Dear Sir/Madam,

Please find attached our submission in response to the Australian Energy Regulator's consultation on Transgrid's System Strength Project 2026-31 Hybrid Revenue Proposal (AER reference: AER24010395).

This submission provides targeted technical and regulatory feedback to support the AER's assessment of the proposed hybrid revenue determination under the NSW Electricity Infrastructure Investment Act 2020 and associated regulatory framework. The submission recognises the growing importance of system-strength investment in the National Electricity Market (NEM) as synchronous generation retires and inverter-based resources, including renewable generation and battery systems, become increasingly central to system operation.

The submission does not oppose the need for the System Strength Project or the broader NSW Priority Network Infrastructure Project direction. Rather, it focuses on how uncertainty, adjustment mechanisms, technology assumptions, hybrid cost-recovery pathways, and long-term consumer exposure should be assessed within increasingly complex and inverter-dominated electricity systems.

In particular, the submission examines issues relating to regulatory observability, transparency of contestable and non-contestable recovery pathways, residual-risk treatment, labour-escalation uncertainty, technology-readiness assumptions, post-commissioning visibility, and lifecycle consumer-risk exposure. It also considers the broader governance implications of hybrid revenue determinations as similar energy-transition infrastructure projects become more common across the NEM.

The submission aims to support the AER's preliminary position paper and subsequent determination process by identifying areas where integrated reporting, adaptive governance, and long-term transparency may strengthen regulatory robustness while preserving delivery flexibility under evolving system conditions. Because apparently the modern energy transition now requires regulators to simultaneously oversee electrical stability, transport logistics for 850-kilometre synchronous condenser deployment, probabilistic risk allocation, and the emotional wellbeing of spreadsheets.

We appreciate the opportunity to contribute to this consultation and would welcome any further discussion or clarification if required.

Yours sincerely,
Associate Professor Saman A. Gorji, PhD, SMIEEE, FHEA

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Title

Regulatory Observability, Technology Uncertainty and Consumer-Risk Control in Transgrid's System Strength Project Hybrid Revenue Proposal

Submission to the Australian Energy Regulator (AER)

Consultation:
System Strength Project Hybrid Revenue Proposal

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Submission Context

This submission is prepared within the broader research activities of the Centre for Smart Power and Energy Research (CSPER), Deakin University, relating to inverter-dominated electricity systems, regulatory observability, system operability, infrastructure uncertainty, and condition-aware energy-system governance. It builds on recent CSPER contributions to the AER Annual Information Orders, Framework and Approach consultation, and AEMO ISP consultation, together with ongoing work on inverter modelling, grid-forming technologies, converter-dominated systems, and low-inertia operability.

The submission does not oppose system-strength investment or the NSW PNIP direction. Rather, it focuses on transparency, uncertainty treatment, technology-assumption disclosure, consumer-risk visibility, and the long-term robustness of hybrid revenue determinations under evolving operating conditions. In this respect, the System Strength Project is treated not only as a major system-security investment, but also as an important governance precedent for future hybrid infrastructure regulation in increasingly complex and inverter-dominated electricity systems. Apparently the energy transition now requires regulators to simultaneously understand engineering physics, evolving inverter behaviour, procurement risk, financial governance, and future operability uncertainty. Entirely reasonable expectation for a consultation process, naturally.

Executive Summary

i. Context

The National Electricity Market (NEM) is undergoing rapid structural transition driven by:

- retirement of synchronous coal generation;
- increasing inverter-based renewable penetration;
- Renewable Energy Zone (REZ) development;
- declining system fault-current capability;
- and increasingly complex operability conditions.

These changes are materially increasing system-strength requirements across New South Wales. Transgrid's System Strength Project proposes synchronous condensers across multiple NSW locations under the PNIP framework and represents one of the earliest major applications of the AER's hybrid revenue-determination framework. Hence, the project carries both:

- system-security significance;
- and broader regulatory-governance significance.

ii. Position of this submission

This submission:

- supports maintaining adequate system strength;
- supports timely infrastructure delivery;
- acknowledges the urgency associated with coal retirement and renewable integration;
- and recognises the operational importance of synchronous condensers under current conditions.

However, the submission argues that the central regulatory issue is not whether system strength is required.

The central issue is whether the proposed hybrid framework:

- adequately exposes uncertainty;
- maintains transparency over consumer-risk exposure;
- avoids overlapping recovery pathways;
- and remains robust under evolving technological and delivery conditions.

iii. Core observations

A. Hybrid determinations create new visibility challenges

The proposal combines:

- contestable procurement;
- non-contestable expenditure;
- risk allowances;
- escalation assumptions;
- and contingent adjustment mechanisms within a single determination structure.

This may fragment visibility across multiple recovery pathways.

B. Technology assumptions increasingly become policy assumptions

Future system operability depends on:

- evolving inverter capability;
- grid-forming technologies;
- hybrid architectures;
- and changing operational standards.

Planning assumptions therefore increasingly influence long-term investment and regulatory outcomes.

C. Approved expenditure does not automatically guarantee operational outcomes

Future system-strength performance depends on:

- commissioning quality;
- inverter interaction;
- operational integration;
- and evolving network conditions, not only physical asset delivery.

D. Consumer exposure may become layered and difficult to interpret

The proposal contains multiple contingent recovery pathways, including:

- transport adjustments;
- residual-risk allowances;
- escalation treatment;
- and contract variation mechanisms.

Individually reasonable mechanisms may collectively create unclear consumer exposure.

E. Future regulation increasingly requires adaptive governance

Future hybrid infrastructure projects are likely to become more common under accelerated energy-transition conditions. This increases the importance of:

- lifecycle transparency;
- post-implementation observability;
- adaptive governance;
- and cumulative risk visibility.

iv. Summary table of key issues

Table 1 outlines the major areas of uncertainty, transparency challenges, and evolving governance risks associated with hybrid infrastructure regulation under high-inverter energy-transition conditions, together with proposed regulatory and reporting responses intended to improve lifecycle observability, consumer accountability, and adaptive regulatory oversight.

Table 1. Summary of Key Regulatory, Governance, and Consumer-Exposure Issues Identified in the System Strength Project Hybrid Revenue Determination Framework.

Area	Key issue	Regulatory concern	Suggested response
Hybrid structure	Multiple recovery pathways	Fragmented consumer visibility	Integrated exposure reporting
Contestable vs non-contestable costs	Different assessment frameworks	Inconsistent transparency	Unified reporting architecture
Adjustment mechanisms	Transport, OEM, D&C variations	Layered contingent recovery	Cumulative adjustment map
Residual-risk allowance	P50 uncertainty treatment	Potential overlap with contingencies	Risk-to-recovery mapping
Technology assumptions	Evolving GFM and inverter capability	Planning assumptions become policy assumptions	Technology-assumption disclosure
Deliverability	Approved spend ≠ realised operability	Performance uncertainty	Post-commissioning reporting
Operability	Weak-grid and inverter interaction	Dynamic future system conditions	Adaptive review pathways
Labour escalation	Capability shortages and market pressure	Escalation uncertainty	Transparent escalation categorisation
Indirect costs	Capex/opex boundary blurring	Difficult cost attribution	Allocation-logic disclosure
Commissioning	Multi-site live-system integration	Long-term performance risk	Commissioning transparency
Consumer exposure	Multiple contingent pathways	Poor cumulative visibility	Lifecycle exposure reporting
Governance	First major hybrid precedent	Future regulatory implications	Best-practice hybrid governance framework

v. Main recommendations

This submission recommends that the AER:

1. Maintain strong scrutiny of cumulative consumer exposure.
2. Require integrated reporting of all adjustment mechanisms and contingent recovery pathways.
3. Introduce risk-to-recovery mapping across all major uncertainty categories.
4. Improve visibility of technology, operability, and deployment assumptions.
5. Strengthen transparency regarding indirect and non-contestable costs.
6. Improve labour-escalation and market-capacity reporting.
7. Introduce post-commissioning observability reporting.
8. Use this project to establish best-practice hybrid governance principles for future energy-transition infrastructure regulation.

In summary, this submission argues that future regulatory robustness increasingly depends not only on approving infrastructure efficiently, but also on maintaining visibility over how:

- uncertainty evolves;
- risks are allocated;
- assumptions change;
- and consumer exposure develops over time.

1. Introduction

This section introduces the purpose, scope, and regulatory context of the submission, with emphasis on hybrid revenue determinations, regulatory observability, uncertainty treatment, and consumer-risk exposure under increasingly inverter-dominated electricity-system conditions.

1.1 Purpose of the submission

This submission responds to the Australian Energy Regulator's (AER) consultation on Transgrid's System Strength Project 2026-31 Hybrid Revenue Proposal [1]. It recognises the growing importance of system strength within the National Electricity Market (NEM) as synchronous generation retires and inverter-based resources become increasingly dominant. AEMO defines system strength as the ability of the power system to maintain and control the voltage waveform during normal operation and disturbances [2].

The submission does not dispute the need for system-strength investment in New South Wales. Rather, it provides technical and regulatory feedback regarding prudency, efficiency, transparency, and consumer-risk visibility under the project's hybrid revenue-determination framework combining contestable and non-contestable elements [3]. Moreover, it builds on previous CSPER work relating to regulatory observability and inverter-dominated system planning [4, 5], arguing that the key regulatory issue is not only whether individual expenditures appear reasonable, but also whether the broader structure of assumptions, risks, contingencies, and recovery pathways remains sufficiently transparent for regulators and consumers to understand how future consumer exposure may evolve over time.

1.2 Scope

This submission does not challenge the Ministerial Priority Network Infrastructure Project (PNIP) direction itself. The System Strength Project has been directed under the NSW Electricity Infrastructure Investment framework established through the Electricity Infrastructure Investment Act 2020 (NSW) and associated regulations. Transgrid's proposal states that the PNIP Direction defines the scope, timing, contractual structure, and delivery obligations of the project [6].

Moreover, this submission does not oppose synchronous condensers as a technology. Synchronous condensers are a recognised source of system-strength support within the NEM, and both AEMO and the AER identify synchronous condensers and grid-forming inverter technologies as relevant approaches for addressing future system-strength requirements [7]. Moreover, the AER's determination on the Transgrid NSW system-strength RIT-T recognised synchronous condensers as part of the least-cost portfolio for maintaining minimum system-strength requirements, while also acknowledging the increasing role of grid-forming batteries within future portfolios [8].

Instead, this submission focuses on the regulatory and governance issues that remain important even where project need and broad technology pathways have already been established. In particular, the submission focuses on:

- how hybrid determinations should manage transparency and accountability;
- how uncertainty should be identified, allocated, and reported;
- how adjustment mechanisms should be assessed individually and cumulatively;
- how the AER can maintain visibility over consumer exposure;
- how non-contestable expenditure, risk allowances, escalation assumptions, and contingent recovery mechanisms should be tested for overlap or duplication; and
- how post-commissioning reporting can improve visibility of actual project outcomes and realised system-strength performance.

This focus is consistent with the AER's broader system-strength guidance, which recognises that System Strength Service Providers are required to use reasonable endeavours to meet system-strength standards, but that system strength is not intended to be procured at unlimited cost or without consideration of efficiency and practicality [7]. Consequently, prudency and efficiency must be assessed not only in terms of technical need, but also in terms of uncertainty allocation, transparency, timing risk, and consumer protection.

1.3 Why this matters

The System Strength Project is significant not only due to its role in supporting system security, but also because it represents one of the earliest large-scale applications of the hybrid revenue-determination framework under the NSW Electricity Infrastructure Investment regime [9]. Transgrid's proposal combines contestable elements, including OEM, D&C, and long-term service contracts, with non-contestable components such as internal labour, indirect costs, operations, and maintenance [6]. While hybrid structures may support accelerated infrastructure delivery, they can also fragment visibility across multiple cost-recovery pathways, adjustment mechanisms, escalation treatments, and contingent recovery arrangements.

This issue is particularly important because uncertainty is embedded throughout the project, including transport logistics, delivery timing, labour-market conditions, technology readiness, and operability assumptions [6]. Therefore, the proposal includes several adjustment mechanisms associated with uncertain transport and delivery requirements. Although such uncertainty is not unusual in major infrastructure projects, the key regulatory issue is whether the cumulative interaction of expenditure forecasts, risk allowances, adjustment pathways, and contingent recovery mechanisms remains sufficiently transparent for the AER and consumers to understand the overall exposure profile.

AEMO and the AER both recognise that future system-strength requirements will depend on evolving inverter behaviour, operational conditions, and technology deployment pathways [7, 10]. Consequently, the AER's assessment should extend beyond individual expenditure categories and consider whether the broader recovery architecture preserves both delivery flexibility and long-term regulatory accountability. In this respect, the System Strength Project represents not only a system-security investment, but also an important governance precedent for future hybrid energy-transition infrastructure regulation.

2. System Strength in a High-Inverter Electricity System

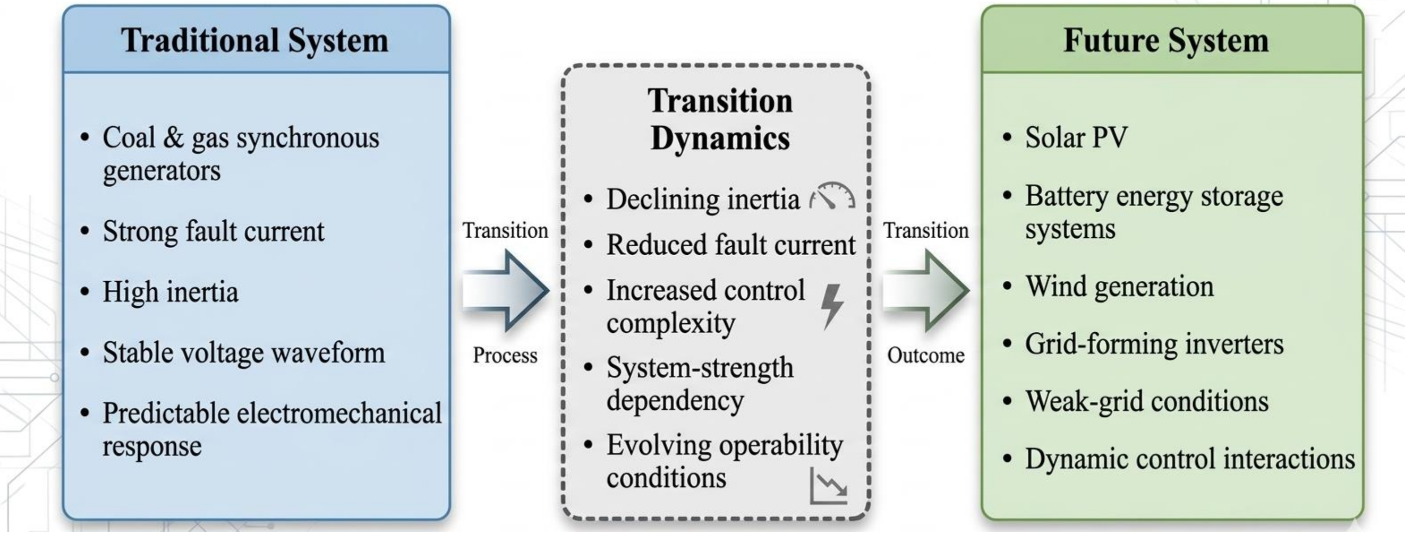
This section examines the evolving role of system strength within the National Electricity Market under increasing inverter-based operation. It discusses the transition from synchronous-dominated systems toward high-inverter conditions, the growing importance of system-strength services for secure operability, and the emerging technological and regulatory uncertainties associated with future system-strength pathways.

2.1 Transition in system behaviour

The National Electricity Market (NEM) is undergoing a major transition from a system historically dominated by synchronous generators toward one increasingly characterised by inverter-based resources such as solar PV, battery storage, and inverter-connected wind generation. As synchronous coal and gas generation retires, traditional stabilising services including inertia, fault-current contribution, voltage support, and waveform stability are becoming less available unless replaced through dedicated technologies or advanced inverter functionality [10]. This transition is particularly significant in New South Wales, where declining synchronous generation is expected to weaken system strength and fault-level conditions unless remedial investment is undertaken [6, 11].

At the same time, inverter-based resources are fundamentally changing system behaviour. Conventional grid-following inverters depend on stable voltage waveforms for operation and may exhibit increasingly complex interactions under weak-grid conditions, including oscillatory behaviour, voltage instability, and reduced fault recoverability [12, 13]. Consequently, future operability challenges extend beyond energy balancing and increasingly involve maintaining stable operation, disturbance response, fault performance, and coordinated control under highly inverter-dominated conditions [14, 15].

Recent CSPER work has similarly highlighted that simplified assumptions regarding inverter behaviour and installed renewable capacity may influence planning outcomes, expenditure assessment, and perceived system operability under stressed conditions [5, 16]. Accordingly, the NEM transition represents not merely a change in generation mix, but a deeper shift in system physics, operability requirements, and infrastructure dependency. System strength has therefore become increasingly important as a foundational requirement for maintaining secure and stable operation in future low-inertia electricity systems. Figure 1 conceptually illustrates this transition from synchronous-dominated operation toward increasingly inverter-dominated system conditions.



Traditional System

- Coal & gas synchronous generators
- Strong fault current
- High inertia
- Stable voltage waveform
- Predictable electromechanical response

Transition Dynamics

- Declining inertia
- Reduced fault current
- Increased control complexity
- System-strength dependency
- Evolving operability conditions

Future System

- Solar PV
- Battery energy storage systems
- Wind generation
- Grid-forming inverters
- Weak-grid conditions
- Dynamic control interactions

Figure 1. Transition from Synchronous-Dominated to Inverter-Dominated System Operation

2.2 Why system strength is required

System strength plays a fundamental role in maintaining stable and secure operation of the electricity system by supporting voltage waveform stability, fault-current behaviour, and reliable operation of both synchronous and inverter-based equipment during normal conditions and disturbances. AEMO defines system strength as the ability of the power system to maintain and control the voltage waveform at any network location, including following faults or disturbances [2]. As synchronous generation retires, declining fault-current contribution and weakening network conditions are creating increasing challenges for protection-system performance, inverter stability, voltage control, and disturbance response across the NEM [11].

Under weak-grid conditions, inverter-dominated systems may become more sensitive to oscillations, unstable control interactions, and transient disturbances, particularly where large numbers of inverter-connected resources operate simultaneously [15]. International experience in regions including Texas, South Australia, and parts of Europe has demonstrated that insufficient system strength can contribute to inverter tripping, cascading instability, and reduced fault recoverability [17]. In response, the National Electricity Rules now place explicit obligations on System Strength Service Providers to maintain minimum system-strength standards, reflecting the growing importance of stable voltage conditions, operability, and secure inverter integration within future low-inertia electricity systems [7,18].

Accordingly, this submission recognises that system-strength remediation is necessary under current and projected NEM conditions. Maintaining adequate fault levels, voltage stability, and secure operation will increasingly require dedicated investment, evolving operability frameworks, and coordinated interaction between synchronous infrastructure, inverter technologies, and future grid-forming capabilities.

2.3 Emerging technology pathways

While the need for system-strength remediation is increasingly well established, the technological pathways for delivering these services remain dynamic and continue to evolve. Current approaches increasingly combine traditional network technologies, advanced inverter capabilities, storage integration, and adaptive operational frameworks. Synchronous condensers presently represent one of the most mature and widely deployed solutions because they can provide fault current, inertia, voltage support, and short-term dynamic stability in a manner broadly similar to conventional synchronous generators. Transgrid's proposal identifies synchronous condensers as the primary technology for the NSW System Strength Project, involving ten units across five transmission locations [6]. Similar deployments have also occurred in South Australia, Great Britain, Texas, and parts of Europe to support weak-grid conditions and declining synchronous inertia [19].

At the same time, grid-forming battery systems and advanced inverter technologies are emerging as increasingly important alternatives or complements to synchronous condensers. Unlike conventional grid-following inverters, grid-forming inverters can establish voltage and frequency references independently, enabling them to support stable operation in weaker-grid environments. AEMO's recent work on grid-forming standards highlights growing industry interest in these technologies as part of future operability and system-strength frameworks [20]. However, despite rapid progress, large-scale deployment of grid-forming technologies remains operationally and commercially immature in several respects, including interoperability standards, protection coordination, and system-level operational integration [6].

Consequently, future system-strength provision is likely to depend on hybrid and adaptive combinations of synchronous support, advanced inverter control, storage integration, dynamic reactive support, and evolving technical standards rather than any single technology pathway alone [14,15]. Recent CSPER work similarly highlights that technology assumptions embedded within planning and regulatory frameworks may become increasingly policy-relevant as converter-dominated systems and grid-forming technologies continue to evolve [5].

2.4 Key observation

This submission accepts the need for system-strength remediation within the evolving NEM. The retirement of synchronous generation, combined with increasing penetrations of inverter-based resources, creates genuine and growing system-strength challenges that require timely investment and operational adaptation.

At the same time, the technological pathways through which system strength will ultimately be provided remain dynamic and uncertainty-sensitive. Synchronous condensers currently provide a mature and proven solution, particularly under present system conditions and regulatory timeframes. However, grid-forming inverter technologies, battery systems, hybrid architectures, and evolving operability frameworks continue to develop rapidly and may increasingly influence future system-strength provision, investment pathways, and network operation.

For this reason, system-strength regulation should not only assess whether proposed investments are technically justified under current conditions. It should also maintain transparency regarding the assumptions, uncertainties, and evolving technology conditions that shape long-term system operability and future consumer exposure.

3. Hybrid Revenue Determinations and Regulatory Observability

This section examines the regulatory and governance implications of applying hybrid revenue-determination frameworks to large-scale energy-transition infrastructure projects. It focuses on how layered recovery mechanisms, evolving uncertainty, and mixed contestable and non-contestable expenditure structures may affect regulatory observability, consumer-risk transparency, and long-term governance robustness.

3.1 What makes this project different

The System Strength Project is significant not only because of its technical scale and system-security role, but also because it represents one of the earliest major applications of the hybrid revenue-determination framework introduced under the NSW Electricity Infrastructure Investment regime. Unlike conventional transmission determinations under the National Electricity Rules, the proposal combines both contestable and non-contestable project elements within a single regulatory process. The AER's revised guideline explains that hybrid determinations were introduced to accommodate projects containing both competitively procured infrastructure and regulated network-service-provider activities [3]. Accordingly, Transgrid's proposal separates contestable components such as OEM supply contracts, delivery-and-construction contracts, and long-term service agreements from non-contestable expenditure including internal labour, indirect costs, operations, maintenance, and broader delivery-support activities [6, 21].

This creates a materially different regulatory structure from traditional transmission regulation. Under conventional frameworks, expenditure categories are generally assessed within a more unified incentive and cost-recovery model. In contrast, hybrid determinations distribute risk allocation and cost recovery across multiple pathways simultaneously. Some expenditures become effectively fixed through competitive procurement, while others remain forecast-based or may later evolve through adjustment mechanisms, true-ups, and contingent recovery processes. As a result, the System Strength Project should be viewed not only as a technical infrastructure proposal, but also as a significant regulatory precedent that may shape how future large-scale energy-transition projects are assessed under increasingly hybridised procurement and delivery structures.

3.2 Regulatory visibility problem

While hybrid revenue determinations may support accelerated infrastructure delivery and procurement flexibility, they can also create significant challenges for regulatory visibility and consumer transparency. Unlike traditional regulatory frameworks, where forecast costs, incentive arrangements, escalation assumptions, and performance obligations are generally assessed within a more integrated structure, hybrid determinations distribute project costs and risks across multiple pathways governed through different mechanisms and levels of regulatory scrutiny. In the present proposal, visibility may become fragmented across contestable procurement outcomes, non-contestable expenditure forecasts, indirect and shared project costs, risk allowances, transport adjustment mechanisms, escalation assumptions, pass-through arrangements, and ex-post true-up processes.

Transgrid's proposal includes several adjustment and variation mechanisms associated with uncertain project elements, particularly transport and enabling works for synchronous condensers and transformers [6]. While many of these mechanisms may be individually reasonable under compressed delivery conditions, the key regulatory issue is whether their cumulative interaction remains sufficiently transparent for regulators and consumers to understand the overall architecture of consumer exposure. This becomes especially important where different expenditure categories are governed through different regulatory principles, with some costs effectively locked in through approved procurement processes while others remain subject to prudency review, adjustment pathways, or contingent recovery mechanisms.

Consequently, the challenge facing the AER is not simply one of expenditure assessment, but one of regulatory interpretability. International energy-transition literature increasingly recognises that modern infrastructure governance depends on adaptive regulation, uncertainty management, and transparent allocation of evolving risks [22, 23]. In this context, effective regulation requires not only determining whether individual cost categories appear reasonable at approval stage but also ensuring that the broader structure of cost recovery remains understandable, observable, and interpretable throughout the project lifecycle. Modern infrastructure regulation now resembles an archaeological exercise where future regulators must excavate overlapping contingencies, adjustment pathways, and procurement structures to determine where the money actually migrated after approval.

3.3 Observability as a regulatory requirement

The present submission argues that regulatory observability should be treated as an important component of robust economic regulation under increasingly complex energy-transition conditions. In our earlier submission to the AER regarding the Annual Information Orders, we argued that regulatory reporting frameworks influence not only what information is collected, but also what regulators, stakeholders, and consumers are ultimately able to observe, compare, benchmark, and interpret within the electricity system [4]. Where important operating conditions, assumptions, or allocation mechanisms are not visible within reporting structures, they may continue shaping regulatory outcomes without remaining easily interpretable afterward.

The same principle applies to hybrid revenue determinations. Regulatory robustness depends not only on cost efficiency, but also on whether the pathways through which costs, risks, and performance evolve remain observable over time. This becomes increasingly important under conditions of high infrastructure uncertainty, evolving technology pathways, contingent adjustment mechanisms, multi-stage procurement structures, and accelerated energy-transition delivery frameworks. In such environments, transparency cannot be reduced merely to disclosure of headline capital expenditure values. Meaningful transparency increasingly depends on whether regulators, consumers, and stakeholders can understand how risks are allocated, how contingent costs emerge, how assumptions evolve, how recovery mechanisms interact, and how final consumer exposure may differ from initial forecast values.

This issue is particularly important in hybrid regulatory structures where expenditure categories may be governed simultaneously through different assessment methodologies, contractual arrangements, and recovery pathways. Without integrated visibility, expenditure interpretation may become fragmented across procurement processes, consultant reports, appendices, adjustment frameworks, and contingent mechanisms. The importance of observability is also reflected indirectly within broader AER and AEMO guidance, both of which increasingly recognise uncertainty associated with future system-strength conditions, inverter behaviour, and evolving operability requirements [7, 10, 14]. Consequently, observability should not be treated as a secondary reporting issue, but as a core regulatory requirement within increasingly dynamic and uncertainty-sensitive electricity systems.

3.4 Recommendation

Given the hybrid and uncertainty-sensitive nature of the System Strength Project, this submission recommends that the AER place particular emphasis on integrated reporting and cumulative transparency across all major recovery pathways associated with the project.

Specifically, the AER should consider requiring:

- integrated reporting of contestable and non-contestable expenditure pathways within a unified consumer-exposure framework;
- transparent identification of how adjustment mechanisms interact with base expenditure allowances and risk contingencies;
- clear separation between forecast expenditure, contingent recovery, escalation treatment, and pass-through-type arrangements;
- annual reporting of triggered adjustment mechanisms and realised cost variations;
- cumulative reporting of consumer exposure across the full project lifecycle rather than isolated assessment of individual mechanisms; and

- post-determination reporting that allows stakeholders to compare forecast assumptions against realised delivery outcomes.

Such reporting would not prevent delivery flexibility or efficient project adaptation under changing conditions. Rather, it would improve transparency regarding how uncertainty is translated into consumer costs over time.

This recommendation is particularly important because hybrid determinations are likely to become increasingly common under accelerated energy-transition frameworks. Establishing strong observability principles early may therefore improve not only the assessment of the present project, but also the long-term robustness and credibility of future hybrid infrastructure regulation.

Modern electricity regulation is increasingly required to manage projects where technical uncertainty, delivery complexity, evolving technology capability, and multi-layered contractual arrangements coexist simultaneously. Under these conditions, maintaining visibility over how costs and risks evolve may become just as important as assessing the initial expenditure forecast itself.

Figure 2 illustrates the conceptual architecture of the hybrid revenue determination framework applied to the System Strength Project. The figure shows how contestable and non-contestable expenditure, risk allowances, escalation assumptions, transport uncertainty, and contract variations interact with multiple recovery mechanisms, including adjustment pathways, true-ups, insurance recovery, and residual-risk treatment. It highlights the potential fragmentation of regulatory visibility and demonstrates how layered recovery structures may collectively influence consumer exposure, lifecycle uncertainty, and long-term regulatory observability under evolving energy-transition conditions.

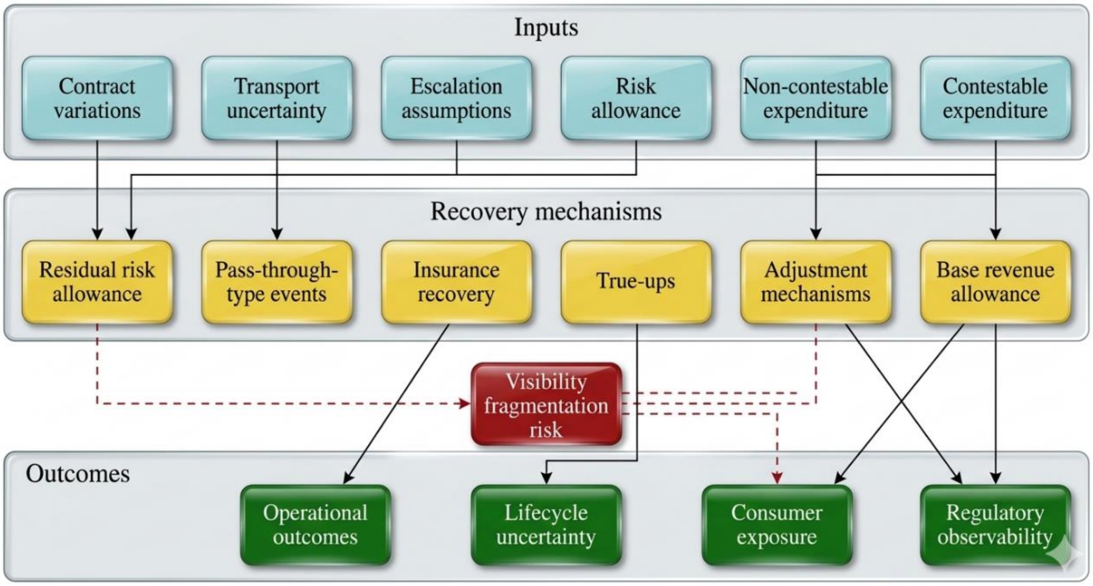


Figure 2. Hybrid Revenue Determination Architecture and Consumer Exposure Pathways

4. Technology Uncertainty and Planning Assumptions

This section examines how evolving inverter technologies, grid-forming capability, and changing operability frameworks are reshaping system-strength planning within the National Electricity Market. It focuses on the growing interaction between technology uncertainty, planning assumptions, and long-term regulatory decision-making, particularly under increasingly inverter-dominated and dynamically evolving power-system conditions.

4.1 Syncons and evolving inverter technologies

The current System Strength Project has been developed during a period of rapid technological transition in power-system operation, particularly regarding inverter-based resources and emerging grid-forming capabilities. While synchronous condensers currently represent one of the most mature and operationally established approaches for delivering system-strength services, the broader technology landscape remains dynamic and continues to evolve. Transgrid's proposal identifies synchronous condensers as the preferred near-term technology pathway for addressing declining synchronous generation and increasing renewable penetration in New South Wales [6]. Their advantages include strong fault-current contribution, voltage support, inertia-like behaviour, and compatibility with existing protection frameworks, making them attractive for deployment under compressed delivery timeframes.

At the same time, advanced inverter technologies, particularly grid-forming battery systems, are emerging as increasingly important components of future system-strength provision. Unlike conventional grid-following inverters, grid-forming inverters can establish voltage and frequency references independently and may contribute directly to voltage stability, low-inertia operability, and broader system security. AEMO's Grid-Forming Technology Access Standards Approach Paper highlights the growing importance of grid-forming capability as the NEM transitions toward higher penetrations of inverter-based resources [20]. However, practical deployment of these technologies remains operationally and commercially uncertain in several respects, including interoperability standards, protection coordination, operational hierarchies, and large-scale system integration [14, 15].

Consequently, future system-strength provision is unlikely to rely exclusively on any single technology pathway. International experience and recent CSPER research increasingly indicate that future low-inertia systems may depend on coordinated combinations of synchronous condensers, grid-forming batteries, fast-response storage, advanced inverter control, synthetic inertia support, and adaptive protection frameworks rather than traditional single-function stability assets alone [23]. While synchronous condensers presently represent a technically mature and reasonable solution under current system conditions, future operability frameworks are likely to evolve alongside rapid advances in inverter capability, storage integration, and coordinated control architectures.

4.2 Planning assumptions become policy assumptions

Under increasingly inverter-dominated power-system conditions, planning assumptions are no longer purely technical simplifications. They increasingly become policy-relevant since they influence expenditure decisions, infrastructure pathways, operability expectations, and long-term consumer outcomes. Future system-strength planning now depends on assumptions regarding inverter capability, grid-forming maturity, deployment timing, interoperability standards, renewable penetration, synchronous-generator retirement pathways, and future operating practices. Once embedded within regulated investment decisions, these assumptions begin shaping technology selection, risk allocation, infrastructure prioritisation, and future cost recovery.

Recent CSPER work similarly highlighted that simplified representations of inverter behaviour may propagate into economically and operationally significant outcomes when embedded within long-term planning frameworks. Assumptions regarding technology maturity, inverter capability, and future operability may therefore influence not only near-term investment decisions, but also long-term regulatory and infrastructure pathways. For example, assumptions regarding limited grid-forming maturity may justify current synchronous-condenser investment, while future assumptions regarding interoperability and deployment capability may determine how long such assets remain central within system-strength portfolios [10,18].

This does not imply that current investment decisions are inappropriate. Rather, it highlights the importance of maintaining transparency regarding uncertain or evolving assumptions embedded within regulatory and planning frameworks. Figure 3 conceptually illustrates the evolving landscape of system-strength technologies and operability frameworks, showing how synchronous condensers, grid-forming technologies, hybrid architectures, advanced protection systems, and adaptive control frameworks may evolve simultaneously under conditions of continuing technological uncertainty.

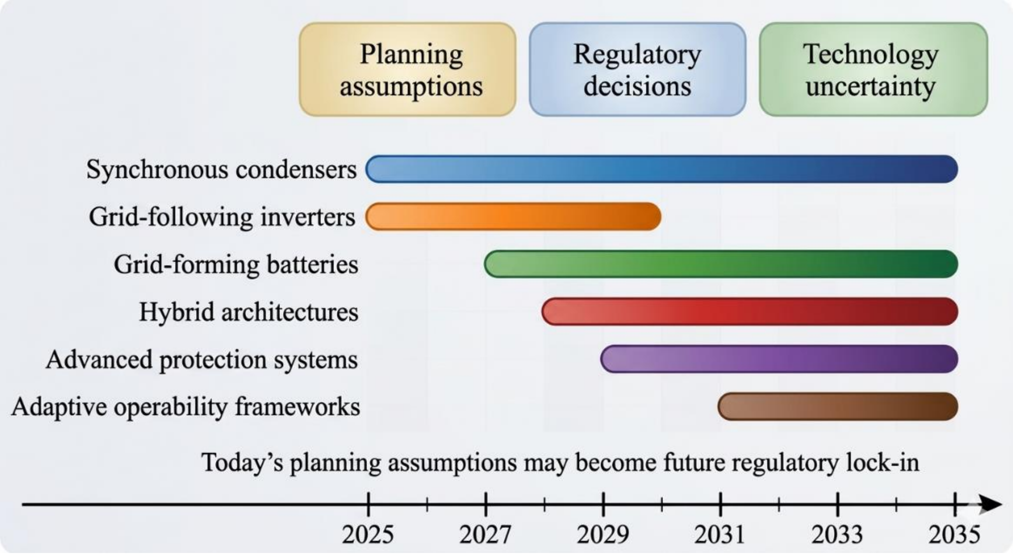


Figure 3. Evolving System-Strength Technology Pathways Under High-Inverter Conditions

4.3 Importance of transparency

Given the increasing uncertainty associated with future inverter capability and system operability, transparency regarding planning assumptions is becoming increasingly important within system-strength regulation. Many future system-strength assessments now depend on assumptions regarding technology maturity, deployment timing, inverter capability, renewable integration pathways, operational coordination frameworks, and evolving control standards. While such assumptions are necessary for planning and modelling, they also introduce uncertainty because these conditions may change materially over the operational life of the infrastructure.

These assumptions may be reasonable but once embedded within regulated investment decisions they begin influencing infrastructure pathways, operability expectations, and long-term consumer outcomes. This issue is particularly important under hybrid revenue determinations, where investments extend across long operational timeframes while technology conditions continue evolving rapidly. Without clear disclosure of underlying assumptions, it becomes increasingly difficult to assess whether investment decisions remain robust under changing technological conditions, how future operability expectations may evolve, or how consumer exposure may ultimately be affected.

Accordingly, this submission recommends greater transparency regarding technology, maturity, deployment, and operability assumptions embedded within planning studies and regulatory analysis. Where frameworks assume limited near-term grid-forming capability or uncertain future inverter coordination standards, the basis and limitations of those assumptions should be clearly disclosed rather than remaining implicit within modelling structures. This recommendation aligns with broader international energy-governance trends recognising that future renewable-dominated systems will require adaptive regulatory approaches capable of accommodating evolving technologies and uncertain operational conditions [19]. Because once assumptions disappear quietly into planning models, they tend to return years later disguised as "unexpected system behaviour," which is usually engineering shorthand for "the future ignored the spreadsheet again."

4.4 Recommendation

Given the rapidly evolving nature of inverter capability, system-strength technologies, and future operability frameworks, this submission recommends that the AER adopt a more adaptive and transparency-oriented approach toward technology assumptions embedded within system-strength determinations. In particular, the AER should encourage clearer disclosure of technology-readiness assumptions, explicit explanation of future grid-forming deployment expectations, greater transparency regarding operability assumptions embedded within planning frameworks, post-implementation reporting comparing realised system conditions with planning assumptions, and adaptive review pathways that allow regulatory approaches to evolve alongside technological development.

Post-implementation reporting may become increasingly important as actual system behaviour under high-inverter conditions evolves over time with rising renewable penetration and wider deployment of grid-forming technologies. Improved visibility regarding realised operability conditions, inverter interactions, and system-strength performance could therefore strengthen future regulatory learning and planning robustness. Similarly, adaptive review pathways may help avoid situations where uncertain planning assumptions become effectively fixed despite rapidly changing technological conditions.

This submission therefore recognises the need for current system-strength remediation while also acknowledging that future operability frameworks remain dynamic and uncertainty-sensitive. As inverter capability, storage integration, and coordinated control architectures continue evolving, future system-strength provision is likely to depend on layered combinations of synchronous support, grid-forming resources, advanced control systems, and adaptive operational standards rather than reliance on a single technology pathway alone. Modern power systems, naturally, have chosen the most administratively exhausting evolutionary pathway possible: multiple technologies maturing simultaneously while regulators attempt to make forty-year infrastructure decisions using assumptions that may survive about six conference cycles.

5. Adjustment Mechanisms and Consumer-Risk Exposure

This section examines how adjustment mechanisms, contingent recovery pathways, and layered uncertainty may influence consumer-risk exposure within the System Strength Project's hybrid revenue framework. It focuses on the interaction between transport adjustments, residual-risk allowances, escalation treatment, contract variations, and pass-through-type mechanisms, highlighting the importance of cumulative transparency and integrated risk observability across the project lifecycle. Modern infrastructure regulation has now evolved into the fascinating institutional practice of asking consumers, regulators, contractors, and engineers to collectively track uncertainty as it migrates between spreadsheets under different accounting labels. An extraordinarily peaceful civilisation we have built here.

5.1 Overview

The System Strength Project includes several areas of uncertainty that Transgrid proposes to manage through adjustment mechanisms and related recovery pathways, including transport-related adjustments, OEM variation events, D&C contract adjustments, consequential cost events, insurance-related adjustments, and broader delivery uncertainties associated with the project's accelerated and geographically dispersed delivery structure [6]. The AER has recognised the proposal as a hybrid revenue determination combining contestable and non-contestable components within a single framework [1, 3].

Transport-related uncertainty is particularly significant because the project requires movement of large synchronous condensers and transformers across multiple locations in New South Wales. Transgrid identifies uncertainty associated with transport routes, enabling works, bridge and road modifications, and local-government-related transport activities, resulting in several transport adjustment mechanisms designed to recover costs that could not be fully forecast at determination stage [6]. The proposal also includes contract-related adjustment mechanisms linked to OEM supply, long-term service arrangements, D&C variation events, and residual-risk allowances intended to address uncertainties not fully captured within base forecasts or contractor pricing [24].

Such mechanisms are not unusual in major infrastructure delivery. International infrastructure-governance literature recognises that large-scale projects frequently involve uncertainty, incomplete information, contract variation risk, and escalation exposure [25]. The key regulatory issue, however, is not whether adjustment mechanisms are necessary, but whether the cumulative structure of these mechanisms remains sufficiently transparent, bounded, and observable for the AER and consumers to understand how total consumer exposure may evolve over time. Because once enough "temporary adjustment pathways" accumulate inside one project, the distinction between a revenue determination and a financial escape room starts becoming academically interesting.

5.2 Cumulative exposure issue

Individually, each adjustment mechanism within the System Strength Project may be reasonable. Transport-route uncertainty may justify later true-up processes, OEM variation events may be necessary where contractual conditions change, D&C adjustments may reflect materially different delivery conditions, and insurance or consequential cost events may arise under evolving project circumstances. However, mechanisms that appear reasonable in isolation may collectively create unclear consumer exposure if they are not assessed within a single integrated risk architecture. The central issue is therefore not any individual mechanism itself, but the cumulative interaction of multiple recovery pathways that may progressively shift uncertainty and cost exposure toward consumers.

This issue is well recognised in international infrastructure-governance literature. The World Bank notes that long-term infrastructure arrangements often create contingent liabilities whose timing, magnitude, and occurrence depend on uncertain future events [26, 27]. Although the System Strength Project is not a conventional PPP, the underlying governance issue is similar: contingent obligations may appear limited at approval stage yet become financially material during delivery or operation. Similarly, OECD guidance emphasises that infrastructure projects require transparent risk allocation and lifecycle governance because weak coordination and fragmented recovery structures can reduce visibility over long-term exposure [28].

For the System Strength Project, the cumulative exposure issue is particularly important because the proposal combines competitively procured contestable components, regulated non-contestable expenditure, residual-risk allowances, transport adjustment mechanisms, contract variation pathways, insurance-related recovery arrangements, escalation assumptions, and potential pass-through-type mechanisms within a single hybrid determination framework. While each element may be individually justifiable, their combined interaction can reduce transparency regarding how risks, uncertainties, and consumer exposure ultimately evolve across the project lifecycle. Modern infrastructure regulation, naturally, has evolved into a system where every uncertainty develops its own recovery mechanism, governance pathway, and explanatory appendix until consumer exposure begins resembling a geological sediment layer rather than a financial forecast.

The AER should therefore assess not only whether each mechanism is individually justified, but also whether their combined effect leaves consumers with an insufficiently bounded or poorly observable exposure profile. Figure 4 conceptually illustrates how multiple recovery pathways within the hybrid revenue framework may collectively layer consumer exposure across the project lifecycle, reducing visibility regarding overall risk allocation and long-term consumer exposure under evolving delivery conditions.

Figure 4. Layered Consumer Exposure Across Recovery Mechanisms

5.3 Risk layering problem

A related issue concerns the interaction between base costs, contingency allowances, residual-risk treatment, adjustment mechanisms, and pass-through structures. If these layers are not clearly separated, there is a risk of double recovery, blurred accountability, or inefficient transfer of risk to consumers. In principle, a well-designed revenue determination should clearly distinguish between costs included within the base forecast, contingencies embedded within contractor pricing, residual risks retained by Transgrid, risks covered through insurance, risks managed through adjustment mechanisms, and risks recoverable through pass-through arrangements.

Transgrid's proposal includes a non-contestable risk-cost allowance intended to compensate for residual risks that remain after feasible mitigation measures and are not otherwise recovered through adjustment pathways or the return on capital [24]. This approach is broadly consistent with AER guidance that risk allowances should reflect efficient probability-weighted estimates of residual uncertainty [29]. However, where multiple adjustment mechanisms and contingent recovery pathways also exist, the AER should carefully examine whether the same underlying risk driver is being recovered through more than one mechanism. For example, delivery delays could simultaneously affect contractor pricing, Transgrid labour costs, insurance exposure, transport works, commissioning activities, and broader project-management expenditure. Unless these pathways are clearly mapped, a single uncertainty may progressively reappear across several recovery layers.

This issue is not merely an accounting concern. It also affects incentive design and efficient risk allocation. If risks are transferred too broadly to consumers through adjustment mechanisms or contingent recovery structures, incentives for efficient risk management may weaken. Conversely, inefficient transfer of risks to contractors may increase tender pricing and ultimately raise consumer costs. International infrastructure-governance guidance consistently emphasises that risks should be allocated to the party best positioned to manage them efficiently [22, 25, 30]. The same principle applies here: uncertainty alone does not automatically justify transferring risk to consumers.

Accordingly, the AER should assess the System Strength Project's risk architecture as an integrated whole rather than reviewing each mechanism independently. This includes examining how base expenditure, contingencies, residual-risk allowances, adjustment mechanisms, and pass-through pathways interact across the broader recovery framework. Because once enough partially overlapping risk mechanisms accumulate inside a project, even experienced regulators begin needing archaeological tools to determine which uncertainty was already paid for three appendices earlier.

5.4 Recommendation

This submission recommends that the AER requires Transgrid to provide a cumulative adjustment and consumer-exposure map for the System Strength Project. The map should present, within a single integrated framework, all material recovery pathways associated with the project, including base expenditure allowances, contingencies, residual risk allowances, adjustment mechanisms, contract variations, transport-related true-ups, insurance-related recovery, pass-through-type arrangements, and any excluded or modified incentive mechanisms. This would improve transparency regarding how uncertainty, risk allocation, and contingent recovery interact across the broader project structure over time.

For each recovery pathway, the map should clearly specify whether the associated exposure is capped, uncapped, subject to risk-sharing arrangements, fully borne by consumers, retained by Transgrid, recoverable only following AER approval, or automatically recovered through formulaic true-up mechanisms. This would improve visibility regarding how different forms of uncertainty and contingent recovery are allocated across the project lifecycle.

The AER should also require annual reporting of all triggered adjustment mechanisms during the regulatory period. This reporting should identify the event that triggered the adjustment, the original forecast allowance where applicable, the additional amount claimed or recovered, whether the cost was already partly covered through base expenditure, contingency, insurance, or residual-risk allowances, the party responsible for managing the underlying risk, and the resulting cumulative impact on consumer charges over time.

This recommendation is consistent with international best practice on infrastructure transparency. The CoST Infrastructure Transparency Initiative has emphasised that infrastructure accountability depends on making project information available across the project lifecycle, including cost changes, scope changes, procurement decisions, and implementation performance [31].

It is also consistent with the OECD's emphasis on systematic collection, management, and use of infrastructure evidence to support better public decision-making [32].

Accordingly, the AER should not assess adjustment mechanisms only as separate technical clauses. It should assess them as part of the total consumer-risk architecture of the project. A mechanism may be individually defensible but collectively problematic if it contributes to unclear, uncapped, or poorly observable consumer exposure.

In summary, the AER should require a clear cumulative adjustment exposure map, annual reporting of triggered adjustments, and explicit categorisation of capped, uncapped, shared-risk, and consumer-risk components. This would preserve flexibility for genuine uncertainty while improving accountability over how uncertainty is converted into consumer costs over time.

6. Risk Allowance, Deliverability and Cost Recovery

This section examines how residual-risk allowances, deliverability uncertainty, and long-term operability outcomes interact within the System Strength Project's broader cost-recovery framework. It focuses on the distinction between approved expenditure and realised system performance, highlighting the importance of transparency regarding risk allocation, commissioning quality, operational integration, and post-implementation observability under increasingly inverter-dominated and uncertainty-sensitive operating conditions. Modern infrastructure governance now apparently requires regulators to approve billions in expenditure while simultaneously accepting that actual system behaviour may only become fully understandable after the infrastructure is already operating. A deeply comforting institutional philosophy, naturally.

6.1 Residual risk allowance

In addition to base expenditure forecasts and adjustment mechanisms, the System Strength Project also includes a residual-risk allowance intended to compensate Transgrid for uncertain project risks that remain after feasible mitigation and contractual allocation measures have been applied. Transgrid states that the non-contestable risk allowance was developed using a probability-based P50 methodology designed to estimate residual risks not already incorporated within base costs, contractor pricing, or adjustment pathways [24]. In infrastructure-risk practice, a P50 estimate generally represents a forecast with approximately a 50% probability that actual costs will not exceed the estimated value.

Probabilistic risk methodologies are widely used in major infrastructure delivery where uncertainty relating to logistics, procurement, labour availability, coordination, and timing cannot be fully specified at approval stage [28, 33]. The key regulatory issue, however, is not simply whether a probabilistic methodology has been applied, but whether the interaction between residual-risk treatment, adjustment mechanisms, and broader recovery structures remains sufficiently transparent and bounded.

In the present proposal, delivery uncertainty arises from several interconnected factors, including transport-route uncertainty, geographically dispersed sites, specialist equipment logistics, contractor coordination, live-substation integration, commissioning complexity, labour-market conditions, and evolving operability requirements. While these uncertainties may justify some residual-risk treatment, similar underlying risks may also already be reflected within contractor pricing, contingencies, escalation assumptions, insurance arrangements, and adjustment mechanisms. If these layers are not clearly separated, consumers may find it increasingly difficult to determine which risks are already embedded within base forecasts, which remain allocated to Transgrid, and which may later reappear through contingent recovery pathways.

International infrastructure-governance guidance similarly warns that unclear allocation of residual risk can weaken accountability and reduce visibility regarding long-term financial exposure [30]. Although the System Strength Project operates under a regulated-network framework rather than a conventional PPP structure, the underlying governance concern remains similar: residual uncertainty must remain observable if long-term accountability is to be maintained. Because once the same uncertainty begins appearing simultaneously inside contractor pricing, contingencies, escalation allowances, and adjustment mechanisms, the distinction between “residual risk” and “recreational duplication” starts becoming intellectually blurry.

For this reason, the AER should assess not only the magnitude of the proposed residual-risk allowance, but also how that allowance interacts with the broader project-recovery architecture and existing contingent recovery pathways.

6.2 Deliverability versus approved expenditure

A further issue concerns the relationship between approved expenditure and realised system outcomes. Traditional regulatory assessment can implicitly assume that once expenditure is approved and infrastructure is constructed, the intended operational outcome will naturally follow. However, under increasingly inverter-dominated and uncertainty-sensitive system conditions, this relationship is becoming less direct.

As highlighted in our earlier ISP-related work, installed infrastructure capacity does not necessarily correspond to reliably deliverable capability under real operating conditions [16]. Operational performance increasingly depends on factors such as network conditions, inverter interaction, curtailment exposure, commissioning quality, and broader operability assumptions. Accordingly, approved expenditure alone does not guarantee realised system-strength outcomes.

The System Strength Project involves not only physical asset construction, but also commissioning under evolving network conditions, integration across live transmission environments, interaction with inverter-based resources, and long-term operation within changing operability frameworks. Successful delivery should therefore be assessed not only by construction completion, but also by whether the assets maintain stable operation, expected availability, and reliable system-strength performance over time.

Figure 5 conceptually illustrates this distinction between approved expenditure and realised operability outcomes. The framework highlights that actual system-strength performance depends not only on asset delivery, but also on commissioning quality, weak-grid behaviour, inverter interaction, operational integration, outage performance, and maintenance effectiveness. Infrastructure approval, unfortunately, does not compel physics to cooperate with the original spreadsheet assumptions.

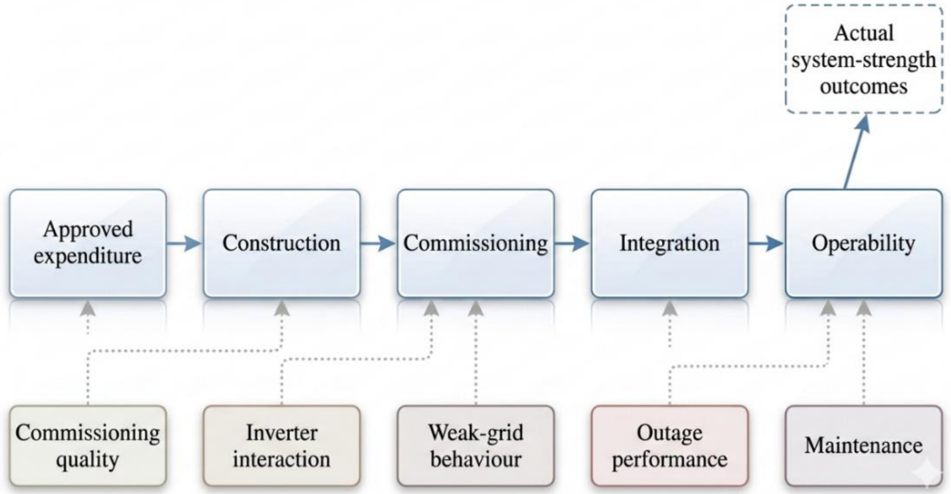


Figure 5. Distinction Between Approved Expenditure and Realised Operability Outcomes

This distinction is increasingly important because future network outcomes are becoming more conditional than deterministic. AEMO’s Engineering Framework and Transition Plan for System Security both emphasise that future system security depends not only on infrastructure investment, but also on coordinated operability, evolving technical standards, and interaction between multiple system services [10, 14]. International infrastructure-governance literature similarly stresses that infrastructure success should be evaluated based on realised operational performance rather than asset completion alone [23, 28].

6.3 Deliverability transparency

Given the increasing complexity of modern power-system operation, this submission recommends stronger transparency regarding how approved expenditure translates into measurable delivery and operability outcomes. While current regulatory assessment appropriately focuses on forecast expenditure efficiency and procurement processes, future regulatory robustness may also require clearer visibility regarding the specific functions expenditure is intended to deliver, how commissioning success will be assessed, and how operational performance will be monitored over time.

Accordingly, the AER should consider requiring stronger linkage between expenditure approval and measurable delivery functions, system-operability outcomes, commissioning readiness, and post-implementation performance. Reporting frameworks could therefore include greater visibility regarding commissioning milestones, achieved fault-level contribution, weak-grid operability performance, interaction with inverter-based resources, operational availability, maintenance-related outages, and realised performance against intended system-strength objectives.

Such reporting would not eliminate uncertainty, nor should it attempt to create unrealistic guarantees regarding future operating conditions. Rather, it would improve transparency regarding whether approved expenditure is translating into the operational outcomes that originally justified the investment. This approach is consistent with broader international infrastructure-governance principles emphasising lifecycle transparency and linkage between expenditure approval and measurable operational outcomes [28, 31].

In the context of the System Strength Project, stronger deliverability transparency may become particularly important because system-strength performance depends on evolving operating conditions, inverter interactions may change over time, and future operability frameworks remain dynamic. Under such conditions, effective infrastructure regulation increasingly requires visibility not only over how money is spent, but also over how intended system functions are ultimately realised.

7. Labour Escalation, Capability Constraints and Market Conditions

This section examines how labour-market constraints, specialist workforce scarcity, and escalation uncertainty may influence delivery risk, commissioning capability, and long-term project costs within the System Strength Project. It highlights the growing importance of distinguishing between unavoidable sector-wide escalation pressures and project-specific delivery inefficiencies, while emphasising the need for transparent escalation reporting and clearer visibility over how capability constraints interact with risk allocation, contingencies, and consumer exposure. The modern energy transition has reached the charming stage where countries simultaneously announce trillion-dollar infrastructure ambitions while quietly discovering that highly specialised power-system engineers cannot, in fact, be manufactured in industrial batches like concrete barriers.

7.1 Specialist workforce constraints

The delivery of the System Strength Project is occurring within an increasingly constrained labour and infrastructure-delivery environment across the Australian energy sector. Beyond equipment procurement and transport complexity, the project depends heavily on the availability of specialised engineering, commissioning, construction, operational, and project-management capability under conditions of simultaneous large-scale energy-transition investment across multiple jurisdictions.

Transgrid’s proposal and supporting consultant reports recognise labour availability and capability constraints as significant project risks given the scale, timing, and technical complexity of the works [6]. The project involves live-substation integration, multi-site coordination, specialised commissioning, contractor mobilisation, and advanced technical integration activities requiring expertise in high-voltage systems, synchronous-machine installation, protection coordination, dynamic-system testing, inverter interaction assessment, and broader system-operability management.

These capabilities are not infinitely scalable across the market. Australia’s broader energy transition is simultaneously increasing demand for similar expertise across transmission expansion, Renewable Energy Zones, battery integration, renewable-generation connections, and grid-modernisation programs. AEMO’s Integrated System Plan and Transition Plan for System Security both acknowledge that accelerated infrastructure development will place increasing pressure on workforce capability and supply-chain availability across the NEM [10, 34]. International organisations including the IEA and IRENA similarly identify shortages in specialised engineering, commissioning, and grid-integration capability as emerging constraints on energy-transition delivery globally [35, 36].

The labour issue therefore extends beyond ordinary wage escalation. It increasingly involves competition for scarce technical capability across overlapping infrastructure programs operating under compressed delivery schedules and evolving technical requirements. In practice, many of the required functions depend on relatively small pools of highly specialised personnel with expertise that cannot be rapidly expanded through conventional workforce scaling alone. Commissioning engineers, protection specialists, high-voltage integration experts, and advanced control-system personnel require years of training and operational experience, particularly under live-network and weak-grid conditions.

This issue is particularly relevant for the System Strength Project because commissioning quality and operability integration are central to achieving intended system-strength outcomes. Delays or shortages in specialised capability may therefore affect not only project timing, but also testing quality, operational readiness, integration performance, and long-term system reliability. Under increasingly inverter-dominated conditions, the quality of commissioning, protection coordination, and operational integration may become just as important as the physical infrastructure itself.

More broadly, workforce constraints are becoming part of the wider governance challenge associated with accelerated energy-transition delivery. Infrastructure programs no longer compete only for capital and equipment. They increasingly compete for engineering capability, operational expertise, commissioning capacity, and organisational attention across multiple simultaneous projects.

7.2 Escalation uncertainty

In addition to capability constraints, the System Strength Project faces broader escalation uncertainty associated with labour-market pressure, supply-chain congestion, inflationary conditions, and delivery competition across the energy-transition sector. Transgrid's proposal and supporting analysis identify labour-market conditions and sector-wide demand growth as significant escalation risks [6, 35]. Australia's simultaneous expansion of transmission infrastructure, Renewable Energy Zones, battery deployment, and renewable-generation projects is increasing competition for engineering firms, commissioning specialists, contractors, and technical labour. AEMO, Infrastructure Australia, the OECD, and the World Bank similarly recognise that large-scale concurrent infrastructure programs can create labour shortages, contractor scarcity, procurement congestion, and inflationary delivery conditions that extend beyond conventional forecasting assumptions [28, 34, 37, 38].

Under such conditions, escalation may arise through wage inflation, contractor pricing pressure, specialist labour scarcity, commissioning bottlenecks, supply-chain constraints, and project sequencing conflicts. The key regulatory issue is therefore not whether escalation exists, but whether escalation drivers remain sufficiently transparent and distinguishable from project-specific inefficiency, coordination problems, or delivery underperformance. Because eventually every infrastructure project starts blaming "market conditions," and regulators are left trying to determine whether the problem was genuinely global capability scarcity or simply organisational chaos wearing a macroeconomic costume.

7.3 Recommendation

This submission recommends that the AER require clearer and more transparent treatment of labour escalation, capability constraints, and market-condition assumptions within the System Strength Project determination framework.

In particular, the AER should consider requiring clearer disclosure of labour-escalation assumptions used in forecasting, transparent identification of capability-constrained activities, clearer distinction between sector-wide escalation and project-specific delivery inefficiency, periodic reporting of realised labour-market conditions during project delivery, and improved visibility regarding how escalation assumptions interact with risk allowances, contingencies, and adjustment mechanisms.

This distinction between unavoidable market escalation and project-specific inefficiency is particularly important under current energy-transition conditions. International infrastructure-governance literature consistently emphasises that effective regulation requires separation between external market pressures and internal delivery performance.

For example, the UK National Infrastructure Commission notes that infrastructure regulation should distinguish between economy-wide delivery pressures and project-specific management inefficiencies when evaluating cost escalation and performance outcomes [39].

Similarly, the OECD's infrastructure-governance framework emphasises that transparent identification of escalation drivers is essential for maintaining accountability and preserving incentives for efficient delivery [28]. The OECD warns that poorly distinguished escalation treatment may weaken incentives for cost control if consumers ultimately bear risks that could otherwise be managed more efficiently through project planning, sequencing, or procurement strategy.

The International Energy Agency also notes that workforce and supply-chain constraints are becoming structural features of global energy-transition infrastructure delivery rather than temporary anomalies [40]. Under such conditions, escalation treatment increasingly becomes a regulatory issue as much as a forecasting issue.

Accordingly, the AER should ensure that escalation treatment within the System Strength Project remains sufficiently transparent to allow stakeholders to distinguish between:

- unavoidable sector-wide labour and market pressures;
- externally driven inflationary conditions;
- and escalation associated with project-specific delivery outcomes.

This would improve accountability without preventing reasonable recovery of genuinely unavoidable market-cost impacts.

Modern infrastructure regulation increasingly operates under conditions where multiple large-scale projects compete simultaneously for the same limited engineering and delivery capability. In such environments, labour escalation is no longer merely an economic forecasting variable. It becomes part of the broader governance question of how uncertainty, capability scarcity, and delivery risk are allocated between network businesses and consumers over time.

8. Capitalisation Boundaries and Indirect-Cost Transparency

This section examines how complex infrastructure delivery can blur the boundaries between capital expenditure, operational support, governance activities, organisational capability development, and indirect project costs within accelerated energy-transition projects. It highlights the importance of transparent capitalisation criteria, indirect-cost allocation methodologies, and clearer visibility over how support, integration, commissioning, and organisational functions are ultimately translated into long-term regulated cost recovery. Modern infrastructure projects increasingly require armies of coordinators, integration specialists, governance teams, commissioning experts, and systems engineers just to organise meetings about organising other meetings. Naturally, the accounting frameworks trying to classify all this were designed in an era when a power station mostly involved pouring concrete and hoping turbines behaved themselves.

8.1 Why this matters

The System Strength Project is being delivered under accelerated timelines, complex coordination requirements, and evolving technical conditions associated with the broader energy transition. Under such conditions, distinctions between capital expenditure, operational expenditure, indirect support functions, governance activities, capability development, and commissioning support become increasingly difficult to interpret. Large infrastructure programs now depend not only on physical asset construction, but also on organisational integration, operational preparedness, systems coordination, specialist commissioning, workforce capability, and long-term service support [28]. Consequently, expenditure categories that once appeared relatively separable may increasingly overlap across delivery, operational readiness, and organisational adaptation functions.

Transgrid's proposal and supporting capitalisation documentation acknowledge this complexity through the inclusion of indirect-cost allocation frameworks covering labour, governance, engineering support, integration activities, and broader corporate functions [6, 41]. International accounting and infrastructure-governance guidance from IPSASB and IFAC similarly recognises that modern infrastructure projects often require substantial judgment when distinguishing capitalisable asset-related expenditure from broader operational or organisational functions [42, 43]. The key issue is therefore not whether these support activities are necessary, but whether their treatment and allocation remain sufficiently transparent for regulators and consumers to understand which categories of expenditure are ultimately being capitalised and recovered over time.

8.2 Visibility issue

The visibility of indirect costs and allocation boundaries becomes increasingly important as infrastructure projects grow in complexity, duration, and organisational scale. While direct infrastructure costs such as synchronous condensers, transformers, and civil works are generally identifiable and linked to tangible delivery functions, indirect costs often involve shared project management, engineering support, governance, commissioning, corporate overheads, workforce capability development, operational preparedness, and broader systems integration activities. As these functions expand and overlap, allocation boundaries become increasingly important because they influence what expenditure is capitalised, what costs are recovered from consumers over long asset lives, and how project efficiency is interpreted within regulatory assessment.

This issue is particularly relevant under accelerated energy-transition conditions where project delivery depends heavily on coordination, organisational mobilisation, and systems integration beyond physical asset construction alone [44]. The OECD and World Bank both note that indirect-cost structures and overhead allocation can become increasingly opaque unless allocation methodologies are clearly disclosed and consistently applied [38, 44]. The challenge becomes even greater under hybrid procurement frameworks where some organisational functions support both contestable and non-contestable activities simultaneously. Consequently, transparency regarding allocation logic and capitalisation boundaries becomes essential for understanding which costs relate directly to asset creation, operational readiness, broader organisational capability, or shared governance functions.

8.3 Recommendation

This submission recommends that the AER require clearer and more explicit disclosure regarding capitalisation boundaries, indirect-cost treatment, and allocation methodologies associated with the System Strength Project.

In particular, the AER should consider requiring explicit explanation of the allocation logic used for indirect and shared costs, clearer disclosure of capitalisation criteria applied to project-support activities, transparent identification of indirect-cost attribution methodologies, clearer treatment of governance, commissioning, and capability-development expenditure, and improved visibility regarding corporate support and overhead allocation associated with the project.

This recommendation is consistent with broader international infrastructure-governance principles emphasising transparency, traceability, and accountability in complex infrastructure delivery.

For example, the OECD stresses that effective infrastructure governance requires clear allocation frameworks and transparent decision-making structures capable of linking expenditure categories to identifiable project outcomes [28]. Similarly, the International Federation of Accountants notes that infrastructure accountability increasingly depends on transparent reporting of lifecycle support costs, governance functions, and organisational capability expenditure associated with long-term infrastructure programs [43].

The IPSASB also highlights that judgment-based infrastructure accounting requires clear disclosure where allocation boundaries involve significant estimation or interpretation, particularly in projects involving integrated operational and organisational transition activities [42].

In practical terms, the AER should seek clearer explanation regarding which activities are treated as directly attributable to asset creation, which are classified as operational or support functions, how commissioning and integration activities are categorised, how shared engineering and governance resources are allocated, and how broader corporate support functions are attributed to the project. The AER should also consider whether certain categories of capability uplift or organisational preparedness represent project-specific delivery functions, broader corporate capability development, or hybrid functions requiring partial allocation treatment.

This distinction matters because capitalisation treatment directly affects long-term consumer recovery. Costs capitalised into regulated assets may ultimately be recovered over extended asset lives through network charges. Consequently, transparency regarding capitalisation boundaries is not merely an accounting issue. It is also a consumer-accountability issue.

Under increasingly complex and accelerated energy-transition conditions, infrastructure projects are likely to involve growing interaction between engineering delivery, operational integration, governance capability, and organisational adaptation. As a result, future regulatory robustness may depend increasingly on whether allocation boundaries remain sufficiently transparent to allow stakeholders to understand how indirect and organisational costs are translated into long-term regulated expenditure.

In summary, the AER should require clearer disclosure of allocation logic, capitalisation criteria, indirect-cost attribution methodologies, and corporate-support treatment within the System Strength Project. This would improve transparency regarding how complex organisational and support activities are incorporated into long-term regulated cost recovery while preserving flexibility for efficient project delivery under evolving system conditions.

9. Post-Commissioning Observability and Adaptive Governance

This section examines the importance of post-commissioning observability and adaptive governance within increasingly complex, inverter-dominated electricity systems where future operability conditions, technology interactions, and system-strength requirements may evolve significantly after regulatory approval. It argues that robust regulation should extend beyond ex-ante expenditure assessment to include stronger lifecycle reporting, ex-post operational visibility, and adaptive governance mechanisms capable of tracking how infrastructure actually performs under changing system conditions. Modern infrastructure regulation has entered the delightful phase where billion-dollar assets are approved using models that quietly assume the future will remain polite enough to behave like the spreadsheets that justified them. Unfortunately, inverter-dominated power systems did not receive that memo.

9.1 Current issue

The current regulatory framework for major network infrastructure projects remains heavily focused on ex-ante assessment, including forecast expenditure, procurement structures, prudency review, and anticipated delivery outcomes. While necessary, such approaches may become increasingly insufficient under conditions where future system behaviour, inverter interaction, operational requirements, and technology pathways remain highly uncertain. This issue is particularly relevant for the System Strength Project, which is being delivered within a rapidly evolving electricity system characterised by increasing inverter penetration, declining synchronous generation, emerging grid-forming capability, and changing system-operability conditions.

AEMO's Transition Plan for System Security and Engineering Framework both emphasise that future system-security outcomes will depend not only on infrastructure investment itself, but also on evolving operational coordination, inverter behaviour, system services, and dynamic network conditions [10, 14]. Consequently, many assumptions underpinning current system-strength planning may change significantly over the operational life of the assets. Inverter standards, grid-forming deployment, operating patterns, and interaction between synchronous and inverter-based technologies may all evolve beyond present expectations, creating potential gaps between forecast assumptions and realised operational outcomes.

This issue aligns closely with CSPER's earlier work on regulatory observability, which argued that regulatory frameworks influence not only decision-making, but also what regulators are later able to observe and interpret regarding infrastructure performance and expenditure outcomes [4]. The OECD and IEA similarly recognise that future infrastructure governance will increasingly require adaptive, lifecycle-oriented oversight supported by continuous operational monitoring and post-implementation visibility [23, 28].

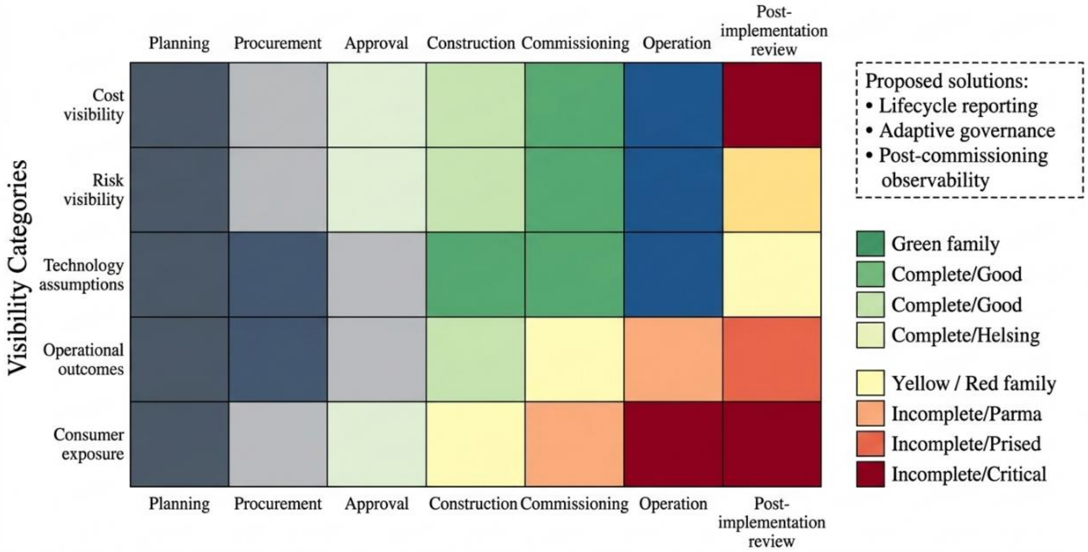


Figure 6. Regulatory Observability Across the Infrastructure Lifecycle

Figure 6 conceptually illustrates how regulatory visibility may progressively weaken across the infrastructure lifecycle, particularly after approval and commissioning stages, unless supported by stronger lifecycle reporting, adaptive governance, and post-commissioning observability mechanisms. The framework highlights how visibility regarding costs, risks, technology assumptions, operational outcomes, and consumer exposure may deteriorate over time under increasingly uncertainty-sensitive and inverter-dominated system conditions. Accordingly, the challenge is no longer simply whether infrastructure appears prudent at approval stage, but whether regulators, consumers, and stakeholders remain able to observe, interpret, and evaluate how the project actually performs under evolving operational conditions throughout its lifecycle.

9.2 Need for ex-post visibility

Given the evolving and uncertainty-sensitive nature of future system operation, this submission recommends stronger ex-post observability and post-implementation reporting for the System Strength Project. While regulatory assessment is necessarily forecast-based, future regulatory robustness may increasingly depend on whether actual operational outcomes remain visible after implementation under changing network and inverter-dominated conditions.

Accordingly, the AER should consider requiring post-commissioning reporting on realised system-strength contribution, fault-level support, operational availability, outage behaviour, maintenance performance, commissioning outcomes, interaction with inverter-based and grid-forming resources, realised delivery costs, and triggered adjustment mechanisms over time. Such reporting would improve transparency regarding whether assets perform as anticipated, whether planning assumptions remain valid, and how uncertainty ultimately translates into operational and consumer outcomes.

This issue is particularly important because future system-strength performance may increasingly depend on interaction between synchronous infrastructure and evolving grid-forming technologies [20]. Ex-post reporting would therefore improve transparency, strengthen understanding of future operability conditions, support regulatory learning for future hybrid projects, and provide clearer visibility regarding realised consumer exposure. International governance frameworks from CoST and the OECD similarly emphasise that infrastructure accountability increasingly depends on lifecycle transparency and ongoing operational evidence rather than ex-ante approval alone [31, 44].

This recommendation does not assume future system conditions can be perfectly predicted. Rather, it recognises that modern infrastructure governance increasingly depends on the ability to observe how assets actually perform after approval, especially in electricity systems where technology, operating conditions, and control frameworks continue evolving faster than the regulatory paperwork pretending to describe them.

9.3 Adaptive regulation

The System Strength Project should be viewed within the broader context of evolving energy-transition regulation, where hybrid revenue determinations, contestable procurement structures, adaptive system-strength frameworks, and uncertainty-sensitive planning are likely to become increasingly common. Accordingly, the project represents not only a major infrastructure determination, but also an important governance precedent for how future hybrid infrastructure projects may be regulated under conditions of accelerated delivery, evolving technology pathways, dynamic operability requirements, and layered cost-recovery mechanisms.

Future electricity systems are unlikely to evolve through stable or predictable technological transitions. Instead, regulators will increasingly face situations where multiple technologies mature simultaneously, infrastructure roles evolve over time, and planning assumptions require periodic reassessment. International governance literature from the OECD and IEA increasingly supports adaptive and iterative regulatory approaches capable of learning and evolving alongside changing infrastructure systems [23, 45].

For this reason, the project should not be treated solely as a one-off approval exercise, but also as an opportunity to establish stronger governance principles for future hybrid infrastructure regulation. This submission therefore recommends stronger post-implementation observability requirements, lifecycle-oriented reporting, and adaptive governance mechanisms that improve visibility regarding how infrastructure, costs, and operational outcomes evolve after approval. Such measures would strengthen long-term regulatory credibility without undermining investment certainty. Modern electricity regulation increasingly resembles the management of a moving target built on top of another moving target, while everyone involved insists the original spreadsheet assumptions were perfectly reasonable at the time.

10. Recommendations

This submission recommends that the AER assess the System Strength Project not only as an individual revenue proposal, but also as an important precedent for future hybrid revenue determinations under accelerated energy-transition conditions. The recommendations below are intended to strengthen transparency, consumer protection, and regulatory robustness while preserving appropriate flexibility for genuine delivery uncertainty.

i. Maintain strong scrutiny of cumulative consumer exposure

The AER should assess the cumulative consumer exposure created by the full project architecture, not only the reasonableness of individual expenditure categories. This should include contestable contracts, non-contestable expenditure, risk allowances, escalation assumptions, adjustment mechanisms, pass-through-type events, and any excluded or modified incentive arrangements.

This approach is consistent with international infrastructure-governance practice. The World Bank has emphasised that long-term infrastructure arrangements can create firm and contingent obligations that are not always visible at approval stage but may become material during delivery or operation [27]. The OECD similarly recommends that governments and regulators identify contingent liabilities and assess exposure to infrastructure-related fiscal risks as part of infrastructure governance [46].

For the System Strength Project, the equivalent consumer-risk issue is whether future recovery pathways are sufficiently visible before consumers are exposed to them through network charges. The AER should therefore require Transgrid to present cumulative consumer exposure in an integrated and accessible form.

ii. Require integrated reporting of adjustment mechanisms

The AER should require integrated reporting of all adjustment mechanisms associated with the project. This should include transport adjustments, OEM-related adjustments, D&C adjustments, insurance-related adjustments, consequential cost events, and any annual true-up mechanisms.

International regulatory practice provides useful precedent. In the United Kingdom, Ofgem's RIIO price-control framework uses uncertainty mechanisms to adjust allowances during a regulatory period when there is clearer evidence of need, cost, and consumer benefit [47]. Ofgem states that uncertainty mechanisms are intended to avoid setting allowances either too high or too low while still maintaining regulatory oversight and consumer protection.

The AER should apply a similar principle here: flexibility is appropriate, but only where adjustment pathways are transparent, evidence-based, and subject to clear reporting. A single integrated adjustment register should be required so that consumers and stakeholders can understand how the project's forecast costs change over time.

iii. Require risk-to-recovery mapping

The AER should require a risk-to-recovery map showing how each material project risk is treated. This map should identify whether each risk is included in base expenditure, contractor pricing, contingency, residual risk allowance, insurance, adjustment mechanisms, pass-through mechanisms, or retained by Transgrid.

This would help prevent double recovery and clarify accountability. The World Bank's risk-allocation guidance states that risks should be allocated to the party best able to manage them cost-effectively, rather than automatically transferred to either the public sector or private sector [30]. The OECD also cautions against one-size-fits-all risk allocation in major infrastructure projects because inappropriate allocation can increase costs and create implementation problems [25].

For this project, the AER should require Transgrid to demonstrate that the same risk is not recovered through multiple pathways. Tiny detail, apparently: consumers should not pay twice for the same uncertainty wearing two different spreadsheet labels.

iv. Improve visibility of technology assumptions

The AER should require clearer disclosure of the technology-readiness, deployment, maturity, and operability assumptions underpinning the proposal. This should include assumptions about synchronous condensers, grid-forming batteries, future inverter capability, and the expected role of hybrid system-strength solutions over time.

This recommendation is consistent with the direction of international system-planning practice. The International Energy Agency has emphasised that electricity grids must adapt to changing technology portfolios, higher renewable penetration, and more complex operational conditions [23]. AEMO's grid-forming technology work also recognises that grid-forming inverter capability and related access standards remain under active development in Australia [20].

This recommendation also aligns with CSPER's works on inverter-dominated system behaviour, where simplified technical assumptions were shown to become policy-relevant when embedded in planning and regulatory decisions.

The AER should not reopen the PNIP technology decision, but it should ensure that technology assumptions remain visible, testable, and interpretable over time.

v. Strengthen transparency of indirect and non-contestable costs

The AER should require clearer disclosure of the allocation logic, capitalisation criteria, indirect-cost attribution, and corporate-support treatment applied to the non-contestable components of the project.

This is important because large accelerated projects can blur the boundary between asset delivery, project management, governance, training, commissioning support, capability uplift, and operational readiness. International accounting and infrastructure-governance bodies recognise that complex infrastructure projects require transparent treatment of indirect costs, lifecycle support costs, and organisational capability expenditure [42].

The OECD also emphasises that infrastructure governance depends on linking expenditure categories to identifiable project outcomes and maintaining clear accountability across the project lifecycle [28].

The AER should therefore require Transgrid to explain clearly which support costs are directly attributable to project delivery, which relate to broader corporate capability, and how shared functions have been allocated.

vi. Improve escalation-risk reporting

The AER should require transparent reporting of labour escalation, specialist workforce constraints, and market-capacity assumptions. This should distinguish between unavoidable sector-wide escalation and project-specific inefficiency.

This distinction is important because energy-transition projects are increasingly competing for the same limited pool of specialist labour, contractors, commissioning engineers, and high-voltage expertise. Infrastructure Australia has identified labour shortages and delivery-market capacity constraints as material risks for Australia's infrastructure pipeline [37]. Internationally, the IEA has similarly identified skilled labour shortages as a growing constraint on clean-energy infrastructure delivery [35].

The OECD has also warned that simultaneous infrastructure expansion can create market-capacity pressures, procurement congestion, and delivery-cost escalation [28].

Accordingly, the AER should require Transgrid to separate:

- external labour-market escalation;
- supply-chain and contractor-market escalation;
- and escalation caused by avoidable project delays, poor coordination, or inefficient delivery.

This would allow reasonable recovery of genuine market pressures while preserving incentives for efficient project management.

vii. Introduce post-commissioning observability reporting

The AER should require post-commissioning reporting on actual system-strength contribution, availability, outage behaviour, maintenance burden, commissioning outcomes, realised delivery costs, triggered adjustment mechanisms, and interaction with grid-forming or inverter-based resources.

This recommendation reflects the fact that revenue determinations are mainly ex-ante, while system performance unfolds over time. The OECD recommends systematic collection, storage, and use of infrastructure evidence to improve future decision-making and accountability [44, 46]. The CoST Infrastructure Transparency Initiative also emphasises lifecycle transparency, including disclosure of cost changes, implementation performance, and operational outcomes [31].

For the System Strength Project, this means the AER should not only assess whether the proposed expenditure is justified before delivery. It should also ensure that stakeholders can later observe whether the assets performed as expected, whether adjustment mechanisms were triggered, and whether consumer-funded expenditure translated into the intended system-strength outcomes.

viii. Use this project to establish best-practice hybrid governance principles

The AER should treat this determination as an opportunity to establish best-practice governance principles for future hybrid revenue determinations. Hybrid determinations are likely to become more common as electricity-transition infrastructure becomes more urgent, complex, and dependent on mixed procurement models.

International experience shows that major infrastructure governance increasingly requires adaptive, transparent, and evidence-based frameworks. The OECD argues that major infrastructure governance should include clear risk allocation, lifecycle accountability, transparent decision-making, and adaptive institutional learning [28, 45]. Ofgem's RIIO framework also provides an example of how uncertainty mechanisms can be used to provide flexibility while retaining oversight and protecting consumers [47].

The AER should therefore use this project to develop principles for:

- cumulative consumer-risk reporting;
- integrated adjustment-mechanism disclosure;
- technology-assumption transparency;
- risk-to-recovery mapping;
- post-implementation performance reporting;
- and lifecycle observability for hybrid infrastructure projects.

In summary, this submission recommends that the AER preserve delivery flexibility while strengthening visibility over how costs, risks, and system outcomes evolve. That is the core governance challenge here. Not whether uncertainty exists. It obviously does. The question is whether uncertainty is managed in a way that remains visible, bounded, and accountable to consumers over time.

Table 2 summarises the principal governance challenges identified throughout this submission and links them to their underlying uncertainty drivers, associated regulatory risks, and potential governance responses. The table highlights that future hybrid infrastructure regulation increasingly depends not only on efficient expenditure approval, but also on maintaining transparency, observability, adaptive governance, and clear allocation of risks and responsibilities across the project lifecycle. Because apparently modern electricity regulation now requires simultaneously managing engineering physics, infrastructure finance, institutional governance, labour economics, and technological evolution inside one determination framework. Perfectly normal administrative behaviour.

Table 2. Governance Challenges, Uncertainty Drivers, Regulatory Risks, and Suggested Governance Responses for Hybrid Energy-Transition Infrastructure Projects

Issue	Source of uncertainty	Regulatory risk	Suggested governance response
Technology evolution	Grid-forming uncertainty	Planning lock-in	Adaptive review
Labour escalation	Capability shortage	Cost escalation	Escalation reporting
Adjustment mechanisms	Layered recovery pathways	Consumer opacity	Exposure mapping
Indirect costs	Allocation complexity	Visibility fragmentation	Allocation disclosure
Deliverability	Operability uncertainty	Performance mismatch	Post-commissioning reporting
Technology assumptions	Evolving inverter capability	Forecast obsolescence	Assumption transparency

Hybrid determinations	Mixed procurement structures	Fragmented observability	Integrated reporting
Residual-risk allowances	Overlapping contingencies	Double recovery risk	Risk-to-recovery mapping
Commissioning complexity	Multi-site integration	Operability uncertainty	Lifecycle performance reporting
Consumer exposure	Multiple contingent pathways	Unclear cumulative liability	Cumulative exposure framework
Governance adaptation	Dynamic system evolution	Static regulatory lock-in	Adaptive governance mechanisms
System operability	Weak-grid interaction	Stability uncertainty	Operability monitoring

11. Conclusion

This submission supports the objective of the System Strength Project and recognises the urgency associated with maintaining secure and stable operation of the National Electricity Market during a period of rapid energy-system transition. The retirement of synchronous generation, increasing penetration of inverter-based resources, Renewable Energy Zone development, and evolving weak-grid conditions are creating genuine system-strength challenges that require timely infrastructure investment and coordinated operational adaptation.

At the same time, the project also highlights the increasing complexity of regulating infrastructure within highly inverter-dominated and uncertainty-sensitive electricity systems. Hybrid revenue determinations, evolving technology pathways, contingent adjustment mechanisms, delivery uncertainty, and changing operability conditions are likely to become increasingly common features of future network regulation.

For this reason, the central issue considered in this submission is not whether system-strength investment is needed. Rather, it is whether the regulatory framework remains sufficiently transparent, observable, and robust under conditions of evolving technological, operational, and delivery uncertainty.

This submission therefore argues that future regulatory robustness will increasingly depend on:

- transparency of recovery pathways and cost allocation;
- visibility of uncertainty and technology assumptions;
- adaptive governance capable of responding to evolving system conditions;
- and stronger observability of cumulative consumer-risk exposure over time.

The System Strength Project should therefore be viewed not only as a major system-security investment, but also as an important governance precedent for future hybrid infrastructure regulation within the energy transition.

As electricity systems become more dynamic, inverter-dominated, and operationally complex, future regulatory effectiveness may depend not only on efficient ex-ante expenditure assessment, but also on the ability to maintain visibility over how infrastructure, risks, assumptions, and operational outcomes evolve throughout the project lifecycle.

Because modern electricity regulation increasingly resembles: "Here is a multi-billion-dollar infrastructure project operating under evolving technological assumptions, uncertain delivery conditions, layered adjustment mechanisms, and partially confidential contractual structures. Please determine prudency efficiently and transparently."

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