Electricity Pricing Event Reports

MARCH 2016

TABLE OF CONTENTS

** A summary was prepared as the maximum daily spot price was between $500/MWh and $2,000/MWh*

Tuesday 01 March 2016 – High Energy price SA, VIC

Market Outcomes: Spot price reached $2,125.74/MWh in South Australia and $1,905.34 in Victoria for Trading Interval (TI) ending 1500 hrs.

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

Counter price flows caused negative settlement residues of approximately $390,000 to accumulate on the Victoria to New South Wales directional interconnector between 1430 hrs and 1830 hrs. AEMO managed these from 1455 hrs to 1540 hrs (Market Notices 52122 and 52124) and 1545 hrs to 1600 hrs (Market Notices 52125 to 52126).

Further information is provided below.

Detailed Analysis: The 5-Minute prices reached $13,329.95/MWh in South Australia and $12,199.55/MWh in Victoria for Dispatch Interval (DI) ending 1455 hrs. These high prices can be attributed to a steep supply curve during a high demand period in Victoria, low wind generation, and limited interconnector availability.

Victorian demand peaked at 7,714 MW for TI ending 1630 hrs and the demand increased by 210 MW for DI ending 1455 hrs. Melbourne Airport reached a maximum temperature of 32.6°C. South Australian demand peaked at 2,049 MW in TI ending 1630 hrs and Adelaide Airport reached a maximum temperature of 34.5°C. During the high priced DI, wind generation in South Australia was low, at 127 MW.

A planned outage of the Jindera – Wagga no. 62 330 kV line was scheduled between 0610 hrs on 01 March 2016 and 1231 hrs on 03 March 2016. The thermal outage constraint equation V>>V-JNWG_RADIAL_1A was invoked to manage the overload of the Murray to Dederang No.1 330kV line during the outage of Jindera to Wagga no. 62 330kV line. For DI ending 1455 hrs, constraint equation V>>V-JNWG_RADIAL_1A was binding and the constraint forced the VIC-NSW interconnector to flow towards New South Wales during the high priced period.

The target flow on the VIC-NSW interconnector was 350 MW towards New South Wales. Due to the counter-price flow on the VIC-NSW interconnector, the Negative Settlement Residue management (NRM) constraint equation NRM_VIC1_NSW1 was invoked for 12 DIs between DIs ending 1500hrs and 1600 hrs. The negative settlement residue management constraint equation reduced the interconnector flow towards New South Wales, but was violated for 8 DIs between DIs ending 1515 hrs and DI ending 1600 hrs. Cheaper priced generation was available but limited due to ramp rates (Newport PS and Hallett GT), or FCAS profiles (Yallourn W PS unit 1 and 3), or required more than one DI to synchronise (Bairnsdale GT unit 2).

For DI ending 1500 hrs, the 5-minute prices in South Australia and Victoria collapsed to negative prices of -$1000/MWh and -$940.96/MWh, respectively. This was due to a total of 1086 MW in South Australia and 1823 MW in Victoria rebid to at or below -$991.08/MWh or the Market Floor Price (MFP) of -$1,000/MWh.

The 5-minute price in South Australia and Victoria increased to $64.99/MWh and $43.22/MWh respectively for DI ending 1505 hrs. The price increase is due to 620 MW of generation capacity in South Australia and 1,403 MW of generation capacity in Victoria rebid or shifted from negative priced bands to band priced at or above $0/MWh.

The high 30-minute spot price for Victoria was not forecast in the latest pre-dispatch schedule, as the forecast demand was approximately 277 MW lower in the pre-dispatch schedule for Victoria.

Wednesday 02 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot price was $2,135.13/MWh for trading interval (TI) ending 1930 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $12,497.41/MWh for Dispatch Interval (DI) ending 1920 hrs. This high price can be attributed to rebidding of generation capacity during a period of high demand.

Queensland demand peaked at 7,987 MW for TI ending 1700 hrs. The maximum temperature in Brisbane was 31.1°C.

Between DIs ending 1910 hrs and 1920 hrs, QGC, CS Energy and Stanwell rebid 442 MW of generation capacity from bands priced below $60.00/MWh to bands priced at or above $12,497.41/MWh or the Market Price Cap (MPC) of $13,800/MWh.

Cheaper priced generation was available but required more than one DI to synchronise (Braemar 2 PS unit 5) or was constrained off by the system normal thermal constraint equation Q>NIL_MRTA_A (Oakey PS unit 1). The Q>NIL_MRTA_A system normal constraint equation prevents thermal overload of a Middle Ridge – Tangkam 110 kV line for trip of the parallel Middle Ridge – Tangkam 110 kV line.

For DI ending 1920 hrs, the target flow on the QNI interconnector was limited up to 166 MW towards Queensland by the system normal voltage stability constraint equation N^^Q_NIL_B1. This constraint equation prevents voltage collapse in New South Wales for the loss of Kogan Creek PS. The target flow on the Terranora interconnector was limited up to 17 MW towards Queensland by constraint equation N^^Q_NIL_B1 and the outage constraint equation N>N-BAMB_132_OPEN_A. This constraint equation prevents the overload of a Lismore – Dunoon 132 kV transmission line for the trip of the parallel Lismore – Dunoon line during the outage of a Ballina – Mullumbimby 132 kV transmission line.

The 5-minute price reduced to $33.97/MWh in the DI subsequent to the high priced interval, when demand reduced by 298.5 MW and 914 MW of generation capacity shifted from bands priced at or above $12,947.50/MWh to bands priced at or below $36.00/MWh.

The high 30-minute spot price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of the rebidding of generation capacity within the affected trading interval.

Tuesday 08 March 2016 – High Energy Price SA, VIC

Market Outcomes: South Australian spot prices reached $1,215.77/MWh, $1,867.72/MWh and $1,505.98/MWh for trading intervals (TI) ending 1630 hrs, 1700 hrs and 1830 hrs, respectively. Victorian spot prices reached $2,031.00/MWh, $2,108.55/MWh and $1,973.94/MWh for the same TIs.

Counter price flows caused negative settlement residues of approximately $957,000 to accumulate on the Victoria to New South Wales directional interconnector between 1630 hrs and 1900 hrs. AEMO managed these from 1625 hrs to 1720 hrs (Market Notices 52258 and 52266) and from 1820 hrs to 1925 hrs (Market Notices 52273 and 52278). AEMO also managed accumulation of negative residues on the South Australia to Victoria directional interconnector between 1805 hrs to 1845 hrs (Market Notices 52271 and 52277).

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

Detailed Analysis: The 5-Minute dispatch price in South Australia was between $10,410.66/MWh and $13,004.66/MWh for dispatch intervals (DI) ending 1605 hrs, 1655 hrs and 1805 hrs. The 5-Minute dispatch price in Victoria was between $11,500.81/MWh and the Market Price Cap (MPC) of $13,800.00/MWh for the same DIs.

These high prices can be attributed to a steep supply curve during a high demand period, rebidding of generation capacity and limited interconnector support. The negative prices, following the high prices, can be attributed to rebidding to lower priced bands resulting in excess cheaper priced generation.

Victorian demand peaked at 9,363 MW for TI ending 1700 hrs and South Australian demand peaked at 2,573 MW for the same TI. Melbourne Airport and Adelaide Airport reached maximum temperatures of 40°C and 34°C, respectively. During the high priced TIs, wind generation in South Australia was moderate, between 414 MW and 574 MW.

For all the high priced DIs, South Australian generation capacity was offered at less than $371/MWh or above $10,759/MWh. For the same DIs, Victorian generation capacity was offered at less than $31/MWh or above $10,751/MWh, resulting in a steep supply curve.

For DI ending 1605 hrs, in South Australia, Lumo Generation and AGL shifted or rebid 211 MW of generation capacity from bands priced below $300/MWh to bands priced at or above $10,759.99/MWh. For the same DI, South Australia demand increased by 69 MW when non-scheduled generation reduced output by 47 MW. Cheaper priced generation was available, but were limited by ramp rates (Dry Creek GT Unit 3, Torrens Island PS Units A2, A4, B1, B2, B3 and B4), or required more than one DI to synchronise (Dry Creek GT units 1 and 2). Some cheaper priced generation was constrained off by the outage thermal constraint equation S>>BWMP_MKRB_BRTW (Snowtown North, Snowtown South and Hallett 1 wind farms, Hallett GT, Northern PS unit 1). The S>>BWMP_MKRB_BRTW constraint equation prevents the overload of Brinkworth - Templers West 275kV line for the loss of Mokota - Robertstown 275kV line during the outage of a Blyth West-Munno Para 275kV line.

For the same DI, in Victoria, Snowy Hydro and Origin Energy shifted 452 MW of generation capacity from bands priced at or below $289.99/MWh to the MPC.

For DI ending 1605 hrs, The target flow towards Victoria on the Murraylink interconnector was limited to 73 MW, by the thermal constraint equations V>>V_NIL_1B and S>>BWMP_MKRB_BRTW. The V>>V_NIL_1B system normal constraint equation avoids the overload of Dederang to Murray No.2 330kV line for the loss of the parallel Dederang to Murray No.1 330kV line. The target flow towards Victoria on the VIC-NSW interconnector was also limited to 128 MW by the V>>V_NIL_1B constraint equation.

The 5-minute price in South Australia reduced to $298.61/MWh in the subsequent interval, DI ending 1610 hrs, then collapsed to bands priced at or below -$998.30/MWh for four DIs between DI ending 1615 hrs and 1630 hrs. During these intervals, up to 1,246 MW of generation capacity was rebid from higher priced bands to bands priced below -$991.08/MWh or the MFP. By DI ending 1610 hrs, 46 MW of non-scheduled generation came online and continued to generate at that level till DI ending 1630 hrs.

Between DIs ending 1645 hrs and 1655 hrs, in South Australia, AGL rebid 310 MW of generation capacity from bands priced below $300/MWh to bands priced at or above $10,759.99/MWh or the MPC. Cheaper priced generation was available but limited due to ramp rates (Dry Creek GT Units 1, 2 and 3, Mintaro, and Pelican Point) and FCAS profiles (Northern PS unit 1).

Between DIs ending 1635 hrs and 1645 hrs, in Victoria, AGL, Origin and Snowy Hydro shifted 487 MW of generation capacity from bands priced at the MFP to bands priced at $11,746.25/MWh or the MPC.

For DI ending 1655 hrs, the target flow on the Murraylink interconnector was limited to 26 MW towards South Australia by the V>>V_NIL_1B and V^SML_NSWRB_2 constraint equations. The V^SML_NSWRB_2 is a system normal voltage stability constraint equation that avoids voltage collapse in Victoria for the loss of Darlington Point to Buronga (X5) 220 kV line. For the same DI, the target flow on the VIC-NSW interconnector was limited to 147 MW towards Victoria by the V>>V_NIL_1B constraint equation.

For DI ending 1805 hrs, in Victoria, AGL withdrew 539 MW of generation capacity from Dartmouth, Eildon, McKay and West Kiewa power stations with the reasons '1740~A~050 CHG IN AEMO PD~55 5MIN PD PRICE INCREASE VIC $2067 18:05' and '1755~A~060 UNFCAST NETWORK CONSTRAINT~61 CONSTR ON OUT OF MERIT ORDER V>>V_NIL_4A'. The withdrawal of generation capacity for these power stations caused the thermal constraint equation V>>V_NIL_4A to bind. The V>>V_NIL_4A system normal constraint equation manages the pre-contingent flow on the Dederang H1 330/220kV transformer. This binding constraint forced the target flow on the VIC-NSW interconnector to reverse from 196 MW towards Victoria for DI ending 1800 hrs to 38 MW towards New South Wales in the high priced DI ending 1805 hrs. The reversed flow on the VIC-NSW interconnector resulted in counter-price flow across the Victoria to New South Wales directional interconnector.

To manage accumulation of negative residues, the negative settlement residue management (NRM) constraint equation NRM_VIC1_NSW1 was invoked for 24 DIs between DIs ending 1630 hrs and 1925 hrs.

For the same DI, South Australia demand increased by 41 MW when non-scheduled generation reduced output by 54 MW. Cheaper priced generation was available but limited due to ramp rates (Northern PS Unit 2, Torrens Island PS Units A2, A3, A4, B1, B2, B3 and B4) or FCAS profiles (Northern PS unit 1).

For DI ending 1805 hrs, the target flow on the Murraylink interconnector was limited to 129 MW towards Victoria by the system normal thermal constraint equations S>NIL_NIL_NWMH2 and V>>V_NIL_4A. The S>NIL_NIL_NWMH2 constraint equation avoids pre-contingent overload of the North West Bend-Monash no.2 132kV line.

Following the high prices at DI ending 1805 hrs, between DIs ending 1815 hrs and 1830 hrs, the South Australian 5-minute dispatch price collapsed to the MFP, when 929 MW of generation

capacity was rebid from bands priced above $79/MWh to the MFP. Between DIs ending 1825 hrs and 1830 hrs, the Victorian 5-minute dispatch price also collapsed to the MFP, after 1661 MW of generation capacity was rebid from bands priced above $0MWh to the MFP. Prices returned to normal in South Australia and Victoria for DI ending 1835 hrs when generation capacity was shifted or rebid to higher priced bands.

The high 30-minute spot price for TIs ending 1630 hrs and 1830 hrs in South Australia and Victoria were forecast in the pre-dispatch schedules.

Sunday 13 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot price was $2,335.93/MWh for trading interval (TI) ending 1900 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $13,788.88/MWh for Dispatch Interval (DI) ending 1845 hrs. The high price can be attributed to a spike in 5-minute demand during a period of limited interconnector support due to planned outages.

Between DIs ending 1840 hrs and 1845 hrs, Queensland demand increased by 182 MW. Cheaper priced generation was available but required more than one DI to synchronise (Braemar 2 PS unit 6) or were limited by ramp rates (Braemar1 PS unit 1 and Condamine PS).

During the high priced interval, the target flow on the QNI interconnector was limited up to 205 MW towards Queensland by the system normal voltage stability constraint equation, N^^Q_NIL_B1. This constraint equation prevents voltage collapse in New South Wales for the loss of Kogan Creek PS. The target flow on the Terranora interconnector was limited up to 12 MW towards Queensland by the outage constraint equation, N>N-BAMB_132_OPEN_A. This constraint equation prevents the overload of a Lismore – Dunoon 132 kV transmission line for the loss of the parallel Lismore – Dunoon line during the outage of a Ballina – Lennoxhead 132 kV transmission line.

The 5-minute price reduced to $39.67/MWh in the DI subsequent to the high priced interval, when demand reduced by 344 MW and 183 MW of generation capacity shifted from bands priced at or above $12,947.50/MWh to Market Floor Price (MFP) of -$1,000.00/MWh.

The high 30-minute spot price for Queensland was not forecast in the latest pre-dispatch schedule. In pre-dispatch, the forecast demand was approximately 196 MW lower as compared to the forecast demand in Dispatch.

Tuesday 15 March 2016 – High Energy price QLD*

Market Outcomes: Queensland spot price reached $1977.85/MWh for TI ending 0630 hrs.

Counter price flows caused negative settlement residues of approximately $528,000 to accumulate on the Queensland to New South Wales directional interconnector for TI ending 0630 hrs. AEMO managed these from 0615 hrs and 0645 hrs (Market Notices 52355 and 52356).

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

Detailed Analysis: 5-minute dispatch price in Queensland reached $13,799.50/MWh for dispatch interval (DI) ending 0605 hrs. The high price can be attributed to rebidding of generation capacity during a planned outage.

- For DI ending 0605 hrs, demand increased by 122 MW.
- Planned outage of Armidale – Tamworth no. 85 330 kV line was scheduled to commence at 0630 hrs. Various ramping constraint equations were invoked to prepare for the line outage. The ramping constraint equations violated between DIs ending 0600 hrs and 0605 hrs.
- During the high priced DI, the ramping constraints reduced target flow towards Queensland across the QNI and Terranora interconnectors. The combined target flow across QNI and Terranora Interconnectors decreased from 150 MW to 29 MW towards Queensland between DIs ending 0555 hrs and 0605 hrs.
- For DI ending 0605 hrs, CS Energy rebid 80 MW of generation capacity from bands priced at or below $27.40/MWh to the Market Price Cap (MPC) of $13,800/MWh.
- Cheaper priced generation was available but limited due to ramp rates (Callide PP unit 4, Condamine PS A, Darling Downs PS unit 1, Millmerran PP unit 2, Oakey PS unit 1, Stanwell PS units 1, 2, 3 and 4 and Tarong PS units 2, 3 and 4), or required more than one DI to synchronise (Braemar PS unit 1).
- The negative settlement residue management (NRM) constraint equation, NRM_QLD1_NSW1, was invoked for DI ending 0620 hrs. Rebidding of generation capacity in Queensland during this period caused the flows on QNI to change direction rapidly, resulting in intervals when negative residues accumulated.

Between DIs ending 0620 hrs and 0625 hrs, Queensland dispatch price collapsed to the Market Floor Price (MFP) of -$1000/MWh, when:

- For DI ending 0620 hrs, demand decreased by approximately 76 MW.
- Between DIs ending 0610 hrs and 0625 hrs, 1926 MW of generation capacity was rebid from higher priced bands priced to at or below -$971.05/MWh.

Queensland dispatch price increased to $6.96/MWh for DI ending 0630 hrs when:

- Demand increased by approximately 97 MW.

** A summary was prepared as the maximum daily spot price was between $500/MWh and $2,000/MWh.*

Wednesday 16 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot price reached $2,313.04/MWh for trading interval (TI) ending 0700 hrs.

Counter price flows caused negative settlement residues of approximately $275,000 to accumulate on the Queensland to New South Wales directional interconnector between 0630 hrs and 1030 hrs. AEMO managed these from 0655 hrs to 1130 hrs (Market Notices 52381 and 52382).

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $12,947.50/MWh for Dispatch Interval (DI) ending 0655 hrs. This high price can be attributed to the rebidding of generation capacity during a planned outage.

Planned outage of the Armidale – Tamworth no. 85 330kV line was scheduled between 0640 hrs and 1353 hrs on 16 March 2016. Outage constraint sets F-N_ARTW_85 and N_ARTW_85 were invoked between DIs ending 0635 hrs and 1355 hrs. Various ramping constraints were invoked between DIs ending 0600 hrs and 0700 hrs to prepare for this outage. During the high priced DI, these ramping constraints were binding, which forced the target flow across the QNI and Terranora interconnectors towards New South Wales.

For DI ending 0655 hrs, CS Energy rebid 163 MW of generation capacity from bands priced at or below $27.40/MWh to bands priced above $13,799/MWh.

Cheaper priced generation was available but were limited by ramp rates (Darling Downs PS), or required more than one DI to synchronise (Braemar PS 1 unit 2).

Between DIs ending 0705 hrs and 1355 hrs, target flow on the QNI interconnector was forced to flow towards New South Wales by the outage constraint equations N^^Q_ARTW_B1 or N>N-ARTW85_1B. The N^^Q_ARTW_B1 constraint equation prevents voltage collapse in New South Wales for the loss of Kogan Creek PS during the outage of an Armidale – Tamworth 330 kV line. The N>N-ARTW85_1B constraint equation avoids the overload of the Armidale – Tamworth no. 86 330kV line for the loss of the largest generation in QLD, during the outage of Armidale – Tamworth no. 85 330kV line.

For 47 DIs between DIs ending 0705 hrs and 1355 hrs, target flow on the Terranora interconnector was forced to flow towards New South Wales by the constraint equations N^^Q_ARTW_B1 or N>N-ARTW85_1B.

Due to the counter-price flow on the QLD to NSW directional interconnector, the Negative Settlement Residue management (NRM) constraint equation NRM_QLD1_NSW1 was invoked between DIs ending 0700hrs and 1130 hrs. The NRM constraint equation bound or violated for 34 DIs during this period.

The 5-minute price reduced to $24.94/MWh in the DI subsequent to the high priced interval, when demand reduced by 154 MW and 58 MW of generation capacity was rebid from bands priced at or above $12,947.49/MWh to the Market Floor Price (MFP) of -$1000/MWh.

The high 30-minute spot price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of rebidding of generation capacity during a period of planned outages affecting interconnector flows.

Thursday 17 March 2016 – High Energy and FCAS price TAS

Market Outcomes: Spot price in Tasmania reached $796.6/MWh and the sum of all Frequency Control Ancillary service (FCAS) prices in Tasmania reached $3,287.45/MWh for trading interval (TI) ending 1100 hrs.

FCAS prices and energy prices in other NEM regions were not affected.

Further information is provided below.

Detailed Analysis: The 5-Minute price in Tasmania reached $1,936.25/MWh and $1,782.99/MWh for dispatch intervals (DIs) ending 1035 hrs and 1040 hrs respectively. For the same DIs, Fast raise FCAS service price reached $7,749.98/MWh and $7,136.97/MWh. The high energy can be attributed to limited availability of cheaper priced generation and the high FCAS prices can be attributed to withdrawal of fast raise FCAS service capacity during a period of high fast raise FCAS requirement.

During the period when Basslink is out of service, to reduce Contingency Raise FCAS service requirements within Tasmania, an Adaptive Under Frequency Load Shedding (AUFLS) scheme has been implemented. The AUFLS scheme involves enabling load shed services within Tasmania to assist in maintaining frequency within required limits following the loss of generation in Tasmania.

Between DIs ending 1020 hrs and 1025 hrs, the fast raise FCAS service requirement within Tasmania increased from 40.84 MW to 83.55 MW. This was caused by the reduction in consumption by a major load that was enabled for the AUFLS scheme.

For DI ending 1035 hrs, Hydro Tasmania withdrew up to 127 MW of Gordon PS generation capacity from fast raise, slow raise, regulation raise and delayed raise FCAS services. The rebid was submitted with the reason “1025A DEMAND < FORECAST: TAS”. The withdrawal of generation capacity resulted in insufficient fast raise FCAS services within Tasmania for DIs ending 1035 hrs and 1040 hrs. The fast raise FCAS requirement constraint equation, F_T+NIL_MG_R6 violated for both DIs.

For the high priced DIs, cheaper priced generation was available in the Energy market but were limited due to ramp rates (Bastyan PS, Fisher PS, John Butters PS, Mackintosh PS, Poatina PS units 3, 4, 5 and 6, Reece PS unit 1, Tribute PS, Tungatinah PS and Tamar Valley PS).

For DI ending 1045 hrs, the 5-minute energy price in Tasmania reduced to $280.12/MWh and the Fast raise FCAS service price reduced to $1,125.48/MWh. The prices reduced when the fast raise FCAS service requirement reduced, following an increase in consumption by the major load.

The high 30 minute FCAS price was forecast in the pre-dispatch schedule. The high 30 minute spot price was not forecast in the pre-dispatch schedules.

Friday 18 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot prices were between $2,114.8/MWh and $4,648.35/MWh for 3 trading intervals (TIs) between TIs ending 1700 hrs and 1830 hrs.

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

Detailed Analysis: 5-Minute dispatch prices in Queensland were between $12,496.11/MWh and $13,788.88/MWh for 4 Dispatch Intervals (DIs) between DIs ending 1655 hrs and 1830 hrs. These high prices can be attributed to the rebidding of generation capacity during periods of limited interconnector availability.

During the high priced DIs, CS Energy, Millmerran and Alinta shifted or rebid up to 493 MW of generation capacity from bands priced at or below $299.91/MWh to bands priced at or above

$12,496.11/MWh. For DI ending 1700 hrs, 64 MW of generation capacity was withdrawn from Roma GT units 7 and 8 with the reason "1650A AVOID UNECONOMIC START SL".

Cheaper priced generation was available for the high price DIs ending 1655 hrs, 1800 hrs and 1830 hrs, but required more than one DI to synchronise (Roma PS units 7 and 8) or was limited by ramp rates (Darling Downs PS, Oakey PS unit 2, Tarong PS units 2 and 4, Millmerran PS unit 2 and Tarong PS units 1, 2, 3 and 4) or constrained off by system normal constraint equation Q>NIL_MRTA_A (Oakey PS unit 1 and 2) and Q>NIL_BI_FB (Gladstone unit 3 and 4). The Q>NIL_MRTA_A constraint equation prevents thermal overload of a Middle Ridge – Tangkam 110 kV line for loss of the parallel Middle Ridge – Tangkam 110 kV line. The Q>NIL_BI_FB constraint equation prevents overloading of feeder bushings at Boyne Island for the contingent loss of one Calliope River – Boyne Island 132 kV line.

During the high priced DIs, target flow on the QNI interconnector was limited up to 274 MW towards Queensland by the system normal constraint equation N^Q_NIL_A. The N^Q_NIL_A constraint equation prevents voltage collapse in New South Wales for the loss of Liddell – Muswellbrook no. 83 330kV transmission line. The target flow on the Terranora interconnector was limited up to 9 MW towards Queensland by the same constraint equation.

The 5-minute price reduced to below $59.45/MWh in the DIs subsequent to the high priced DIs, when demand reduced by up to 326 MW and generation capacity was rebid from higher price bands to lower price bands.

The high 30-minute spot price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of the rebidding of generation capacity within the affected trading interval.

Saturday 19 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot price was $2,247.63/MWh for trading interval (TI) ending 1630 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $12,947.50/MWh for Dispatch Interval (DI) ending 1625 hrs. This high price can be attributed to rebidding of generation capacity and limited interconnector flows during the evening peak demand period.

For DI ending 1610 hrs, 150 MW of generation capacity from Callide PP unit 3 was withdrawn from the Market Floor Price (MFP) of -$1000/MWh price band. The reason of the withdrawal was '1559P REHEATER SPLIT, CLINKER DELOAD'. Between DIs ending 1620 hrs and 1625 hrs, Stanwell and CS Energy rebid 150 MW of generation capacity from bands priced below $48.90/MWh to the Market Price Cap (MPC) of $13,800/MWh.

Cheaper priced generation was available but was limited due to FCAS profile (Wivenhoe PS unit 1) or constrained off by the system normal thermal constraint equation Q>NIL_BI_FB (Gladstone PS units 3 and 4). The Q>NIL_BI_FB constraint equation prevents overloading of feeder bushings at Boyne Island for the contingent loss of one Calliope River to Boyne Island 132 kV line.

For DI ending 1625 hrs, the target flow on the QNI interconnector was limited to 457 MW towards Queensland by the system normal constraint equation N>>N-NIL__3_OPENED. This constraint equation prevents the overload of Liddell – Muswellbrook 330 kV transmission line for the loss of the Liddell – Tamworth 330 kV transmission line. The target flow on the Terranora interconnector was limited to 24 MW towards Queensland by constraint equation N>>N-NIL__3_OPENED and the outage constraint equation N>N-BAMB_132_OPEN_A. This constraint equation prevents the overload of a Lismore – Dunoon 132 kV transmission line for the trip of the parallel Lismore – Dunoon line during the outage of a Ballina – Mullumbimby 132 kV transmission line.

The 5-minute price reduced to $38.17/MWh in the DI subsequent to the high priced interval, when demand reduced by 287 MW and 382 MW of generation capacity shifted from bands priced at or above $0/MWh to the MFP.

The pre-dispatch schedule for TI ending 1630 hrs forecast a spot price of $345.73/MWh. The difference in prices between pre-dispatch and dispatch was a result of the rebidding of generation capacity within the affected trading interval.

Monday 21 March 2016 – High Energy price QLD*

Market Outcomes: Queensland spot price reached $727.01/MWh for trading interval (TI) ending 0900 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $1,399.70/MWh between dispatch intervals (DI) ending 0845 hrs and 0855 hrs. The high prices can be attributed to rebidding and withdrawal of generation capacity and limited interconnector support.

- Demand increased by approximately 142 MW for DI ending 0845 hrs.
- Between DIs ending ending 0845 hrs and 0850 hrs, Stanwell, CS Energy and Millmerran rebid 320 MW of generation capacity from bands priced below $61/MWh to bands priced at or above $1,399.70/MWh.
- For DI ending 0850 hrs, 160 MW of generation capacity was withdrawn from Braemar 2 PS unit 5, from bands priced at $345.71/MWh, with the reason '0840A QLD PRICE HIGHER THAN FORECAST: AVOID UNECONOMIC START SL'.
- During the high priced DIs, target flow on the QNI interconnector was limited up to 390 MW towards Queensland by the system normal constraint equation N^Q_NIL_A. The N^Q_NIL_A constraint equation prevents voltage collapse in New South Wales for the loss of Liddell – Muswellbrook no. 83 330kV transmission line. For the same DIs, target flow on the Terranora was limited to 25 MW towards Queensland by the same constraint equation.
- Cheaper priced generation was available during the high priced intervals but was limited due to ramp rates (Braemar PS units 2 and 3, Callide PP unit 4, Millmerran PP unit 2 and Oakey PS unit 1), or required more than one DI to synchronise (Braemar PS units 5 and 6), or constrained off by the system normal constraint equation Q>NIL_BI_FB (Gladstone PS units 3 and 4). This constraint equation prevents overloading of feeder bushings at Boyne Island for the contingent loss of one Calliope River to Boyne Island 132 kV line.

For DI ending 0900 hrs, Queensland dispatch price reduced to $45.70/MWh when:

- 38 MW of generation capacity was rebid from bands priced at $1400.70/MWh to the Market Floor Price (MFP) of -$1000/MWh.
- The constraint equation N^Q_NIL_A was no longer binding and the QNI and Terranora interconnectors were no longer limited.

** A summary was prepared as the maximum daily spot price was between $500/MWh and $2,000/MWh.*

Tuesday 22 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot price reached $2,359.62/MWh for trading interval (TI) ending 2230 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $13,788.88/MWh for Dispatch Interval (DI) ending 2220 hrs. This high price can be attributed to rebidding of generation capacity during a period of limited interconnector support.

Between DIs ending 2205 hrs and 2220 hrs, Stanwell, Alinta, Origin, CS Energy, Millmerran and ERM Power shifted or rebid 1,644 MW of generation capacity from bands priced at or below $1,400.70/MWh to bands priced at or above $12,496.11/MWh or the Market Price Cap (MPC) of $13,800/MWh. Cheaper priced generation was available but required more than one DI to synchronise (Braemar 2 PS unit 6).

For DI ending 2220 hrs, the target flow on the QNI interconnector was limited to 346 MW towards Queensland by the system normal constraint equation N^Q_NIL_A. The N^Q_NIL_A constraint equation prevents voltage collapse in New South Wales for the loss of Liddell – Muswellbrook no. 83 330kV transmission line. For the same DI, target flow on the Terranora was limited to 11 MW towards Queensland by the same constraint equation.

The 5-minute price reduced to $26.84/MWh in the DI subsequent to the high priced interval, when demand reduced by 389 MW and 642 MW of generation capacity shifted from bands priced at or above $33.98/MWh to bands priced at -$1.03/MWh or the Market Floor Price (MFP) of -$1000/MWh.

The high 30-minute spot price for Queensland was not forecast in the predispatch schedules as it

Wednesday 23 March 2016 – High Energy and FCAS price QLD

Market Outcomes: Queensland spot price, Fast Raise Frequency Control Ancillary Service (FCAS) and Slow Raise FCAS prices reached $2,344.16/MWh, $2,027.02/MWh and $205.15/MWh respectively for trading interval (TI) ending 1000 hrs.

FCAS prices and energy prices in other NEM regions were not affected.

Detailed Analysis: The Queensland spot price reached the Market Price Cap (MPC) of $13,800/MWh for Dispatch Interval (DI) ending 1000 hrs. For the same DI, the Fast Raise FCAS price reached

$12,124.49/MWh and Slow Raise FCAS price reached $1,200/MWh. The high energy and FCAS prices can be attributed to the rebidding of generation capacity and local FCAS requirement in Queensland during a planned network outage.

Planned outage of the Armidale – Tamworth no. 86 330kV line was scheduled between 0600 hrs and 1600 hrs on 23 March 2016. The outage increased the risk of synchronous separation between Queensland and New South Wales, which created a need for Contingency FCAS in QLD and limited interconnector flows. Outage constraint sets F-N_ARTW_86 and N_ARTW_86 were invoked between DIs ending 0600 hrs and 1515 hrs.

Between DIs ending 0945 hrs and 1000 hrs, Stanwell, CS Energy and Millmerran rebid 693 MW of generation capacity from bands priced below $299.91/MWh to bands priced at or above $13,799.99/MWh. For DI ending 0955 hrs, AGL withdrew 10 MW of generation capacity with the reason "0945~P~010 UNEXPECTED/PLANT LIMITS~MIN LOAD 10MW".

For DI ending 0955 hrs, CS Energy withdrew up to 150 MW of Gladstone PS generation capacity from each Fast Raise, Slow Raise and Regulation Raise FCAS markets, with the reason "0947F FCAS/ENERGY CO-OPTIMISATION-SL".

Cheaper priced generation in the energy market was available but required more than one DI to synchronise (Braemar PS units 5 and 6) or was limited by ramp rates (Tarong PS units 1, 2, 3 and 4) or was constrained off by a system normal constraint equation Q>NIL_MRTA_B (Oakey PS unit 1 and 2). This constraint equation limits the output of Oakey PS to prevent overloading of a Middle Ridge – Tangkam 110 kV line.

The target flow on the QNI interconnector was limited to 73 MW towards Queensland by the FCAS constraint equations F_Q++ARTW_R5, F_Q++ARTW_R6 and F_Q++ARTW_R60. The target flow on the Terranora interconnector was forced to 17 MW towards New South Wales by the same constraint equations. This circular flow was to maximise the net interconnector flows into Queensland, as different loss factors were applied to the parallel interconnectors.

The 5-minute price reduced to $34.11/MWh in the DI subsequent to the high priced DI, when demand reduced by 354MW and 826 MW of generation capacity was rebid or shifted from bands priced at or above $13,799.99/MWh to bands priced at or below $299.91/MWh.

The Queensland Fast and Slow Raise FCAS prices reduced to $0.80/MWh for DI ending 1005 hrs when Contingency Raise FCAS requirements reduced.

The high 30-minute spot price and sum of all FCAS price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of the rebidding of generation capacity within the affected trading interval and the FCAS requirements in Pre-dispatch were much smaller than Dispatch.

Thursday 24 March 2016 – High Energy and FCAS price QLD

Market Outcomes: Queensland spot price and Fast Raise Frequency Control Ancillary service (FCAS) prices reached $2,355.62/MWh and $2,201.28/MWh for trading interval (TI) ending 0700 hrs.

Counter price flows caused negative settlement residues of approximately $143,000 to accumulate on the Queensland to New South Wales directional interconnector for TI ending 0700 hrs. AEMO managed negative settlement residues from 0700 hrs to 0735 hrs (Market Notices No. 52520 and 52521).

FCAS prices and energy prices in other NEM regions were not affected.

Detailed Analysis: The Queensland spot price reached $13,799.99/MWh for Dispatch Interval (DI) ending 0700 hrs. For the same DI, the Fast Raise FCAS price reached $13,176.25/MWh. The high spot price can be attributed to the rebidding of generation capacity and limited interconnector flows during a planned network outage. The high FCAS price can be attributed to steep supply curves of Fast Raise FCAS capacity and local FCAS requirements in Queensland during planned outage period.

Planned outage of the Armidale – Tamworth no. 86 330kV line was scheduled between 0630 hrs and 1224 hrs on 24 March 2016. The outage increased the risk of synchronous separation between Queensland and New South Wales, which created a need for Contingency FCAS in QLD and limited interconnector flows. Outage constraint sets F-N_ARTW_86 and N_ARTW_86 were invoked between DIs ending 0630 hrs and 1230 hrs.

The target flow on the QNI interconnector was limited to 142 MW towards Queensland by the various Queensland raise FCAS requirement constraint equations F_Q++ARTW_R6 and F_Q++ARTW_R60. The target flow on the Terranora interconnector was forced to 9 MW towards New South Wales by the same constraint equations. The circular flow on the parallel interconnectors was to maximise the net flow towards Queensland.

Between DIs ending 0635 hrs and ending 0700 hrs, CS Energy, Stanwell and Millmerran rebid 581 MW of generation capacity from bands priced at or below $60.90/MWh to bands priced at the Market Price Cap (MPC) of $13,800/MWh.

For DI ending 0700 hrs, local requirements for the Queensland Fast Raise and Slow Raise FCAS both increased by 29 MW. For the same DI, Queensland Fast Raise FCAS capacity was offered at less than $145/MWh or above $12,999/MWh, resulting in a steep supply curve.

Due to the counter-price flow on the Queensland to New South Wales directional interconnector, the Negative Settlement Residue Management (NRM) constraint equation NRM_QLD1_NSW1 was invoked between DIs ending 0705hrs and 0735 hrs. The NRM constraint equation bound for 3 DIs during this period. The 5-minute price reduced to $33.98/MWh in the DI subsequent to the high priced interval, when demand reduced by up to 262MW and 911 MW of generation capacity was rebid or shifted from bands priced at or above $12,496.11/MWh to bands priced at or below $200.15/MWh.

The Queensland Fast Raise FCAS price reduced to $5.00/MWh for DI ending 0705 hrs when raise service requirements reduced.

The high 30-minute spot price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of the rebidding of generation capacity within the affected trading interval.

Saturday 26 March 2016 – High FCAS price SA

Market Outcomes: South Australian Lower Regulation Frequency Control Ancillary Service (FCAS) reached $6,903.66/MWh and $9,140.88/MWh for trading intervals (TIs) ending 0230 hrs and 0300 hrs. The South Australian Raise Regulation FCAS reached $6,901.19/MWh and $8,967.36/MWh for the same TIs.

Energy prices in all regions and FCAS prices in other NEM regions were not affected.

Detailed Analysis: The South Australian Lower Regulation FCAS prices were at or above $13,435.22/MWh for 7 Dispatch Intervals (DIs) between DIs ending 0220 hrs and 0250. For the same DIs, South Australian Raise Regulation FCAS prices were at or above $12,399.79/MWh. The high FCAS price can be attributed to steep supply curves of Lower and Raise Regulation FCAS capacity and local FCAS requirement in South Australia during a short notice outage.

A short notice outage of South Morang No. 1 500kV Bus 1 Circuit breaker, which required an outage of the South Morang No.1 500kV Bus and South Morang – Sydenham No.1 500 kV line, occurred between 0225 hrs and 0252 hrs on 26 March 2016. This outage increased the risk of synchronous separation between South Australia and Victoria. The risk of separation created local Regulation FCAS requirements for South Australia which had to be sourced from within the region. In preparation for the short-notice outage, AEMO invoked the constraint set F-V-MLSY to manage the local Regulation FCAS requirements, effective from DI ending 0220 hrs. The outage constraint sets V-MLSY_R, V-SMSY, V-SMTS_BYPASS_HW_SY and V-SY_CB were also invoked to prepare for the outage, effective from DI ending 0230 hrs (Market Notice no. 52563)

Between DI ending 0220 hrs and 0245 hrs, the two South Australian FCAS regulation providers only offered 12 MW of Lower and Raise Regulation FCAS below $12,000/MWh, increasing to 32 MW from DI 0250 hrs. This resulted in Lower and Raise Regulation FCAS prices ranging from $12,399.79/MWh to $13,799.99/MWh between DIs ending 0220 hrs and 0250 hrs to meet the increased local requirement of 35 MW.

The target flow on the Heywood interconnector was limited to 195 MW towards South Australia by the local contingency FCAS requirement constraint equations F_QNV+MLSY_L6, F_QNV+MLSY_L5 and F_QNV+MLSY_L60 and the ramping constraints #V-SA_RAMP_E_F, #R013767_018_RAMP_V, and V_S_ROCOF.

For DI ending 0255 hrs the South Australian Lower and Raise Regulation FCAS prices reduced to $5.10/MWh and $2.40/MWh, respectively, when the South Morang – Sydenham No. 1 500kV line returned to service and the local Regulation FCAS requirement constraints were revoked.

The high 30-minute FCAS price for South Australian was forecast in the pre-dispatch schedules.

Monday 28 March 2016 – High Energy price QLD

Market Outcomes: Queensland spot prices reached $2,386.06/MWh for trading interval (TI) ending 1900 hrs.

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

Detailed Analysis: 5-Minute dispatch price in Queensland reached $13,799.99/MWh for Dispatch Interval (DI) ending 1855 hrs. This high price can be attributed to the rebidding of generation capacity during a period of limited interconnector support.

Between DIs ending 1845 hrs and 1855 hrs, CS Energy, Stanwell and Millmerran rebid 755 MW of generation capacity from bands priced at or below $299.91/MWh to bands priced at or above $13,799.99/MWh.

Cheaper priced generation was available for DI ending 1855 hrs but required more than one DI to synchronise (Braemar 2 PS unit 6) or were limited by ramp rates (Condamine PS and Stanwell PS unit 4).

For DI ending 1855 hrs, target flow on the QNI interconnector was limited to 258 MW towards Queensland by the system normal constraint equation N^^Q_NIL_B1. This constraint equation prevents voltage collapse in New South Wales for the loss of Kogan Creek PS. The target flow on the Terranora interconnector was limited up to 40 MW towards Queensland by the voltage stability constraint equation N^^Q_NIL_B1 and the outage constraint equation N>N-BAMB_132_OPEN_A. The N>N-BAMB_132_OPEN_A constraint equation prevents the overload of a Lismore – Dunoon 132 kV line for the loss of the parallel Lismore – Dunoon 132 kV line during the outage of the Ballina – Lennox Head 132 kV line.

The 5-minute price reduced to $33.64/MWh for DI ending 0700 hrs, when demand reduced by 437 MW and 494 MW of generation capacity was rebid from bands priced at or above $12,947.50/MWh to bands priced at or below $6.96/MWh.

The high 30-minute spot price for Queensland was not forecast in the pre-dispatch schedules, as it was a result of the rebidding of generation capacity within the affected trading interval.

Wednesday 30 March 2016 – High Energy price SA

Market Outcomes: South Australia spot price reached $2,263.49/MWh for trading interval (TI) ending 0730 hrs.

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

Detailed Analysis: 5-Minute dispatch price in South Australia reached $13,328.64/MWh for dispatch interval (DI) ending 0720 hrs. The high price can be attributed to low wind generation and rebidding of generation capacity during a period of limited interconnector support.

During the high priced TI, South Australian demand reached 1648 MW and wind generation was low at 73 MW.

Planned outage of the Keith - Tailem Bend no.1 and no.2 132kV lines was scheduled between 0743 hrs on 30 March 2016 and 1530 hrs on 1 April 2016. Various ramping constraints were invoked between DIs ending 0700 hrs and 0800 hrs to prepare for the outage. During the high priced DI, these ramping constraints reduced flow from Victoria to South Australia.

For DI ending 0720 hrs, target flow on the Heywood interconnected was limited to 442 MW towards South Australia by the soft ramping constraint #R013775_003_RAMP_V. The target flow on the Murraylink was limited to 220 MW towards South Australia by the upper transfer limit constraint equation, VSML_220.

For DI ending 0710 hrs, Alinta rebid 155 MW of generation capacity from the Market Floor Price (MFP) of -$1000/MWh to the Market Price Cap (MPC) of $13,800/MWh.

Cheaper priced generation was available during the high priced DI, but required more than one DI to synchronise (Hallett PS).

The 5-minute price in South Australia reduced to $40.97/MWh for DI ending 0725 hrs when 673 MW of generation capacity was rebid from bands priced at or above $45.99/MWh to bands priced at or below -$991.08/MWh.

The high 30-minute spot price for South Australia was not forecast in the latest pre-dispatch schedule, as it was a result of a rebidding of generation capacity in the affected TI.

Thursday 31 March 2016 – Negative Energy price VIC

Market Outcomes: Spot price in Victoria was -$148.73/MWh for trading interval (TI) ending 0030 hrs.

FCAS prices in all regions and Energy prices in other NEM regions were not affected.

Further details are provided below.

Detailed Analysis: 5-Minute dispatch price in Victoria decreased to the Market Floor Price (MFP) of -$1,000/MWh for dispatch interval (DI) ending 0015 hrs. The negative price was mainly attributed to reduced interconnector flows from Victoria to manage the power system transient stability during a low demand period.

At 2337 hrs, AEMO's Dynamic Stability Analysis indicated that a fault on a Hazelwood to South Morang 500 kV line would cause system instability. To prevent this transient instability, AEMO invoked a system normal constraint set V-DSA_STAB-200 between DIs ending 0015 hrs and 0325 hrs (Market Notices no. 52628 and 52630). This constraint set was to reduce Victorian transient stability export limits by 200 MW.

For DI ending 0015 hrs, the target flow on the VIC-NSW interconnector was reduced from 525 MW to 441 MW towards New South Wales by the transient stability constraint equation V::N_NIL_V4_-200. This constraint equation prevents transient instability for the fault and loss of a Hazelwood to South Morang 500 kV line. The target flow on the Heywood interconnector was limited to 451 MW towards South Australia by the same constraint equation. The target flow on the Murraylink interconnector was limited to 220 MW towards South Australia by the upper transfer limit constraint equation, VSML_220.

The Victorian generating units that were not constrained and offered capacity at higher than -$1,000/MWh were ramp down rate bound (i.e. their outputs could not be reduced further). This limited dispatch targets of the generating units that were constrained on by the constraint equation V::N_NIL_V4_-200 from increasing further.

With excess cheaper priced generation available in Victoria during the low demand period, the price decreased to the MFP for DI ending 0015 hrs.

The 5-minute price in Victoria increased to $10.50/MWh for the subsequent DI, when Victorian demand and interconnector export flows increased marginally.

The negative spot price for Victoria was not forecast in the pre-dispatch schedules, as the constraint set invoked in real time to manage the change of power system transient stability that was not foreseen.