Electricity Pricing Event Reports

NOVEMBER 2016

TABLE OF CONTENTS

Tuesday 01 November 2016 – High Energy price SA

Market Outcomes: Spot price in South Australia reached $2,298.56/MWh for trading interval (TI) ending 0730 hrs on 1 November 2016.

Energy prices in other regions were not affected by this event. FCAS prices in all regions were not affected by this event.

Detailed Analysis: The 5-Minute dispatch Energy price in South Australia reached $13,461.60/MWh for dispatch interval (DI) ending 0720 hrs 1 November 2016. This high price can mainly be attributed to a reduction of wind generation and limited availability of lower priced generation, during the morning peak demand period.

Between DIs ending 0715 hrs and 0720 hrs, South Australia demand increased by 14 MW to 1,507 MW reaching the morning peak demand. Between these DIs wind generation in the region decreased by 40 MW to 264 MW at DI ending 0720 hrs.

At DI ending 0715 hrs, target flow on the Heywood interconnector was at the upper limit of 416 MW, set by the constraint equation V_S_NIL_ROCOF. This Rate of Change of Frequency (RoCoF) constraint equation limited flow on the Heywood interconnector from Victoria to South Australia to prevent the RoCoF exceeding 3 Hz/sec in South Australia following the loss of the Heywood interconnector. During the high priced DI, the target flow on the Heywood interconnector increased to 445 MW towards South Australia, violating the upper limit of 421.44 MW set by V_S_NIL_ROCOF constraint equation.

The target flow on the Murraylink interconnector remained at the upper limit of 220 MW towards South Australia for DIs ending 0715 hrs and 0720 hrs.

For DI ending 0720 hrs, Synergen Power rebid 46 MW of capacity from Dry Creek GT unit 3 from bands priced at $1,498.20/MWh and above to bands priced at $300.20/MWh or below. However, the generating unit required more than one DI to synchronise.

The 5-minute price reduced to $55.66/MWh for DI ending 0725 hrs when 548 MW of generation capacity in South Australia was rebid from bands priced at or above $59.99/MWh to Market Floor Price (MFP) of -$1,000/MWh.

The high 30-minute spot price for South Australia was not forecast in the latest pre-dispatch schedules as it was a result of a spike in 5-minute demand and a reduction in wind generation during the affected TI.

Tuesday 08 November 2016 – High Energy price NSW, QLD

Market Outcomes: Spot price in New South Wales (NSW) reached $2,190.99/MWh and spot price in Queensland (QLD) reached $2,029.11/MWh, at TI ending 1530 hrs, on 8 November 2016

Energy prices in other regions were not affected by this event. FCAS prices in all regions were not affected by this event.

Counter price flows caused negative settlement residues of approximately $290,000 to accumulate on the Victoria to New South Wales directional interconnector between 1530 hrs and 1600 hrs. AEMO managed these from 1525 hrs to 1645 hrs (Market Notices 55584 and 55591).

Detailed Analysis: The 5-minute Energy price in NSW reached $13,999.98/MWh and $-999.99/MWh for DIs ending 1505 hrs and 1530 hrs. For these same DIs, the 5-minute Energy price in Queensland was $12,947.48/MWh and -$904.65/MWh. These high and low prices coincided with generator outages, rebidding of capacity in NSW and QLD, and limited interconnector support available from VIC to NSW.

During this period, all Eraring PS units (4 x 750 MW) and Bayswater unit 2 (700 MW) were out of service.

For DI ending 1435 hrs, a number of generators in NSW shifted or rebid capacity from higher priced bands to the Market Floor Price (MFP) of -$1000/MWh. Up to 937 MW of generation capacity was shifted or rebid from bands priced at or above $0/MWh to the MFP. The increased output from some of these generators resulted in increased loading of the Canberra – Yass No.9 and Kangaroo Valley – Dapto No.18 330 kV lines.

For DI ending 1500 hrs, Barcaldine PS (35 MW) withdrew all generation capacity with the reason “08/11/16 1447 P: Failed to sync” and Upper Tumut reduced availability by 12 MW with the reason “14:49 P MATCH BID TO CAPABILITY/POND LEVEL CHANGE”.

Between DIs ending 1505 hrs and 1720 hrs, following real time contingency analysis (RTCA) indications that the Canberra – Yass No.9 330 kV line would overload for the loss of the parallel Kangaroo Valley – Dapto No.18 330 kV line, AEMO invoked CA_SPS_4733E84B_01 constraint equation to prevent the potential overload of the Canberra – Yass No.9 330 kV line. As no pre-formulated constraint equations were available, constraint automation was used to build the CA_SPS_4733E84B_01 constraint equation.

The CA_SPS_4733E84B_01 constraint equation further restricted flow towards NSW on the VIC-NSW interconnector. For DI ending 1505 hrs, target flow on the VIC-NSW interconnector was limited to 51 MW. For the same DI, Darling Downs PS and Mount Stuart unit 1 shifted a combined capacity of 140 MW from bands priced at-$1.03/MWh or below to bands priced at $14,000/MWh. Higher priced generation had to be sourced to meet demand causing the 5-min price in QLD and NSW to reach $12,947.48/MWh and $13,999.98/MWh respectively. Lower priced generation was available but were limited by ramp rates (Barron unit 1, Mount Piper unit 2, Tallawarra PS, Vales Point unit 5 and 6) or required more than one DI to synchronise (Braemar unit 6, Mount Stuart unit 3).

Between DIs ending 1510 hrs and 1605 hrs, flow on the VIC-NSW interconnector was forced towards Victoria by CA_SPS_4733E84B_01 constraint equation starting at 51 MW towards NSW at DI ending 1505 hrs and reversing direction to 99 MW towards VIC at DI ending 1510. This resulted in the accumulation of negative settlement residues across the NSW to VIC directional interconnector amounting to approximately $290,000. The negative residue constraint equation NRM_NSW1_VIC1 was invoked from DI ending 1530 hrs to 1645 hrs.

Between DI ending 1510 hrs and 1530 hrs, 1,249 MW of capacity in QLD and 2,930 MW of capacity in NSW was rebid to the MFP. This increased availability of lower priced capacity resulted in the dispatch price for DI ending 1530 hrs reaching -$904.65/MWh and -$999.99/MWh in QLD and NSW, respectively.

The 5-minute dispatch price increased to $36.29/MWh and $35.17/MWh in NSW and QLD, respectively, for DI ending 1535 hrs when 4,084 MW of capacity in the two regions was rebid or shifted from bands priced at -$1000/MWh to bands priced at $0/MWh or above.

The high 30-minute spot price for New South Wales and Queensland were forecast in the latest pre-dispatch schedules.

Tuesday 08 November to Wednesday 09 November 2016 – High FCAS price SA

Market Outcomes: South Australia Raise Regulation Frequency Control Ancillary Service (FCAS) prices ranged between $304.41/MWh and $7,331.95/MWh for 32 trading intervals (TIs) between TIs ending 2230 hrs on 8 November 2016 and 1900 hrs on 9 November 2016. South Australian Lower Regulation FCAS prices ranged between $300.04/MWh and $7,333.94/MWh for 55 TIs between TIs ending 0700 hrs on 8 November 2016 and 1900 hrs on 9 November 2016.

FCAS prices in the other regions and energy prices in all regions were not affected by this event.

Actual Lack of Reserve Level 2 (LOR2) conditions had been declared for the South Australia region between 0600 hrs on 8 November 2016 and 2010 hrs on 9 November 2016 during the planned outage of the Heywood No.2 500 kV Bus and the Heywood - Mortlake 500 kV transmission line (Market Notices 55577 and 55615). During these LOR2 periods, there were sufficient capacity reserves in the South Australia region to meet electricity demand. However in the event of a credible contingency, whereby South Australia separated from the rest of the NEM, power interruptions would have been likely due to automatic under-frequency load shedding as a result of ramp rate limitations associated with dispatching additional generation in a short timeframe.

At 1830 hrs on 9 November 2016, the rolling sum of Raise Regulation FCAS price for the South Australia region for the previous 2,016 dispatch intervals (DIs) exceeded six times the cumulative price threshold (CPT) of $210,100. As a result, an administered price cap (APC) of $300/MWh was applied to all ancillary service prices in South Australia between DIs ending 1840 hrs on 9 November 2016 and 0400 hrs on 16 November 2016 (Market Notices 55612 and 55747).

Detailed Analysis: The 5-minute Raise Regulation FCAS prices ranged between $326.48/MWh and $11,496.69/MWh for 177 DIs within the high priced TIs. The 5-minute Lower Regulation FCAS prices ranged between $300.29/MWh and $11,508.64/MWh for 260 DIs within the high priced TIs. These high prices were mainly attributed to increased Regulation FCAS requirements within South Australia during a planned outage of Heywood No.2 500 kV Bus and the Heywood - Mortlake 500 kV line and limited availability of lower priced Regulation FCAS capacity in South Australia.

The Heywood No.2 500 kV Bus was on a planned outage from 0628 hrs on 8 November 2016 to 1955 hrs on 9 November 2016. The Heywood – Mortlake 500 kV line was on a planned outage from 0628 hrs to 1524 hrs on 8 November 2016 and from 0608 hrs to 1955 hrs on 9 November 2016. This outage increased the risk of electrical separation between South Australia and Victoria. The outage constraint sets F-V-HYMO, S-X_BC_CP, V-HYMO, F-I-HYSE, V-HYTX_M12 and V-HY_500BUS were invoked for the duration of the outage. The constraint equations F-S_LREG_0035 and F-

S_RREG_0035 contained within the F-I-HYSE and F-V-HYMO constraint sets required 35 MW of Lower and Raise Regulation FCAS capacity to be sourced from within South Australia.

Regulation FCAS in South Australia during the outage period was provided by Torrens Island A PS, Torrens Island B PS, Quarantine PS and Pelican Point PS.

For all DIs between DI ending 0605 hrs on 8 November and 0400 hrs on 9 November, there was at least 35 MW of Regulation FCAS capacity offered in bands priced at $350/MWh or below.

For DI ending 0405 hrs, AGL shifted 1 MW each of Regulation FCAS capacity from Torrens Island B PS units 1 and 3 from bands priced at $299.57/MWh to $6,489.91/MWh and above. This shift resulted in more expensive Raise and Lower Regulation capacity being sourced from these units to meet the 35 MW Regulation requirement. The Lower and Raise Regulation FCAS price remained between $6,499/MWh and $6,537.53/MWh between DIs ending 0405 hrs and 1410 hrs.

For DI ending 1415 hrs on 9 November, Raise and Lower Regulation FCAS price was $11,496.69 and $11,508.64/MWh, respectively. This can be attributed to Torrens Island B unit 1 being unavailable to provide Regulation FCAS for this DI. The Automatic Generation Control (AGC) status from the power station indicated the unit being unavailable to provide Regulation services. As a result, higher priced Regulation FCAS services had to be enabled for this DI, to meet the 35 MW Regulation FCAS requirements.

The Lower and Raise Regulation FCAS price reduced to $6,499/MWh from DI ending 1420 hrs when Torrens Island B unit 1 became available for Regulation FCAS. The prices remained at that level until DI ending 1600 hrs. For DI ending 1605 hrs, Origin shifted 1 MW each of Raise and Lower Regulation capacity from Quarantine PS Unit 5 from $0/MWh to bands priced at $14,193.02/MWh. This caused the Regulation FCAS prices to increase to $6,999/MWh between DIs ending 1605 hrs and 1830 hrs. By DI ending 1835 hrs on 9 November 2016, the prolonged high prices caused the rolling sum of Raise Regulation FCAS prices in the South Australia region for the previous 2,016 DIs to exceed six times the CPT, thus triggering an Administered Price Period (APP). An APC of $300/MWh was applied to all ancillary service prices for the South Australia region from DI ending 1840 hrs on 9 November 2016.

Following the commencement of the APP, prices for Regulation FCAS remained at APC between DIs ending 1840 hrs and 1900 hrs.

At DI ending 1905 hrs Quarantine PS unit 5 rebid 12 MW of Regulation capacity from bands priced at $14,193.03/MWh to bands priced at $281.83/MWh. Prices remained below the APC threshold from DI ending 1905 hrs until 2010 hrs.

At DI ending 2015 hrs, the Raise and Lower Regulation FCAS price reduced to $11.99/MWh and $6.02/MWh, respectively, when the outage constraint sets F-I-HYSE and F-V-HYMO were revoked following the completion of the planned outages.

The APC was removed at 0400 hrs on 16 November 2016 when the cumulative sum of Lower and Raise Regulation FCAS prices reduced to below six times the CPT.

The high Regulation FCAS prices were forecast in all pre-dispatch schedules from 1300 hrs on 7 November 2016.

Monday 14 November 2016 – High Energy price SA

Market Outcomes: Spot price in South Australia reached $2,342.76/MWh at TI ending 1400 hrs on 14 November 2016.

Energy prices in other regions were not affected by this event. FCAS prices in all regions were not affected by this event.

Detailed Analysis: The 5-Minute dispatch Energy price in South Australia reached the Market Price Cap (MPC) of $14,000/MWh for dispatch interval (DI) ending 1335 hrs on 14 November 2016. This high price can mainly be attributed to constrained wind generation and shifting of capacity to higher price bands.

Between DI ending 1330 hrs and 1335 hrs demand in SA increased by 29 MW to 1,256.36 MW.

At DI ending 1335 hrs Quarantine PS unit 1 shifted 24 MW of capacity from bands priced at $0.01/MWh and below to bands priced at the MPC.

During DI ending 1335 hrs, 89.46 MW of wind generation was constrained down (North Brown Hill WF, The Bluff WF, Hallet 1 and 2 WF) by the voltage stability constraint equation V^S_NIL_SA_RECLASS. This constraint equation limits generation in SA to prevent flow on the Heywood interconnector exceeding 600 MW following the reduction in MW output from multiple generating units in SA.

The Monash to Murraylink Berri 132 kV line was on a planned outage between 1834 hrs on 11 November to 2130 hrs on 16 November. Constraint set I-ML_ZERO was invoked for the duration of the outage to limit Murraylink flow to zero in either direction.

Between DI ending 1330 hrs and 1335 hrs flow on the Heywood interconnector towards South Australia increased by 19 MW to 581 MW and limited by the upper limit set by the constraint equation V_S_NIL_ROCOF. This is a Rate of Change of Frequency (RoCoF) constraint equation which limits VIC to SA flow on the Heywood interconnector to prevent RoCoF exceeding 3 Hz/sec in SA immediately following the loss of the Heywood interconnector.

Lower priced generation was available but was limited by ramping rates (Osborne PS and Torrens Island PS B unit 1, 2 and 3) or required more than one DI to synchronise (Hallet PS).

The 5-minute price reduced to $70.24/MWh for DI ending 1340 hrs when 443 MW of capacity was rebid from bands priced at or above $484.99/MWh to the Market Floor Price (MFP) of -$1,000/MWh.

The high 30-minute spot price for South Australia was forecast in the latest pre-dispatch schedules.

Friday 18 November 2016 – High Energy price NSW

Market Outcomes: Spot price in New South Wales ranged between $587.87/MWh and $11,700.63/MWh between trading intervals (TIs) ending 1500 hrs and 1630 hrs on 18 November 2016.

Energy prices in other regions were not affected by this event. FCAS prices in all regions were not affected by this event.

Detailed Analysis: The 5-Minute Energy prices in New South Wales (NSW) ranged between $288/MWh and $13,999.96/MWh between dispatch intervals (DIs) ending 1435 hrs and 1630 hrs. These high prices were mainly due to high demand (driven by warm weather), generator outages, rebidding of capacity in NSW, and limited interconnector support available from VIC to NSW.

During the high price TIs, demand in NSW was high, ranging between 10,190 MW and 10,373 MW. These demands coincided with high temperatures in NSW, with a daily peak of 33.4 degrees at 1300 hrs (Sydney Airport).

During this period, all Eraring PS units (4x750 MW) and Liddell PS unit 1 (550 MW) were out of service.

Between DI ending 1410 hrs and 1430 hrs, Origin Energy and Snowy Hydro generators rebid 679 MW from bands priced at $299.60/MWh and above to the Market Floor Price (MFP) of -$1000/MWh.

Increased loading on the Kangaroo Valley – Dapto No.18 and Canberra – Yass No.9 330 kV lines caused the system normal constraint equation N>>N-NIL_01N to bind between DIs ending 1420 hrs and 1655 hrs. This thermal constraint avoids the overload of the Canberra to Yass No.9 330 kV line for the loss of Kangaroo Valley to Dapto No.18 330 kV line.

The binding constraint equation limited target flows on the VIC-NSW interconnector for most of the period between DI ending 1420 hrs and 1655 hrs. During this time, average flow was 164 MW towards NSW, compared to 713 MW at DI ending 1415 hrs before the constraint began to bind.

The binding constraint also constrained off up to 78 MW of other available generation in NSW.

During most DIs within the high price period, flow from QLD to NSW was limited by the system normal constraint equations Q:N_NIL_AR_2L-G and Q>NIL_MUTE_757. The former limits flow on the Queensland – New South Wales interconnector (QNI) to avoid transient instability for a two line to ground fault at Armidale, while the latter maintains transfer on the NSW-QLD Terranora interconnector within thermal limitations.

The net effect of high demand, reduced interconnector support into NSW, and reduced cheaper priced generation availability, resulted in more expensive generation being dispatched to meet demand.

Rebidding and shifting of generation capacity also contributed to the high prices during some intervals as follows:

- For DI ending 1505 hrs Delta Electricity and AGL shifted 115 MW from MFP to bands priced at $13,800/MWh and above.
- For DI ending 1545 hrs, Snowy Hydro rebid 280 MW of capacity from MFP to bands priced at $299.80/MWh and above. Snowy Hydro also withdrew 20 MW of capacity priced at MFP from Upper Tumut and Tumut 3 power station with the reason '15:34:45 P MATCH BID TO CAPABILITY/POND LEVEL CHANGE'.

Between DIs ending 1435 hrs and 1630 hrs, there were 6 DIs when energy price in NSW remained relatively low, ranging between $288/MWh and $305.70/MWh. Rebidding and shifting of generation capacity to lower priced bands contributed to the low prices during these DIs.

These were as follows:

- Between DIs ending 1445 hrs and 1450 hrs, Delta Electricity and AGL rebid 200 MW of generation capacity from bands priced at $13,800/MWh and above to the MFP.
- For DI ending 1505 hrs, Snowy Hydro rebid additional 9 MW of capacity to the MFP.
- Between DIs ending 1515 hrs and 1535 hrs, Energy Australia and AGL rebid or shifted 110 MW of capacity from the $13,637.81/MWh and above to bands priced at $29.96/MWh or less.
- For DI ending 1605 hrs, AGL shifted 40 MW of capacity from bands priced at $13,999.96/MWh to bands priced at $29.96/MWh.

The 5-minute price reduced to $142.20/MWh for DI ending 1635 hrs, when 40 MW of capacity was shifted from bands priced at $13,999.96/MWh to bands priced at $29.96/MWh. The NSW demand also reduced by 84 MW during this DI.

The high spot price for NSW was forecast in the pre-dispatch schedule.

Monday 21 November 2016 – High Energy price QLD

Market Outcomes: Queensland spot price reached -$155.28/MWh for trading interval (TI) ending 0530 hrs on 21 November 2016.

Energy and FCAS prices in other NEM regions were not affected by this event.

Detailed Analysis: The 5-Minute Energy price in Queensland reached the Market Floor Price (MFP) of -$1,000/MWh for dispatch interval (DI) ending 0505 hrs on 21 November 2016. These prices can be attributed to a reduction in scheduled load and excess generation in the region coincident with the planned outage of Armidale - Tamworth (85) 330 kV line.

The Armidale to Tamworth (85) 330 kV line was on a planned outage between 0403 hrs and 0521 hrs on 21 November 2016. This outage increased the risk of electrical separation of Queensland from the rest of the NEM. The outage constraint sets N-ARTW_85, N-MOREESF1_ZERO and F-N-ARTW_85 were invoked between 0400 hrs and 0520 hrs on 21 November 2016.

In Queensland between DIs ending 0500 hrs and 0505 hrs demand decreased by 17 MW to 5,234 MW and scheduled load decreased by 177 MW to 59 MW.

Generators in the region reduced output but were limited by ramp down rates (Callide Unit 1, Condamine CCGT, Kogan Creek, Millmerran Unit 1 and 2 and Townsville GT (Yabulu) Unit 1) resulting in an excess of cheaper priced generation in Queensland.

Between DI ending 0500 hrs and 0505 hrs, flow on the Queensland – New South Wales Interconnector (QNI) increased by 97 MW to reach 378 MW towards New South Wales but was limited by the constraint equation F_Q++ARTW_L5. At DI ending 0500 hrs, Terranora flow was 57 MW towards New South Wales. For the next DI, Terranora reversed directions flowing 22 MW towards Queensland by the F_Q++ARTW_L5 constraint equation. This constraint equation specifies the Delayed Lower FCAS requirement for Queensland for the loss of the other Armidale - Tamworth (85 or 86) line when the Armidale - Tamworth (85 or 86) 330 kV line is out of service.

The 5-minute energy price increased to -$0.05/MWh when demand in the region increased by 109 MW to 5,343 MW.

The low spot price for Queensland were not forecast in the latest pre-dispatch schedule.

Tuesday 22 November 2016 – Negative Energy price VIC and SA

Market Outcomes: Spot price was -$184.53/MWh in South Australia (SA) and -$289.19/MWh in Victoria (VIC) for trading interval (TI) ending 1430 hrs.

FCAS prices in all regions and Energy prices for the other NEM regions were not affected by this event.

Detailed Analysis: The 5-Minute dispatch prices decreased to between -$992.60/MWh and the Market Floor Price (MFP) of -$1,000/MWh in South Australia and Victoria for dispatch intervals (DI) ending 1405 hrs and 1410 hrs. These negative prices can be attributed to rebidding of generation capacity in NSW during a planned outage period and constained VIC-NSW interconnector to manage the outage.

For TI ending 1430 hrs, demand in SA and VIC was 1,446 MW and 5,784 MW, respectively.

Planned maintenance of the Upper Tumut - Canberra No.1 330 kV line was scheduled between 0701 hrs and 1511 hrs on 22 November 2016. Outage constraint set N-CNUT_01 was invoked to manage the outage of the transmission line.

For DI ending 1355 hrs, Origin rebid 640 MW of NSW generation capacity from band priced at the Market Price Cap (MPC) of $14,000/MWh to band priced at the MFP. For DI ending 1405 hrs, Snowy Hydro rebid 2,169 MW of generation capacity from bands priced at or above $0/MWh to band priced at the MFP.

The increased dispatch from these generators caused the N::V_CNUT_2 constraint equation within the N-CNUT_01 constraint set to bind during the negative priced DIs. The constraint equation N::V_CNUT_2 prevents transient instability for faults on various locations between the Yass – South Morang area during outage of the Upper Tumut - Canberra No.1 330 kV line. Between DIs ending 1400 hrs and 1405 hrs, the binding constraint equation limited the target flow on the VIC-NSW interconnector with flow decreasing by 851 MW from 1,211 MW to 360 MW towards NSW. For DI ending 1410 hrs, the target flow reversed direction towards VIC and was limited to 387 MW by the constraint equation.

For DIs ending 1405 hrs and 1410 hrs , the target flow on the Heywood interconnector towards SA was limited to 250 MW and 234 MW, respectively, by the dynamic upper transfer limit constraint equation VS_250_DYN.

The target flow on the Murraylink interconnector increased by 80 MW towards SA to reach 100 MW between DIs ending 1400 hrs and 1405 hrs. For DI ending 1410 hrs, the target flow on Murraylink increased to 164 MW. The flow was limited during both negative priced DIs by the constraint equation equation VSML_ROC_80. This constraint equation limits the rate of change of flow towards SA across the Murraylink interconnector to 80 MW per 5 minutes.

For DI ending 1405 hrs, the target flow on the Basslink interconnector towards VIC was limited to 8 MW by the FCAS constraint equation F_T++NIL_MG_R5. This constraint equation manages the Delayed Raise requirement for the loss of the largest Tasmania (TAS) generation event. For DI ending 1410 hrs, the target flow reversed direction on the Basslink interconnector towards TAS and was limited to 125 MW by the constraint equation V_T_NIL_BL1. This constraint equation manages the limts from VIC to TAS when Bassink enters the no-go zone.

With excess lower priced generation available in SA and VIC, prices in these regions decreased to or below -$992.60/MWh for DIs endings 1405 hrs and 1410 hrs.

For DI ending 1415 hrs, the 5-minute dispatch price in South Australia and Victoria increased to $21.85/MWh and $14.38/MWh, respectively, when target flow on the Basslink interconnector increased by 128 MW to 253 MW towards TAS.

The negative spot prices for South Australia and Victoria were not forecast in the pre-dispatch schedules, as it was a result of short notice rebidding in NSW during a planned outage.

Tuesday 22 November to Saturday 26 November 2016 – High FCAS price SA

Market Outcomes: South Australia Raise Regulation Frequency Control Ancillary Service (FCAS) price ranged between $300.03/MWh and $10,997.33/MWh for 40 trading intervals (TIs) between TIs ending 0730 hrs on 22 November 2016 and 1000 hrs on 26 November 2016. South Australia Lower Regulation FCAS price ranged between $300.01/MWh and $11,014.17/MWh for 99 TIs over the same period.

FCAS prices in the other regions and energy prices in all regions were not affected by this event.

Actual Lack of Reserve Level 2 (LOR2) condition had been declared for the South Australia region between 0715 hrs on 22 November 2016 and 1000 hrs on 26 November 2016 (Market Notice 55810 and 55843). During these LOR2 periods, there were sufficient capacity reserves in the South Australia region to meet electricity demand. However, in the event of a credible contingency, whereby South Australia separated from Victoria, power interruptions would have been likely, due to automatic under-frequency load shedding.

At 1135 hrs on 25 November 2016, the rolling sum of Raise Regulation FCAS price for the South Australia region for the previous 2,016 dispatch intervals (DIs) exceeded six times the cumulative price threshold (CPT) of $210,100. As a result, an administered price cap (APC) of $300/MWh was applied to all ancillary service prices in South Australia between DIs ending 1140 hrs on 25 November 2016 and 0400 hrs on 3 December 2016 (Market Notices 55840 and 56132).

Detailed Analysis: The 5-minute Regulation FCAS prices in South Australia reached between $11,000/MWh and $11,005.92/MWh for DIs ending 1005 hrs and 1035 hrs on 23 November 2016. Between DIs ending 0405 hrs and 1135 hrs on 25 November 2016 the 5-minute Regulation FCAS prices in South Australia ranged between $7,980/MWh and $11,030.16/MWh. For all other DIs between DIs ending 0705 hrs on 22 November and 1000 hrs on 26 November, Regulation FCAS prices were elevated, ranging between $48/MWh and $1,599.98/MWh. These high prices were mainly attributed to increased Regulation FCAS requirements within South Australia during a

planned outage of Heywood - South East No.1 275 kV line and limited availability of lower priced Regulation FCAS in South Australia.

The Heywood - South East No.1 275 kV line was on a planned outage between 0701 hrs on 22 November 2016 and 0954 hrs on 26 November 2016. This outage increased the risk of synchronous separation between South Australia and Victoria. The outage constraint sets F-I-HYSE, I-HYSE, V-HYTX_M12 and S-X_BC_CP were invoked for the duration of the outage. The constraint equations F-S_LREG_0035 and F-S_RREG_0035 contained within the F-I-HYSE constraint set required 35 MW of Lower and Raise Regulation FCAS capacity to be sourced from within South Australia.

Regulation FCAS in South Australia during the outage period was provided by Torrens Island B PS, Quarantine PS, Pelican Point PS and Osborne PS.

For DI ending 1005 hrs and 1035 hrs on 23 November 2016, AGL shifted 8 MW of Regulation FCAS from bands priced at $48/MWh to bands priced at the market price cap (MPC) of $14,000/MWh. As a result, higher priced Regulation FCAS services had to be enabled for these DIs to meet the 35 MW Regulation FCAS requirements. Lower priced capacity was available from Torrens Island B unit 4 however the Automatic Generation Control (AGC) status from the power station indicated the unit being unavailable to provide Regulation services for the DIs. For DI ending 1040 hrs the Raise and Lower Regulation FCAS prices reduced to $299.99/MWh when AGL rebid 8 MW of Regulation FCAS availability from bands priced at $13,980.43/MWh to $47.93/MWh and the AGC status of Torrens B PS unit 4 changed from unavailable to available.

For DI ending 0405 hrs on 25 November 2016, Origin Energy rebid 2 MW of Raise and Lower Regulation FCAS capacity from price band $0/MWh to $10,984.00/MWh. Additional Raise and Lower Regulation FCAS had to be sourced from the more expensive price bands. Consequently, the 5-minute Raise and Lower Regulation FCAS price ranged between $7,980/MWh and $11,030.16/MWh between DI ending 0405 hrs and 1135 hrs on 25 November 2016.

By DI ending 1135 hrs on 25 November 2016, the prolonged high prices caused rolling sum of Raise Regulation FCAS prices in the South Australia region for the previous 2,016 DIs to exceed six times the CPT, thus triggering an Administered Price Period (APP). An APC of $300/MWh was applied to all ancillary service prices for the South Australia region from DI ending 1140 hrs on 25 November 2016.

On 26 November 2016, the APC continued to apply as the cumulative sum of both Lower and Raise Regulation FCAS prices remained above the CPT. Regulation FCAS prices ranged between $48/MWh and $300/MWh for all DIs following the commencement of APP until the completion of the Heywood to South East No.1 275 kV line outage on 26 November 2016. The APC was revoked at 0400 hrs on 3 December 2016.

For DI ending 1005 hrs on 26 November 2016, the Raise and Lower Regulation FCAS prices reduced to $7.4/MWh and $5/MWh, respectively, when the outage constraint set F-I-HYSE was revoked following completion of the outage.

The high Regulation FCAS prices were forecast in the latest pre-dispatch schedule.

Wednesday 30 November 2016 – High Energy price TAS

Market Outcomes: Spot price in Tasmania reached $2,392.93/MWh for trading interval (TI) ending 1230 hrs.

Energy and FCAS prices in other regions were not affected by this event.

Detailed Analysis: The 5-Minute dispatch price in Tasmania (TAS) reached the Market Price Cap (MPC) of $14,000/MWh for dispatch interval (DI) ending 1205 hrs. This high price can be mainly attributed to constrained generation while Basslink was exporting to Victoria.

Planned outage of the Sheffield – George Town No.2 220 kV line was scheduled between 0500 hrs on 30 November 2016 and 1335 hrs on 6 December 2016. The outage constraint set T-GTSH was invoked for the duration of the outage.

Woolnorth WF and Studland WF were unavailable due to an outage of Bluff Point – Studland – Smithton 110 kV line from 0600 hrs to 1600 hrs on 30 November 2016. This resulted in low wind generation of 47 MW in TAS for DI ending 1205 hrs.

During the high priced DI, the target flow on Basslink was forced towards Victoria by the outage constraint equation T>>T_GTSH_EXP_3H. This network control system protection scheme (NCSPS) constraint prevents the overload on Palmerston - Sheffield 220 kV line for the trip of the remaining Sheffield - Georgetown 220 kV line during the outage of the parallel Sheffield - Georgetown 220 kV line. The flow towards Victoria was 79 MW, which violated the constraint limit of 90.04 MW.

For DI ending 1205 hrs, a number of generators (Bastyan PS, Cethana PS, Devils Gate PS, Fisher PS, John Butters PS, Lemonthyme and Wilmont, Mackintosh PS, Reece unit 1 and 2 and Tribute PS) were constrained off by the T>>T_GTSH_EXP_3H constraint equation. Cheaper priced generation was available but limited due to FCAS profiles (Gordon PS, Catagunya, Liapootah and Wayatinah PS, Poatina unit 1 and 2 and Trevallyn PS).

The 5-minute dispatch price reduced to $81.83/MWh for DI ending 1210 hrs, when demand reduced by approximately 25 MW. During this DI, a number of generators were no longer constrained off when the constraint equation T>>T_GTSH_EXP_3H stopped violating.

The high 30-minute spot price was not forecast in any of the pre-dispatch schedules

---

Wednesday 30 November 2016 – High Energy and FCAS price SA

Market Outcomes: South Australia (SA) spot price reached $4,605.06/MWh for trading interval (TI) ending 1100 hrs.

SA Raise Regulation Frequency Control Ancillary Service (FCAS) prices and SA Lower Regulation FCAS prices ranged between $299/MWh and $300/MWh for all TIs between TI ending 0630 hrs on 30 November 2016 and 0000 hrs on 01 December 2016. SA Fast Lower FCAS prices, SA Slow Lower FCAS prices and SA Delayed Lower FCAS prices ranged between $149.22/MWh and $300/MWh for TIs ending 1100 hrs and 1130 hrs on 30 November 2016.

FCAS and Energy prices in the other regions were not affected by this event.

Actual Lack of Reserve Level 2 (LOR2) conditions had been declared for the SA region between 0700 hrs on 30 November 2016 and 2145 hrs on 01 December 2016 (Market Notices 55904, 56025 and 56079). During the LOR2 period, there were sufficient capacity reserves in the SA region to meet electricity demand. However the planned outage of the Heywood No.2 500 kV Bus and Heywood – APD2 – Mortlake No.2 500 kV line meants that a credible contingency could seperate South Australia from the rest of the NEM. Power interruptions would have been likely as it may not have been possible to bring the required additional capacity into service in time to avoid automatic under-frequency load shedding.

At 1135 hrs on 25 November 2016, the rolling sum of Raise Regulation FCAS price for the SA region for the previous 2016 dispatch intervals (DIs) exceeded six times the cumulative price threshold (CPT) of $210,100. As a result, an administered price cap (APC) of $300/MWh was applied to all FCAS prices in SA for DIs ending between 1140 hrs on 25 November 2016 and 0400 hrs on 03 December 2016 (Market Notices 55840 and 56132).

Detailed Analysis: The 5-minute energy dispatch price reached the Market Price Cap (MPC) of $14,000/MWh and $13,998.99/MWh in SA for DIs ending 1050 hrs and 1055 hrs. This high price can be mainly attributed to rebidding of generation capacity during a period of low wind generation and limited interconnector support.

The 5-minute SA Raise Regulation and Lower Regulation FCAS prices ranged between $299/MWh and $300/MWh for all DIs between DIs ending 0605 hrs on 30 November 2016 and 0000 hrs on 01 December. The 5-minute SA Fast Lower FCAS prices, SA Slow Lower FCAS prices and SA Delayed Lower FCAS prices ranged between $295.19/MWh and $300/MWh for all DIs between DIs ending 1050 hrs and 1130 hrs on 30 November 2016. These high FCAS prices are mainly attributed to the application of local Regulation FCAS requirements within SA during a planned outage of the Heywood No. 2 500 kV Bus and Heywood – APD2 – Mortlake No. 2 500kV line. Other contributing factors include shifting and withdrawal of generation capacity and limitations associated with available Regulation FCAS during some DIs.

Concurrent planned outages of the Heywood No. 2 500 kV Bus and Heywood – APD2 – Mortlake No. 2 500kV line took place between 0602 hrs on 30 November 2016 and 0429 hrs on 01 December. The outage constraint sets F-I_HYSE, F-V-HYMO, S-X_BC_CP, V-HYTX_M12, V-HY_500BUS and V-HYMO were invoked for the duration of these outages. These outages increased the risk of synchronous separation between SA and Victoria. The constraint equations F_S+LREG_0035 and F_S+RREG_0035 contained within the F-V-HYMO and F-I_HYSE constraint sets required 35 MW of Lower and Raise Regulation FCAS capacity to be sourced from within SA.

The SA wind generation was low at approximately 164.31 MW for the high priced TI.

For DI ending 1045 hrs, in SA Energy Australia rebid 35 MW of generation capacity from band priced at $578.81/MWh to band priced at $13,998.99/MWh.

For DI ending 1050 hrs, the target flow on the Heywood interconnector reversed from 250 MW towards SA to 147 MW towards VIC due to the outage constraint equation V_HYMO2_1. This constraint equation prevents excessive voltage unbalance at APD 500 kV bus during the outage of Heywood – Mortlake No.2 500 kV line when one of the Mortlake units is in service. This constraint was binding between DI ending 1050 hrs and 1135 hrs when Mortlake GT unit 2 came online, forcing flow from SA to VIC. Mortlake GT unit 2 rebid 150 MW of generation capacity from the MPC to the Market Floor Price (MFP) of -$1,000/MWh by Origin at DI ending 1040 hrs.

The target flow towards SA on the Murraylink interconnector was limited to 220 MW by the upper transfer limit constraint equation, VSML_220.

For the high energy priced DIs, cheaper priced generation was available but limited due to ramp rates (Snuggery and Torrens B unit 2, 3 and 4) or required more than one DI to synchronise (Dry Creek GTs, Ladbroke PS, Mintaro GT, Port Lincoln GTs, Quarantine PS unit 1, 2, 3 and 4 and Snuggery PS).

For DI ending 1050 hrs, additional generation had to be sourced from Osborne PS unit 5, Pelican Point PS and Torrens Island B PS at more expensive price bands. The increased dispatch in the Energy market reduced Osborne PS unit 5, Torrens Island B unit 2, 3 and 4 availability in the Raise Regulation FCAS market to zero. This violated the F_S+RREG_0035 constraint equation as only 1.35 MW of Raise Regulation capacity was available in South Australia, below the 35 MW required by the constraint equation. Between DIs ending 1050 hrs and 1135 hrs, the F_S++HYSE_L6_1 constraint equation was also violated as Heywood interconnector reversed direction to flow towards VIC.

For DI ending 1100 hrs, the 5-minute price reduced to -$1,000/MWh when Energy Australia rebid 23 MW of generation capacity from bands priced at $13,998.99/MWh to bands priced at $1,000/MWh. Demand reduced by 68 MW between DI ending 1055 hrs and 1100 hrs.

The 5-minute price increased to $148.08/MWh for DI ending 1105 hrs when Energy Australia, ENGIE, Origin and AGL rebid a total of 622 MW of generation capacity from bands priced at -$1,000/MWh to bands priced at $79.988/MWh or above.

The high 30-minute spot price for SA was not forecast in the pre-dispatch schedules as it was a result of generator rebidding. The high FCAS prices were forecast in pre-dispatch schedules published from the 1100 hrs run on 30 November 2016.