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System Security Roadmap Operational Technology Upgrades

RIT-T Project Assessment Draft Report Summary

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Summary

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for Transgrid's System Security Roadmap Operational Technology contingent project to upgrade operational technologies and tools for use in our control rooms and corporate offices.

The Australian Energy Regulator (AER) accepted the System Security Roadmap Operational Technology project as a contingent project for Transgrid's 2023-28 regulatory period, subject to the successful completion of early works and fulfillment of specific trigger events.[1]

One of the trigger events identified by the AER for the Contingent Project Application (CPA) is the successful completion of a RIT-T. This RIT-T demonstrates that an investment in operational technology and tools is the preferred option to address the increasingly complex operational challenges faced by Transgrid as the owner and operator of the New South Wales (NSW)/Australian Capital Territory (ACT) transmission network. Publication of this Project Assessment Draft Report (PADR) is the second step in the RIT-T process. It follows the publication of the Project Specification Consultation Report (PSCR) on 14 October 2024.

The PSCR received one submission from Energy Consumers Australia (ECA). We have also sought responses from potential vendors in a request for information (RFI), which have informed refinements to the scope of the options and the cost estimates in this PADR. In addition, we have continued to engage closely with the Transgrid Advisory Council (TAC) in progressing and testing the assessment in this PADR.

Project context: operational challenges in a transitioning power system

The electricity system in NSW is currently undergoing a period of transformation, with several factors driving increased complexity in power system planning and operations.

Historically, the consistent profile and flexible output of baseload generators allowed transmission network operators to quickly stabilise the technical operating envelope of the power system and return the system to secure operations following contingency incidents (generator trips, equipment failures, weather events, etc.). However, the NSW power system is undergoing a transition from a small number of large, centrally distributed thermal generators to many small, distributed, variable generator connections and storage resources. This results in a more complex and dynamic transmission network to manage, given the significant increase in the number of resources connected to the transmission network, more monitored points for the control room, new asset types and variable bi-directional power flows.

Whilst these developments will ultimately benefit consumers through increased access to lower cost, zero-emission energy sources and the ability for the network to operate more flexibly overall to meet demand, they also increase the complexity of the system Transgrid needs to manage.

This transition is driving a substantial increase in information and analysis requirements across our operational control and operational planning functions, which is exacerbated by an increase in the number of transmission assets and the new types of transmission assets, combined with unprecedented changes in generation and load interacting with our network. Additional complexity also arises from the more variable characteristics defining renewable generation and storage compared to retiring baseload generation. In the

[1] AER, *Transgrid transmission determination – 1 July 2023 to 30 June 2028 – Attachment 5: Capital expenditure*, Final decision, p. 47.

absence of an upgrade to the capabilities used in our control rooms and corporate offices, the increasing complexity of the NSW power system means that:

- it is likely that, as a result of Transgrid maintaining static operating limits, constraints will need to be imposed more frequently on the operation of the power system in NSW and the system will begin to be operated in a more conservative manner (which may require constraining the operation of low marginal cost renewable generators), to have sufficient confidence that the system will remain within its required operating envelope; and
- there is an increased likelihood of emergency outages or disruptions when our operators are overburdened from needing to access and confirm the accuracy of information from multiple sources following contingency events, which are expected to increase in frequency. Specifically, there is a greater risk of failure for operators to take required actions within the required time, in turn leading to an increased risk of expected unserved energy (EUE) to end consumers going forward.

Transgrid plans to address these potential adverse outcomes proactively and this RIT-T is being carried out to provide us with the tools to prevent such a situation from arising.

Identified need: net market benefits arising from investment in operational technologies and tools for use in control rooms and corporate offices

The identified need for this RIT-T is to increase overall net market benefits in the National Electricity Market (NEM) as the complexity of the electricity system increases, by:

- avoiding the need to impose more frequent constraints on the operation of generators connected to our system going forward to ensure the system remains within its required operating envelope. This includes reducing the need to impose constraints during periods of planned and unplanned transmission outages, including outages necessary to connect new generation and undertake network upgrades; and
- allowing our control system operators to better prepare for, and then assess information and respond to, contingency events in an increasingly complex operating environment with a substantial increase in information sources needing to be monitored, which, amongst other things, is expected to reduce the likelihood of load shedding (i.e., expected unserved energy (EUE)).

We expect market benefits will predominately arise from:

- reduced dispatch costs and greenhouse gas emissions, resulting from the ability to operate the system with fewer constraints on low marginal cost and low emissions renewable generation; and
- reduced expected EUE, resulting from a reduction in the risk of contingency events escalating to the point where load shedding is required.

Our assessment indicates that the market benefits from enhancing the capabilities of the operational technology and tools (including our Supervisory Control and Data Acquisition (SCADA) system) in our control room and corporate offices will exceed the costs of these investments. As such, we have identified this as a 'market benefits' driven RIT-T (i.e., as opposed to a 'reliability corrective action' to address regulatory or service standard obligations).

Developments since the publication of the PSCR

There have been two important developments since the publication of the PSCR. The first is that in October 2024 AEMO provided a letter of written support for Transgrid's proposed upgrades to operational technology and tools for use in our control room and corporate offices.[2] The full letter has been published on our website.

In particular, AEMO acknowledged the urgent need for the investment to enhance Transgrid's capabilities to securely operate, plan and, manage the NSW/ACT power system. AEMO highlighted that Transgrid's proposed investments in operational technology and tools are:[3]

> *consistent with the experience of system and network operators globally, which are undergoing similar shifts and are making equivalent investments in the architecture, data and tools required to operate, plan and manage the system of the future.*

AEMO also highlighted the interdependent roles, systems and capabilities between itself and Network Service Providers (NSPs), emphasising that investments in operational tools by AEMO alone are insufficient to ensure system security across the NEM during the energy transition.

AEMO has confirmed that the options outlined by Transgrid in the PSCR are 'fully aligned' and complementary to AEMO's Operational Technology and Engineering Roadmaps, which describe the emerging operational and engineering challenges from the transition to higher levels of renewable generation while maintaining reliability, security and resilience.[4]

The second development is Transgrid's market testing process, which, following consultation with TAC, was conducted to confirm the availability, capacity, solutions and expected cost to deliver the proposed levels of capability uplift. This process considered each option within the PSCR in light of retaining and building on our core SCADA/Emergency Management System (EMS).

Transgrid considers it prudent to retain, at the core, the existing software as it will be more efficient to leverage the SCADA/EMS asset that was commissioned in 2022. This software remains commonplace in the industry, and the software has been updated to support renewable resources. As such, responses were sought from all of the existing software's Australian-based System Integrators as part of a RFI to explore a range of solutions and attain latest market pricing. The System Integrator model was used as it offers cost efficiencies by reducing redundancies when delivering a program of technologies and reduces delivery risk through ensuring all components function together smoothly, with a focus on data and integration. Vendors were requested to submit proposals against requirements encompassing the three options defined within the PSCR (i.e., reactive, proactive and predictive).

Through this market testing process, valuable insights emerged from vendors' local and global experience with transmission and distribution network service providers. Notably, vendors indicated that the desired levels of capability uplift within Option 3, while well aligned with industry and vendor software product roadmaps, had high degrees of cost and functional uncertainty. Additionally, the RFI identified that Option 3 could not be delivered by the targeted date of 2030. As a result, Option 3 has now been excluded as a

[2] *AEMO, Support for Transgrid's proposed investment to upgrade operational technology and tools for use in its control room and corporate offices, 15 October 2024.*

[3] *AEMO, Support for Transgrid's proposed investment to upgrade operational technology and tools for use in its control room and corporate offices, 15 October 2024.*

[4] *AEMO, Support for Transgrid's proposed investment to upgrade operational technology and tools for use in its control room and corporate offices, 15 October 2024.*

credible option. The proposed technology architecture for Options 1 and 2 will enable Transgrid to readily scale and take advantage of new functionality sought within Option 3 at a future date, when there is greater certainty in relation to its cost and functionality, if there were benefits of doing so.

Consultation undertaken on the PSCR

The PSCR was released in October 2024. We received 1 submission from ECA, which we have published on our website.[5]

The ECA is generally supportive of developing new capabilities to accommodate the demands of the energy transition but wants to see further evidence, such as through a cost-benefit analysis, demonstrating that the options have net benefits in the best interests of residential and small business energy consumers. The ECA also requested that the volatility of wholesale price should be part of this assessment, as well as estimating the likelihood that savings would be passed on to consumers.

Transgrid engaged with the ECA following its submission and discussed the types of consumer benefits delivered by the project along with the approach to quantifying the benefits. In addition, Transgrid notes that many of these benefits quantified under the case studies will accrue directly to consumers and small businesses – Transgrid and the TAC are developing a summary document that sets out these benefits, which will be released shortly after this PADR. This separate summary of the consumer benefits has been prepared as a direct result of the ECA request to make this information more transparent.[6]

On 21 November 2024, the requirements set out in the AER's RIT-T Application Guidelines were amended. The amended guidelines now expect a RIT-T proponent to explicitly consider community engagement and social licence during the RIT-T process.

Under the transitional provisions, the new guideline requirements do not apply to this RIT-T.[7] Notwithstanding, we note that community engagement and social licence considerations are not expected to be relevant to this project since the investments proposed will take place in Transgrid's control rooms and corporate offices. Accordingly, no specific community is expected to be affected by the proposed investments.

Two credible options have been assessed in the PADR

Transgrid has investigated and considered alternative options for improving our control systems and corporate office capabilities. This has involved extensive investigation and planning by our internal teams, as well as the commissioning of expert input from independent international and Australian experts (Electric Power Research Institute (EPRI) and GHD Advisory). It has also been informed and refined through a comprehensive market testing process.

We have identified two credible options from a technical, commercial, and project delivery perspective, i.e.:

[5] *ECA, System Security Roadmap Operational Technology upgrades PSCR submission, 15 January 2025, available at: https://www.transgrid.com.au/media/aalnhz2i/system-security-roadmap-operational-technology-upgrades-pscr-submission-eca.pdf*

[6] The consumer benefits explainer is available on the consultation page, available at: https://www.transgrid.com.au/projects-innovation/.

[7] The new guidelines do not apply to any RIT-T project where a PSCR was published prior to 21 November 2024. The PSCR for this RIT-T was published on 14 October 2024.

- Option 1: **Reactive capability –** provides enhancements to Transgrid's existing core operational technology and tools to improve the reactive capabilities of Transgrid's control room and corporate offices; and
- Option 2: **Proactive capability –** provides further, moderate enhancements to Transgrid's existing operational technology and tools, in addition to several new capabilities, so that Transgrid can proactively plan for, and respond to, operational issues across its control room and corporate offices.

Option 2 includes the initiatives and capabilities in Option 1, typically at a higher level of technical uplift. In other words, Option 2 increases in scope, capability and the degree of technical uplift for each of these capabilities. The implementation of technology initiatives under each option is staged to prioritise initiatives that deliver the highest immediate net benefits, and defer investments that can be implemented in the future.

The two options have been developed as packages to reflect the minimum incremental technology solution required to enable a defined level of capability (i.e., reactive or proactive). As a result, partial implementation of either option would not result in the intended capability uplift under each option being achieved, and so would not provide the benefits of avoided unserved energy, fuel costs and greenhouse gas emissions identified. The scope and timing of these two options has been further tested and refined in the light of responses to the RFI – we discuss this further in the PADR.

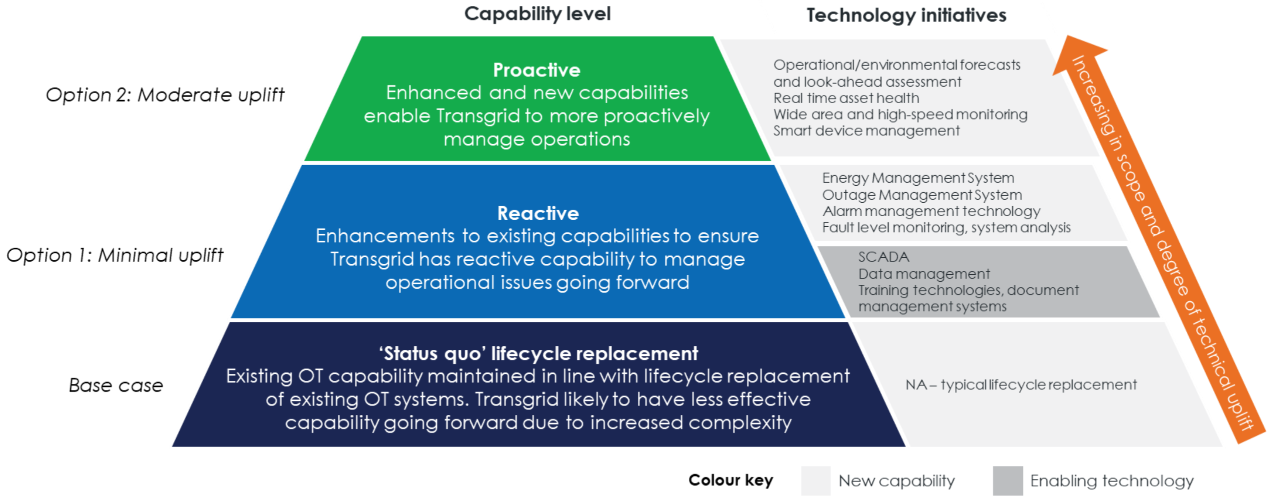
In the PSCR, we also identified a third option, i.e., Option 3: **Predictive capability** – this option would have provided a suite of advanced enhancements to existing capabilities, as well as adding advanced new capabilities, to enable Transgrid to employ a predictive approach to operations in our control room and corporate offices. However, in responses to the RFI, vendors indicated that the desired levels of capability uplift within Option 3:

- whilst well aligned with industry and software product roadmaps, had high degrees of cost and functional uncertainty;
- had significantly higher costs (i.e., more than triple) compared to Transgrid's preliminary estimates in the PSCR and compared to the cost escalation for the other options between the PSCR and PADR; and
- could not be delivered in a similar timeframe to Option 2 (i.e., would take significantly longer to deliver).

Accordingly, Transgrid does not currently consider Option 3 technically and commercially feasible. However, because each option builds upon the previous option, the proposed technology architecture for Options 1 and 2 will still enable Transgrid to readily scale and take advantage of new functionality sought within Option 3 at a future date, if there are net market benefits in doing so.

The differing features of the two credible options are illustrated in Figure E-1.1 below, which summarises the key characteristics of the options, in terms of the capabilities, associated technology and the extent of technical uplift.

Figure E.1.1: Option capability-technology pyramid for operational tools



Note: In addition to the technology initiatives identified above, operational planning sits across several of the technology initiatives as an enabling and complementary function.

We present the estimated capital expenditure for upgrades to our operational technologies and tools under each option in Table E.1 below.

Table E.1 Summary of estimated capital expenditure ($m $2024/25).

	Estimated capital expenditure
Option 1	123.1
Option 2	179.2

As Transgrid is undertaking this RIT-T over a 15-year assessment period, to capture the full benefit realisation period, and because the economic life of operational technologies and tools is typically between 5 and 7 years, we have assumed indicative refresh costs for each of the initiatives at the end of their economic life in both the base case and option cases. There is significant uncertainty for the value of any refresh costs. For the purposes of this RIT-T, Transgrid has conservatively assumed equal costs of replacement in real terms at the end of the economic life of the assets. We considered five additional options, including the potential for non-network options, to meet the identified need in this RIT-T. However, these options were not progressed as they were not considered to be commercially and technically feasible to assist with meeting the identified need for this RIT-T (discussed further in the PADR).

Both options are expected to deliver significant economic benefits

Upgrades to Transgrid's operational tools represent a step change in control room capabilities, which is expected to provide a broad range of benefits that accrue to consumers.

The market benefits of operational technologies and tools are not typically quantified through the RIT-T process, and are difficult to measure. This is because, unlike the benefits from specific network augmentation or network replacement expenditure (which are the most typical investments subject to the RIT-T) which have a specific, traceable impact on electricity network operation, the benefits from operational technologies and tools accrue across the network through improved system reliability, market efficiency and utilisation.

Accordingly, the approach to quantifying the benefits from operational technologies and tools needs to be different to that taken for network investments. We have adopted a 'case study' approach to estimate a subset of the market benefits from each option compared to the base case to showcase the improved operational capability benefits from specific operational technologies and tools.

The case study approach is a transparent and tractable method of quantifying the market benefits from upgrades to Transgrid's operational tools. The case studies link technology upgrades to specific, distinct outcomes and market benefits that result from that uplift in operational capabilities. Rather than attempt a broad calculation of all possible benefits, we've focused on three specific case studies where we can make transparent assumptions about the change in outcomes that we expect to be achieved under each option, and have estimated the benefits associated with these case studies.

Our case study approach represents a conservative approach to quantifying the market benefits, as we:

- only quantify a subset of the total market benefits that are likely to accrue from this project, focusing on case studies that result in market benefits that can be estimated simply and tractably using a set of transparent assumptions; and
- have made reasonable assumptions where there is uncertainty to ensure that we have not overestimated the benefits of these investments.

Whilst the full range of benefits associated with the options is difficult to measure in dollars, the options are expected to create real value through improved operations, enhanced staff capabilities and their contribution to meeting regulatory requirements.

We have estimated benefits under three case studies, i.e.:

- **Case study 1**: reduction in the likelihood of unserved energy compared to the base case, as a result of better situational awareness in the control room which we have quantified using alarm volumes and a cognitive load threshold for control room operators;
- **Case study 2**: increased network utilisation arising from less conservative operation of the network, which we have quantified based on a reduction in the impact of constraints applied on inverter constraints; and
- **Case study 3**: improved outage management through a reduction in switching time in the event that an outage occurs.

Table E.2 summaries these case studies.

Table E.2: Summary of market benefit case studies estimated in this RIT-T

ID	Case study	Benefit driver
Case study 1	Reduction in the likelihood of unserved energy	Early detection and intervention for faults reduces the probability of an event escalating to an outage event with unserved energy, as well as the need to operate the network more conservatively and take assets offline. This outcome arises from better visibility of asset conditions and network fault levels, prioritisation of information and supported decision making, which together reduces the cognitive load on control room operators in a complex operating environment. This RIT-T only quantifies the benefits related to the reduction in the likelihood of unserved energy and does not quantify any additional benefits from reduced risk of asset failure or less conservative network operation.

Case study 2	Increase in network utilisation	Alleviating pre-emptive and conservative constraints on generators through real-time and near-term network analysis replacing static scenario measurements. This facilitates less conservative network asset utilisation by updating operating limits and providing the ability to operate closer to the power system's technical envelope.
Case study 3	Reduction in the duration of outages	Reduction in planned outage duration associated with switching operations through enhanced ability to better coordinate switching operations and new tools to verify equipment/safety status.

We have estimated the gross market benefit for each option under each case study for each of the ISP scenarios. Table E.3 below presents the present value of the gross market benefits for each option under each case study, and in total, on a weighted basis across the three ISP scenarios. This shows that significant benefits for Option 2 are delivered under all three case studies, and in particular that the additional technologies enabling increased network utilisation under Option 2 deliver substantial additional benefits compared to Option 1.

Table E.3: Present value of gross market benefits by case study ($m, PV)

Case study	Option 1	Option 2
Reduction in the likelihood of outages	123.2	180.3
Increased network utilisation	12.5	68.6
Reduced duration of switching operations	80.6	80.6
Total	216.2	329.5

The net present value analysis identifies Option 2 as the preferred option

The present value of estimated costs for each option are summarised in Table E.4 below. We have assessed the options against a base case where no investment to improve Transgrid's operational technology and tools for use in its control rooms and corporate offices is undertaken. However, consistent with the base case under the RIT-T, we assume a range of economically prudent BAU activities to best maintain our control room capabilities required for compliance with the NER until the end of the assessment period will occur, including a lifecycle, non-enhanced replacement of our SCADA/EMS system by June 2030. Because we have undertaken a 15-year assessment for this RIT-T to capture the full benefit realisation period, these options include refresh costs for technologies to 2039.

Table E.4: Net Present value of capital and operating costs by option (present value, $ millions)

	Capital costs	Operating costs	Total costs
Option 1	115.6	34.1	149.8
Option 2	169.4	48.8	218.2

In Table E.5 below, we set out the net present value (NPV) for each option across the three scenarios modelled, and on a weighted basis. The analysis shows that both options are expected to deliver net benefits across all three ISP scenarios. On a weighted basis, Option 2 is expected to deliver a NPV of $111.3 million, compared with $66.5 million for Option 1.

Table E.5: Net present value of options compared to base case (present value, $ millions)

	Progressive change	Step change	Green energy exports	Weighted NPV	Rank
Option 1	34.8	76.8	125.5	66.5	2
Option 2	43.0	140.8	218.1	111.3	1

We have also undertaken sensitivity testing to examine how the net economic benefit of the credible options changes with respect to changes in key assumptions, including changes to costs, the total amount of benefits realised, and the discount rate. The results of the sensitivity analysis show that no reasonable change in key assumptions would result in Option 2 no longer being the preferred option or failing to deliver positive net market benefits over the evaluation period. In particular, we find that a 1 year delay in the delivery of the preferred option (Option 2) would result in a $19.4 million decrease in net market benefits.[8]

Given the above, Option 2 is the preferred option at this draft stage, because it is the credible option that maximises the net present value of the net economic benefit (in accordance with NER clause 5.15A.2(b)(12)).

Submissions and next steps

We welcome written submissions on materials contained in this PADR. Submissions are due on 24 June 2025.

Submissions should be emailed to our Regulation team via regulatory.consultation@transgrid.com.au.[9] In the subject field, please reference 'System Security Roadmap Operational Technology upgrades PADR'.

At the conclusion of the consultation process, all submissions received will be published on our website. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement. Subject to what is proposed in submissions to this PADR, we anticipate publication of a PACR by second half of 2025. This section outlines our case study approach for calculating gross market benefits for each of the credible options identified in this RIT-T, compared to the base case, across the three ISP scenarios. It also presents the outcome of that calculation.

We present gross market benefits only (i.e., exclusive of investment cost) in this section, for each of the case studies and under each of the ISP scenarios. The costs and net benefits of each option are further in the PADR. Detailed assumptions used to calculate the benefits are set out in Appendix B.

[8] We discuss this in further detail in the PADR.

[9] Transgrid is bound by the Privacy Act 1988 (Cth). In making submissions in response to this consultation process, Transgrid will collect and hold your personal information such as your name, email address, employer and phone number for the purpose of receiving and following up on your submissions. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement. See Privacy Notice within the Disclaimer for more details.