OPTIONS EVALUATION REPORT (OER)

Maintain capacity during Climate Change

OER- N2655 revision 0.0

Ellipse project no(s):
TRIM file: [TRIM No]

Project reason: Capability - Improved Asset Management
Project category: Prescribed - NCIPAP

Approvals

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Change history

Revision	Date	**Amendment**
0.1	8-Nov-2021	Initial Issue
0.2	9-Nov-2021	Added calculation details following AEMO comments.

Executive summary

Transgrid presently has a number of dynamically rated transmission lines. There is an opportunity to use more dynamic ratings to improve the utilisation of Transgrid's transmission lines.

Thermal ratings of overhead lines are determined by the current being carried and ambient climatic conditions. Higher temperatures as a result of climate change will give rise to lower ratings, and thus a reduction in current-carrying capacity across the electricity network. Coupled with demand growth and installation of renewable generation on weaker sections of the network, this could necessitate costly reinforcements and upgrades. UK-based studies[1] have demonstrated that widespread use of real-time dynamic rating systems are likely to represent the most cost-efficient adaptation method for lines which are frequently thermally constrained.

In the last three years there has been over 800 MW of renewable generation connected to the transmission network, with over 2,000 MW currently progressing towards connection in the coming years. It is expected renewable generation connections will increase in the coming decade in all areas of NSW. Already, Transgrid has had to limit connected generation due to line ratings in parts of the network, and many more will require limiting throughout the network into the future.

If dynamic line ratings (DLR) are extended, line ratings can be optimised depending on the prevailing weather conditions, thereby reducing potential curtailment of lower cost generation due to the thermal limitations of these transmission lines. This would deliver market benefits from reducing constraints on dispatch of low-cost generation as a consequence of taking advantage of the additional thermal capacity of the lines.

The assessment of the options considered to address the need/opportunity appears in Table 1.

Table 1 - Evaluated options

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[2] ($m)	Weighted NPV (PV, $m)	Rank
Option A	Implement DLR on Transgrid's highly utilised lines	4.54	1.35	5.89	3.5	1

Preferred Option

The preferred option is Option A – Implement DLR on Transgrid's highly utilised lines.

This option involves installation of weather station elements connected back to a central processing unit (HMI) via a suitable mobile network (e.g. Telstra) to enable Transgrid to apply DLR to a selection of constrained lines.

The preferred option was selected because it meets the identified need, is a proven method which is technically feasible and has a higher Net Present Value than the Base Case option.

[1] Lucy C. Cradden, Gareth P. Harrison, "Adapting overhead lines to climate change: Are dynamic ratings the answer?", Energy Policy, Volume 63, 2013, Pages 197-206.

[2] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

1. Need/opportunity

There is an opportunity to improve the utilisation of Transgrid's transmission lines using Dynamic Line Ratings (DLR).

In order to optimise the loading level of a given transmission line, DLR weather monitoring systems have been developed and installed on a number of transmission lines that are approaching loading limits under normal conditions and/or where ratings may become a local network constraint under contingency conditions. The use of real-time localised data can obviate the need for applying conservative maximum line rating estimates which are based on assumptions and safety factors as opposed to actual loading and weather conditions, thereby releasing additional network capacity.

In the last three years there has been over 800 MW of renewable generation connected to the transmission network, with over 2,000 MW currently progressing towards connection in the coming years. It is expected renewable generation connections will increase in the coming decade in all areas of NSW. Already, Transgrid has had to limit connected generation due to transmission line static ratings in parts of the network, and many more will require limiting throughout the network into the future.

If DLR is extended, the additional line ratings can be optimised depending on the prevailing weather conditions, thereby reducing potential curtailment of lower cost generation due to the thermal limitations of these transmission lines. This would deliver market benefits from reducing constraints on dispatch of low-cost generation as a consequence of taking advantage of the additional thermal capacity of the lines.

2. Related needs/opportunities

- DCN526 – Dynamic Line Rating Monitoring
- 1579 – Real Time Dynamic Line Rating
- 2470 – Increase Capacity of 94T – DLR
- N1971 – Operationalise DLR into the Control Room

3. Options

3.1 Base case

The base case under this need is to not extend DLR on transmission lines that are constraining generator dispatch. The primary opportunity for Transgrid to address the need is to lower the constraints limiting lower cost generation over the coming years due to the use of static thermal limits for transmission lines.

3.2 Options evaluated

Option A — Implement DLR on Transgrid's highly utilised lines

This option will require installation of weather station elements connected back to a central processing unit (HMI) via a suitable mobile network (e.g. Telstra) to enable Transgrid to apply DLR to a selection of 11 constrained lines which are listed in the table below.

Line	From	To	Rated (kV)	Length (km)
96N	Armidale	Inverell	132	111.2
9R3	Deniliq132	Finley 132	132	46.63

99L	Coleambally	Deniliquin	132	152.7
999	Bango Wind	Cowra	132	83.62
8C	Armidale	Dumaresq	330	172.4
8E	Armidale	Sapphire	330	113.4
8J	Dumaresq	Sapphire	330	58.99
964/1,2	Port Macquarie	Taree	132	66.0
992	Burrinjuck	Tumut 132	132	52.68
993	Gadara	Wagga 330	132	79.57
99A	Finley	Uranquinty	132	167.3

The collected data is required to interface with Transgrid's SCADA and EMS.

The expected commissioning date for this option is 2026/27.

The expected expenditure profile for this option generally obtained using PS / PSE's Estimating System. The estimates in the table below have an uncertainty of ± 25% and exclude capitalised interest.

Table 2 – Option A expected expenditure

	Total Project Base Cost	FY2023/24	FY2024/25	FY2025/26	FY2026/27
Estimated Cost – non-escalated ($m 2020-21)	5.89	0.05	0.14	5.66	0.03

It is expected that an amount up to $0.5M is required to progress the project from DG1 to DG2. This will cover completion of concept designs, scoping activities, establishment of project agreement with SHL, obtaining environmental approval, and procurement of major plant equipment.

This project is expected to be completed in an estimate 37 months following the approval of DG1.

3.3 Options considered and not progressed

No other options were considered to address the need.

4. Evaluation

4.1 Commercial evaluation methodology

The economic assessment undertaken for this project includes three scenarios that reflect a central set of assumptions based on current information that is most likely to eventuate (central scenario), a set of assumptions that give rise to a lower bound for net benefits (lower bound scenario), and a set of assumptions that give rise to an upper bound on benefits (higher bound scenario).

Assumptions for each scenario are set out in the table below.

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Demand Growth	Medium (POE50)	Low (POE90)	High (POE10)
Capital cost	100%	125%	75%
Operating expenditure	100%	125%	75%
VCR	AER Latest VCR (escalated) 100%	70%	130%
MW of Fuel Saving	10	5	20
Scenario weighting	**50%**	**25%**	**25%**

Since the central scenario represents the most likely scenario to occur, we have weighted it at 50 per cent. The other two scenarios reflect extreme combinations of assumptions designed to stress test the results. Accordingly, these scenarios are weighted at 25 per cent each.

Parameters used in this commercial evaluation:

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	FY21
Base year	The year that dollar value outputs are expressed in real terms	FY21 dollars
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 Years

The capex figures in this OER do not include any real cost escalation.

Benefit Calculation

Economic (market) benefits are expected to accrue from the provision of additional capacity using the DLR to increase the transfer capability of the 11 lines, thereby displacing higher-cost thermal generation. These have been assessed, below:

Assumptions:

- Expected use of extra capacity = an average of 5 to 20 MW (continuously)[3].
- Generation cost advantage of renewable generation compared to thermal generation = $32.04/MWh

Extra renewable generation capacity available in NEM = (5 to 20) x 24 x 365 MWh/year
= 43,800 to 175,200 MWh/year

Expected annual market benefit = $ (43,800 to 175,200) x 32.04

= $ 1.40 million to 5.61 million

Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 2. Details appear in Appendix A.

Table 3 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	OPEX Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Base Case	0	0	0	0	0	0	2
Option A	3.5	1.1	21.6	1.2	93.6	34.5	1

[3] A modest increase of 5 to 20 MW was assumed for the entire project (about 455kW to 1.82 MW continuously for each line dynamically rated).

4.2 Preferred option

The preferred option is Option A. Under this option, the following investments will be undertaken:

> installation of weather station elements connected back to a central processing unit (HMI) via a suitable mobile network

The preferred option was selected because this is the only option that meets the identified need, is technically feasible and has a higher Net Present Value than the Base Case option.

Capital and Operating Expenditure

The preferred option requires capital expenditure of $5.89 million. No additional operating expenditure has been identified for this option.

The base case requires no capital or operating expenditure.

Regulatory Investment Test

As the estimated cost of the project is below the Regulatory Investment Test (RIT-T) threshold of $6M, a RIT-T will not be required.

5. Optimal Timing

The test for optimal timing of the preferred option has been undertaken. The approach taken is to identify the optimal commissioning year for the preferred option where net cost is minimised while remaining compliant with all regulatory obligations. Results showed unconstrained optimal timing would be today, so constrained by constructability and funding the optimal time becomes the earliest timing in the OFS.

The results of optimal timing analysis is:

> Optimal commissioning year: FY2026/27

Based on the optimal timing, the project is expected to be completed in the 2023-2028 Regulatory Period.

6. Recommendation

The recommendation is to progress with Option A. This option requires $0.5 million of capex to progress the project to Decision Gate 2 (DG2).

Appendix A – Option Summaries

Project Description	[Project Name] ***Sydney Site Transformer Replacement***		
Option Description	Option A — Implement DLR on Transgrid's highly utilised lines		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	50	NPV Year	*2020/21*
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	*21.6*	Annualised CAPEX ($m)	*0.024*
NPV @ Lower Bound Scenario (PV, $m)	*1.2*	Network Safety Risk Reduction ($m)	*N/A*
NPV @ Higher Bound Scenario (PV, $m)	*93.6*	ALARP	*N/A*
NPV Weighted (PV, $m)	*34.5*	Optimal Timing	*2026/27*
Cost			
Direct Capex ($m)	4.54	Network and Corporate Overheads ($m)	1.35
Total Capex ($m)	5.9	Cost Capex (PV,$m)	3.5
Terminal Value ($m)	3.6	Terminal Value (PV,$m)	1.2