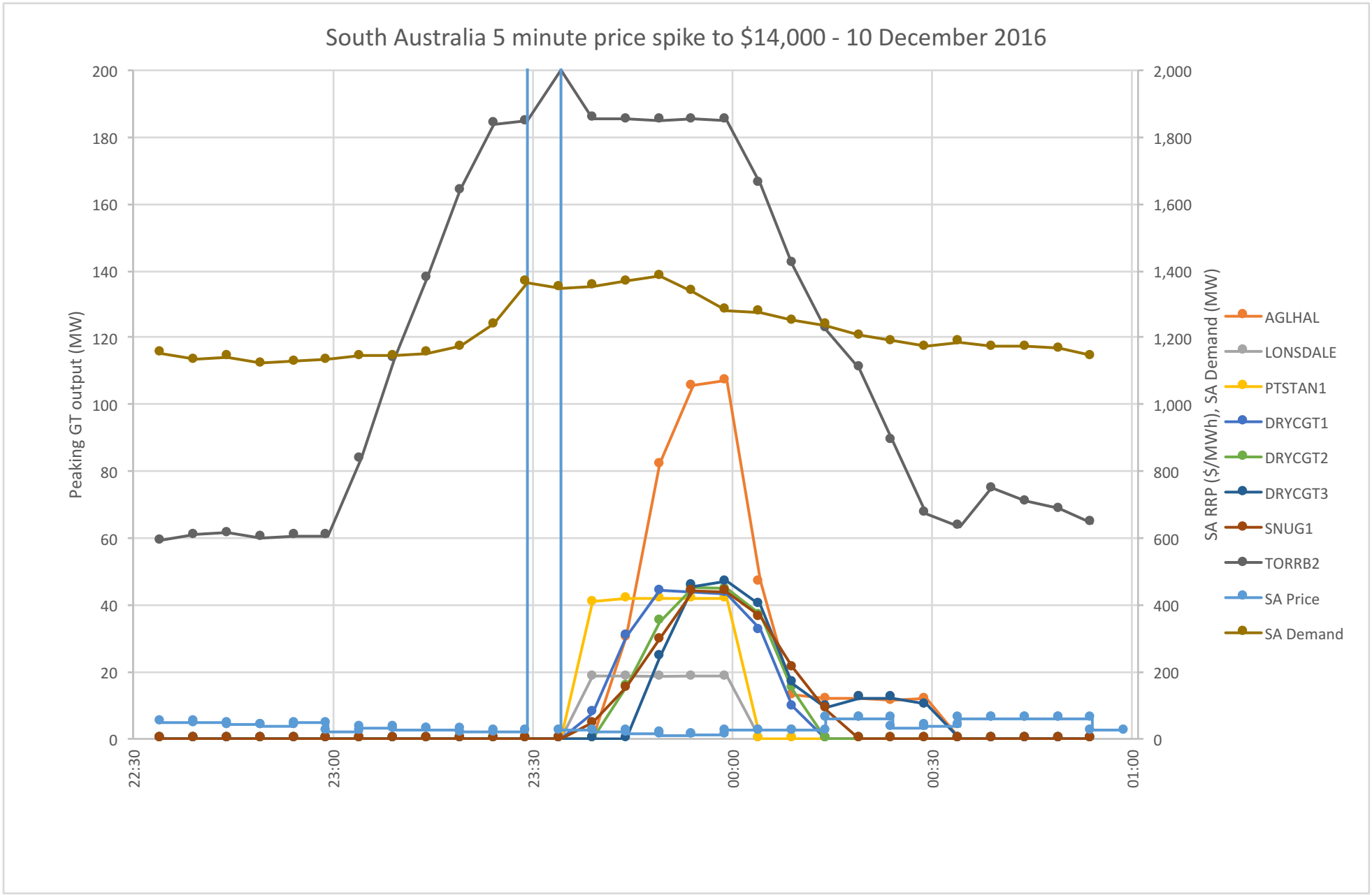

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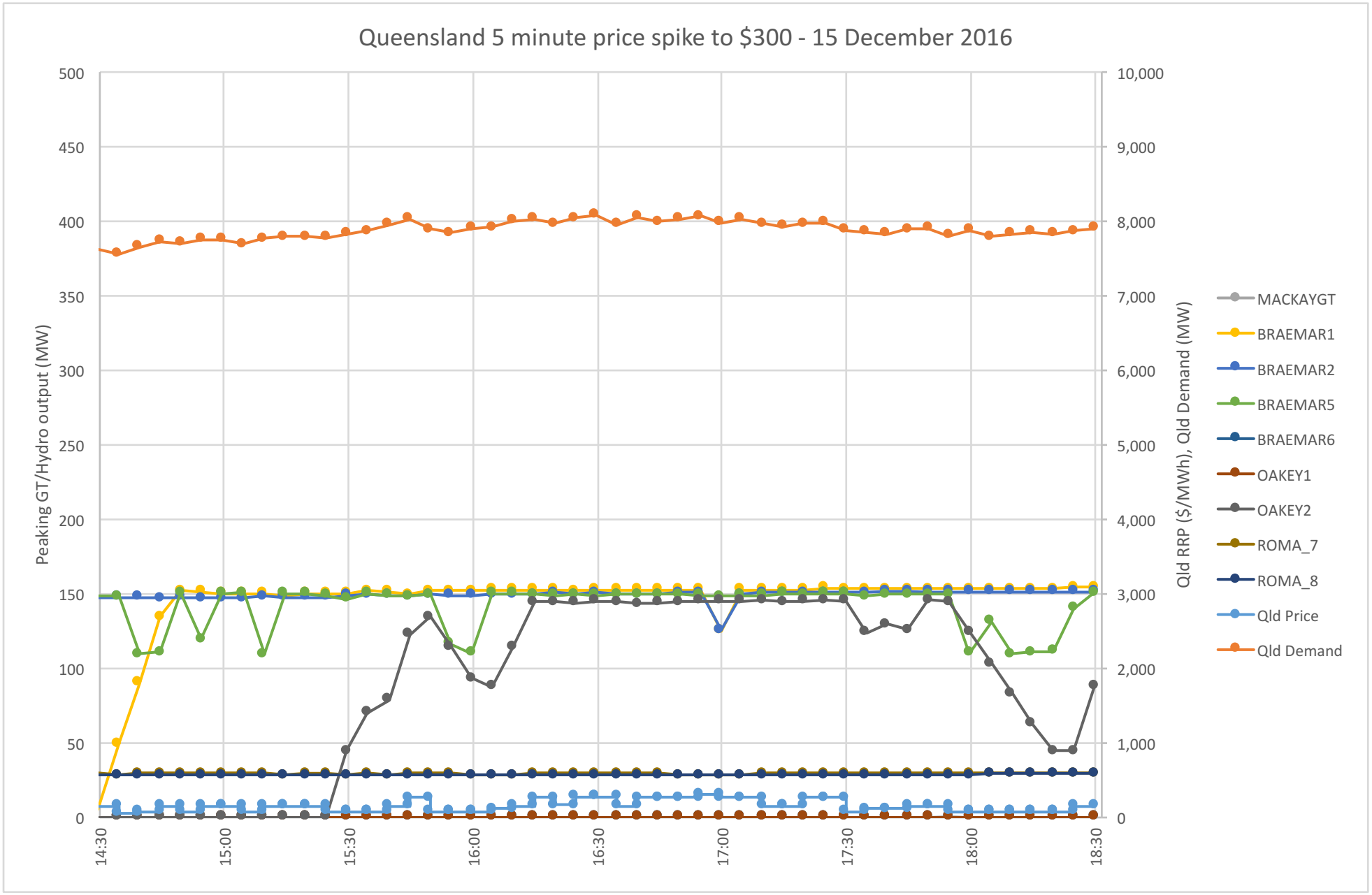

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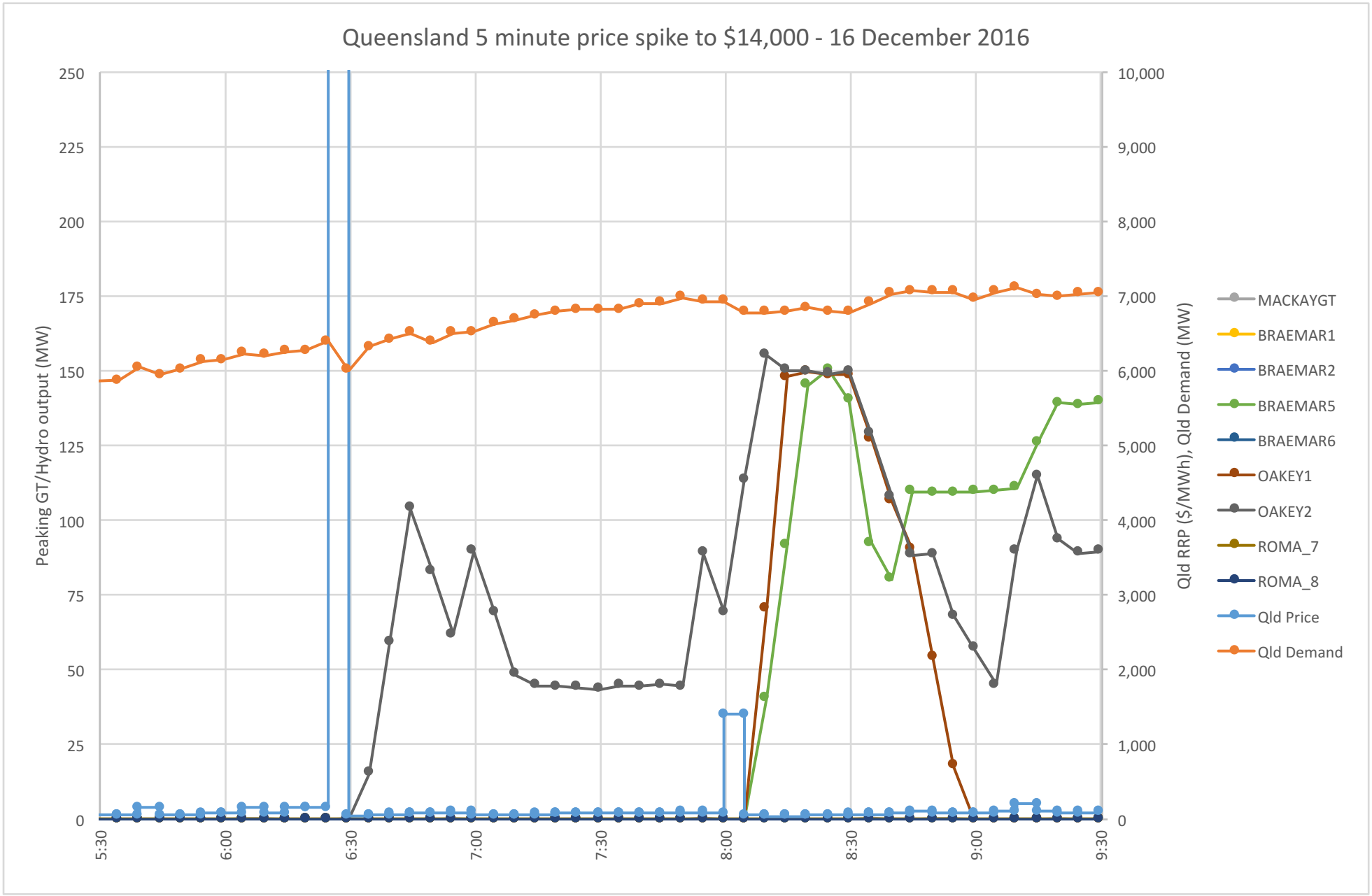

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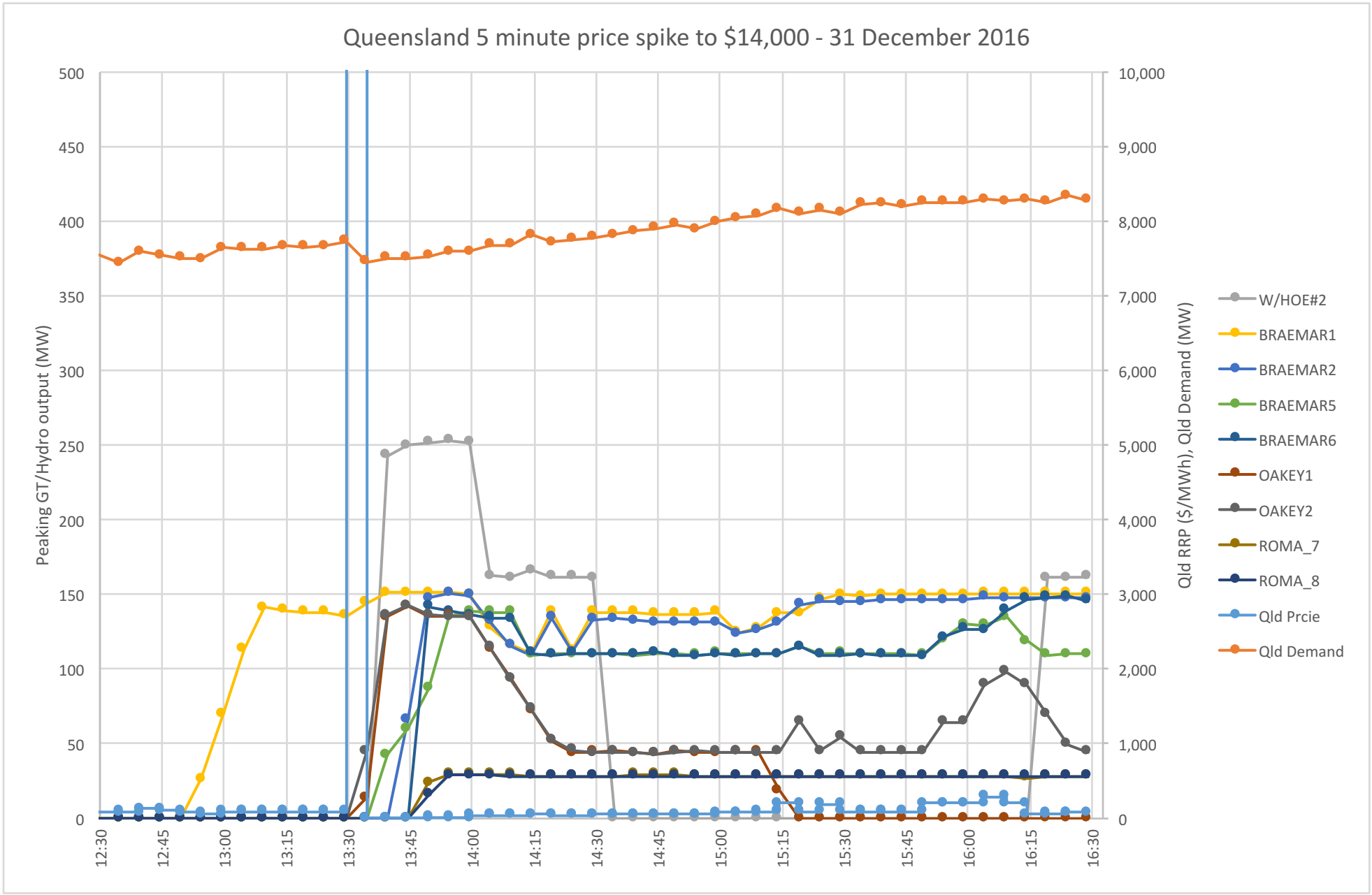

Appendix 4

HWL EBSWORTH
LAWYERS

Advice of impact of 5 minute settlement on hedge transactions

Russ Skelton & Associates Pty Limited

24 February 2017

Doc ID 396606193/v2

1. Executive Summary

The key conclusions reached, and points made, in this advice are:

(a) the Rule change to move to a 5 minute settlement price, would be likely to constitute a Market Disruption Event or "change in law" for the purposes of OTC hedge contracts;

(b) the terms of the OTC hedge contracts would usually require a renegotiation in such circumstances;

(c) a move to 5 minute settlements would also probably give rise to a need to renegotiate the hedge quantities and hedge calculation period, which presently are usually set to half-hourly quantities and calculations;

(d) most renewable source power stations would have long-term OTC hedge contracts, lasting up to 2030 (the expiry of the RET scheme); and

(e) there are also some large industrial OTC hedge contracts for smelters and refineries which will have terms of 15 to 20 years.

2. Background

2.1 Current NEM Rules

Under the current arrangements, some generators and other wholesale market participants submit bids or offers to the market operator, signalling their willingness to generate, consume or transport electric energy. The dispatch price is the bid of the most expensive generator that needs to be dispatched in order to balance demand and supply in each five minute period.

While a dispatch price is determined for each five minute dispatch interval, settlement - the transfer of money for electric energy supplied to the market and consumed by end users - is calculated on a 30 minute basis. The settlement price is the time-weighted average of the six dispatch prices that occurred during any given 30 minute trading interval.

2.2 Proposed Rule Change

Sun Metals has applied to the Australian Energy Markets Commission (AEMC) for a Rule Change. Sun Metals is of the view that the mismatch between the dispatch and settlement intervals leads to inefficiencies in the operation and generation mix of the market. It submits that this aspect of the market design provides incentives for generators to withdraw capacity to influence price outcomes and impedes some categories of participants from entering the market.

Sun Metals proposes a possible solution that involves compulsory five minute settlement for generators. Demand side participants in the wholesale market, including retailers and large consumers, could choose to be settled on either a five or

30 minute basis. The AEMC is consulting on the components of the proposed solution, which are likely to form part of any possible solution.

Neither Sun Metals nor the AEMC has yet proposed a draft text of the actual changes to the Rules that would follow from these changes.

2.3 Request for advice

Russ Skelton & Associates has requested advice on:

(a) whether the proposed Rule change would have any impact on existing transactions entered in the over-the-counter (OTC) hedge market;

(b) the potential consequences of such impact (if any); and

(c) the likely transition period during which such impacts (if any) would be felt.

3. Existing OTC contracts and their wording

3.1 Swap and option contracts

Most swap and option contracts designed to operate as hedges against the electricity market price involve a fixed (or strike price), and a floating (or reference) price.

In a cash-settled swap contract, the buyer pays the seller the difference when the floating price is less than the fixed price, and the seller pays the buyer the difference when the floating price is greater than the fixed price.

In an option contract, the buyer pays a fixed premium to the seller, and the seller pays the buyer the excess if the floating price exceeds the agreed strike price.

3.2 Contract forms

There are multiple forms of contract used in hedges against the electricity spot price. These include:

(a) exchange-traded contracts on the ASX24 market;

(b) over-the-counter (OTC) contracts using the ISDA Master Agreement as its basis; and

(c) other bespoke forms of OTC contracts for differences.

3.3 ASX24 Contracts

ASX24 exchange-traded hedges against the electricity spot price include monthly and quarterly baseload and peak futures contracts. These are settled using a "Cash Settlement Price", which is defined in the contract specifications as the arithmetic

average of the Wholesale Electricity Pool Market [base load / peak] spot prices **on a half hourly basis** over the [Contract Month/Quarter].[1]

The ASX24 Operating Rules define the Cash Settlement Price slightly differently, as "the regional reference price as determined by the Exchange and calculated by AEMO, or its successor, **on a half hourly basis** for purposes of invoicing physical deliveries of electricity".[2]

Note that Rule [3100] provides that the Exchange may direct that contracts be settled at a price other than that determined in accordance with the Individual Contract Specifications, where it determines necessary for the fair, orderly and transparent operation of the market.

On settlement, the account of a person selling such an exchange-traded contract will be debited by an amount which the Exchange determines is the Cash Settlement Price, multiplied by the contract quantities, and the account of a person buying such an exchange-traded contract will be debited by an amount which is the Cash Settlement Price multiplied by the contract quantities.

ASX24 electricity contracts are presently traded up to 4 years in advance, although most of the liquidity is in the first two years.

3.4 OTC ISDA forms

The ISDA Master Agreement, published in 2002 by the International Swaps and Derivatives Association Inc ("ISDA"), is the most common form used for OTC electricity hedge transactions in Australia. Prior versions were published in 1987 and 1992.

Supporting its use, ISDA has published "Commodity Definitions" that contain specific provisions that can be incorporated by reference by parties into their hedge transactions. There are two principal versions of this, issued 1993 and 2005 respectively.

The Australian Financial Markets Association (AFMA) has also published an "Australian Addendum No 13 - Electricity and REC transactions" which contains provisions that can be incorporated by reference by parties into their hedge transactions.

Most Australian OTC electricity hedge transactions would adopt the AFMA Electricity and REC Addendum and apply it to their electricity hedge transaction.

Clause 3(a) of the AFMA Electricity and REC Addendum provides that the ISDA Commodity Derivatives Definitions 1993 apply to the transactions to which the Addendum applies.

Most parties expressly modify this to provide that the ISDA Commodity Definitions 2005 apply to transactions to which the Addendum applies.

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[1] Australian Electricity Futures and Options, Contract Specifications.

[2] Rule 2.60 of sub-section 2D of Schedule 1 to the ASX24 Operating Rules.

The transaction confirmation for an electricity confirmation using the ISDA Agreement and the AFMA Electricity and REC Addendum will usually provide that the floating price for a calculation period under the hedge is the "Spot Price".

The AFMA Electricity and REC Addendum defines "Spot Price" as a commodity reference price for which the Commodity is Electricity, the Unit is MWh, the Price Source is NEMMCO (AEMO) and the Specified Price is "**the spot price at the regional reference node**, as determined under the National Code (now National Electricity Rules).

Most parties will insert in their Master Schedule a provision applicable to all electricity commodity transactions which provides (in a form suggested in AFMA's OTC Guide):

> "When a Calculation Period for a commodity transaction is less than one day, the term "Pricing Date" for that Calculation Period means that Calculation Period."

3.5 OTC bespoke contracts

There are some OTC bespoke contracts for differences that are used for hedging the electricity price.

As these vary from contract to contract, it is difficult to make general comments about them.

However, in our experience it would be reasonable to say that most would probably refer to the "spot price" under the NEM Rules in some fashion, as the basis for calculation of the floating price leg of the hedge for each calculation period in the contract.

4. Potential Rule change

4.1 Current spot price usage

As we have discussed above, the ASX24 Exchange contract uses the expression "regional reference price", and the OTC contracts mostly use the expression "spot price" (or "spot price at the regional reference node").

4.2 Current regional reference price definition

The National Electricity Rules presently define "regional reference price" (in Chapter 10) as:

regional reference price

> *Spot price* at the *regional reference node*.

4.3 Current spot price definition

The National Electricity Rules presently define "Spot Price" (in Chapter 10) as:

spot price

> The price for electricity in a *trading interval* at a *regional reference node* or a *connection point* as determined in accordance with clause 3.9.2.

Note the reference to "trading interval", which is defined in Chapter 10 as:

trading interval

> A 30 minute period ending on the hour (EST) or on the half hour and, where identified by a time, means the 30 minute period ending at that time.

4.4 Difficulties presented by proposed Rule change

The Rule Change Proposal by Sun Metals does not set out the proposed new wording of the Rules if the Rule Change Proposal were adopted, but we anticipate that there would be difficulties under the contracts we have discussed if:

(a) there was no longer a "Spot Price" published by AEMO in relation to the regional reference node;

(b) there was a "Spot Price" published by AEMO in relation to the regional reference node, but it was no longer in relation to, or for, a half-hourly "trading interval" (but was, say, a 5 minute Spot Price); or

(c) the Spot Price was no longer determined in accordance with clause 3.9.2, or the manner of determination pursuant to clause 3.9.2 was changed (such as by providing that it was now recalculated to exclude those parties that were settled on a 5 minute dispatch price).

4.5 Nature of difficulties

The first two difficulties are commonly referred to in derivatives markets by the term "Disappearance of commodity reference price", and the third difficulty is commonly referred to as "Material change in formula".

4.6 ASX24 Contracts

Rule [3100] of the ASX24 Operating Rules allows the Exchange to determine that contracts be settled at a price other than that determined in accordance with the Individual Contract Specifications, so the disappearance of the reference price, or a material change in the formula calculating the reference price, might give the Exchange the opportunity to express its own price at which the ASX24 contracts are settled.

Whether or not the Exchange uses a reformulated "spot price", this may cause the contracts to be settled at a price other than the contract parties were expecting, and it may also cause the contract parties to be required to settle at a price to which they no longer have access, because (for instance) their NEM settlement receipts (against which they are seeking to hedge) are now calculated by reference to 5 minute dispatch price but their ASX24 exposure is calculated by reference to some other basis under a reformulated half-hourly "spot price".

4.7 OTC Contracts - disappearance of commodity reference price

Section 7.4 of the ISDA Commodity Definitions 2005 defines "Disappearance of Commodity Reference Price" as:

> (c)(iii)(C) the disappearance or permanent disappearance or unavailability of a Commodity Reference Price, notwithstanding the availability of the Related Price Source or the status of trading in the relevant futures contract or the relevant Commodity.

That is, if the Rules were amended so that AEMO (the Related Price Source) ceased to publish a "Spot Price" at the regional reference node for a trading interval, this definition would likely be satisfied, notwithstanding that trading in electricity continued, or that other prices were published.

"Disappearance of Commodity Reference Price" is one type of event of a larger class of events defined in the ISDA Commodity Definitions 2005 as a "Market Disruption Event".

4.8 OTC Contracts - material change in formula

Section 7.4 of the ISDA Commodity Definitions 2005 defines "Material Change in Formula" as:

> (c)(iv) the occurrence since the Trade Date of the transaction of a material change in the formula for or the method of calculating the relevant Commodity Reference Price.

The "Trade Date" of a transaction is the date on which the parties first agreed the transaction.

Even if AEMO continued to publish a "Spot Price" as at the regional reference node, if it was no longer a half-hourly price, or the formula or method for calculating the Spot Price contained a material change from what existed at the original date of the transaction (the Trade Date), a Material Change in Formula would be satisfied.

We expect that any change would likely be "material", because the AEMC would be unlikely to make Rule changes unless they satisfied a materiality test for Rule change.

"Material Change in Formula" is also a type of event of a larger class of events defined in the ISDA Commodity Definitions 2005 as a "Market Disruption Event".

4.9 Application of these Market Disruption Events

Section 7.4(d) of the ISDA Commodity Definitions 2005 provides that parties will be deemed to have applied "Disappearance of Commodity Reference Price" and "Material Change in Formula" as Market Disruption Events applicable to their commodity transactions, unless they expressly provide otherwise.

In our experience, parties usually continue to apply "Disappearance of Commodity Reference Price" and "Material Change in Formula" as applicable to their electricity commodity transactions.

Each hedge transaction will have a party designated as the "Calculation Agent". It is the Calculation Agent's role to determine whether the Market Disruption Event has occurred.

Where a Market Disruption Event has occurred, the affected Relevant Price is determined by the Calculation Agent using methodologies described as "applicable Disruption Fallbacks".

4.10 Applicable Disruption Fallbacks

Section 7.5 of the ISDA Commodity Definitions 2005 defines a number of alternative actions to be implemented where a Market Disruption Event has occurred.

Parties to a hedge documented using the ISDA Commodity Definitions 2005 will usually specify which of the Disruption Fallback methodologies will be applied to resolve the Market Disruption Event, and in which order.

If the parties have not specified which Disruption Fallback methodologies apply, clause 7.5(d) of the ISDA Commodity Definitions 2005 deems them to have specified certain fallbacks, but in our experience most electricity hedge transactions in Australia specify these fallbacks, in this order:

(a) Negotiated Fallback (in which the parties endeavour have 5 Business Days after the occurrence of the Market Disruption Event to agree a substitute replacement price as the Commodity Reference Price, otherwise the next fallback applies);

(b) Calculation Agent Determination (using an independent expert as the calculation agent to determine the replacement price), taking into account the last available quotation for the relevant Commodity Reference Price and any other information that in good faith it deems relevant; and

(c) No Fault Termination (if a result is not produced by the above method within 30 days), under which the transaction is marked to market and terminated, with the party out of the money on the hedge paying a close-out amount to the party in the money).

No Fault Termination would likely have significant cash-flow implications for the parties, replacing their payments due over the term of the hedge with a single payment due immediately.

4.11 Fallback calculation

The object of the Negotiated Fallback and Calculation Agent Determination is to find a replacement price that reflects the original intent of the hedge - to settle against the wholesale value of electricity delivered at the regional reference node during the half-hour.

This would not necessarily be the same as the half-hourly settlement price following the Rule change, because if the Rule Change was to retain half-hour settlements we understand it is likely to deduct all of the energy value settled on 5-minute dispatch prices, and represent only the value of energy settled half-hourly.

4.12 Renegotiation of calculation period and quantities

Most, if not all, OTC hedge contracts use a half-hourly calculation period, as the period over which the floating price and the fixed price are compared.

Although some OTC hedge contracts use a flat or fixed single quantity referable to all calculation periods, others use a table of half-hourly quantities, with different quantities for each half hour during the day, and others are "load-following", setting their hedge quantity to the buyer's metered load, or the generator's metered output, for each half-hour.

If the settlement period was adjusted from half-hourly to 5 minute settlement periods, it would be necessary for parties to negotiate as to whether they amend their contracts to change to a 5 minute calculation period, and the quantities to apply to each 5 minute period, or remain with a half-hourly calculation period.

4.13 Bespoke contract renegotiation

Most bespoke OTC hedge contracts and PPAs, although they may not adopt the ISDA formulation of "Market Disruption Event" will usually have a "change of law event", enabling either party to invoke a renegotiation if it feels that it is adversely affected by a change in law. For instance, if the contract hedged the spot price, and the effect of the law change was to reduce the published spot price, the buyer under the hedge may complain that it is now being required to pay greater difference payments than it would have had the change of law not occurred, requiring a renegotiation of the hedge contract price.

5. Term of existing contracts

5.1 ASX24 contracts

Some ASX24 contracts written on the current terminology and current methodology for determining the spot price may have terms lasting up to 4 years in the future, during which period the contracts could be operating in a price regime that is different than that which was current when they were originally priced and entered.

5.2 OTC contracts

The term of OTC contracts varies from very short to very long.

Most, if not all, of the hedge contracts supporting the entry of new renewable generation plant will have a term of at least 10 years, to support the period of debt financing of the projects.

Most of the hedge contracts supporting the entry of new renewable generation plant that are being entered at present have a term continuing until 31 December 2030, the date of expiry of the Renewable Energy Target.

We have also seen a number of hedge contracts supporting the power consumption loads of large smelters and refineries whose term extends beyond 2030.

6. Number of affected contracts

6.1 NEM power stations

AEMO's NEM Registration list shows 109 registered Generators, and 388 registered power stations. 191 of the power stations are based on renewable sources. We would expect most of the renewable source power stations developed since 2001 would have long-term OTC offtake contracts supporting them. Most of the other generators would be likely to have OTC or exchange-traded hedge contracts in place.

7. Conclusion

7.1 Basis risk exposure

Introducing the contemplated Rule Change would, at the very least, be likely to introduce a basis risk exposure for participants on existing contracts, in that the prices which they pay or receive to and from the NEM spot market will become different than the average half-hourly spot price currently provided as the reference price in their hedge and futures contracts.

7.2 Re-pricing risk

Where the "Spot Price" as currently defined in OTC contracts disappears or the basis of its calculation is materially changed, a "Market Disruption Event" is likely to arise, requiring a renegotiation of the price so that the replacement reference price that is adopted for remaining calculation periods under the hedge is reflective of the original intent to reflect the average price of all energy delivered at the regional reference node in that half-hour.

If the parties cannot agree a replacement price methodology within 5 Business Days after the change is implemented, then under most hedge contracts it will require the appointment of an independent expert to calculate the floating price for all future periods under the hedge.

7.3 Termination risk

If the parties cannot agree on a replacement price or methodology, and the independent expert does not produce a replacement price or methodology within 30 days of the change being implemented, the whole hedge contract terminates and a cash settlement amount for the present value of the hedge is payable by one party to the other.

7.4 Applicable term

Although exchanged-traded contracts have short terms, and some OTC hedge contracts are entered only for terms of up to 2 or 3 years, there are many OTC hedge contracts extending for much longer terms, particularly those hedge contracts supporting the entry of renewable generation under the Renewable Energy Target.

The AEMO registration list presently shows about 162 renewable generators currently registered. Of these, we estimate more than 50% (that is, 80-90) would have long-term power price hedge contracts extending to the end of the Renewable Energy Target in 2030.

There are also long-term power price hedge contracts in place in relation to large loads such as smelters and refineries.

HWL Ebsworth

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