

NEED/OPPORTUNITY STATEMENT (NOS)



Dynamic Line Rating System

NOS- 000000001579 revision 2.0

Ellipse project description: Dynamic Line Rating Systems for NSW Connection Opportunities

TRIM file: [TRIM No]

Project reason: Economic Efficiency - Network developments to achieve market benefits

Project category: Prescribed - NCIPAP

Approvals

Author	Jay Esson	Network Modelling and Performance Engineer
Endorsed	Jahan Peiris	Network Modelling and Performance Manager
	Hoang Tong	Operations Analysis Manager
	Garrie Chubb	Investment Support Manager
	Anwar Kurukchi	Project Portfolio Sponsorship Manager
Approved	Andrew Kingsmill	Manager/Power System Analysis
Date submitted for approval	[Date]	

1. Background

This proposal forms part of the Network Capability Incentive Parameter Action Plan (NCIPAP), for the 2018/19 to 2022/23 regulatory control period. The NCIPAP portion of the STPIS described in section 5 of the STPIS guideline¹ is a plan consisting of a suite of small projects aimed at improving the capability of transmission assets through operational expenditure and minor capital expenditure on the transmission network which results in:

- > Improved capability of those elements of the transmission system most important to determining spot prices;
OR
- > Improved capability of the transmission system at times when Transmission Network Users place greatest value on the reliability of the transmission system.

Currently there is a static rating associated with all transmission lines in the TransGrid network.

Dynamic Line Rating (DLR) weather monitoring systems have been previously installed as part of the NCIPAP for the 2009/10 – 2013/14 regulatory control period on the following transmission lines:

- 8 Dapto – Marulan 330 kV
- 16 Avon – Marulan 330 kV
- 87 Armidale – Coffs Harbour 330 kV
- 96C Armidale – Coffs Harbour 132 kV

The system consists of weather station elements connected back to a central processing unit (HMI) over a private network (WAN) using Telstra's NextG mobile network. The collected data interfaces with TransGrid's SCADA and EMS.

The following transmission lines are already included in the current NCIPAP for the 2018/19 to 2022/23 regulatory control period under project DCN526 to meet overall network reliability requirements:

- Snowy – Yass and Canberra 330 kV lines
- 65 Murray – Upper Tumut 330 kV
- 66 Murray – Lower Tumut 330 kV
- 4 & 5 Yass – Marulan 330 kV
- 9 Yass – Canberra 330 kV
- 61 Yass – Bannaby 330 kV
- 39 Bannaby – Sydney West 330 kV
- 83 Liddell – Muswellbrook 330 kV
- 84 Liddell – Tamworth 330 kV
- 85 & 86 Tamworth – Armidale 330 kV
- 88 Muswellbrook – Tamworth 330 kV
- 967 Lismore – Koolkhan 132 kV
- 966 Armidale – Koolkhan 132 kV
- 96T Armidale – Glen Innes 132 kV
- 96R Glen Innes – Tenterfield 132 kV

¹ AER, Final Electricity Transmission Network Service Providers Service Target Performance Incentive Scheme, Version 5 October 2015.

- 969 Tamworth – Gunnedah 132 kV

2. Need/opportunity

TransGrid's present static ratings consider the probabilistic nature of weather and line loading conditions. However, the weather data used as the basis for determining the static ratings do not necessarily refer to the critical constraint spans of a transmission line where conductor sagging is the constraining issue. Real-time localised data can obviate the need for conservative estimates and assumptions and high safety factors introduced into the maximum line loading determination.

Additional transmission lines for the installation of DLR have been identified based on the location of future NSW Connection Opportunities that have been identified on the TransGrid website and connection enquires that TransGrid has received. The following table² summarises the transmission circuits that might be the connection point for a NSW Connection Opportunity. Terminal equipment limitations (if any) also need to be relieved to realise the benefits of DLRs on these lines.

Circuit	Voltage (kV)	Current Capacity ³ (MVA)	Static Conductor Rating ⁴ (MVA)
X5/1 Balranald – Darlington Point	220	301	456
X5/3 Balranald – Buronga	220	227	456
X2 Buronga – Broken Hill	220	95	456
63 Wagga – Darlington Point	330	569	995
99K Darlington Point – Griffith	132	114	199
99D Darlington Point – Yanco	132	114	199
99T Darlington Point – Coleambally	132	125	137
99J Griffith – Yanco	132	125	137
94K Parkes – Wellington	132	120	143
94U Parkes – Forbes	132	134	143
94H Parkes – Manildra.	132	134	143
72 Mt Piper – Wellington	330	915	1032

² Source - <https://www.transgrid.com.au/what-we-do/our-network/NSWConnectionOpportunities/Pages/default.aspx>

³ This includes terminal equipment and protection limitations. As per Ratings Operating Manuals 304 to 307

⁴ Based on conductor contingency rating given in ratings OMs

Circuit	Voltage (kV)	Current Capacity ³ (MVA)	Static Conductor Rating ⁴ (MVA)
79 Wollar – Wellington	330	915	1048
945 Wellington – Molong	132	91	120
94B Wellington – Beryl	132	134	143
947 Wellington – Orange North	132	134	143
9U4 Inverell – Glen Innes	132	136	136

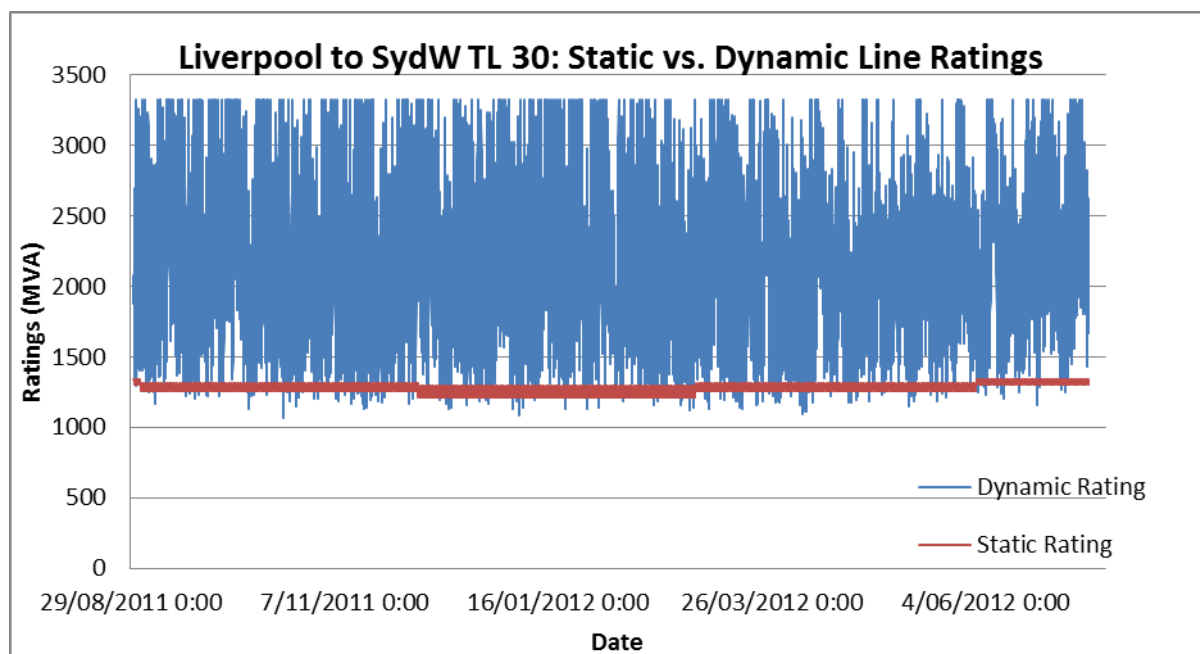
3. Related needs/opportunities

Project DCN526 – Real Time Dynamic Line Rating

4. Expected Benefits

Real time line ratings are expected to provide benefits in the form of:

- Allowing maximum power transfer capability of the system (where thermal ratings are the determining factor) to be available for use by market participants (market benefits). The figure below illustrates an example of the benefits of dynamic over static line ratings for Liverpool to Sydney West 330 kV line determined from one year's worth of data:



*One year comparison of Dynamic vs. Static Line Ratings for Liverpool to Sydney West (transmission line 30).
Weather data parameters are monitored at Liverpool substation.*

- De-rating lines in order to protect the assets and the system during adverse conditions
- Allowing the use of extra line capacity if available, during planned outage conditions

- Reducing the quantity of load shedding required if load shedding is implemented as a way of managing over loading of the lines under contingencies

Benefit Calculation:

The benefit of implementation of Dynamic Line Ratings on a given line can be calculated using the following:

- Extra capacity available on average = 4-20%⁵
- Expected use of extra capacity = 1%⁶
- Average generation cost of thermal generation compared to renewable generation⁷ = \$25/MWh

If line static rating is R, increase in capacity due to DLR = 0.04 to 0.2 R

Extra renewable (wind/solar) generation capacity available in NEM = (0.04 to 0.2 R) * 0.01 * 24 * 365 MWh/year
Market benefit = \$ (0.04 to 0.2 R) * 0.01 * 24 * 365 * 25 /year

Accordingly, the benefit in implementing the DLRs on the identified lines can be summarised as given in the table below:

Circuit	Current Capacity ⁸ (MVA)	Static Conductor Rating ⁹ -R (MVA)	Benefit due to DLR (\$ million/year)
X5/1 Balranald – Darlington Point	301	456	0.040
X5/3 Balranald – Buronga	227	456	0.040
X2 Buronga – Broken Hill	95	456	0.040
63 Wagga – Darlington Point	569	995	0.327
99K Darlington Point – Griffith	114	199	0.087
99D Darlington Point – Yanco	114	199	0.087
99T Darlington Point – Coleambally	125	137	0.060
99J Griffith – Yanco	125	137	0.060
94K Parkes – Wellington	120	143	0.063
94U Parkes – Forbes	134	143	0.063

⁵ This is a conservative assumption based on the historical DLRs calculated for lines with DLRs implemented (refer Figure above) and extra capacity available from existing, or with minor equipment replacements or ratio changes

⁶ Based on expected wind farm generation and existing line capacities

⁷ Based on the NSW Black Coal variable costs of \$25 – refer page 61 of Jacobs report “Retail electricity price history and projections.pdf” filed in PDGS supporting documents. Typical bid price for renewable (wind/solar) generation is either \$0 or negative. Accordingly, Market impact = \$25 - \$0 = \$25..

⁸ This includes terminal equipment and protection limitations. As per Ratings Operating Manuals 304 to 307

⁹ Based on conductor contingency rating given in ratings OMs

Circuit	Current Capacity ⁸ (MVA)	Static Conductor Rating ⁹ -R (MVA)	Benefit due to DLR (\$ million/year)
94H Parkes – Manildra.	134	143	0.063
72 Mt Piper – Wellington	915	1032	0.249
79 Wollar – Wellington	915	1048	0.207
945 Wellington – Molong	91	120	0.053
94B Wellington – Beryl	134	143	0.063
947 Wellington – Orange North	134	143	0.063
9U4 Inverell – Glen Innes	136	136	0.060
Total Benefit (\$ million/year)			1.621 ¹⁰

5. Recommendation

It is recommended that Dynamic Line Rating systems be installed along the identified transmission lines as part of TransGrid's NCIPAP for the regulatory period 2018 – 2023.

¹⁰ Refer to file "1579-Benefit calculations Nov 2016" in PDGS supporting documents for details of the calculations for individual feeders