Market ancillary service prices above $5000/MW

31 December 2009
Tasmania

AUSTRALIAN ENERGY REGULATOR

Introduction

The AER is required to publish a report where prices for a market ancillary service over a period significantly exceed the relevant spot price for energy and $5000/MW for a number of trading intervals within that period.[1] The report must:

- describe the significant factors that contributed to the market ancillary service prices exceeding $5000/MW;
- identify any linkages between spot prices in the energy market and market ancillary service prices contributing to the occurrence; and
- assess whether rebidding pursuant to clause 3.8.22 contributed to prices exceeding $5000/MW.

This is the first time the AER has prepared a *Market ancillary service price above $5000/MW* report.

Summary/assessment

On 31 December 2009, prices in Tasmania for the raise 6-second contingency frequency control ancillary service (R6) rose to $10 000/MW from the 7.40 pm dispatch interval to 9.10 pm dispatch intervals inclusive. Lightning storms in Tasmania led to the loss of a number of different multiple transmission circuits to be reclassified as credible. This restricted the ability of generators in the vicinity of Farrell (West Tasmania) and at Gordon (in the South West) to provide the R6 service, and led to a shortage.

The Australian Energy Market Operator (AEMO) directed Hydro Tasmania (Hydro) to provide additional services at its Tungatinah unit, but the price remained at the price cap.

Once the lightning storm had passed, one of the reclassifications was revoked allowing Hydro's Gordon generator to provide the R6 service - the price then fell to less than $1/MW.

There was no significant rebidding.

Frequency control ancillary services

Frequency control ancillary services (FCAS) are required to maintain the frequency of the power system within the frequency operating standards. Raise contingency FCAS are the services required to be available to correct the frequency excursions that have arisen from a credible contingency event[2] that leads to an imbalance in supply and demand and results in a decrease in frequency.

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[1] This requirement is set out in clause 3.13.7 (e) of the National Electricity Rules.
[2] Any real power system is subject to shocks, for example the loss of a transmission line or a generator. Those shocks which have a material probability of occurring and/or are likely to have serious consequences are known as "credible contingencies".

The three raise contingency services are:

- *fast services*, which arrest a frequency deviation within the first six seconds of a contingent event (R6);
- *slow services*, which stabilise frequency deviations within 60 seconds of the event (R60); and
- delayed services, which provide further stability to the system by returning the frequency to the normal operating band within 5 minutes (R5).

Pricing outcomes

On 31 December 2009, prices for R6 rose to $10 000/MW from the 7.40 pm dispatch interval to 9.10 pm dispatch intervals.

A shortage of services led AEMO to direct Hydro to supply additional R6 from the 8.35 pm dispatch interval to the 9.15 pm dispatch interval inclusive. As a result, intervention (or "what-if") pricing[3] was triggered which caused the R6 prices for the 8.45 pm to 9 pm dispatch intervals inclusive to be increased to $10 000/MW. Intervention pricing and the direction to Hydro are discussed further in the section "Direction and intervention pricing".

As reported in the *Electricity Weekly Market Analysis* report for the week 27 December 2009 to 2 January 2010, the total cost of FCAS in Tasmania for the week was $883 000 (about 20 per cent of energy turnover in Tasmania), with the majority of this cost incurred during the period covered by this *Market ancillary services prices above $5000/MW* report. This compares to the total cost of FCAS on the mainland for the same week of $138 000 (less than one per cent of energy turnover).

Although the price for R6 reached the price cap on the day, the energy price was not materially affected, reaching a maximum spot price of $70/MWh at 8.30 pm (driven by a 5-minute price of $250/MWh at 8.20 pm). Prices for the other raise contingency services for the day did not exceed $2/MW.

Figure 1 compares the five-minute dispatch price for R6 that was initially determined by the market systems and the "intervention price" for R6 (that would have occurred without the direction)[4]. The period of the direction is shaded in the table. Also shown is the five-minute dispatch price for energy in Tasmania at the time.

[3] 'Intervention pricing' sets the energy and FCAS prices based on dispatch that would have occurred in the absence of the direction.

[4] Although constraints violated at the time of high prices resulting in the requirement for an over constrained dispatch re-run, prices remained at $10 000/MW. Where any interconnector, intra-regional network element or regional FCAS requirement constraint is violated and any regional energy or FCAS price is greater than or equal to the market price cap ($10 000/MW), an over-constrained dispatch (OCD) re-run is triggered. The OCD re-run is required to determine the marginal price, which represents the marginal value of supply. There were several OCD re-runs during the period under review, which allowed NEMDE to reach a solution by "relaxing" the relevant constraint by the amount of the violation and being re-run.

Figure 1: Pre-intervention R6 prices, intervention R6 prices and energy prices

Dispatch interval	R6 price ($/MW)	R6 "intervention" price ($/MW)	Energy price ($/MWh)
7.35 pm	4072	4072	35.34
7.40 pm	10 000	10 000	35.34
7.45 pm	10 000	10 000	37.36
8.00 pm	10 000	10 000	37.36
8.05 pm	10 000	10 000	37.36
8.10 pm	10 000	10 000	22.13
8.15 pm	10 000	10 000	37.36
8.20 pm	10 000	10 000	250.16
8.25 pm	10 000	10 000	38.21
8.30 pm	10 000	10 000	38.21
8.35 pm	10 000	10 000	38.21
8.40 pm	10 000	10 000	38.21
8.45 pm	4283	10 000	38.21
8.50 pm	4283	10 000	38.21
8.55 pm	4283	10 000	38.21
9.00 pm	4283	10 000	38.21
9.05 pm	10 000	10 000	38.36
9.10 pm	10 000	10 000	38.24
9.15 pm	0.3	0.3	18.90

Events on the day

On the evening of 31 December 2009, lightning storms moved across Tasmania. To keep the power system in a secure operating state AEMO reclassified the outages of several double circuit transmission lines as credible contingency events[5].

At around 7.30 pm the simultaneous trip of the Farrell to Sheffield No.1 and No.2 220 kV transmission lines was reclassified as a credible contingency event. Constraint set F-T-FASH_N-2 (which included constraint equation[6] F_T+FASH_N-2_R6) was invoked from 7.30 pm to 9.40 pm in response. The constraint set restricts the ability for Hydro's Bastyan, John Butters and Reece 2 hydro generation units to provide raise contingency FCAS. These generators would be separated from the rest of the power system in the event of loss of both Farrell to Sheffield lines[7]. If this were to occur then output of FCAS from these generators would not assist in restoring the supply-demand balance, so this constraint excludes these generators from providing FCAS.

Also at around 7.30 pm the simultaneous trip of the Chapel Street to Gordon No.1 and No.2 220 kV transmission lines was reclassified as a credible contingency event. As a result, constraint set F-T-CSGO (which included F_T+T_CSGO_R6) was invoked for the 7.35 pm to 9.10 pm dispatch intervals. Constraint equation F_T+T_CSGO_R6 restricts Hydro's Gordon hydro generation unit from providing R6 FCAS[8].

Gordon is the largest generator in Tasmania and is the largest provider of R6 in Tasmania. The Bastyan, John Butters and Reece 2 generators also regularly provide R6 FCAS in Tasmania. Limiting the R6 output of these generators to zero led to a shortage of R6 to

[5] Under normal conditions the simultaneous trip of both circuits of a double circuit transmission line would be considered a non credible contingency event. However, during lightning storms AEMO may determine that the occurrence of that non-credible contingency event is reasonably possible and AEMO may reclassify that event to be a credible contingency event.

[6] Constraint equations are mathematical expressions used in the National Electricity Market Dispatch Engine (NEMDE) to describe the physical limitations of the power system.

[7] Constraint F_T+FASH_N-2_R6 limits to zero the ability of these generators to supply R6.

[8] The Gordon generators would be separated from the rest of the power system in the event of loss of both Chapel Street to Gordon lines. If this were to occur then output of FCAS from these generators would not assist in restoring the supply-demand balance, so this constraint excludes these generators from providing FCAS.

manage the loss of Basslink (the F_T+NIL_BL_R6_1 constraint) for most of the time between 7.35 pm and 9.10 pm inclusive.

At other times during this period the constraints F_T+FASH_N-2_R6 and F_T+T_CSGO_R6 (the constraint that restricted the provision of R6 from these generators) also violated. At all times between 7.35 pm and 9.10 pm at least one of these constraints was violated. These violations ceased once the F-T-CSGO constraint set (that restricted Gordon from providing R6) was revoked. As a result, Gordon could then be dispatched and the shortage was relieved.

In addition to the above restrictions on the provision of FCAS, at 7.30 pm the Farrell to John Butters line tripped offloading John Butters which had been generating at 142 MW. This reduced the ability for demand to be met from local generation and therefore increased energy flows into Tasmania across Basslink. The impact of this is explained in the "Basslink" section. The John Butters generator returned to service at around 7.45 pm.

Further compounding matters, the Farrell to Bastyan line tripped, offloading Bastyan from around 70 MW at 8 10pm. The Bastyan generator returned to service at around 9 pm.

The simultaneous trip of the Palmerston to Liapootah No. 1 and No. 2 220 kV transmission lines was declared a credible contingency event from 8.45 pm to 10.25 pm. Constraint set T-LIPM_N-2 was invoked from 8.50 pm to 10.25 pm but had no impact on market outcomes.

Basslink

When Basslink is at or close to its rated import capacity of 480 MW or its no-go zones of +/- 50 MW, or in the event that Basslink is out of service, the requirement for raise contingency FCAS to cater for a Tasmanian contingency event must be supplied from local providers. As Basslink is not able to transfer FCAS to cater for its own tripping, around 60 MW of R6 must be enabled locally to cater for its loss while importing.

At the start of the high priced period, Basslink was flowing from Victoria to Tasmania at around 450 MW. This led to an R6 requirement of 60 MW that had to be met by providers in Tasmania. The trip of John Butters at 7.30 pm led to an increased requirement for energy in Tasmania and increased flows on Basslink. The R6 requirement varies slightly with flow across Basslink, increasing at a rate of 4 per cent of the flow.

As described in the "Events on the day" section there was a shortage of R6 from 7.35 pm. In an attempt to remove the violation of the R6 requirement, AEMO attempted to back off Basslink. However, this didn't prove to be as effective as AEMO anticipated and provided only limited assistance in alleviating the violation of the R6 requirement, despite reducing imports from 450 MW to 150 MW.[9]

Direction and intervention pricing

An "intervention price dispatch interval"[10] is declared when AEMO intervenes in the market to direct a participant to operate plant other than in accordance with dispatch instructions, or activates a reserve contract.

'Intervention pricing' sets the energy and FCAS prices for all regions based on dispatch that would have occurred in the absence of the direction. This mechanism exists to minimise the

[9] AEMO has advised that as Basslink was reduced the amount of load shedding armed by the Frequency Control Special Protection Service (FCSPS) was also proportionately reduced, which resulted in a status quo situation with regards to the amount of R6 required. The FCSPS is in place to ensure that if Basslink trips, the frequency in Tasmania can be maintained within acceptable limits by interrupting industrial customer demand.

[10] Clause 3.9.3(a) of the National Electricity Rules says that in respect of a dispatch interval where an AEMO intervention event occurs, AEMO must declare that dispatch interval to be an intervention price dispatch interval.

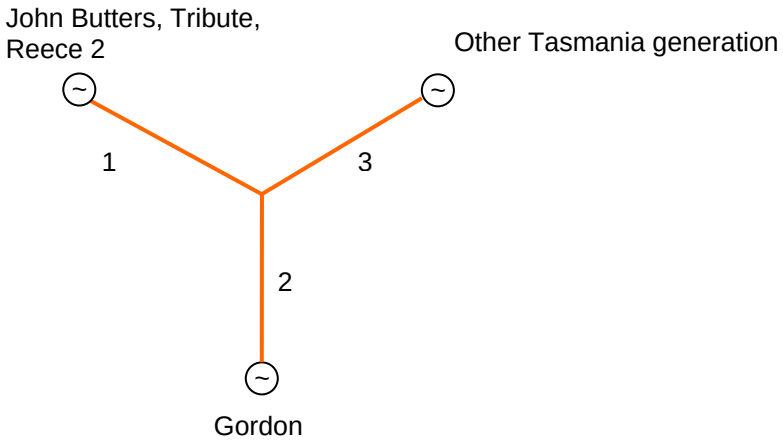
distortion that arises as a result of the direction to provide an additional service, by maintaining a pricing signal consistent with a shortage of that service.

At 8.22 pm, in response to the shortage of FCAS at the time, Hydro was directed to make 9 MW of R6 available at its Tungatinah plant. 'Intervention pricing' occurred from the 8.35 pm dispatch interval to the 9.15 pm dispatch interval inclusive.

Constraint equation formulation

Figure 2 provides a simplified representation of the Tasmanian network. From around 7.30 pm the loss of the Farrell to Sheffield No.1 and No.2 220 kV transmission lines (represented as line 1) and then the Chapel Street to Gordon No.1 and No.2 220 kV transmission lines (represented as line 2) were both reclassified as credible. In this multiple reclassifications event, the John Butters, Tribute and Reece 2 generators (for the first reclassification) and the Gordon generator (for the second reclassification) were all excluded from providing raise contingency FCAS.

Figure 2: Simplified representation of the Tasmanian transmission network



AEMO has advised that, generators which were constrained down to zero output of FCAS for the loss of their network connection should have been able to provide FCAS to help cover other contingencies such as the risk of tripping other lines. In other words if line "1" is reclassified, Gordon combined with "Other Tasmanian generation" should have been available to meet the R6 requirement and if line "2" is reclassified, the combination of John Butters, Tribute and Reece and "Other Tasmanian generation" should have been available to meet the requirement.

In this way, when both lines are reclassified, Gordon and the west coast generation at John Butters, Reece and Tribute can contribute to the requirement for FCAS. AEMO has advised that it has been using this approach since 14 February 2010.

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