NEM SCHEDULING ERROR –

INCORRECT SOUTH EAST TRANSFORMER RATING IN SOUTH AUSTRALIA

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

AEMO published an earlier version of this scheduling error report in November 2015. The earlier report has been updated in December 2016 to include revised estimates of market impact (outlined in Section 5.3 and Appendix C).

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1. SUMMARY

AEMO has determined a scheduling error has occurred because it applied incorrect directional ratings[1] to manage flow on the No.1 and No.2 South East 275/132 kV transformers in South Australia.

The scheduling error occurred over 18 days, from dispatch interval (DI) ending 0945 hrs on 11 December 2014 to Dispatch Interval (DI) ending 1020 hrs on 29 December 2014 (5,192 DIs in total).These ratings are used in the S>>V_NIL_SETX_SETX constraint equation which manages flow on either South East 275/132 kV transformer for the trip of the parallel transformer.

With the correct ratings, the limits (right hand side, or RHS) of that constraint equation would have been higher, decreasing the potential for the constraint equation to bind (actively influence central dispatch outcomes). Application of the correct ratings would have allowed the South East transformers to operate at a higher loading, thus reducing the likelihood for generation to be constrained-off[2].

Under National Electricity Rule (NER) clause 3.16.2(a), Market Participants affected by a scheduling error may apply to the dispute resolution panel established under NER clause 8.2.6A for a determination of compensation.

2. THIS REPORT

AEMO has prepared this report to declare a National Electricity Market (NEM) scheduling error under NER clause 3.8.24(a)(2).

The report describes the scheduling error and the level of impact to the market.

This report is based on analysing data from AEMO's Energy Management System (EMS) and Electricity Market Management System (EMMS).

Electranet was consulted in preparation of this report.

All references to time in this report are to Australian Eastern Standard Time.

[1] Directional ratings refer to equipment ratings that change depending on the direction of power flow (export/import).
[2] In respect of a generating unit, constrained-off energy is the state where, due to a constraint on a network, the output of that generating unit is limited by AEMO below the level to which it would otherwise have been dispatched on the basis of its dispatch offer.

3. BACKGROUND

As part of AEMO's role as the power system operator, AEMO conducts peer reviews to assess the validity of changes to power system equipment ratings as advised by Network Service Providers (NSPs). This requires AEMO to confirm with the relevant NSP that the rating values entered in the Static Ratings Workbook[3] are correct. Once AEMO has confirmed the changes with the NSP, AEMO loads the new ratings into its Energy Management System (EMS) database. From there, the ratings are loaded into the AEMO Pre-production and Production operational environments. The ratings are then input to constraint equations used by National Electricity Market Dispatch Engine (NEMDE) to determine dispatch targets for generating units and interconnectors.

The loading of directional ratings into the EMS database is a manual process.

4. EVENT DETAILS

On 1 September 2014, Electranet advised AEMO of new directional ratings for the South East transformers, with a load-shed[4] rating of 208 MVA to apply when the power flow across the transformers is from low to high voltage (132 kV to 275 kV) and a rating of 160 MVA to apply when the power flow is from high to low voltage (275 kV to 132 kV). These directional ratings were manually loaded into the EMS database and implemented in the Production environment on 18 September 2014.

An unrelated EMS database load on 11 December 2014 resulted in the directional rating changes implemented in September 2014 to no longer apply. With the new database load, a load-shed rating of 160 MVA applied in both directions, 48 MVA lower than the correct load-shed rating of 208 MVA for periods when the power flow across the transformers was from low to high voltage (132 kV to 275 kV).

On 29 December 2014, AEMO rectified the error by hand dressing the load-shed ratings to 208 MVA for periods when power flows from low to high voltage (132 kV to 275 kV).

Under NER clause 3.8.24 (a)(2), a scheduling error occurs when AEMO determines it has failed to follow the central dispatch process set out in rule 3.8.

In this case, AEMO has determined that its procedures for applying ratings in dispatch were not correctly followed and AEMO declares that a scheduling error has occurred from DI 0945 hrs on 11 December 2014 to DI 1020 hrs on 29 December 2014.

Under NER clause 3.16.2(a), Market Participants affected by a scheduling error may apply to the dispute resolution panel established under NER clause 8.2.6A for a determination on whether they are entitled to compensation.

[3] Ratings workbook refers to workbooks within which the static ratings (Normal, Emergency and Load Shed) for all transmission equipment within a region are stored. The workbooks are maintained by AEMO and the Network Service Providers in each region update the equipment ratings as required.

[4] Load shed (LDSH) ratings are short time ratings that are applied under post-contingent conditions. The LDSH rating will only be applied in cases where a mechanism exists to reduce equipment loading to normal levels within the nominated time following a contingent event.

5. MARKET IMPACT

To assess the market impact of the scheduling error, AEMO firstly identified DIs where the incorrect load-shed rating was used in constraint equations – this was between DI 0945 hrs on 11 December 2014 and DI 1020 hrs on 29 December 2014 (5,192 DIs in total). AEMO then conducted a simulated rerun of the NEMDE Dispatch files over those DIs, replacing the South East transformers' load-shed rating of 160 MVA with the correct rating of 208 MVA for intervals when the power flow across the transformers was from low to high voltage (132 kV to 275 kV).

The constraint, interconnector and generator target outcomes from the simulated run are summarised in Section 5.1, Section 5.2 and Section 5.3 respectively.

5.1 Constraint Equation

The RHS of the following constraint equation was affected by the scheduling error.

Table 1 Affected constraint equation

Constraint Equations	Rating term on RHS of constraint equation
S>>V_NIL_SETX_SETX	SA: South East 275/132 kV #1 transformer LDSH rating SA: South East 275/132 kV #2 transformer LDSH rating

The S>>V_NIL_SETX_SETX is a system normal constraint equation that prevents overload of a South East 275/132 kV transformer for the loss of the parallel South East 275/132 kV transformer. Appendix A provides the formulation for the S>>V_NIL_SETX_SETX constraint equation.

The S>>V_NIL_SETX_SETX constraint equation was observed to bind (actively influence central dispatch outcomes) for 224 distinct DIs in either the original (with the incorrect load-shed rating of 160 MVA) or simulated runs (with the correct load-shed rating of 208 MVA). The market impact has been assessed for all 224 DIs.

Table 2 shows the dates that the affected constraint equation was binding in either the original or simulated run, and the number of DIs involved.

Table 2 No. of DIs when constraints bound during scheduling error period

Date	No. of Dispatch Intervals when S>>V_NIL_SETX_SETX equation bound
13/12/2014	27
16/12/2014	124
18/12/2014	42
22/12/2014	2
25/12/2014	4
29/12/2014	25
Total	**224**

5.2 Interconnectors

AEMO observed that the target flow from Victoria to South Australia on the Heywood Interconnector was less restrictive in the simulated run than the original run. This change in interconnector flow on the Heywood interconnector affected the export and import conditions of the other interconnectors in the

simulated run. For DIs when the S>>V_NIL_SETX_SETX constraint equation bound, Heywood, VIC-NSW and QNI interconnector flows were notably different between the original and simulated runs, as detailed below.

Heywood (VIC-SA):

The number of binding DIs with target Heywood flow towards Victoria reduced compared to the original run, whereas the number of DIs with target flow towards SA increased.

Table 3 No. of binding DIs when Heywood is exporting or importing

Flow Direction	Simulated Run – No. of binding DIs when flow is in this direction	Original Run – No. of binding DIs when flow is in this direction
VIC ->SA (Export)	26	13
SA -> VIC (Import)	198	211

VIC – NSW:

The number of binding DIs with target VIC-NSW flow towards New South Wales reduced compared to the original run, whereas the number of DIs with target flow towards Victoria increased.

Table 4 No. of binding DIs when VIC-NSW is exporting or importing

Flow Direction	Simulated Run – No. of DIs when flow is in this direction	Original Run – No. of DIs when flow is in this direction
VIC ->NSW (Export)	215	224
NSW -> VIC (Import)	9	0

QNI (NSW1-QLD1):

The number of binding DIs with target QNI flow towards Queensland reduced compared to the original run, whereas the number of DIs with target flow towards New South Wales increased.

Table 5 No. of binding DIs when QNI is exporting or importing

Flow Direction	Simulated Run – No. of DIs when flow is in this direction	Original Run – No. of DIs when flow is in this direction
NSW ->QLD (Export)	9	15
QLD -> NSW (Import)	215	209

For all other interconnectors, there were only minor differences between the original and simulated run results. The results for the remaining interconnectors are summarised in Appendix B.

5.3 Generators

A total of 7,252 MWh of generation was constrained-off[5] across all regions in the NEM due to the scheduling error. The MWh constrained-off in each region is listed below.

Table 6 Generation constrained-off in each region

Region	MWh constrained-off
New South Wales	4,087
Queensland	1,122
South Australia	958
Tasmania	411
Victoria	674

The MWh constrained-off for each scheduled and semi-scheduled generating unit in the NEM is provided in Appendix C. The MWh constrained-off is based on the difference between the targets from the simulated run and the larger between the original target and Initial MW[6] for each of the generating units[7]. In accordance with NER clause 3.16.2(d), only generating units that would have been dispatched higher in the simulated run for each trading interval of the scheduling error period have been considered in determining the MWh constrained-off.

Note that the LHS of the S>>V_NIL_SETX_SETX constraint equation includes Lake Bonney 2 and Lake Bonney 3 wind farm generation terms, with co-efficients of +1. Both wind farms are dispatched higher in the simulated run as compared to the original run due to their positive co-efficients and the less restrictive RHS of the constraint equation. Semi-scheduled generating units are only considered constrained-off if the semi-dispatch cap was set in the original run.

The LHS of the S>>V_NIL_SETX_SETX constraint equation also includes Snuggery and Ladbroke GT terms with co-efficients of +1 and +0.9624, respectively. The generation profile for both Snuggery and Ladbroke GT remained similar in the simulated run as compared to the original run.

6. FURTHER ACTIONS

AEMO has since developed a newer version of the Static Ratings workbook with the capability for directional ratings to be automatically updated into the EMS database.

[5] In respect of a generating unit, constrained-off energy is the state where, due to a constraint on a network, the output of that generating unit is limited below the level to which it would otherwise have been dispatched by AEMO on the basis of its dispatch offer.
[6] Initial MW refers to the actual loading level of each generating unit, snapped at the start of each Dispatch Interval.
[7] This logic avoids over-compensating units that are not complying with their original dispatch target.

APPENDIX A. CONSTRAINT FORMULATION FOR BINDING CONSTRAINT EQUATIONS

A.1 Constraint: S>>V_NIL_SETX_SETX

Constraint type: LHS<=RHS

Effective date: 18/09/2014

Author: DHOOLE

Version No: 1

Weight: 30

Constraint active in: Dispatch and DS PASA, Predispatch and PD PASA, ST PASA

5 Min Predispatch RHS: Predispatch

Active in PASA for: LRC & LOR

Constraint description: Out= Nil, avoid overloading a South East 275/132 kV transformer on trip of the remaining South East 275/132 kV transformer, Feedback

Impact: SA Generation + Interconnectors

Source: AEMO

Limit type: Thermal

Reason: Trip of South East 275/132 kV transformer

Modifications: #1 Updated equation to include directional LDSH ratings for South East transformers.

Additional Notes: #CCR1700

LHS=

1 X Lake Bonney 2 wind farm (ENERGY)
+ 1 X Lake Bonney 3 wind farm (ENERGY)
0.9624 x Ladbroke Grove GT unit 1 (ENERGY)
0.9624 x Ladbroke Grove GT unit 2 (ENERGY)
+ Snuggery GT (3 aggregated units) (ENERGY)
-0.2199 x MW flow west on the Vic-SA AC interconnector

RHS

Default RHS value= 208

Dispatch RHS=

1.479 x (Min
(
SA: South East 275/132 kV #1 transformer LDSH rating
- MVA on South East #1 275/132 kV transformer
- 0.8806 x [MVA on South East #2 275/132 kV transformer],
SA: South East 275/132 kV #2 transformer LDSH rating

- MVA on South East #2 275/132 kV transformer
- 0.8814 x [MVA on South East #1 275/132 kV transformer]
)
- 10 {Operating_Margin})
- 0.2199 x [MW flow west on the Vic-SA AC interconnector]
+ 0.9624 x [Ladbroke Grove GT unit 1]
+ 0.9624 x [Ladbroke Grove GT unit 2]
+ Lake Bonney 2 wind farm
+ Lake Bonney 3 wind farm
+ Snuggery GT (3 aggregated units)

APPENDIX B. FLOW TREND ACROSS INTERCONNECTORS FOR THE BINDING INTERVALS

Murraylink (V-S-MNSP1):

The number of binding DIs with target Murraylink flow towards South Australia reduced slightly compared to the original run, whereas the number of DIs with target flow towards Victoria increased.

Table 7 No. of binding DIs when Murraylink is exporting or importing

Flow Direction	Simulated Run – No. of DIs when flow is in this direction	Original Run – No. of DIs when flow is in this direction
VIC ->SA (Export)	28	29
SA -> VIC (Import)	196	195

Directlink (N-Q-MNSP1):

The number of binding DIs with target Directlink flow towards and from Queensland remained the same for both the original and simulated runs.

Table 8 No. of binding DIs when Directlink is exporting or importing

Flow Direction	Simulated Run – No. of DIs when flow is in this direction	Original Run – No. of DIs when flow is in this direction
NSW ->QLD (Export)	1	1
QLD -> NSW (Import)	223	223

Basslink (T-V-MNSP1):

The number of binding DIs with target Basslink flow towards and from Victoria across Basslink remained the same for both the original and simulated runs.

Table 9 No. of binding DIs when Murraylink is exporting or importing

Flow Direction	Simulated Run – No. of DIs when flow is in this direction	Original Run – No. of DIs when flow is in this direction
TAS ->VIC (Export)	0	0
VIC -> TAS (Import)	224	224

APPENDIX C. MWH CONSTRAINED FOR EACH GENERATING UNIT

C.1 New South Wales

DUID	MWh constrained-off
UPPTUMUT	1179
MP2	402
ER03	317
TUMUT3	298
LD02	290
BW03	263
VP5	251
BW04	220
BW01	217
BW02	201
ER04	181
ER01	165
VP6	70
ER02	21
TALWA1	7
LD04	2
URANQ11	2
URANQ13	1

C.2 Queensland

DUID	MWh constrained-off
TARONG#1	131
GSTONE4	93
STAN-3	74
STAN-2	73
BRAEMAR3	64
GSTONE6	62
STAN-1	58
STAN-4	54
GSTONE1	46
KPP_1	45
OAKEY1	44
GSTONE5	42
TARONG#3	41
BRAEMAR2	40
GSTONE2	40
TARONG#4	39

DUID	MWh constrained-off
CPP_4	35
OAKEY2	32
BRAEMAR5	26
BRAEMAR7	22
CPP_3	22
GSTONE3	9
DDPS1	8
BRAEMAR1	7
CALL_B_2	6
MPP_2	5
BARRON-1	1
MSTUART3	1
TNPS1	1
CPSA	1

C.3 South Australia

DUID	MWh constrained-off
LKBONNY3	412
LKBONNY2	408
OSB-AG	52
PPCCGT	28
NPS1	17
TORRB4	14
SNOWSTH1	8
WATERLWF	6
SNOWNTH1	5
TORRB1	3
NPS2	2
SNOWTWN1	1
TORRA4	1

C.4 Tasmania

DUID	MWh constrained-off
TARRALEA	130
GORDON	64
POAT220	52
TUNGATIN	37
DEVILS_G	30
REECE2	25
POAT110	21
MACKNTSH	16

DUID	MWh constrained-off
TRIBUTE	12
BASTYAN	10
LEM_WIL	8
CETHANA	3
LI_WY_CA	2
JBUTTERS	1

C.5 Victoria

DUID	MWh constrained-off
MURRAY	184
APS	143
LOYYB1	99
LOYYB2	95
LYA2	41
YWPS1	22
MORTLK12	20
MACARTH1	14
OAKLAND1	12
YWPS4	11
HWPS8	7
HWPS1	4
HWPS5	4
YWPS2	4
LYA3	3
HWPS2	3
LYA1	2
YWPS3	2
HWPS6	2
LYA4	1
BDL02	1
MOR3	1

ABBREVIATIONS

Abbreviation	Expanded name
AEMO	Australian Energy Market Operator
DI	Dispatch Interval
EMS	Energy Management System
kV	Kilovolt
LHS	Left Hand Side
MNSP	Market Network Service Provider
MVA	Mega-volt ampere
MW	Megawatt
MWh	Megawatt Hour
NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network Service Provider
NSW	New South Wales
NSW1-QLD1	New South Wales – Queensland Interconnector
N-Q-MNSP1	Directlink Interconnector
QLD	Queensland
QNI	Queensland – New South Wales Interconnector
RHS	Right Hand Side
SA	South Australia
TAS	Tasmania
TNSP	Transmission Network Service Provider
T-V-MNSP1	Basslink Interconnector (MNSP)
VIC	Victoria
VIC–NSW	Victoria – New South Wales Interconnector
V–SA	Victoria – South Australia Interconnector
V-S-MNSP1	Murraylink Interconnector

GLOSSARY

Term	Definition
DI	Dispatch Interval
DIs	Dispatch Intervals
Hand Dress	Limits applied manually in AEMO systems to overwrite rating values from database
Rating	Describes an aspect of a network element's operating parameters, including categories like current-carrying capability, maximum voltage rating, and maximum fault level interrupting and withstand capability. Network elements must always be operated within their ratings. Network elements may have rating that depend on time duration (such as short-term current-carrying capacity.)
Scheduling Error	As defined in NER Rule Clause 3.8.24