Electricity Pricing Event Report - Thursday 1 December 2016

Market Outcomes: The spot price in South Australia (SA) reached between $1,963.32/MWh and $13,766.58 for 10 trading intervals (TIs) between (a) TI ending 0030 hrs and TI ending 0500 hrs, and (b) TI ending 1000 hrs and TI ending 1030 hrs on 1 December 2016. The spot price in SA reached -$112.62/MWh for TI ending 1100 hrs on 1 December 2016.

High SA Regulation Frequency Control Ancillary Service (FCAS) prices continued from 30 November 2016 and reached $300/MWh for most TIs between TI ending 0100 hrs and TI ending 0530 hrs. Contingency FCAS prices reached $300/MWh for all TIs between TI ending 0100 hrs and TI ending 0430 hrs. SA Lower Regulation FCAS and Lower Contingency FCAS also reached $300/MWh for TI ending 1030 hrs on 1 December 2016.

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

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:

Event 1: Unplanned outage of Moorabool – Tarrone 500 kV line

The 5-minute dispatch energy price in South Australia (SA) reached between $11,630.69/MWh and the Market Price Cap (MPC) of $14,000/MWh for 16 dispatch intervals (DIs) between DI ending 0030 hrs and DI ending 0435 hrs. These high prices can mainly be attributed to zero flows across the Heywood interconnector following an unplanned outage, rebidding/ shifting of generation capacity, and limited cheaper priced generation capacity.

The 5-minute regulation FCAS dispatch prices in SA reached between $299/MWh and the APC of $300/MWh for most DIs between DI ending 0005 hrs and DI ending 0535 hrs. The 5-minute Contingency FCAS prices reached $300/MWh for most DIs between DI ending 0030 hrs and DI ending 0455 hrs. These high prices can mainly be attributed to local FCAS requirements within SA during outages and limited availability of local FCAS capacity.

The Heywood No.2 500 kV bus had a planned outage between 0602 hrs on 30 November 2016 and 0429 hrs on 1 December 2016. This outage increased the risk of separation between SA and Victoria (VIC), and the associated constraint sets F-I-HYSE, F-V-HYMO, S-X_BC_CP, V-HYMO, V-HYTX_M12 and V-HY_500BUS were invoked for the entire duration of the outage. The constraint equations F_S+LREG_0035 and F_S+RREG_0035 contained within the F-V- HYMO constraint set required 35 MW of Lower and Raise Regulation FCAS capacity to be sourced from within SA.
The Heywood – APD2 – Mortlake No. 2 500 kV line also had a planned outage, between 0640 hrs on 28 November 2016 and 0429 hrs on 1 December 2016.

At 0016 hrs, a fault on the Moorabool – Tarrone 500 kV line occurred and tripped the line. The outage of this line lasted until 2134 hrs on 1 December 2016, with the associated constraint sets F-V-MLTR, S-X_BC_CP, V-MACARTHUR_ZERO and V-MLTR invoked for the entire duration of the outage. The F-V- MLTR constraint set continued the SA local requirement of 35 MW of Lower and Raise Regulation FCAS capacity until DI ending 2145 hrs.

Prior to the trip of Moorabool – Tarrone 500 kV line, power flow on the Heywood interconnector was 217 MW towards SA. Immediately after the line tripped, the power flow on the Heywood

interconnector reversed, reaching 480 MW towards VIC to supply the load at APD. Approximately 400 milliseconds after the fault, the Emergency APD Potline Tripping Scheme (EAPTS) operated to disconnect the APD load from SA. As a result, SA separated from VIC on the AC Heywood interconnector.

The sudden loss of supply to SA resulted in the frequency falling to 48.23 Hz. South Australia Power Networks' Under Frequency Load Shedding (UFLS) operated to shed approximately 190 MW of load in SA for DI ending 0025 hrs.

Multiple directions were issued by AEMO between 0130 hrs and 0500 hrs to ensure that the SA power system was in a secure operating state, with a separate Direction report still to be issued. Intervention pricing was implemented for all DIs between DI ending 0135 hrs and 0500 hrs. The prices from the pricing run during this period are referenced in this report.

For DI ending 0025 hrs, the target flow on the Heywood interconnector was 148 MW towards SA. At 0025 hrs, the constraint set SA_ESTN_ISLE was invoked, restricting flow on the Heywood interconnector to zero in both directions. Accordingly, the target flow on the Heywood interconnector was 0 MW for all DIs between DIs ending 0030 hrs and DI ending 0455 hrs. Furthermore, the constraint set F-SA_ISLE was invoked for the same duration, requiring SA Contingency FCAS requirements to be sourced locally.

Target flow on the Murraylink interconnector ranged between 0 MW and 98 MW towards SA during the high priced DIs, limited by the constraint equations V::N_HYTR_Q4, VSML_ROC_80 and V::N_HYTR_V4. The V::N_HYTR_Q4 and V::N_HYTR_V4 transient stability constraint equations prevent transient instability for fault and trip of a Heywood – South Morang 500 kV line during the outage of the Heywood – Tarrone No.1 500 kV line. The VSML_ROC_80 system normal ramping constraint equation limits the rate of change of VIC to SA flows on the Murraylink interconnector to 80 MW per 5 minutes.

For most high priced DIs, generation capacity of up to 414 MW was rebid or shifted from band priced at the Market Floor Price (MFP) of -$1,000/MWh to bands priced at $10,549.69/MWh and above.

The 5-minute dispatch prices reduced to $1,498.80/MWh or below in the DIs subsequent to the high priced DIs, when generation capacity of up to 414 MW was rebid from bands priced at $10,578.87/MWh or above to the MFP.

From DI ending 0030 hrs until DI ending 0455 hrs, Regulation and Contingency FCAS in SA was provided by Pelican Point CCGT, Quarantine PS unit 5, Torrens Island A unit 1, and Torrens Island B units 2-4. The Raise and Lower Regulation FCAS dispatch prices ranged between $295/MWh and the APC of $300/MWh for most of the DIs until DI ending 2145 hrs. The Raise and Lower Regulation FCAS dispatch prices reduced to $10.80/MWh or below for DI ending 2150 hrs, when the local Regulation FCAS requirement was revoked. The Raise and Lower Contingency FCAS dispatch prices reduced to $4.90/MWh or below for DI ending 0500 hrs, when constraint set F-SA_ISLE was revoked and the local Contingency FCAS requirement was no longer required.

Event 2: Constraint Equation Action due to Generation by Mortlake PS

The 5-minute dispatch energy price in SA reached the MPC for all DIs between DI ending 1000 hrs and 1020 hrs, and the MFP for DI ending 1045 hrs. These prices can mainly be attributed to high flows on the Heywood interconnector towards VIC due to rebidding of VIC generation capacity and limited cheaply priced generation capacity in SA.

The 5-minute Lower Regulation FCAS dispatch prices in SA reached the APC of $300/MWh for all DIs between DI ending 1000 hrs and DI ending 1050 hrs. The 5-minute Contingency Lower FCAS prices reached $300/MWh for most DIs between TI ending 1000 hrs and TI ending 1045 hrs. These high prices can mainly be attributed to local Regulation FCAS requirements within SA during outages, local Lower Contingency FCAS requirements within SA due to high flows on the Heywood interconnector towards VIC, and limited availability of cheaply priced FCAS capacity.

For DI ending 0950 hrs, Mortlake unit 12 (DUID MORTLK12) rebid 270 MW of generation capacity from band priced at the MPC to band priced at the MFP. Mortlake unit 12 began to synchronise during DI ending 0950 hrs, and reached its minimum operating load of 90 MW for DI ending 1000 hrs.

Due to Mortlake unit 12 having synchronised, between DIs ending 0955 hrs and 1000 hrs, target flow on the Heywood interconnector changed directions from 250 MW towards SA, to 200 MW towards VIC. This violated a number of constraint equations, including FCAS constraint equations and outage constraint equations (V_HYML1_3 and V_HYML1_4). Target flow on the Heywood interconnector ranged between 200 MW and 500 MW towards VIC for all DIs between DI ending 1000 hrs and 1040 hrs. These constraint equations prevent excessive voltage unbalance at APD 500 kV bus during the outage of the Moorabool – Tarrone No.1 500 kV line, when one of the Mortlake units is in service.

The high flows on the Heywood interconnector towards VIC resulted in SA requirements for Contingency Lower FCAS to prevent excessive frequency rise in SA if the Heywood interconnection was lost. SA local requirement of 35 MW of Lower and Raise Regulation FCAS capacity was also set due to the Moorabool – Tarrone No.1 500 kV line outage until DI ending 2145 hrs.

Target flow on the Murraylink interconnector ranged was 220 MW towards SA during the high priced DIs, limited by the constraint equation VSML_220. This system normal constraint equation sets the upper limit on VIC to SA flows on the Murraylink interconnector to 220 MW.

As a result of Mortlake unit 12's inflexibility profile, NEMDE could not issue an instruction to reduce the output below 90 MW for 38 minutes following Mortlake unit 12 reaching minimum operating load. The inflexibility profile has a higher constraint violation penalty (CVP) compared to power system security constraints and Fast Lower FCAS constraints, meaning that power system security and FCAS constraints will violate before an inflexibility profile is violated.
At 1030 hrs, AEMO issued a direction under clause 4.8.9 Instruction to Origin Energy to reduce generation at Mortlake power station unit 12 to zero MW as soon as possible (MN 56046). For DI ending 1035 hrs, Mortlake unit 12 received a dispatch target down to 25 MW, reaching zero MW by 1034 hrs. AEMO modelled the generator circuit breaker as open at the same time, with all constraint violations ceasing by DI ending 1045 hrs. The direction was cancelled at 1545 hrs (MN 56067) and a separate Direction report is still to be issued.

During the high priced DIs, cheaper priced generation capacity was available but required more than one DI to synchronise (Dry Creek GT unit 1, Mintaro, Port Lincoln units 1 & 3, Quarantine PS units 1-4 and Snuggery) or was limited by ramp rates (Torrens Island A unit 1 and Torrens Island B units 2-4).

From DI ending 1000 hrs until DI ending 1045 hrs, Lower Regulation and Contingency Lower FCAS in SA was provided by Pelican Point CCGT, Quarantine PS unit 5, Torrens Island A unit 1, and Torrens Island B units 2-4. Cheaper priced FCAS capacity was available but was limited by its FCAS trapezium (Pelican Point CCGT, Quarantine PS unit 5 and Torrens Island A unit 1). The Lower Contingency FCAS dispatch prices reduced to $0.15/MWh or below for DI ending 1050 hrs, when the local Contingency Lower FCAS constraints were no longer binding due to de-synchronisation of Mortlake unit 12 .

The 5-minute dispatch energy price reduced to $53.81/MWh for DI ending 1025 hrs when 67 MW of generation capacity was made available at the MFP. The 5-minute dispatch energy price reduced further to the MFP for DI ending 1030 hrs, when 474 MW of generation capacity was rebid from bands priced at $59.99/MWh and above to the MFP.

Between DIs ending 1040 hrs and 1045 hrs, target flow on the Heywood interconnector decreased from 250 MW towards VIC to 76 MW towards VIC, due to an OFF generating status for Mortlake unit 12. For the same DIs, target flow on the Murraylink interconnector decreased from 127 MW towards SA to 49 MW towards SA, limited by the constraint equation SVML_ROC_80. The net decrease in SA outflows to VIC resulted in excess cheaper priced capacity within SA, with the 5-minute dispatch energy price reaching the MFP for DI ending 1045 hrs.

The high (and low) 30-minute energy spot prices and Contingency FCAS prices were not forecast in the pre-dispatch schedules, as they were due to the tripping of a 500 kV line, constraint equation action not modelled in pre-dispatch or rebidding of capacity. The high 30-minute Regulation FCAS prices were forecast in the pre-dispatch schedules.

For further details regarding the events on 1 December 2016, prefer refer to AEMO's System Event Reports.