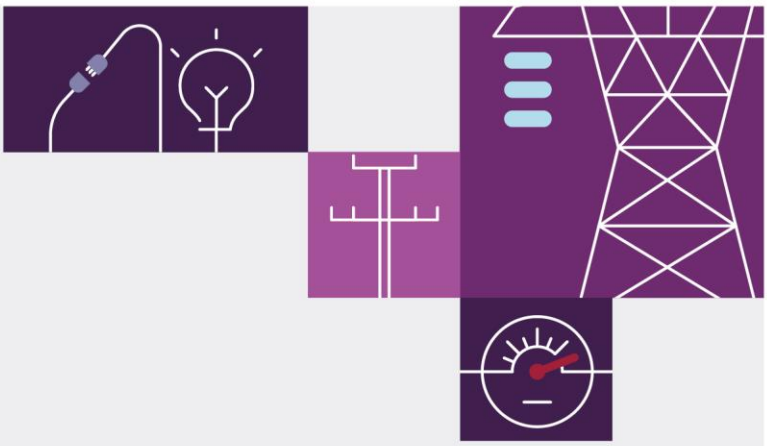
AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Monthly Constraint Report

April 2025

A report for the National Electricity Market on Constraint results.



Important notice

Purpose

This publication has been prepared by AEMO to provide information about constraint equation performance and related issues, as at the date of publication.

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1 Introduction

This report details constraint equation performance and transmission congestion related issues for April 2025. Included are investigations of violating constraint equations, usage of the constraint automation and performance of Pre-dispatch constraint equations. Transmission and generation changes are also detailed along with the number of constraint equation changes.

2 Constraint Equation Performance

2.1 Top 10 binding constraint equations

A constraint equation is binding when the power system flows managed by it have reached the applicable thermal or stability limit or the constraint equation is setting a Frequency Control Ancillary Service (FCAS) requirement. Normally there is one constraint equation setting the FCAS requirement for each of the eight services at any time. This leads to many more hours of binding for FCAS constraint equations - as such these have been excluded from the following table.

Table 1 Top 10 binding network constraint equations

Constraint Equation ID (System Normal Bold)	Description	#DIs (Hours)	Limit Type
V_T_NIL_FCSPS	Basslink limit from Vic to Tas for load enabled for FCSPS	3220 (268.33)	Other
Q_STR_7C0K_HASF_2	No limit to Haughton Solar Farm if Stan>=2+Stan+Cal>=3+Glad>=2+ (Stan+Cal+Glad) >=7, NQLD>250&270(AVG),Ross_FN>100&120(AVG),Haughton Syncon is ON, Zero otherwise.	2701 (225.08)	System Strength
N>NIL_94T	Out= Nil, avoid O/L Molong to Orange North (94T) on trip of Nil, Feedback	2107 (175.58)	Thermal
Q_STR_8C_7C2K_RGUSF	No limit to Rugby Run SF to if Stan>=3+Cal>=1+Glad>=2+ (Stan+Cal+Glad)>=8+ one SVC(Dysart/ Nebo/Strathmore)OS OR Stan>=2+Cal>=1+Glad>=2+(Stan+Cal+Glad)>=7+Kar>=2+Dysart SVC OS/Haughton Syncon ON,NQLD>350&370(AVG),Ross_FN>150&170(AVG), Zero otherwise	2036 (169.66)	System Strength
Q_STR_7C0K_HASF_4	Limit to Haughton Solar Farm output depends on the number units online in Stanwell, Callide B, Callide C, Gladstone and Kareeya generators and Haughton Syncon, North Queensland demand, Zero if it does not meet minimum generator online.	1382 (115.16)	System Strength
N>NIL_969	Out= Nil, avoid O/L Gunnedah to Tamworth (969) on trip of Nil, Feedback. Metering is used as specified in OM520 [Note: swamped with 96M or 9UJ or 9UH is O/S]	1359 (113.25)	Thermal
N>NIL_901	Out= Nil, avoid O/L West Wyalong to Temora 132kV (901) line on trip of Nil, Feedback	1321 (110.08)	Thermal
N>NIL_9R6_991	Out= Nil, avoid O/L Wagga North to Wagga (9R6) 132kV line on trip of Wagga North to Murrumburrah (991) 132kV line, Feedback	1161 (96.75)	Thermal
VS_600_TEST	Out = Nil, Vic to SA on Heywood limit of 600 MW, limit for testing of Heywood interconnection upgrade	1089 (90.75)	Other
S>NIL_MHNW1_MHNW2	Out= Nil, avoid O/L Monash-North West Bend #2 132kV on trip of Monash-North West Bend #1 132kV line, Feedback	1057 (88.08)	Thermal

2.2 Top 10 binding impact constraint equations

Binding constraint equations affect electricity market pricing. The binding impact is used to distinguish the severity of different binding constraint equations.

The binding impact of a constraint is derived by summarising the marginal value for each dispatch interval (DI) from the marginal constraint cost (MCC) re-run[1] over the period considered. The marginal value is a mathematical term for the binding impact arising from relaxing the RHS of a binding constraint by one MW. As the market clears each DI, the binding impact is measured in $/MW/DI.

The binding impact in $/MW/DI is a relative comparison and a helpful way to analyse congestion issues. It can be converted to $/MWh by dividing the binding impact by 12 (as there are 12 DIs per hour). This value of congestion is still only a proxy (and always an upper bound) of the value per MW of congestion over the period calculated; any change to the limits (RHS) may cause other constraints to bind almost immediately after.

Table 2 Top 10 binding impact network constraint equations

Constraint Equation ID (System Normal Bold)	Description	∑ Marginal Values	Limit Type
N>NIL_94T	Out= Nil, avoid O/L Molong to Orange North (94T) on trip of Nil, Feedback	4,056,528	Thermal
N>NIL_969	Out= Nil, avoid O/L Gunnedah to Tamworth (969) on trip of Nil, Feedback. Metering is used as specified in OM520 [Note: swamped with 96M or 9UJ or 9UH is O/S]	1,230,877	Thermal
N>NIL_9R6_991	Out= Nil, avoid O/L Wagga North to Wagga (9R6) 132kV line on trip of Wagga North to Murrumburrah (991) 132kV line, Feedback	1,166,799	Thermal
S_DALNTH1_LE_ZERO	Dalrymple BESS (BDU registration) Energy limit <= 0 MW	822,500	Unit Zero
N_DARLSF_FLT_65	Limit Darlington Pt Solar Farm upper limit to 65 MW to manage post contingent voltage oscillation	814,425	System Strength
N_FINLYSF_FLT_40	Limit Finley solar farm upper limit to 40 MW to manage post contingent voltage oscillation	780,205	System Strength
N_LIMOSF2_FLT_10	Limit Limondale 2 solar farm upper limit to 10 MW to manage post contingent voltage oscillation	767,518	System Strength
V_BANNERTSF_FLT_45	Limit Bannerton Solar Farm upper limit to 45 MW to manage post contingent voltage oscillation	685,456	System Strength
N_SUNRSF_FLT_60	Limit Sunraysia solar farm upper limit to 60 MW to manage post contingent voltage oscillation	651,788	System Strength
N_LIMOSF1_FLT_50	Limit Limondale 1 solar farm upper limit to 50 MW to manage post contingent voltage oscillation	644,777	System Strength

2.3 Top 10 violating constraint equations

A constraint equation is violating when NEMDE is unable to dispatch the entities on the left-hand side (LHS) so the summated LHS value is less than or equal to, or greater than or equal to, the right-hand side (RHS) value (depending on the

[1] The MCC re-run relaxes any violating constraint equations and constraint equations with a marginal value equal to the constraint equation's violation penalty factor (CVP) x market price cap (MPC). The calculation caps the marginal value in each DI at the MPC value valid on that date. MPC is increased annually on 1st July.

mathematical operator selected for the constraint equation). The following table includes the FCAS constraint equations. Reasons for the violations are covered in 2.3.1.

Table 3 Top 10 violating constraint equations

Constraint Equation ID (System Normal Bold)	Description	#DIs (Hours)	Limit Type
Q_STR_7C0K_CKWF_1	No limit to Clarke Creek Wind Farm if Stan>=2+Stan+Cal>=3+Glad>=2+ (Stan+Cal+Glad) >=7+(Haughton syncon ON or Kareeya=>2), NQLD>250&270(AVG),Ross_FN>100&120(AVG),Clarke Creek Syncon is ON, Zero otherwise.	8 (0.66)	System Strength
Q_STR_7C0K_CKWF_3	Limit Clarke Creek Windfarm output depends on the number units online in Stanwell, Callide B, Callide C, Gladstone and Kareeya generators and Clarke Creek Syncon, North Queensland demand, Zero if it does not meet minimum generator online.	8 (0.66)	System Strength
N_BHBESS_G_0INV	Broken Hill Battery inverter limit of zero. Constraint to violate if Broken Hill Battery as a generator and inverter availability greater than zero. Swamp out otherwise. DS only	7 (0.58)	System Strength
N_BHBESS_L_0INV	Broken Hill Battery inverter limit of zero. Constraint to violate if Broken Hill Battery as a load and inverter availability greater than zero. Swamp out otherwise. DS only	7 (0.58)	System Strength
V_GANWRSF_0INV	Gannawarra Solar Farm inverter limit of zero. Constraint to violate if Gannawarra Solar Farm inverter availability greater than zero. Swamp out otherwise. DS only	6 (0.5)	System Strength
Q_STR_7C0K_KBWF_12	Limit Kaban WF output depends on the number units online in Stanwell, Callide B, Callide C, Gladstone and Kareeya generators and Haughton Syncon, North Queensland demand, Zero if it does not meet minimum generator online.	4 (0.33)	System Strength
Q_STR_7C0K_KBWF_14	Limit Kaban WF output depends on the number units online in Stanwell, Callide B, Callide C, Gladstone and Kareeya generators and Haughton Syncon, North Queensland demand, Zero if it does not meet minimum generator online.	4 (0.33)	System Strength
Q_STR_7C0K_KBWF_4	Limit 80% to Kaban WF if Stan>=2+Stan+Cal>=3+Glad>=2+ (Stan+Cal+Glad) >=7,Kar >=2, NQLD>350&370(AVG),Ross_FN>150&170(AVG)(100% if Haughton Syncon ON or at night),25% if Kar<0 or if NQLD>250&270(AVG),Ross_FN>100&120(AVG) (40% if Syncon ON), Zero otherwise.	4 (0.33)	System Strength
Q-X>RS2TX_TX_TX_C	Out= Two Ross 275/132 KV transformers, avoid O/L on the remaining Ross 275/132 KV transformer on trip of another Ross 275/132 KV transformer with 132 KV network between Ross and Woree closed, Feedback	3 (0.25)	Thermal
Q_STR_7C0K_MEWF_12	Limit Mt Emerald WF output depends on the number units online in Stanwell, Callide B, Callide C, Gladstone and Kareeya generators and Haughton Syncon, North Queensland demand, Zero if it does not meet minimum generator online.	3 (0.25)	System Strength

2.3.1 Reasons for constraint equation violations

Table 4 Reasons for constraint equation violations

Constraint Equation ID (System Normal Bold)	Description
Q_STR_7C0K_CKWF_1	Constraint equation violated for 2 consecutive DIs on 1/04/2025 1345 hrs and 1350 hrs and for 6 consecutive DIs on 1/04/2025 1450 hrs to 1515 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Clark Creek Wind Farm exceeding its MVAr limit.
Q_STR_7C0K_CKWF_3	Constraint equation violated for 2 consecutive DIs on 1/04/2025 1345 hrs and 1350 hrs and for 6 consecutive DIs on 1/04/2025 1450 hrs to 1515 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Clark Creek Wind Farm exceeding its MVAr limit.
N_BHBESS_G_0INV	Constraint equation violated for 3 non-consecutive DIs on 7/04/2025 0605 hrs, 13/04/2025 2055 hrs and 13/04/2025 2100 hrs and for 4 consecutive DIs on 30/04/2025 0905 hrs to 0920 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Broken Hill Battery inverter availability exceeding its limit.

Constraint Equation ID (System Normal Bold)	Description
N_BHBESS_L_0INV	Constraint equation violated for 3 non-consecutive DIs on 7/04/2025 0605 hrs, 13/04/2025 2055 hrs and 13/04/2025 2100 hrs and for 4 consecutive DIs on 30/04/2025 0905 hrs to 0920 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Broken Hill Battery inverter availability exceeding its limit.
V_GANWRSF_0INV	Constraint equation violated for 5 non-consecutive DIs on 1/04/2025 0625 hrs to 2/04/2025 0635 hrs and for 1 DI on 12/04/2025 0635 hrs with a violation degree of 0.01 MW. Constraint equation violated due to Gannawarra Solar Farm inverter availability exceeding its limit.
Q_STR_7C0K_KBWF_12	Constraint equation violated for 4 consecutive DIs on 1/04/2025 1345 hrs to 1400 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Kaban Wind Farm exceeding its MVAr limit.
Q_STR_7C0K_KBWF_14	Constraint equation violated for 4 consecutive DIs on 1/04/2025 1345 hrs to 1400 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Kaban Wind Farm exceeding its MVAr limit.
Q_STR_7C0K_KBWF_4	Constraint equation violated for 4 consecutive DIs on 1/04/2025 1345 hrs to 1400 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Kaban Wind Farm exceeding its MVAr limit.
Q-X>RS2TX_TX_TX_C	Constraint equation violated for 3 consecutive DIs on 29/04/2025 2115 hrs, 2120 hrs and 2125 hrs with a max violation degree of 3.37 MW occurring at 29/04/2025 2125 hrs. Constraint equation violated due to hand-dressed non-zero MVA values on outage/offloaded transformers at Ross.
Q_STR_7C0K_MEWF_12	Constraint equation violated for 3 consecutive DIs on 1/04/2025 1345 hrs, 1350 hrs and 1355 hrs with a violation degree of 0.001 MW. Constraint equation violated due to Mt Emerald Wind Farm exceeding its MVAr limit.

2.4 Top 10 binding interconnector limit setters

Binding constraint equations can set the interconnector limits for each of the interconnectors on the constraint equation left-hand side (LHS). Table 5 lists the top (by binding hours) interconnector limit setters for all the interconnectors in the NEM and for each direction on that interconnector.

Table 5 Top 10 binding interconnector limit setters

Constraint Equation ID (System Normal Bold)	Interconnector	Description	#DIs (Hours)	Average Limit (Max)
V_T_NIL_FCSPS	T-V-MNSP1 Import	Basslink limit from Vic to Tas for load enabled for FCSPS	2395 (199.58)	-443.67 (-477.99)
VS_600_TEST	V-SA Export	Out = Nil, Vic to SA on Heywood limit of 600 MW, limit for testing of Heywood interconnection upgrade	1072 (89.33)	550.88 (699.28)
VS_600_TEST	V-S-MNSP1 Export	Out = Nil, Vic to SA on Heywood limit of 600 MW, limit for testing of Heywood interconnection upgrade	831 (69.25)	133.36 (185.79)
S>NIL_MHNW1_MHNW2	V-S-MNSP1 Export	Out= Nil, avoid O/L Monash-North West Bend #2 132kV on trip of Monash-North West Bend #1 132kV line, Feedback	830 (69.17)	160.3 (186.98)
N>Q-NIL_757_758	N-Q-MNSP1 Export	Out= Nil, Avoid overloading 757 or 758 (T174 Terranora to H4 Mudgeeraba) 110kV line on trip of the other 758 or 757 (T174 Terranora to H4 Mudgeeraba line), Flow North, Feedback	603 (50.25)	96.43 (97.0)
N::N_03+4_2	VIC1-NSW1 Export	Out= Lower Tumut - Yass (03) and Collector - Marulan (4) 330kV lines, stability limit (SNOWY-NSW) for critical fault on a 330kV line between Yass and Bannaby/Marulan	529 (44.08)	61.72 (757.4)
SVML^NIL_MH-CAP_ON	V-S-MNSP1 Import	Out=NIL, SA to Vic on ML upper transfer limit to manage voltage collapse at Monash (Note: applies when capacitor banks at Monash are available and I/S for switching.)	485 (40.42)	-150.68 (-172.62)
F_MAIN++APD_TL_L60	T-V-MNSP1 Import	Out = Nil, Lower 60 sec Service Requirement for a Mainland Network Event-loss of APD potlines due to undervoltage following a fault on MOPS-HYTS-APD 500 kV line, Basslink able to transfer FCAS	457 (38.08)	-336.26 (-478.0)

Constraint Equation ID (System Normal Bold)	Interconnector	Description	#DIs (Hours)	Average Limit (Max)
F_MAIN++APD_TL_L5	T-V-MNSP1 Import	Out = Nil, Lower 5 min Service Requirement for a Mainland Network Event-loss of APD potlines due to undervoltage following a fault on MOPS-HYTS-APD 500 kV line, Basslink able to transfer FCAS	455 (37.92)	-404.15 (-478.0)
N>>NIL_85_86_S	NSW1-QLD1 Import	Out= NIL, avoid O/L Uralla to Tamworth (85) on trip of Armidale to Tamworth (86) line, Feedback	429 (35.75)	-839.07 (-1155.35)

2.5 Constraint Automation Usage

The constraint automation is an application in AEMO's energy management system (EMS) which generates thermal overload constraint equations based on the current or planned state of the power system. It is currently used by on-line staff to create thermal overload constraint equations for power system conditions where there were no existing constraint equations or the existing constraint equations did not operate correctly.

The following section details the reason for each invocation of the non-real time constraint automation constraint sets and the results of AEMO's investigation into each case.

Non-real time constraint automation was not used.

2.5.1 Further Investigation

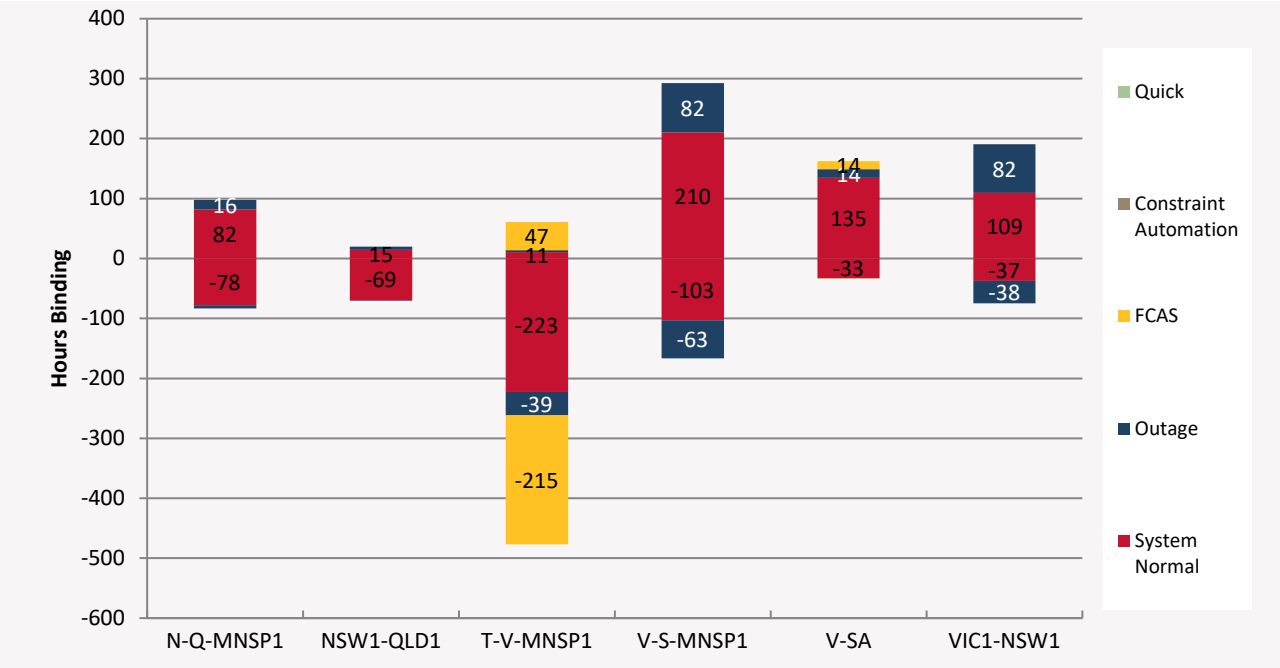
Non-real time constraint automation was not used.

2.6 Binding Dispatch Hours

This section examines the number of hours of binding constraint equations on each interconnector and by region. The results are further categorized into five types: system normal, outage, FCAS (both outage and system normal), constraint automation and quick constraints.

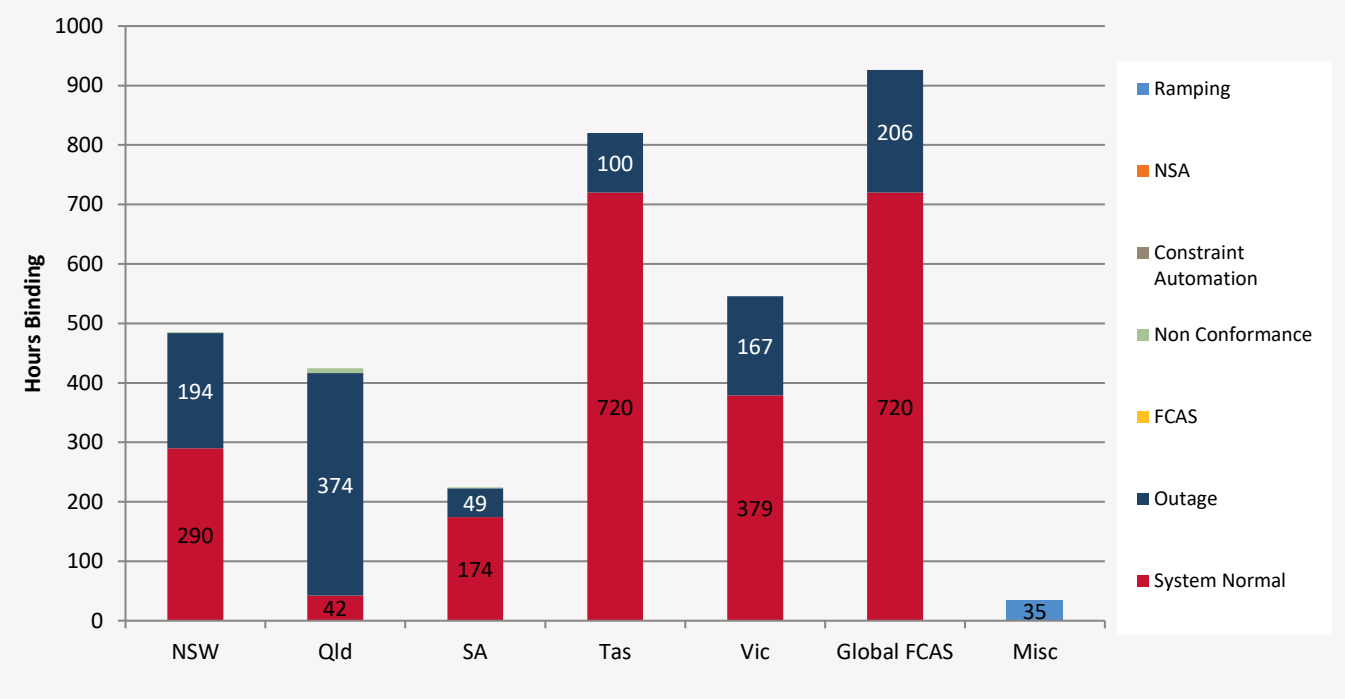
In the following graph the export binding hours are indicated as positive numbers and import with negative values.

Figure 1 Interconnector binding dispatch hours



The regional comparison graph below uses the same categories as in Figure 1 as well as non-conformance, network support agreement and ramping. Constraint equations that cross a region boundary are allocated to the sending end region. Global FCAS covers both global and mainland requirements.

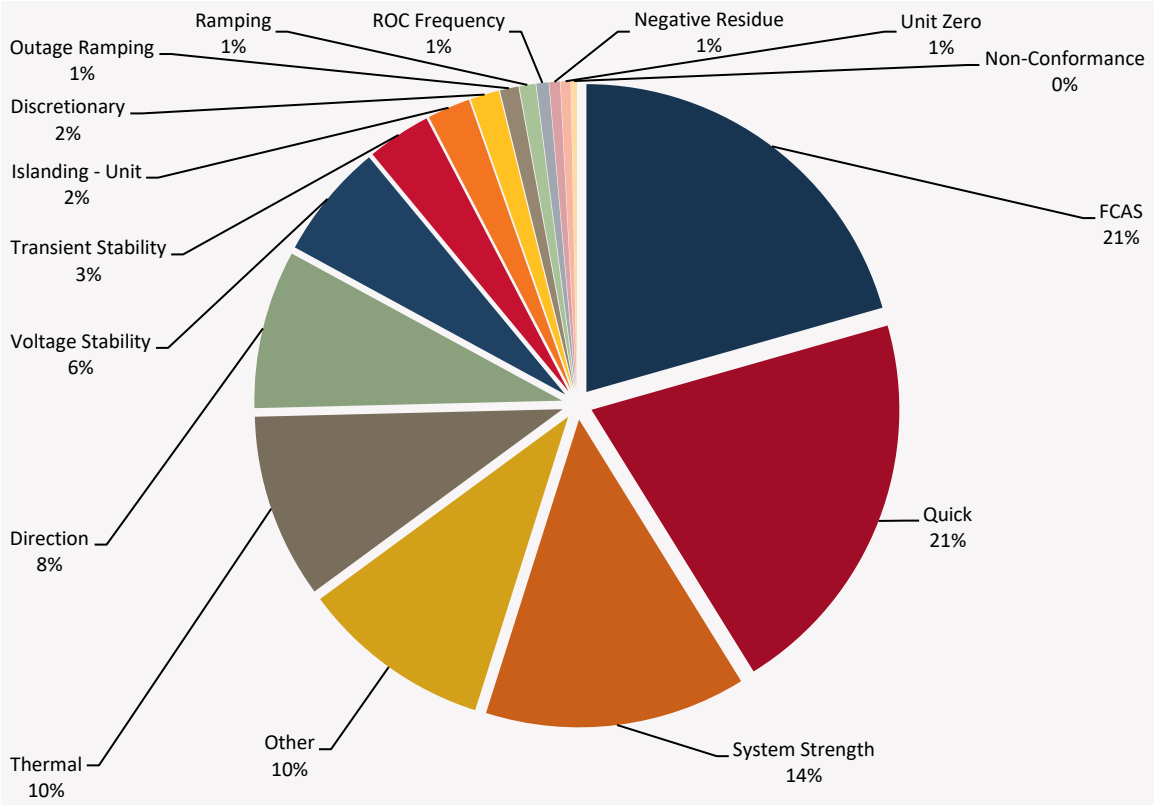
Figure 2 Regional binding dispatch hours



2.7 Binding Constraint Equations by Limit Type

The following pie charts show the percentage of dispatch intervals for April 2025 that the different types of constraint equations bound.

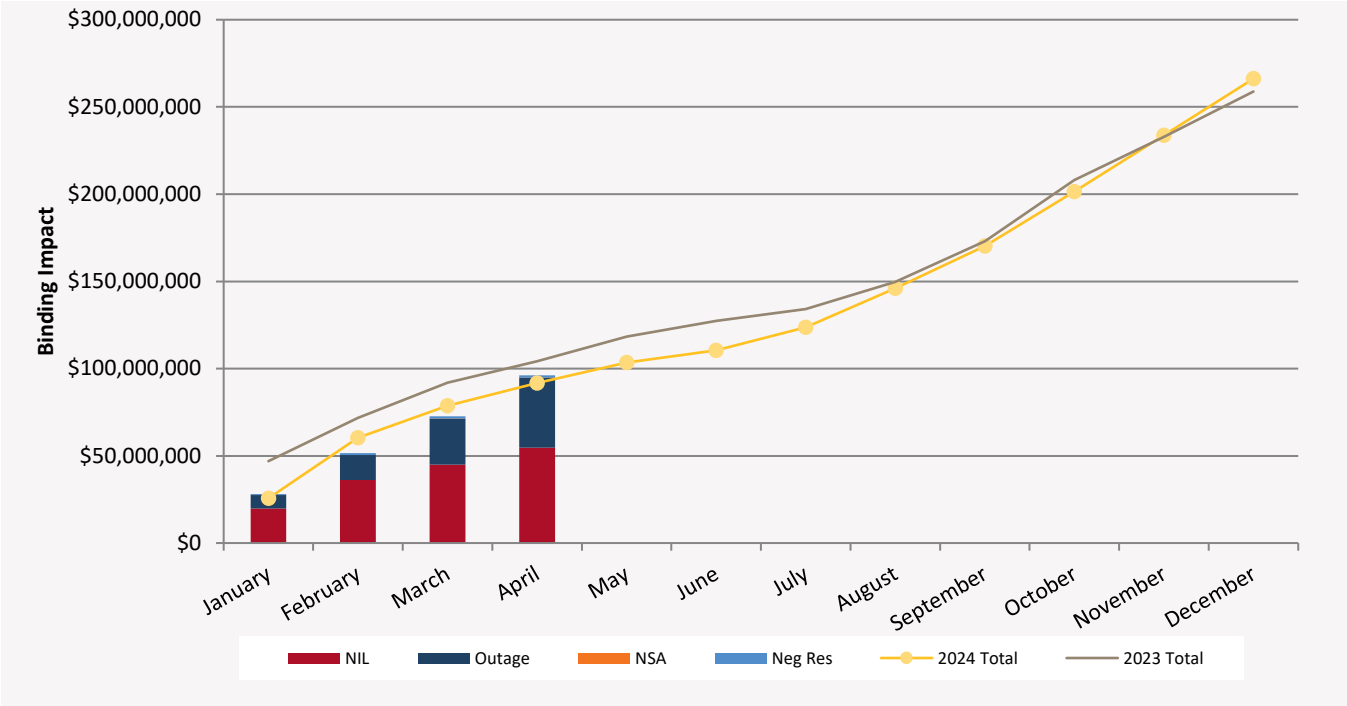
Figure 3 Binding by limit type



2.8 Binding Impact Comparison

The following graph compares the cumulative binding impact (calculated by summating the marginal values from the MCC re-run – the same as in section 2.2) for each month for the current year (indicated by type as a stacked bar chart) against the cumulative values from the previous two years (the line graphs). The current year is further categorised into system normal (NIL), outage, network support agreement (NSA) and negative residue constraint equation types.

Figure 4 Binding Impact comparison



2.9 Pre-dispatch RHS Accuracy

Pre-dispatch RHS accuracy is measured by the comparing the dispatch RHS value and the pre-dispatch RHS value forecast four hours in the future. The following table shows the pre-dispatch accuracy of the top ten largest differences for binding (in dispatch or pre-dispatch) constraint equations. This excludes FCAS constraint equations, constraint equations that violated in Dispatch, differences larger than ±9500 (this is to exclude constraint equations with swamping logic) and constraint equations that only bound for one or two Dispatch intervals. AEMO investigates constraint equations that have a Dispatch/Pre-dispatch RHS difference greater than 5% and ten absolute difference which have either bound for greater than 25 dispatch intervals or have a greater than $1,000 binding impact. The investigations are detailed in 2.9.1.

Table 6 Top 10 largest Dispatch / Pre-dispatch differences

Constraint Equation ID (System Normal Bold)	Description	#DIs	% + Max Diff	% + Avg Diff
V^^SML_ARWBBA_1	Out = Ballarat to Waubra to Ararat 220kV line (or any line section between Ballarat and Ararat), avoid voltage collapse for loss of Bendigo to Kerang 220kV line	50	13,120% (81.48)	447% (29.53)
V^SML_BUDP_3	Out = Buronga to Balranald (X3) or Balranald to Darlington Pt (X5) 220 kV line, avoid voltage collapse for loss of Bendigo to Kerang 220kV line	51	9,786% (69.53)	307% (21.6)
V^SML_HORC_3	Out = Horsham to Murra Warra to Red Cliffs 220kV line OR Murra Warra to Red Cliffs 220kV line, avoid voltage collapse for loss of Bendigo to Kerang 220kV line	79	6,793% (58.01)	156% (18.19)
V_S_HEYWOOD_UFLS	Out= Nil, Limit Heywood flows when SA under frequency load shedding (UFLS) is insufficient (i.e. when UFLS blocks in SA <1000 MW) to manage for double-circuit loss of Heywood IC. Note: Constraint is swamped if UFLS blocks >= 1000 MW.	189	1,829% (9,482)	878% (5,152)
N>N_LSDU_9U6_1	Out= one of Lismore 132 to Dunoon 132kV line (9U6 or 9U7), avoid O/L the remaining 132kV line, NSW to Qld limit	36	256% (74.13)	36.65% (22.27)

Constraint Equation ID (System Normal Bold)	Description	#DIs	% + Max Diff	% + Avg Diff
V::N_NIL_V2	Out = NIL, prevent transient instability for fault and trip of a HWTS-SMTS 500 kV line, VIC accelerates. Yallourn W G1 on 500kV.	32	210% (200.48)	31.01% (77.44)
I_6F_SN_150	Discretionary limit of 150 MW on Bundey to Buronga (6F) 330 kV Line (SA to NSW)	15	121.4% (1,027)	61.35% (517)
Q>NIL_EMCM_6056	Out= NIL, avoid thermal overload on Emerald to Comet (6056) 66 kV Feeder	81	119.11% (61.18)	40.02% (21.79)
V:T_HAPM_BL_1	Out = Hadspen to Palmerston 220 kV line, limit Basslink flow VIC to TAS at low TAS fault levels to avoid inverter commutation instability following trip of remaining Hadspen to Palmerston 220 kV line, Tamar CCGT out of service	58	100.43% (305.89)	48.37% (158.13)

2.9.1 Further Investigation

The following constraint equation(s) have been investigated:

V^^SML_ARWBBA_1: Investigated and no improvement can be made to the constraint equation at this stage.

V^SML_BUDP_3: Investigated and no improvement can be made to the constraint equation at this stage.

V^SML_HORC_3: Investigated and no improvement can be made to the constraint equation at this stage.

V_S_HEYWOOD_UFLS: Investigated and no improvement can be made to the constraint equation at this stage. Changes to the status of the reactive devices between DS/PD contributes to the PD accuracy.

N>N_LSDU_9U6_1: Under investigation and will be improved if possible.

V::N_NIL_V2: Investigated and no improvement can be made to the constraint equation at this stage

Q>NIL_EMCM_6056: Investigated and no improvement can be made to the constraint equation at this stage.**N>>NIL_998:** Investigated and no improvement can be made to the constraint equation at this stage.

V:T_HAPM_BL_1: Investigated and no improvement can be made to the constraint equation at this stage.

3 Generator / Transmission Changes

One of the main drivers for changes to constraint equations is from power system change, whether this is the addition or removal of plant (either generation or transmission). The following table details changes that occurred in April 2025.

Table 7 Generator and transmission changes

Project	Date	Region	Notes
Latrobe Valley Bess BDU	8 April 2025	Victoria	New Battery
Clarke Creek Wind Farm 2	23 April 2025	Qld	New Generator
Mortlake Cut-in	29 April 2025	Victoria	Haunted Gully - Tarrone No.1 500 kV transmission line has been cut in at Mortlake Power Station (MOPS) to form the following transmission line sections: • MOPS - Tarrone No.1 500 kV transmission line • MOPS - Haunted Gully No.1 500 kV transmission line

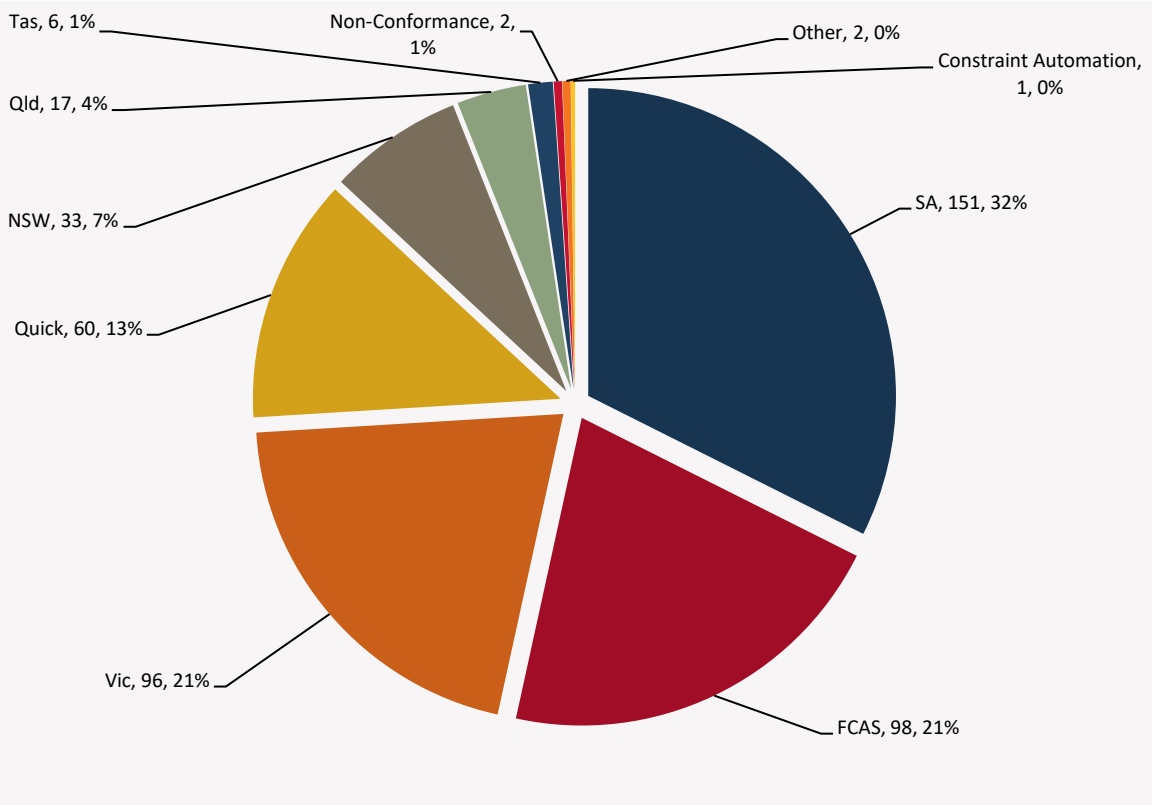
3.1 Constraint Equation Changes

The following pie chart indicates the regional location of constraint equation changes. For details on individual constraint equation changes refer to the Weekly Constraint Library Changes Report[2] or the constraint equations in the MMS Data Model[3].

[2] AEMO. *NEM Weekly Constraint Library Changes Report.* Available at: http://www.nemweb.com.au/REPORTS/CURRENT/Weekly_Constraint_Reports/

[3] AEMO. *MMS Data Model*. Available at: https://www.aemo.com.au/energy-systems/market-it-systems/nem-guides/wholesale-it-systems-software

Figure 5 Constraint equation changes



The following graph compares the constraint equation changes for the current year versus the previous two years. The current year is categorised by region.

Figure 6 Constraint equation changes per month compared to previous two years