Submission to AEMO
Assessment of the Draft 2025-26 Integrated System Plan

Independent Engineers, Scientists and Professionals
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This report reviews the draft 2025-26 Integrated System Plan (ISP) published by the Australian Energy Market Operator (AEMO) for consultation and public review. It also includes information from the Draft 2026 Inputs and Assumptions Workbook, the 2025 Electricity Statement of Opportunities (ESOO) report and AEMO's Electricity Forecasting Data Portal.

This report was prepared and supported by independent engineers, scientists and professionals, who have not received any monetary or employment benefits in its preparation.

The views and conclusions presented in this submission are the opinions of the authors and supporters based on their wide experience in power systems engineering with the objective to inform public policy for Australia.

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Executive Summary

This submission finds that AEMO's draft 2025–26 Integrated System Plan (ISP) is internally contradictory, bereft of key data and fundamentally unviable as a blueprint for Australia's National Electricity Market (NEM). After more than a decade of planning, the ISP still fails to meet basic principles of high-reliability system design, transparent costing, and accountability.

Its central claims on reliability, affordability, emissions reduction and security of supply are not supported by its own data when examined rigorously. Impressive narratives, charts and graphics are mired in detail, while neglecting system design fundamentals. Its numbers just don't add up.

Reliability Claims

The ISP's claims for system reliability are unconvincing and misleading. The ISP lacks even a basic power budget for revealing the dispatchable reserve margin (DRM), which (historically at about plus 20%) has been the key to maintaining system reliability in the face of facility outages. The ISP does not address DRM transparently, instead relying on charts that exaggerate dispatchable power by obscuring the limited duration of battery storage, typically only a few hours.

Although the ISP acknowledges significant uncertainties associated with weather-related generation lulls over minutes, hours, days, weeks, and seasons, these risks are not adequately reflected in its system design. Substantial additional uncertainties in future demand forecasts, storage outputs and facility outages are not addressed in its design. This submission presents a power budget based on AEMO data, which shows DRM currently in single digits and deeply negative from 2030 and beyond.

Modelling used by the ISP to demonstrate reliability through lulls in wind and solar power relies on non-worst-case conditions, below-peak demand, misuse of average daily demand profiles, and optimistic assumptions including no facility outages and continuous high output from hydro and gas. Its results show only that its system design used 'firmed renewables' is untenable.

The ISP's system design completely lacks adequate reserves to counter uncertainties from facility outages, prolonged wind and solar droughts, and unexpected demand growth. It is completely reliant on weather-dependent wind and solar under worst-case conditions.

Cost Transparency and True Economic Burden

The ISP presents a capital cost estimate to 2050 of $128 billion in amortised present value terms. This figure is highly misleading of the true scope of costs for the transition of the NEM. It appears designed to minimise costs. Consumer energy resources (CER) are excluded but noted as an additional $50 billion in amortised present value. When converted to unamortised capital expenditure costs (capex), it equates to about $442 billion.

However, the ISP estimate does not include 'sunk' costs before 2025, future transmission projects committed and anticipated and local distribution network upgrades. This submission presents a full capex cost analysis, including replacements costs for end-of-life wind, solar and batteries before 2050.

This independent top-level assessment, using CSIRO's GenCost capital cost factors and ISP capacities, indicates the real whole-of-system/whole-of-life (WOS/WOL) capex cost to the economy is $1.0–1.4 trillion for the ISP, almost three times the ISP's capex cost figure. It is also around double the cost of four alternative systems using coal, gas, hydro or nuclear with modest renewable penetration. The constant claims that wind and solar are the cheapest form of power generation are belied by skyrocketing power prices.

Emissions and Climate Claims

Australia produces around one percent of global greenhouse gas emissions. Since CO_2 diffuses uniformly in the global atmosphere, Australia's emission reductions cannot produce any impact on either global climate or on local weather, despite such claims from ministers and media. This is solely a matter of physics, not opinion.

The ISP restricts its emissions accounting to operating emissions alone. It deliberately excludes emissions associated with the mining, processing, manufacture, installation, decommissioning, recycling, and disposal of wind turbines, solar panels, batteries, and associated infrastructure required for back-up. These facilities require up to 800 times more materials than reliable baseload power plants. The emissions, largely embedded in China, are substantial.

Wind, solar, and battery technologies are therefore not emissions-free, and their relatively short asset lifetimes amplify these effects. On that basis, the ISP's claim to deliver Net Zero is unsubstantiated.

In any case, the global trend away from Net Zero is a result of growing awareness that CO_2's effect on climate has been greatly exaggerated. This undermines the principal driver of current energy policies.

Environmental Impacts

The wider community is only now learning of the substantial damage to the environment imposed by vast land-use footprints from wind and solar generators and the needed expansion of transmission lines. This damage includes habitat loss, bird and wildlife mortality, reduced agricultural productivity, and landscape fragmentation. Resistance from environmentalists is rising.

Demand-Side Participation and Rationing

The ISP undermines its own reliability claims by relying on demand-side participation (DSP), including load shedding and time-of-use tariffs, to 'manage demand' in times of wind and solar shortages. This inversion of the normal supplier–customer relationship, prevents consumers from accessing electricity *when they need it*.

Load shedding, already imposed on major businesses, represents a failure to design a reliable grid putting Australia into third world status. The ISP's indefensible treatment of DSP, a form of rationing, as a 'generation source' highlights the depth of inadequacy of its system design.

Security, Accountability, and Governance

Despite claims for security of supply, the ISP does not address cyber security. A fully internet-connected system control grid with millions of nodes presents serious national security risks. Software-embedded products from China are central to the ISP's design.

Underlying these failures is a profound lack of accountability. No independent body has the technical authority, mandate and resources to certify that the ISP is technically sound or economically viable.

High-reliability sectors such as aviation and nuclear operate under rigorous engineering standards and independent oversight because lives are at stake. The electricity system underpins the entire economy, jobs, public safety, and national productivity. It warrants the same discipline.

Social Licence and Community Impact

While the ISP speaks repeatedly of social licence, government actions contradict this narrative. Fast-tracked approvals for wind, solar, and battery projects have generated intense resistance in rural and regional communities. Rather than consent, the transition is increasingly characterised by community division, planning conflict, and loss of trust. The ISP fails to reconcile its stated objectives with the social realities now playing out across the country.

Quite simply, it appears that AEMO has no Plan B. It needs the courage to tell truth to power.

Recommendations

1. AEMO must start over at the system design level to implement high reliability system design practices based on rigorously defined worst-case conditions.
2. Reliability performance must be assured under worst-case conditions without recourse to any weather-dependent assets.
3. The ISP must include defined worst-case conditions and system power budgets, which demonstrate positive and adequate dispatchable reserve margins on a continuous basis.
4. The ISP must provide clear allocation of any storages to different roles such as smoothing and back-up, and provide transparent data on power outputs from all storages based on real operating limits and as a function of duration of power delivery and recharge time.
5. The ISP must disclose estimates of full capital expenditure costs to the economy of the WOS/WOL NEM transition, regardless of who pays.
6. The ISP must abandon partial cost estimates in financial metrics that minimise costs and provide misleading information, which can be misused in public discourse.
7. The ISP should include full system capital cost comparisons with alternative technology agnostic grid designs to better inform government and the public, recognising that simultaneously meeting NEO targets for reliability, affordability and emission reductions cannot be practically achieved, even by the current ISP system design.
8. The ISP must present an honest accounting for WOS/WOL emissions, which include upfront mining, processing and manufacturing, system installation and end-of-life decommissioning and disposal.
9. The ISP should include economic cost estimates for the environmental damage resulting from the huge footprints of wind and solar generation and associated back-up facilities.
10. The ISP must drop DSP measures, which implement rationing and prevents consumers from accessing power *when it is needed*, in favour of a properly designed grid, which delivers reliable power with adequate safety margins under worst-case conditions.
11. Time-of-use tariffs, which punish consumers for using power *when they need it* must be abandoned.
12. The ISP must contain information on how cyber threats will be defeated in the internet-connected command and control system of the grid design.
13. AEMO must address the lack of independent accountability mechanisms for the technical and financial viability of the ISP through both a rigorous internal design review process and externally by requesting government to take action to establish an independent regulatory certification agency.
14. AEMO should publicly support the elimination of all subsidies and measures, which distort the market principles of the NEM and prevent proper cost comparisons.
15. AEMO should abandon the concept that the grid is responsible for backing up intermittent power sources and require all energy suppliers to contractually meet clearly defined quality standards for reliability and stability.
16. AEMO should support a requirement that all energy suppliers provide a public bond that adequately covers the full costs of decommissioning, disposal and land restoration.
17. AEMO should publicly provide support for the removal of legislative bans on civil nuclear power.

It is recognised that not all of these recommendations are within complete control of AEMO to implement but leadership is required to effect badly needed reforms. The most important recommendation is for governments at all levels to replace energy policies, which attempt to constrain the design of the NEM.

Synopsis

The Bottom Line

While the Disclaimer on the draft 2025-26 Integrated System Plan (ISP) warns that it may not provide "..accurate, complete or appropriate.." information and that "..modelling inherently requires assumptions.." about "..future behaviours and market interactions.." and "..may result in forecasts that deviate from future conditions..", the CEO's Preface confidently claims[1] (not once but twice) that the ISP presents the "..least-cost pathway.." to provide "..reliable electricity to consumers *while meeting government policies*". (italics added)

Throughout the document, this ISP is careful to include this caveat with every claim. The full truth is that in November 2022, the government inserted specific targets for so-called renewable wind and solar energy capacities into the National Electricity Objectives (NEO), which already had targets for CO_2 emission reductions. The National Electricity Law (NEL) requires the Australian Energy Market Commission (AEMC) to reflect the NEO in its National Electricity Rules (NER), which in turn require that AEMO's ISP meets the requirements of the NEO[2], such as '82% renewables by 2050'.

> The imposition of these constraints replaces power system engineers with technically unqualified politicians and bureaucrats. It prevents a proper assessment of a full range of NEM designs to determine the real least-cost and most reliable national grid system.

Therefore, the claim by the CEO is only a partial truth, which hides the full truth. The reality is that other grid designs, as shown by Section 2 of this submission, cost far less. The ISP is Plan A, with an obvious singular objective of meeting Net Zero targets by 2050, primarily by using intermittent wind and solar power. **There is no Plan B.**

This submission highlights many internal contradictions in the ISP and the relevant energy policies.

1. The drive to reduce emissions in Australia cannot affect local weather despite many statements and insinuations by government ministers and media to the contrary. CO_2 always exists as a gas in the atmosphere and diffuses almost evenly around the world. Anyway, water vapour is the primary greenhouse gas by a ratio of about 50:1, according to scientific measurements. The role of CO_2 in global warming has been exaggerated beyond reason, as many highly credentialed scientists are now pointing out.[3]
2. Reducing Australia's emissions, which constitute only around 1% of global emissions, can have no measurable impact on global climate nor our own weather.
3. The ISP's claimed emission reductions[4] are limited to operating emissions – the emissions associated with mining, processing and manufacture of wind, solar and battery equipment, largely in China, are massive but deliberately ignored. Wind and solar technologies are not Net Zero. Emissions associated with decommissioning, recycling and disposal of short lifetime wind, solar and batteries are also ignored. A whole of system/whole-of-life (WOS/WOL) analysis will reveal the truth.

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[1] Draft ISP P3 The ISP sets out the least-cost investment pathway for the National Electricity Market (NEM) to meet consumer energy needs and government policies.

[2] Draft ISP P8 The ISP must contribute to achieving the National Electricity Objective, see also P90

[3] Lindzen and Happer, 7 June 2025 Physics Demonstrates the increasing greenhouse gasses cannot cause dangerous warming, extreme weather or any harm. Also, Koonin, Curry, Freeman and Dyson

[4] Draft ISP P91 10.2 Government policies and targets would be met and Figure 22 Forecast NEM emissions trajectory

4. Emission reductions are intended to ameliorate the atmospheric environment yet the ISP's transition plan imposes massive land use footprints, creating huge environmental damage, harming birds, impacting other wildlife habitat and reducing agricultural productivity.
5. The ISP talks about efforts to gain social licence yet the government has fast-tracked applications for solar, wind and battery installations triggering tremendous resistance in affected rural areas.
6. Given endless claims by government ministers that firmed renewables are the cheapest form of generating electricity, why are subsidies aimed at every part of the transition necessary? Why have power prices already skyrocketed? If these claims were true, no subsidies would be needed and the market would readily adopt these technologies.
7. Despite generous subsidies, sophisticated investors are proving reluctant – without guarantees and long term power purchase agreements – to invest in weather-dependent solar, wind and associated battery projects.
8. Intermittent and highly variable renewable energy (VRE) causes not only severe technical problems for frequency and voltage management on the grid but also financial chaos in wholesale markets with massive overproduction at mid-day and severe shortages both day and night under worst-case conditions.
9. The ISP turns the normal supplier/customer relationship upside down by recruiting consumers (both residential and business) into being energy suppliers to the grid[5]. Generous monetary inducements lure consumers (unsophisticated investors) into spending their own capital on solar panels and short-life batteries to generate and store energy. They are promised reduced energy bills, while ignoring their substantial capital investment and lost opportunity costs, and they are subjected to short-term contracts. Subsequent withdrawals of benefits, as already have occurred with solar feed-in tariffs, are then harmful to consumers, because subsidies are completely unsustainable on the scale needed.
10. The ISP claims it will provide reliable electricity at lowest cost[6] while meeting government policies, but it acknowledges that consumer energy resources (CER) are essential to its implementation without revealing that, by 2050, CER solar will be 58% of all solar generation and CER batteries will be 47% of all storage batteries[7]. This level of CER support is a make-or-break proposition, which relies entirely on goodwill and uncritical acceptance of government policies and the ISP, and permanent continuation of unsustainable subsidies.
11. The ISP provides an estimate of system capital cost as 'annualised present value' (amortised discounted cash flow) of $128 Billion[8] in 2025 dollars. Yet, it explicitly excludes its own estimate of $50 billion present value costs of CER resources, despite them being relied upon as the major supplier of solar and battery capacity. Furthermore, these costs are amortised over somewhat optimistic asset lifetimes[9], some of which extend beyond 2050, amounting to $28 billion present value by the ISP and are not included. When converted to unamortised cash flow expenditures (capex), the total cost estimate for the ISP plan, including CER, in real terms is about $442 billion.
12. The ISP also treats commissioned, committed and anticipated projects (mainly transmission lines) as sunk costs, despite committed and anticipated plans being future spending. Faced with massive potential costs for upgrading the low voltage distribution networks, the ISP turns it back on consumers by adopting curtailment to block CER generation from overloading local distribution

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[5] Draft ISP P84 9.1 CER are Forecast to reach over one third of the NEM capacities

[6] Draft ISP P5 Executive Summary

[7] Draft ISP Figures 15 and 18

[8] Draft ISP P93 Capital costs for the ODP investments

[9] Draft ISP No data on lifetimes; CSIRO GenCost P73 Table B9; no data on batteries

networks and leaving it to DNSPs[10] to finance the necessary upgrades without including these costs in their estimate.

13. This submission's top-level assessment, using GenCost capital cost factors and ISP capacities, of the full WOS/WOL capex cost to the economy is \$1.0-\$1.4 trillion[11], almost three times the incomplete capex in the ISP. All this for a system that cannot deliver reliable power!
14. Four options using the same methodology for baseload systems using various mixes of coal, gas, hydro and nuclear with modest VRE are about half the full cost to the economy of the ISP system. The reluctance to disclose realistic capex costs is a complete disservice to all Australians, who deserve to know the realistic cost of this unprecedented plan and its comparison to other alternatives.
15. The ISP claims for reliability are entirely unconvincing, considering that its own capacity data[12] easily shows that dispatchable reserve margins (DRM), long considered to be at least 20% for required reliability (at 99.998%), are now teetering around 7% and heading down to be deeply negative by 2030 and beyond. The ISP does not explicitly state DRM data but displays misleading dispatchable power charts without flagging the fact that the battery storages will last just a few hours and then not be able to supply back-up power until recharged at some future time.
16. The ISP realistically discusses large uncertainties with forecasting weather-related lulls[13] over periods of minutes, hours, days, weeks and seasonal, yet the ISP's design fails to adequately take this into account.[14]
17. Claims to demonstrate system reliability with a 7-day simulation model for June 2040 fall completely flat when investigation shows it is based on non-worst-case conditions, lower than peak demand and inappropriate daily demand profiles based on 'average' conditions. The model actually shows only a two-day wind and solar lull, and relies on daytime wind and solar to recharge storages. It also assumes no facility outages and continuous operation of all hydro and gas baseload generators at high output[15].
18. The ISP design fails to provide adequate reserve margins for facility outages, future VRE droughts and demand growth exceeding uncertain forecasts. This approach is not modern high reliability engineering. The major uncertainties acknowledged in the ISP are ignored by the NEM system design.
19. The ISP claims for reliability of supply are undermined by the necessity to also rely on demand side participation (DSP) to cut back the use of electricity by consumers[16] by load shedding, whenever the grid experiences shortages and to adopt time-of-use tariffs to change energy use behaviour. This violates the normal commercial relationship between supplier and customer. **People must have access to required electrical power *when it is needed*.** DSP load shedding, which is already being practised with major businesses, is a serious admission of failure to design a reliable grid, putting Australia into third world status. The ISP's listing of DSP, a form of rationing, as a source of power generation (2.3 GW by 2050) is completely ridiculous![17]
20. The ISP claims to provide security of supply but the word cyber occurs not at all. The implications for national security of a national electricity grid running entirely on an internet-based command

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[10] Distributed Networks Service Providers

[11] Section 2

[12] Draft ISP P58 Figure 15 NEM capacity and P67 Figure 18 Forecast storage capacities

[13] Draft ISP P68 Reliability through renewable lulls

[14] Draft ISP App 4.6 P27 The timing, severity and duration of prolonged dark and still weather conditions over a wide area are difficult to predict.

[15] Draft ISP App 4.6 PP25-35 operating the power system during long, dark and still conditions

[16] Draft ISP App 2 P10, 16, 73 and App 9 P36, 42

[17] Draft ISP App 2 P16 Table 2

and control network with millions of nodes are extremely concerning. Proper design of such networks requires a full and detailed engineering assessment of equipment reliability and network cyber security provisions.

The issues identified above point to the question of how, after a decade of planning, the national plan for a radical transition of the nation's entire electrical grid is so deficient[18]. The answers can only be found in a lack of proper high reliability engineering, no independent accountability and a defective energy policy demanding the impossible.

Public and Private Consultations

Accountability was canvassed thoroughly in a Senate Select Committee on Energy Planning and Regulation in 2024. Many submissions identified AEMO accountability as a major problem. Neither AER nor AEMC (or even DCCEEW) have the technical resources and mandate to properly evaluate the viability of its plan and hold AEMO accountable for its engineering and financial deficiencies. If the lights go out, whose heads will roll?

The December 2024 final report of the Senate Select Committee pointed to many submissions, including our own[19], regarding the lack of accountability for AEMO. Yet it singularly failed to prescribe any significant recommendations to improve accountability.

The many public and private consultations, including this one, are useful processes for providing feedback to AEMO, which then judges them according to its own wishes. There is simply no external accountability to an independent body that has the power to approve or certify that the ISP is a technically and economically viable plan…..before implementation takes place.

Reliability Engineering

Much can be learned from the commercial aviation sector where high reliability system engineering is the norm and aircraft manufacturers are subject to rigorous technical accountability by national regulatory bodies such as the FAA and EASA. Surely, the criticality of the national electricity grid to the entire economy, jobs, people's standard of living, national productivity, national security and to the maintenance of life itself, demands that planning work is conducted in accordance with principles of high reliability engineering and fiducial responsibility for efficiency and cost effectiveness.

> High reliability systems engineering is based on rigorously-analysed worst-case technical and environmental conditions with added safety margins to guard against the absence of some parts of the system due to degradation, failures, planned maintenance or repairs. Redundancy and quality are its hallmarks.

In the aviation sector, progress over the last hundred years has led to excellence in high reliability design and greatly improved safety records. Lives are at stake.

If on a flight from Sydney to Los Angeles, the Captain welcomed passengers aboard by announcing that enough fuel was loaded plus an extra reserve to account for average head winds, would you feel safe? And what if it was noted that some turbulence was expected but not to worry since the manufacturer had designed the aircraft structure to handle average turbulence loads.

Average data has no place in high reliability design!

It is becoming obvious that Australia's energy system is on the brink of crisis.

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[18] Bryan Leyland, Net Zero, Power Costs and Grid Reality in Australia

[19] Submission 7 Independent Engineers, Scientists and Professionals, 11 October 2024 Senate Select Committee on Energy Planning and Regulation.

As one CEO of an Australian data centre business put it, *" This is not renewables versus anything else, it is system design. For mission-critical infrastructure, reliability is not negotiable"*.[20] Larry Fink, BlackRock CEO, one of the most influential global investors, also declared that "*intermittent power alone cannot meet round-the-clock demands and data centres*". It is patently obvious that a great many businesses, institutions and agencies are also mission-critical with respect to people's health, security and economic well-being. There is a growing realisation that Australia's NEM is heading towards unreliability and insufficiency.

The world focus is now decisively shifting away from the global warming scare campaign of the last 30 years to intense concerns around energy costs, national security, productivity, inflation, economic progress and the standard of living across society.

Impact of Energy Policies

AEMO's ISP is based on unachievable energy policies that are being progressively dismantled (or ignored) in other countries as the unsustainability of Net Zero becomes clear. But the ISP itself, in any case, is significantly flawed.

Today's power system with a DRM in single digits, teeters on the edge of instability and blackouts. The operational imperative to balance supply with demand continuously, minute by minute, has been made tremendously difficult and it is rapidly getting worse as weather-dependent VRE continues to enter the system without adequate back-up. AEMO has been increasingly forced to issue Lack of Reserve (LOR) warning notices.

Recently, the AEMC advised that manual directives from AEMO to maintain or restore security, safety and reliability of the NEM had soared from 321 in 2020 to over 1800 in 2024. There is, therefore, a sense of high urgency in addressing this looming disaster.

System Design Deficiencies

This submission, like our previous ones, is highly critical of the ISP and finds it is far from viable as a plan for the NEM, which underpins the economy and society. While it is obviously the result of a large number of people working hard, its complexity and detail appear to have lost sight of basic system design fundamentals. Its claims are exaggerated and some of its material is misleading. It employs narratives to acknowledge risks and challenges, but its numbers just don't add up.

Detailed design efforts cannot overcome system design deficiencies. If the system design contains major problems, they cannot be corrected by more and more detailed design. It first requires a rigorous top-down system redesign to ensure practicality.

This submission is structured so that the Executive Summary and Synopsis sections can be read as a stand-alone document. Following this synopsis are more substantive sections supporting our findings and conclusions to provide justification for our findings.

Conclusions

This submission concludes the draft 2025-26 ISP, is simply not viable as:

1. It will not deliver Net Zero emission reductions, when whole-of-system/whole-of-life is considered.
2. Its contribution to reducing global warming or improving local weather will be negligible for no benefit whatsoever.
3. It will inflict major environmental damage with huge land-use footprints, as is now being witnessed.

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[20] NextDC CEO Craig Scroggie, 28 January 2026

4. Despite talking up social licence, it is sparking angry resistance in rural areas and creating division within communities.
5. Government claims that firmed renewables are the cheapest form of electricity generation are false. The 2026 ISP will cost the economy far more to build than alternative options that are unconstrained by current government policies.
6. The ISP inherently relies on presumed social licence from consumers, but it harms home owners and small businesses by luring them into capital expenditures with subsidies and benefits, which soon disappear.
7. It attempts to minimise (hide) its full capital cost by ignoring CER costs, assuming sunk costs for not only completed transmission projects but also committed and anticipated future projects, ignoring the impact of short lifetimes for VRE, dismissing the cost of distribution network upgrades at the expense of CER investments, and casting a partial cost as $128 billion in terms of amortised present value (discounted cash flow), which by itself more than halves the estimated cost.
8. The true cost to the economy of the ISP is estimated by this submission in capital expenditure terms to be $1.0-$1.4 trillion – for a system that will not deliver reliable power.
9. The ISP will directly lead to massive future electricity price increases as most capital expenditures have not yet hit power bills.
10. Higher power prices will incur a huge negative impact on national productivity and is leading to deindustrialisation.
11. The ISP cannot deliver reliable electricity because its energy storage and baseload capacities are far less than required to back up intermittent and highly variable VRE generation, resulting in negative dispatchable reserve margins by 2030. **Only a complete duplication of the renewables power generation with baseload power will guarantee reliability**.
12. Energy storages to ‘firm renewables’ are impractical for back up due to their very high costs, short lifespan (batteries) and the lengthy time required to recharge them.
13. Coal power is the only system capacity that is underpinning system reliability – it will be needed indefinitely.
14. The ISP cannot deliver reliable power throughout a single 24 hour cycle under real worst-case conditions. It is designed without reserves to protect against facility outages and future growth exceeding uncertain forecasts. This is design based on hopeful narratives, instead of rigorous high reliability design.
15. It completely inverts the customer/supplier relationship that results in preventing customers from using power **when it is needed**.
16. It will harm both national security and the security of residents and businesses alike. It does not address resilience in the face of well-known cyber threats.

Quite simply, AEMO apparently has no Plan B. It needs the courage to tell ‘truth to power’.

1 Reliability Assessments

1.1 Introduction

The ISP states the NEM "*needs to be reliable and secure, operating within engineering limits and operating standards at all times*"[21]. It further describes system reliability as "*a very high level of confidence*" to supply customers with energy that they demand[22] and "*the NEM's reliability standard as 99.998% of forecast demand to be met each year*."[23] That amounts to about 10 minutes of system output per year.

Security is further defined[24] as the ability "*to continue to operate safely within defined technical limits despite highly variable demand and renewable supply, with the ability to withstand credible disturbances, return to secure operation, and restart following a widespread outage*."

These statements are undermined by "*mounting unease across energy-intensive industries that Australia's evolving energy mix risks prioritising low cost (renewables) generation over dependable supply.*"[25] "*Solar and wind… are variable by design. A data centre load is not*", according to Craig Scroggie, CEO of NextDC. His statements back up those of BlackRock CEO Larry Fink, one of the world's most influential investors, who recently cautioned that "*intermittent power alone cannot meet the around-the-clock demands of data centres*."

Scroggie warns that "*Data centres are 24/7, mission-critical infrastructure. They support defence systems, emergency services, telecommunications networks, hospitals, financial markets and government platforms. They do not pause when the sun sets or the wind drops*."

Mr Scroggie rejected framing the issue as a contest between renewables and fossil fuels. "*This is not renewables versus anything else. It's system design*" he said. "*All forms of firming make up energy system security. For mission-critical infrastructure, reliability is non-negotiable*."

These clearly stated requirements and growing awareness of the shortcomings of the government's plan to depend on intermittent renewables as the primary source of electricity generation, demand that reliability be the top-most priority in the 2026 ISP. Further, it is assessed that the draft ISP is highly unlikely to achieve acceptable reliability due to an inadequate high reliability system design engineering process, which has failed to take into account:

1. A rigorous definition of worst-case conditions
2. Significant uncertainties in future demand including potential for unexpected growth
3. Completely inadequate dispatchable power generation and impractical storage capacities
4. Major uncertainties in the availability of power from weather-dependent renewables
5. Reliance on complex simulation models based on inappropriate assumptions involving non-worst case conditions, unrealistic average daily demand profiles with major overnight drops, and improbable minimum levels of weather-driven renewable power generation

The fact that the ISP, as in previous versions, does not contain a basic NEM top-down power budget is a significant indicator itself that AEMO is not confident that its NEM design is able to meet system reliability requirements. Our previous submissions have pointed to this deficiency.

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[21] Draft ISP P48 Power system reliability and security

[22] Draft ISP P49 See https://www.aemc.gov.au/energy-system/electricity/electricity-system/reliability.

[23] The reliability standard is set in the NER and is reviewed by the independent Reliability Panel.

[24] Draft ISP P49 System security, see also Table 3

[25] Cranston and Packham 28 Jan 2026 NextDC boss says renewables alone cannot power Australia's AI data centre boom

This section lays out the reasons for this assessment. The starting point for high reliability system design is the definition of worst-case assumptions. Only then can a top-level system power budget be constructed. No matter how detailed and impressive is a system model, its results will always fall close within reasonable range of that defined in a top-level system power budget. The principal danger is that detailed models often lose sight of system-level design fundamentals.

High reliability systems engineering is based on rigorously-analysed worst-case technical and environmental conditions with added safety margins to guard against the absence of some parts of the system due to degradation, failures, planned maintenance or repairs. Redundancy and quality are its hallmarks.

Subsection 1.2 section addresses the uncertainties, which drive worst-case conditions definition. Section 1.3 presents a top-level WOS power budget based on these worst case conditions. Section 1.4 closes with a critique of the draft ISP system simulation modelling in a 2040 time frame, for which Appendix 4.6 of the ISP states "*This analysis provides a sample demonstration that with appropriate energy and fuel management, the NEM is capable to withstand lower levels of VRE availability under the proposed ODP, even for extended durations*."

Unfortunately, this simulation model demonstrates unequivocally that the ISP has abandoned the normal use of reliable dispatchable power in favour of a reliance on weather-dependent renewable power to claim system reliability. The major uncertainties, which the ISP itself states clearly[26], make it impossible to have any confidence in the draft ISP's claims.

1.2 Worst-case Conditions for High Reliability Engineering

Four areas of uncertainty need particular attention before a top-down power budget for the NEM is considered. These areas comprise forecast NEM demand, storage battery power outputs, weather uncertainties for renewables and facility outages.

1.2.1 Demand Forecast Uncertainties

AEMO's ISP does not provide demand data. The ESOO provides a detailed discussion including the following[27]:

ESOO Definition of operational maximum demand forecasts

- a **50% probability of exceedance (POE),** meaning they are expected statistically to be met or exceeded one year in two, *and are based on* ***average*** *weather conditions* (also called one-in-two-year)
- a **10% POE** (for maximum demand), based on ***more extreme*** *conditions* that could be expected one year in 10 (also called one-in-10-year)

It also states[28] that "*Maximum and minimum operational demand means the highest and lowest level of electricity drawn from the transmission system, measured and* ***averaged*** *from the power system in half-hour intervals in either summer (November to March for mainland regions and December to February for Tasmania) or winter (June to August). These forecasts are presented as sent out*." i.e. Power delivered by the grid.

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[26] Draft ISP App 4.6 P27 ""The timing, severity and duration of prolonged dark and still conditions over a wide area are difficult to predict."

[27] 2025 ESOO P19

[28] 2025 ESOO P18

Which of these conditions is realistically worst-case? Obviously, **it is the 10% POE maximum sent out operational demand since average weather conditions cannot be reliably considered worst-case conditions**. Would anyone expect certification of an aircraft design designed to handle the weight of average passenger loads?

The definition of operational demand appears to exclude consumer demands, which are being satisfied by consumers own solar generation capacity. However, considering solar is absolutely zero every overnight period, it can be assumed that maximum 10% POE demand will probably include all consumer loads, when solar is unavailable. The draft ISP should clearly confirm this fact. This assessment of worst-case conditions assumes this condition. As for consumer battery storages, the draft ISP assumes that coordinated CER batteries in a VPP are part of the NEM[29]. Passive consumer batteries remain behind the meter to handle only the owner's loads.

Table 1 provides 10% POE maximum demand data for winter and summer conditions for the states and NEM from AEMO's electricity forecasting data portal. The difference between 10% POE and 50% POE are not large, being less than 1 GW up to 2040 and then rising to 3.4 GW by 2050, about 2.5% to 6.5%. These data indicate high confidence in the characterisation of growth in demand over the next 25 years, both in terms of daily demand profiles and annual growth.

Table 1 Maximum Demand GW from AEMO Electricity Forecasting Data Portal[30]

10% POE	**Winter**					**Summer**		
Region	2025	2030	2040	2050	2026	2030	2040	2050
NSW	12.7	13.8	16.3	17.2	14.0	14.9	18.0	18.8
QLD	8.5	9.1	11.2	11.8	11.1	11.7	14.3	15.2
SA	2.7	3.3	3.8	4.2	3.5	4.0	4.6	5.0
TAS	1.8	1.9	2.0	2.0	1.3	1.5	1.5	1.5
VIC	8.6	9.6	12.3	14.0	10.3	10.9	12.9	13.6
Totals	34.3	37.6	45.6	49.3	40.3	43.0	51.3	54.1

50% POE	2025	2030	2040	2050	2026	2030	2040	2050
NSW	12.38	13.46	15.84	16.65	13.10	13.92	16.70	17.50
QLD	8.26	8.81	10.89	11.50	10.42	10.92	13.46	14.36
SA	2.63	3.14	3.65	4.03	3.20	3.66	4.25	4.61
TAS	1.77	1.89	1.93	1.90	1.30	1.42	1.47	1.46
VIC	8.41	9.40	12.18	13.84	9.57	10.14	12.20	12.78
Totals	33.45	36.70	44.49	47.92	37.60	40.07	48.08	50.70

According to the ISP[31], uncertainties remain due to unknown uptake of CER, consumer behavioural choices, AI uptake adoption (requiring rapid expansion of data centres), the rate at which electrification will replace fossil fuels, population growth and major industrial growth in mining, manufacturing and other industrial processes. None of these potential growth drivers appear particularly easy to forecast within a few percent.

How demand affects overall growth and daily demand profiles must be considered a major uncertainty.

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[29] Draft ISP P67 Figure 18 Forecast storage capacities

[30] https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/electricity-forecasting-data-portal

[31] Draft ISP App 4.2 P9 NEM's demand profiles will continue to evolve

This is a major weakness in the ISP because it has not identified any reserve capacity as a hedge against potential growth exceeding what has been predicted. Building a power grid with no built-in capacity to absorb future unexpected growth shows a lack of system design maturity. It would be incredibly unwise, considering the lead time from identifying a looming growth problem to the lag in planning, approval and building additional capacity, which can take many years.

As a minimum, the ISP should acknowledge the uncertainty associated with future growth in demand forecasts, provide a range of values or state what margin was included in forecasts to cope with ‘unexpected’ growth.

The ISP has also projected that future average daily demand profiles will change between now and 2039-40[32]. ISP Appendix 4 Figure 1 characterises a significant drop in daytime operational sent out demand as consumers use more of their own solar panels for power. Forecast daily demand profiles to 2050 are shown in draft ISP Appendix 4 Figure 2, which is presented below as Figure 1 of this submission.

However, what is critical for NEM system design is the overnight period of about <u>16 hours when solar power generation falls to absolute zero every single day across the entire NEM</u>. Note that solar generation is about two thirds of all renewable power in the ISP. That leaves only one third, wind power, at night and that is highly variable and also subject to droughts that can last for days, weeks and even seasonally, as AEMO’s data indicate and as has been experienced by other countries.

As stated previously, proper high reliability design must employ worst-case assumptions. These should include that overnight demand remains flat due to unanticipated growth characteristics such as EVs and AI data centres, and departures from the many assumptions discussed above.

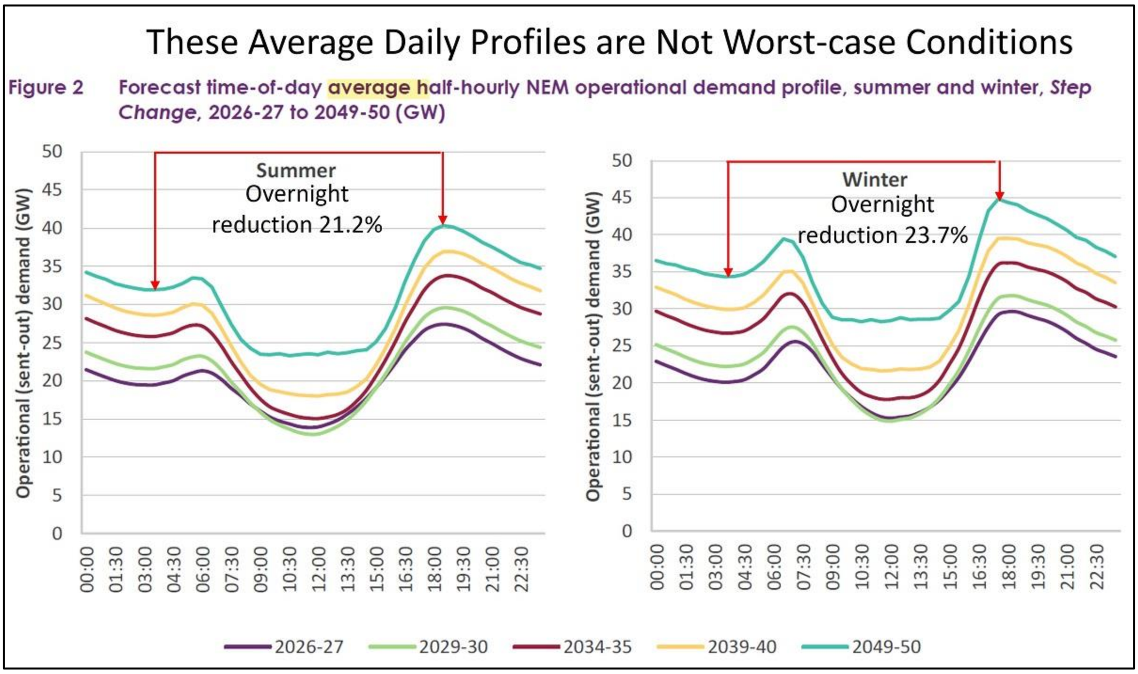

Figure 1 Draft ISP Average Daily Demand Profiles[33]

Figure 1 charts show a small trend (about one third) towards overnight flattening as indicated by the measured data in Table 2 below. But the uncertainties concerning future growth in demand over the

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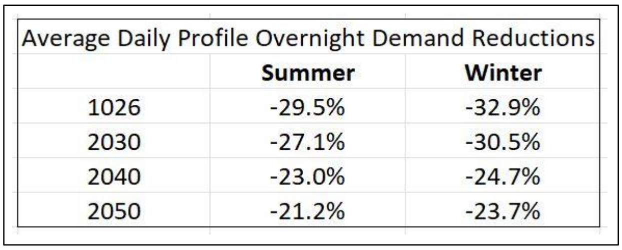
[32] Draft ISP App 4.2 P9 Figure 1 Projected time-of-day average demand profile for the NEM

[33] Draft ISP App 4.2 P10 Figure 2 Forecast average NEM operational demand profile



Average Daily Profile Overnight Demand Reductions		
	Summer	**Winter**
1026	-29.5%	-32.9%
2030	-27.1%	-30.5%
2040	-23.0%	-24.7%
2050	-21.2%	-23.7%

Table 2 Draft ISP Daily Profile

next 25 years are considerable. It must also be reiterated that these data, especially being average data, have no place in high reliability design. However, subsequent subsections show that it has indeed been used in a 2040 simulation that alleges the ISP can deliver reliable power.

Using a daily profile based on averages is inherently not suitable for worst-case analysis and design.

The forecast Step Change time-of-day average half hourly NEM operational demand profiles for summer and winter[34] exhibit substantial percentage drops overnight. But AEMO in past ISP versions predicted a flattening overnight as EV charging, in particular, is expected to raise demand at night. Concerted efforts are underway to change consumer behaviour by offering free mid-day power when solar peaks, just when busy people are expected to be using their EVs. How long before punitive tariffs are placed on overnight EV charging from homes and businesses?

Can AEMO guarantee that peak overnight demand will always fall by about 25% (based on average demand data) **for the next 25 years**? Absolutely not. **Worst-case conditions must be based on peak demand remaining relatively flat overnight.**

1.2.2 Storage Output Uncertainties

Reliability of the NEM has always been assured by a dispatchable reserve margin (DRM) to guard against facility and equipment failures. Prior to 2019, it was about 20%.

Baseload generators have made up the largest part of the dispatchable reserve margin. Hydro electricity is included but, under prolonged drought conditions, some limitations can be expected. The ISP includes storage batteries and pumped hydro[35] as dispatchable. The DRM has fallen to about 6.8% based on AEMO data, as shown by the top-down WOS power budget in this submission.[36]

A black line in draft ISP Figure 1 (See Figure 2 of this submission) indicates dispatchable capacity provides 79 GW of power by 2050 – impressive considering maximum 10% POE demand is projected by 2050 to be just 54 GW. A 20% DRM makes the design requirement 65 GW.

As has been pointed out in our 2024 submission and our 2024 IASR submission, this figure is misleading, since a large part of it, batteries, can provide such power for just a few hours. Some would say this figure is deceptive, since previous submissions have clearly called it out.

Elsewhere in the draft ISP, it does discuss limited battery power outputs over longer durations[37] due to their small energy storage capacities and lengthy recharge times, but this kind of chart is the sort of information often placed before senior leaders, who do not have the time to read the entire document. It certainly conveys a false impression and should be revised or notated with a warning.

This submission provides the real picture, where storage outputs defined by the draft ISP are spread evenly across various timescales to match the flat peak demand scenario we advocate as worst-case for system design. Note batteries are able to adjust their inverter outputs from maximum power to much lower levels to extend the duration of power delivery to 16 hours or more.

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[34] Draft ISP App 4.2 P10 Figure 2 Forecast time-of-day NEM operational demand profiles

[35] Draft ISP P11 Figure 1 and P58 Figure 15

[36] See Section 1.3

[37] Draft ISP P65 "..most of this near-term storage is relatively shallow, storing only enough energy to discharge at full capacity for four hours or less."

Pumped hydro includes Snowy 2.0 and Borumba as per draft ISP Figure 18, which now includes Kidston and Phoenix under Deep Storage.[38] Snowy 2.0 is often touted as the key to backing up renewables but its 2.2 GW maximum output is less than 5% of peak demands and its 7 day duration is actually limited because its lower reservoir capacity is unable to hold more than 5 days worth of capacity.[39] It cannot therefore fully recharge the upper reservoir if Snowy 2.0 is discharged beyond that duration. Furthermore, practical operating constraints limit operations of pumped hydro schemes, preventing full discharge of reservoirs.

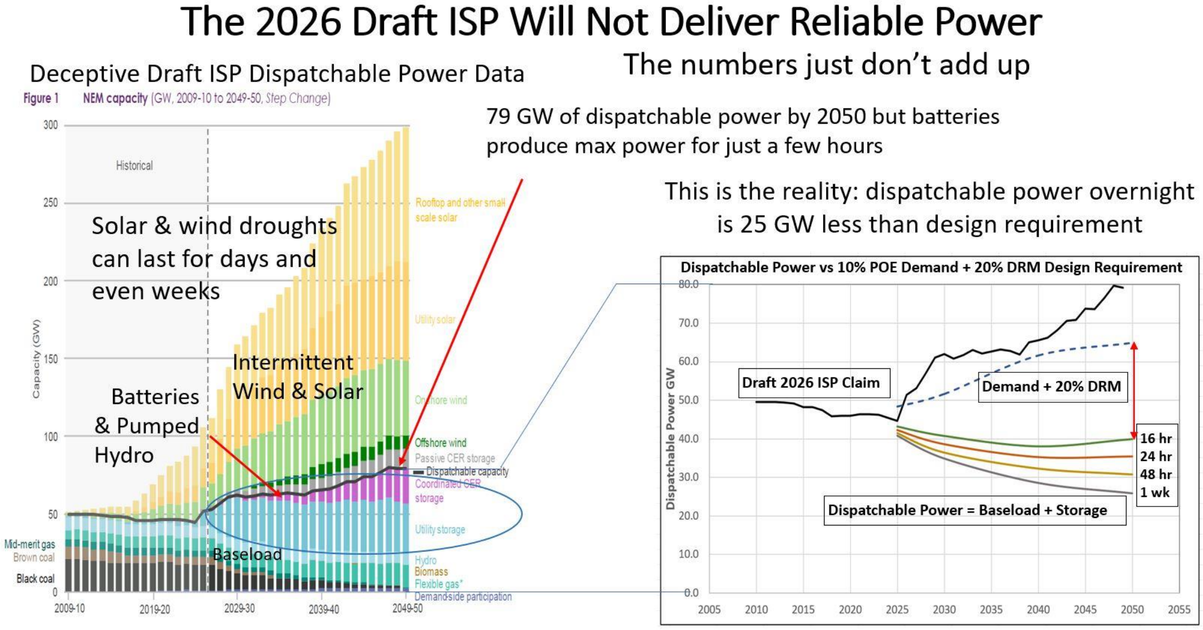

Figure 2 Storage Capacities vs Duration

Batteries are not just simple buckets for electrons. Energy is stored and released through chemical reactions that are not perfect. Some heat is released during charge and discharge since the reactions are not 100% efficient. Over charging and over discharging can have serious consequences that reduce lifetime, which is already short at about 10-12 years.

Most battery manufacturers quote their storage capacity after leaving a 10% margin to represent a minimum depth of discharge. But standard recommendations are to operate a battery between about 20% and 85% of full charge to achieve maximum lifetime. In addition, batteries exhibit a decrease in capacity over their lifetime, which averages about 3% per year (30% after 10 years). This 25% safety margin and aging degradation have not been factored into the chart in Figure 2 and has major operating, cost and system design implications.

The draft ISP also describes the role that batteries play in stabilising the grid to provide security by smoothing rapid fluctuations in VRE since weather changes can be abrupt.[40] ”*They can help maintain grid stability and inertia, smooth out volatile frequencies, and can balance out fast changes in supply and demand*.”

Batteries, with very fast reaction capabilities, are better than pumped hydro in this role and such grid services are required at all times during night and day. However, the draft ISP acknowledges that

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[38] Snowy 2.0 at 2.2 GW for up to 7 days; Borumba at 2.0 GW for up to 24 hours; Kidston at 0.25 GW for up to 8 hours; and Phoenix at 0.8 GW for up to 15 hours.

[39] Bowden An Overview of the Snowy 2.0 Pumped Hydro Energy Storage System Aug 2025

[40] Draft ISP P66 ISP Explainer: firming and shaping by storages

batteries are also needed for intra day firming to accommodate peaks and troughs in renewable generation to match supply and demand. It cannot therefore be assumed that batteries will all be in a state of full charge at the start of every 16 hour overnight cycle, during which solar is always zero across the entire NEM and wind outputs can vary from high to very little. The draft ISP assures that: "*The ISP seeks the most efficient balance between (these roles) to meet its reliability, affordability and emission priorities…. (while) optimising both reliability and system security services*."

Appendix A4.5 of the draft ISP[41] provides details of how *"…storages… play roles… including energy firming, system balancing, active power reserves in addition to advanced power system services such as synthetic inertia and system strength support.*" Its narratives describe the various time periods that are required; intra-day storage, intra-week storages and seasonal storage and long duration seasonal firming. Even the consequences of imperfect planning are described. However, this mostly narrative material is not persuasive – the reality is that the planned storages are overwhelmingly inadequate to meet real worst-case conditions as this submission shows in subsequent sections.[42]

1.2.3 Weather Condition Uncertainties

The draft ISP acknowledges the need for reliability in the face of "*potentially long periods of dark and still renewable lulls across the NEM*"[43] and for system security in "*terms of frequency and inertia, voltage management and system restoration*" after a blackout. "*The NEM must be resilient in its capability to provide energy in all conditions, including when there is minimal or no sunshine or wind for prolonged periods.*[44]"

The question is what are the worst-case conditions affecting the output levels from weather-dependent renewables? What conditions are appropriate for high reliability system design?

The draft ISP acknowledges that ***"renewable lulls are common".***[45] It states that "*local weather events ..last a few hours, a day or two, or on rare occasions a week*". It goes on to say that "…***lulls that affect considerable portions of the NEM are a key concern****. Extended renewable lulls covering wide areas are hard to predict in duration and intensity*."

Appendix 4.6 also makes it clear: "*The timing, severity and duration of prolonged dark and still weather conditions over a wide area are difficult to predict*."

The fact that weather conditions affect wide areas simultaneously is well known. First, a couple of examples that illustrate the size of weather systems are shown in Figures 3 and 4 for cloud cover affecting solar and high pressure zones that result in low gradients indicating low wind conditions. These are typical conditions, which occur frequently.

Weather conditions also lead to frequent droughts in this dry continent. These conditions can lead to major decreases in water availability in some hydro dams. Acting over longer periods than wind and solar lulls, hydro insufficiency affects over 7 GW of reliable baseload power, which adds another uncertainty to grid reliability.

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[41] Draft ISP Appendix 4 P21

[42] Miskelly Storage Requirement for 100% Renewables on the Eastern Australia Grid 7Feb2026

[43] Draft ISP p49 System reliability

[44] Draft ISP App 4.6 P27 Operating the power system during long, dark and still conditions

[45] Draft ISP P68 ISP Explainer: Reliability through renewable lulls

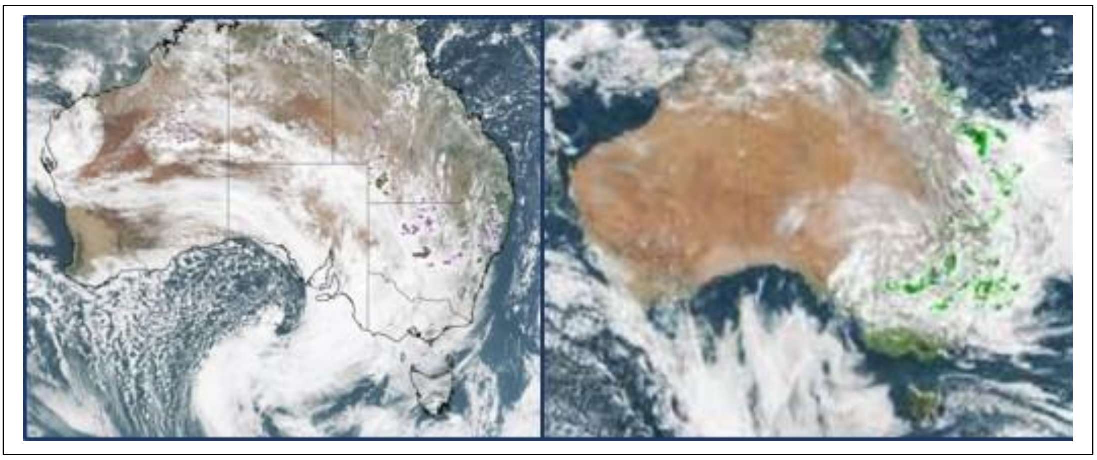

Figure 3 Example: Weather Systems Can Be Very Extensive for Days at a Time

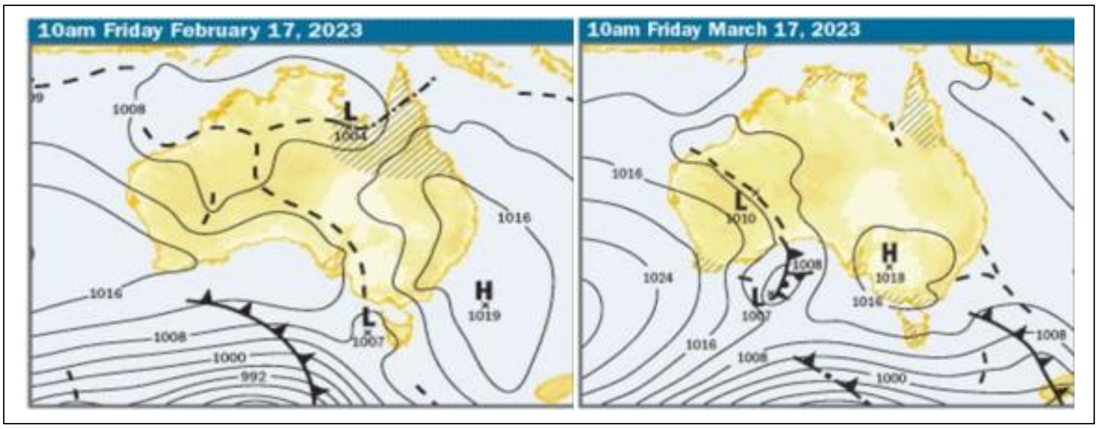

Figure 4 Example: Large-scale High Covering Much of the NEM

Second, Table 3 provides 10 years of wind drought data from Australian wind farms for periods when NEM wind capacity factor (CF) fell below 10%. The numbers of events each year are considerable and the duration of events ranges from 4 hours up to over 18, as indicated in the table. Furthermore, the right hand side breaks down the number of events in terms of capacity factors. In fact, there are considerable numbers of events each year when CF fell below 6%. Figure 5 below the table illustrates the extreme volatility of total NEM wind power for just a single month in June 2020.

	Number of Events of Wind Drought								
	Duration of Period hrs when CF <= 10%					Annual	**Capacity Factors**		
Year	4-6	6-10	10-14	14-18	18+	Max Duration	0-6%	6-8%	8-10%
2022	9	14	4	1	2	20 h	3	18	19
2021	17	30	10	5	0	16 h	9	36	52
2020	22	27	14	4	4	34 h	21	21	53
2019	16	33	9	6	4	42 h	18	34	57
2018	28	34	9	5	5	57 h	17	51	54
2017	15	34	15	5	17	71 h	28	41	57
2016	24	17	18	2	6	62 h	17	35	64
2015	10	24	17	11	16	39 h	25	46	45
2014	29	29	22	2	13	46 h	19	51	77
2013	30	30	15	6	9	54 h	26	48	64
2012	20	33	12	6	19	66 h	36	46	59

Table 3 Historic Wind Power Data Eastern Australia[46]

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[46] Source Mike O'Ceirin from AEMO data

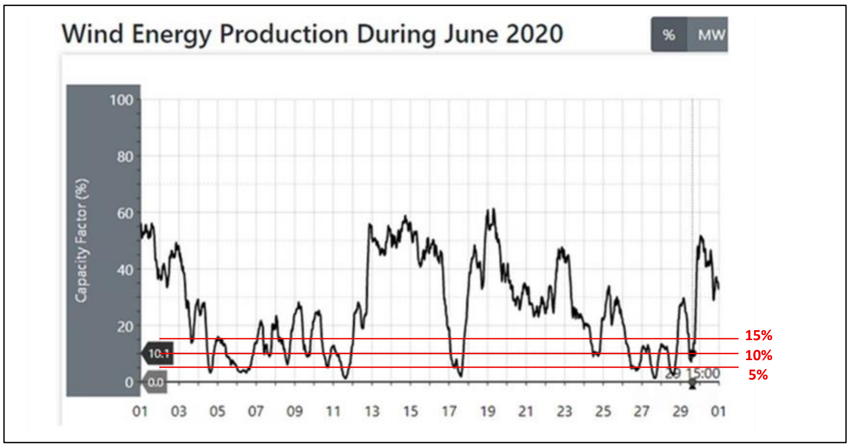

Figure 5 Wind Capacitor Factor for June 2020[47]

This real operating data provides an indication of frequency, duration and intensity of wind droughts in a form that is easily understandable to most readers.

However, Appendix 4.6 of the ISP forecasts the frequency of VRE daily available capacity factors using a statistical modelling approach based on “*..recently observed weather history.”*[48] *It defines VRE lulls as “…events where availability of wind and solar generation across the NEM is… below the fifth percentile.*” It states “*AEMO’s modelling leverages 15 years of observed weather patterns, providing a diverse mix of weather conditions, **but future conditions may provide more extreme conditions than have been observed in this period***.” (emphasis added)

ISP Appendix 4 Figures 16 – 20 provide forecasts for 2039-40 for daily VRE CF.

From a grid system design perspective, the available data are not difficult to assess. Defining worst-case conditions first focuses on the critical 16 hour overnight period when solar generation is zero every single night all across the NEM. That accounts for 72.5% of all VRE capacity.

NEM wind power availability is highly variable as shown in Figure 5 and Table 3, which demonstrates numerous events of wind CF less than 10% and durations of up to three days (72 hours).

The only sensible conclusion for worst-case high reliability engineering design is to assume that both solar and wind are zero for an entire 16 hour period. It cannot be relied upon. This assumption eliminates all weather uncertainty for the purpose of designing a reliable power grid over a 16 hour period.

The reality is that even assuming 10% CF for winds overnight, by 2050 it amounts to just 5.7 GW of power, when far more dispatchable power – at least 25 GW – is needed in the draft ISP design to maintain reliability by restoring the DRM to plus 20%.

1.2.4 Facility Outage Uncertainties

All complex power generation facilities require regular maintenance to assure maximum reliability. Sometimes this requires complete shutdown of a facility for major upgrades. But unexpected failures sometimes happen, which necessitates shutdowns for repairs. Shutdowns can sometimes take months to resolve. Data on the reliability of individual facilities is difficult to obtain and is commercially sensitive.

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[47] https://anero.id/energy/wind-energy/2020 /june

[48] Draft ISP Ap 4.6 P27 references analysis by Risk Frontiers, nfi

Therefore, system design must rely on past experience when a DRM of at least 20% was maintained to protect the reliability of the NEM against facility outages. By 2050, the necessary 20% DRM margin relative to 10% POE demand, is 10.8 GW, which would cover situations where multiple facilities are out at the same time. It is not intended to compensate for wind and solar droughts and for poor system design.

1.2.5 Summary of Uncertainties

1. 10% POE maximum demand should be used as worst case.
2. A major weakness in the draft ISP is the lack of identification of uncertainty pertaining to forecasts of future power demands over the next 25 years. Proper system design should build in an allowance for unexpected future power demand growth with little lead time.
3. The use of average daily demand profiles has no place in high reliability design. Given the data show that the overnight reduction depth of daily demand profiles is actually decreasing, the forecasting uncertainties associated with profile flattening from EV charging, AI data centres, changing consumer behaviour and major industrial loads. Worst-case conditions require a forecast of flat demand at the 10% POE level.
4. Uncertainties in future storage capacities due to restricted depth of discharge and aging need close examination. The balance between battery support for system security services and readiness to supply back-up power overnight needs further examination to support system design.
5. Weather-dependent VRE uncertainties make it necessary to assume that worst-case conditions cannot rely on any VRE during critical overnight periods.
6. The DRM should be set at least 20% to protect against facility outages.

1.3 Top-Level Draft ISP Power Budget

The ISP does not provide demand data nor a power budget to demonstrate the proposed Step Change grid design is viable. Such a power budget must be constructed for worst-case conditions for system design purposes to ensure reliability.

Therefore, this submission presents a top-level NEM system power budget in Table 4. It was constructed using 10% POE demand data from AEMO’s Electricity Forecasting Data Portal and capacities for all generation and storage facilities given in the spreadsheet data for Figures 15 and 18 respectively.

As the first step, this power budget addresses a 24 hour cycle, broken into 8 hours daytime and 16 hours overnight. It provides the budget for four years; 2025-26, 2029-30, 2039-40 and 2049-50 starting with demand data plus a 20% DRM to define a total system design requirement. While currently the design requirement is 48 GW, it grows to 65 GW by 2050. The DRM is indispensable.

The ISP baseload generation capacities currently are about 40 GW, but with the closing of coal generation, it falls to just 22 GW by 2050. This is the first indication of a probable reliability problem.

Energy storage capacities in terms of energy storage (GWh) and max power output (GW) are defined by the ISP. Passive storages do not directly support the grid and are therefore not included in the power budget totals. They are shown in the table for completeness and use in WOS cost estimation. The storage power outputs are spread evenly over the 16 hours of night to match the flat 10% POE demand assumption. They rise from 2.4 GW currently to almost 18 GW by 2050. When added to 22 GW of baseload power, the total 40 GW is far below the design requirement of 65GW.

From the foregoing draft ISP data, the DRM, which is currently only about 7%, falls to negative values by 2030 (-5.2%) due to inadequate storages and baseload generation and is deeply negative by 2040 (-25%). Keep in mind, that the design should be based not on zero % DRM, but on plus 20%.

It will be argued by some that this analysis is far too conservative and will be unnecessarily expensive. But the previous subsection shows that the current draft ISP is based on assumptions and hopes that ignore many uncertainties and risks failure. This power budget eliminates uncertainties associated with weather-dependent generation and builds in margins against facility outages. This is high reliability engineering where rigorous analysis, redundancy, safety margins and conservative assumptions predominate. As for costs, the next section of this submission shows how dramatic reductions can be achieved.

It is clear that the draft ISP design falls far short of being able to reliably deliver full power to meet either the 10% POE demand or the system requirement – without relying on wind power overnight. In fact, by 2050, it is 25 GW short of the design requirement. Even with all wind generation at 35% capacity factor, in 2050 it produces about 20 GW – enough to meet 10% POE demand but still short of preserving the full DRM to guard against facility outages.

There is also another problem with recharging storages. This power budget assumes all storages are exhausted in the 16 hour overnight period. It would be essential that during the next 8 hour daytime period, all storages would be returned to full to prepare for the possibility that the overnight wind drought may recur the next evening. Recharging requires that all wind and solar generation recovers to at least 16% capacity factor the following daytime. This necessity makes the draft ISP system dependent on renewables to meet a second consecutive day of wind and solar drought.

This first cut, top-level power budget is based on basic worst-case conditions. However, it ignores several factors, which actually worsen the bottom line:

1. All dispatchable generators are assumed to operate at 100% capacity continuously.
2. Storage battery capacities are limited by operating constraints and are assumed to be fully charged at the start of an overnight discharge cycle.
3. Pumped hydro storages are assumed to be at full output for the full discharge duration.
4. Transmission and distribution power losses are not estimated.
5. No reserve capacity to handle unexpected future growth is incorporated.
6. Reducing solar panel and wind turbine capacity factors over time are not considered.

Thus, the system-level power budget in Table 4 should be viewed as not completely worst-case.

Nevertheless, the results are rather dire. DRM falls into negative numbers as early as 2030, according the draft ISP grid design. Minus 5% is in fact 25% below where it should be to guarantee reliability. i.e. plus 20%. By 2040, DRM plummets to minus 25%, a full 50% below where the design should be.

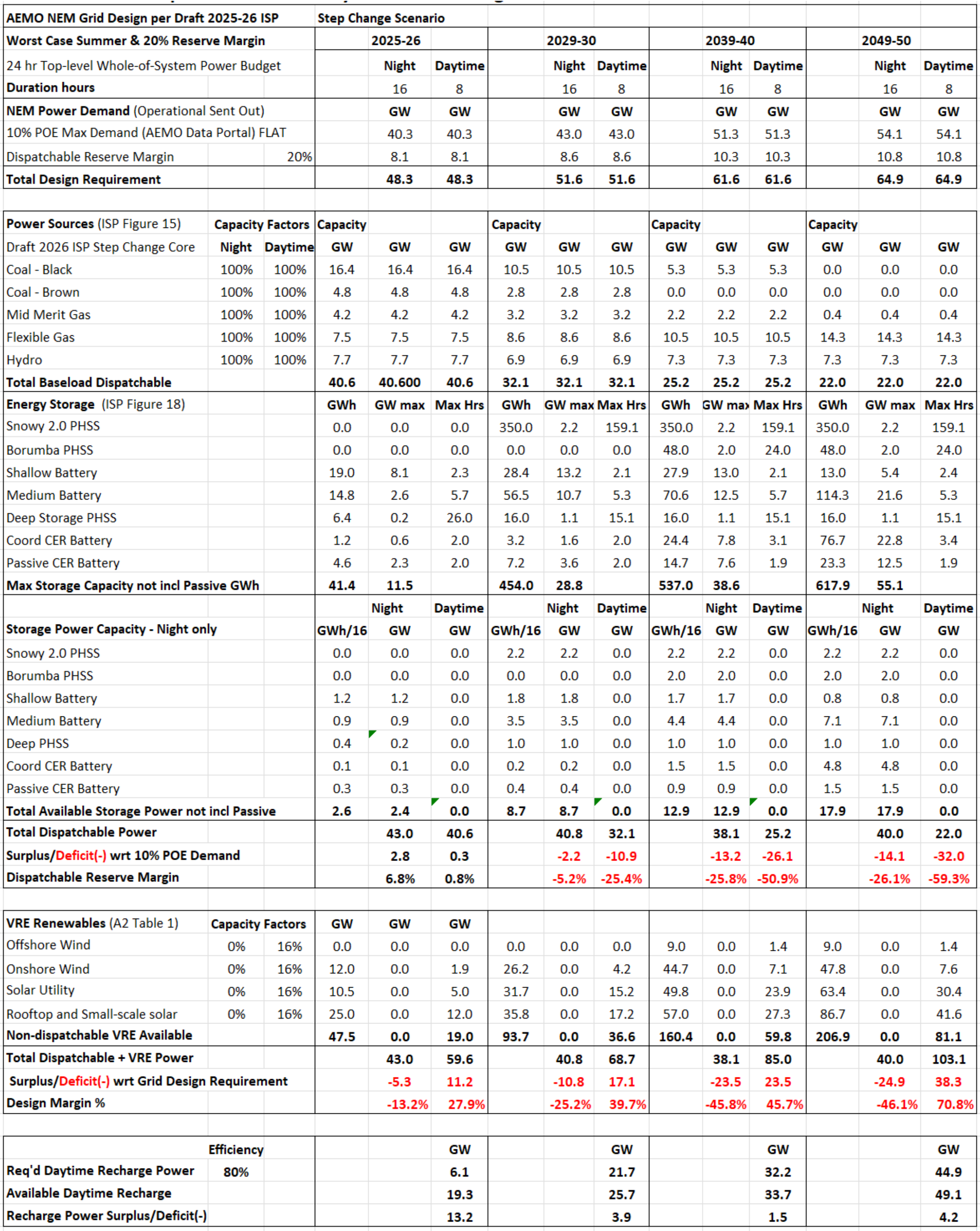
The conclusions are plain to see.

There are simply not enough generation and storage capacities to get through a single 16 hour overnight cycle under conditions when demand is high and overnight wind is very low.

System design cannot be based on hope that these conditions will not occur. The ISP provides no indications that its clearly stated descriptions of the challenges has been taken seriously in its NEM grid design.

The bottom line is that **the draft ISP does not represent a realistic engineering plan to produce reliable power in the NEM**, given many uncertainties that remain to be addressed.

The step change design misses the mark, not by a little but by a very large measure. While a top-down power budget ignores some detail, many of its assumptions to ignore power line losses, aging factors of solar panels, wind turbines and batteries, operating limitations reducing capacities of storage systems and the necessity to use battery resources for grid security services actually suggest a much worse outcome in a more detailed analysis.



AEMO NEM Grid Design per Draft 2025-26 ISP			**Step Change Scenario**											
Worst Case Summer & 20% Reserve Margin				**2025-26**			**2029-30**			**2039-40**			**2049-50**	
24 hr Top-level Whole-of-System Power Budget				**Night**	**Daytime**		**Night**	**Daytime**		**Night**	**Daytime**		**Night**	**Daytime**
Duration hours				16	8		16	8		16	8		16	8
NEM Power Demand (Operational Sent Out)				**GW**	**GW**		**GW**	**GW**		**GW**	**GW**		**GW**	**GW**
10% POE Max Demand (AEMO Data Portal) FLAT				40.3	40.3		43.0	43.0		51.3	51.3		54.1	54.1
Dispatchable Reserve Margin		20%		8.1	8.1		8.6	8.6		10.3	10.3		10.8	10.8
Total Design Requirement				**48.3**	**48.3**		**51.6**	**51.6**		**61.6**	**61.6**		**64.9**	**64.9**
Power Sources (ISP Figure 15)	**Capacity Factors**		**Capacity**			**Capacity**			**Capacity**			**Capacity**		
Draft 2026 ISP Step Change Core	**Night**	**Daytime**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**	**GW**
Coal - Black	100%	100%	16.4	16.4	16.4	10.5	10.5	10.5	5.3	5.3	5.3	0.0	0.0	0.0
Coal - Brown	100%	100%	4.8	4.8	4.8	2.8	2.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0
Mid Merit Gas	100%	100%	4.2	4.2	4.2	3.2	3.2	3.2	2.2	2.2	2.2	0.4	0.4	0.4
Flexible Gas	100%	100%	7.5	7.5	7.5	8.6	8.6	8.6	10.5	10.5	10.5	14.3	14.3	14.3
Hydro	100%	100%	7.7	7.7	7.7	6.9	6.9	6.9	7.3	7.3	7.3	7.3	7.3	7.3
Total Baseload Dispatchable			**40.6**	**40.600**	**40.6**	**32.1**	**32.1**	**32.1**	**25.2**	**25.2**	**25.2**	**22.0**	**22.0**	**22.0**
Energy Storage (ISP Figure 18)			**GWh**	**GW max**	**Max Hrs**	**GWh**	**GW max**	**Max Hrs**	**GWh**	**GW ma**	**Max Hrs**	**GWh**	**GW max**	**Max Hrs**
Snowy 2.0 PHSS			0.0	0.0	0.0	350.0	2.2	159.1	350.0	2.2	159.1	350.0	2.2	159.1
Borumba PHSS			0.0	0.0	0.0	0.0	0.0	0.0	48.0	2.0	24.0	48.0	2.0	24.0
Shallow Battery			19.0	8.1	2.3	28.4	13.2	2.1	27.9	13.0	2.1	13.0	5.4	2.4
Medium Battery			14.8	2.6	5.7	56.5	10.7	5.3	70.6	12.5	5.7	114.3	21.6	5.3
Deep Storage PHSS			6.4	0.2	26.0	16.0	1.1	15.1	16.0	1.1	15.1	16.0	1.1	15.1
Coord CER Battery			1.2	0.6	2.0	3.2	1.6	2.0	24.4	7.8	3.1	76.7	22.8	3.4
Passive CER Battery			4.6	2.3	2.0	7.2	3.6	2.0	14.7	7.6	1.9	23.3	12.5	1.9
Max Storage Capacity not incl Passive GWh			**41.4**	**11.5**		**454.0**	**28.8**		**537.0**	**38.6**		**617.9**	**55.1**	
				Night	**Daytime**		**Night**	**Daytime**		**Night**	**Daytime**		**Night**	**Daytime**
Storage Power Capacity - Night only			**GWh/16**	**GW**	**GW**	**GWh/16**	**GW**	**GW**	**GWh/16**	**GW**	**GW**	**GWh/16**	**GW**	**GW**
Snowy 2.0 PHSS			0.0	0.0	0.0	2.2	2.2	0.0	2.2	2.2	0.0	2.2	2.2	0.0
Borumba PHSS			0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
Shallow Battery			1.2	1.2	0.0	1.8	1.8	0.0	1.7	1.7	0.0	0.8	0.8	0.0
Medium Battery			0.9	0.9	0.0	3.5	3.5	0.0	4.4	4.4	0.0	7.1	7.1	0.0
Deep PHSS			0.4	0.2	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0
Coord CER Battery			0.1	0.1	0.0	0.2	0.2	0.0	1.5	1.5	0.0	4.8	4.8	0.0
Passive CER Battery			0.3	0.3	0.0	0.4	0.4	0.0	0.9	0.9	0.0	1.5	1.5	0.0
Total Available Storage Power not incl Passive			**2.6**	**2.4**	**0.0**	**8.7**	**8.7**	**0.0**	**12.9**	**12.9**	**0.0**	**17.9**	**17.9**	**0.0**
Total Dispatchable Power				**43.0**	**40.6**		**40.8**	**32.1**		**38.1**	**25.2**		**40.0**	**22.0**
Surplus/Deficit(-) wrt 10% POE Demand				**2.8**	**0.3**		**-2.2**	**-10.9**		**-13.2**	**-26.1**		**-14.1**	**-32.0**
Dispatchable Reserve Margin				**6.8%**	**0.8%**		**-5.2%**	**-25.4%**		**-25.8%**	**-50.9%**		**-26.1%**	**-59.3%**
VRE Renewables (A2 Table 1)	**Capacity Factors**		**GW**	**GW**	**GW**									
Offshore Wind	0%	16%	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	1.4	9.0	0.0	1.4
Onshore Wind	0%	16%	12.0	0.0	1.9	26.2	0.0	4.2	44.7	0.0	7.1	47.8	0.0	7.6
Solar Utility	0%	16%	10.5	0.0	5.0	31.7	0.0	15.2	49.8	0.0	23.9	63.4	0.0	30.4
Rooftop and Small-scale solar	0%	16%	25.0	0.0	12.0	35.8	0.0	17.2	57.0	0.0	27.3	86.7	0.0	41.6
Non-dispatchable VRE Available			**47.5**	**0.0**	**19.0**	**93.7**	**0.0**	**36.6**	**160.4**	**0.0**	**59.8**	**206.9**	**0.0**	**81.1**
Total Dispatchable + VRE Power				**43.0**	**59.6**		**40.8**	**68.7**		**38.1**	**85.0**		**40.0**	**103.1**
Surplus/Deficit(-) wrt Grid Design Requirement				**-5.3**	**11.2**		**-10.8**	**17.1**		**-23.5**	**23.5**		**-24.9**	**38.3**
Design Margin %				**-13.2%**	**27.9%**		**-25.2%**	**39.7%**		**-45.8%**	**45.7%**		**-46.1%**	**70.8%**
	Efficiency				**GW**			**GW**			**GW**			**GW**
Req'd Daytime Recharge Power	**80%**				**6.1**			**21.7**			**32.2**			**44.9**
Available Daytime Recharge					**19.3**			**25.7**			**33.7**			**49.1**
Recharge Power Surplus/Deficit(-)					**13.2**			**3.9**			**1.5**			**4.2**

Table 4 Draft ISP Top-level Power Budget

1.4 The 2040 Simulation

The ISP presents a simulation example of a one week period in June 2040 during which a three day VRE lull occurs. It seeks to demonstrate that the ISP design is able to successfully deal with this scenario causing it to declare[49] that: "*This analysis provides a sample demonstration that with appropriate energy and fuel management, the NEM is capable to withstand lower levels of VRE availability under the proposed ODP, even for extended durations*."

Unfortunately, this example does not provide any confidence that this claim is accurate. In fact, it demonstrates the opposite. Figure 6 reproduces Figure 21 in the draft ISP App 4.6 with annotations.

This simulation fails on many counts to represent worst-case conditions and therefore provides no certainty to validate the draft ISP claims. It serves only to deflect attention from the obvious; the baseline Step Change NEM design cannot deliver reliable power to consumers because it provides far too little baseload power and grossly inadequate storage capacities.

The critical period in Figure 6 is two days, the 16th and 17th of June 2040 in the overnight periods. From the perspective of high reliability engineering design, the worst-case conditions for June 2040 are based on 10% POE demand plus a 20% DRM for NSW, VIC and SA, as shown on the chart. However, the evening peak demand in those days is about 4.5 – 5.5 GW below 10% POE. In fact, it is about 1 GW below the evening peaks in the rest of the week, for some reason.

But the simulation low is another 5.7 – 6.4 GW lower again due to the 'average daily profile' from Figure 2 in Appendix 4 being assumed. (The percentage reduction from high to low matches the daily profile data in Appendix 4 Figure 2.) Two more assumptions add to non-worst-case conditions: non-dispatchable wind power of 2.5 – 4 GW is assumed and 2 GW of power is imported.

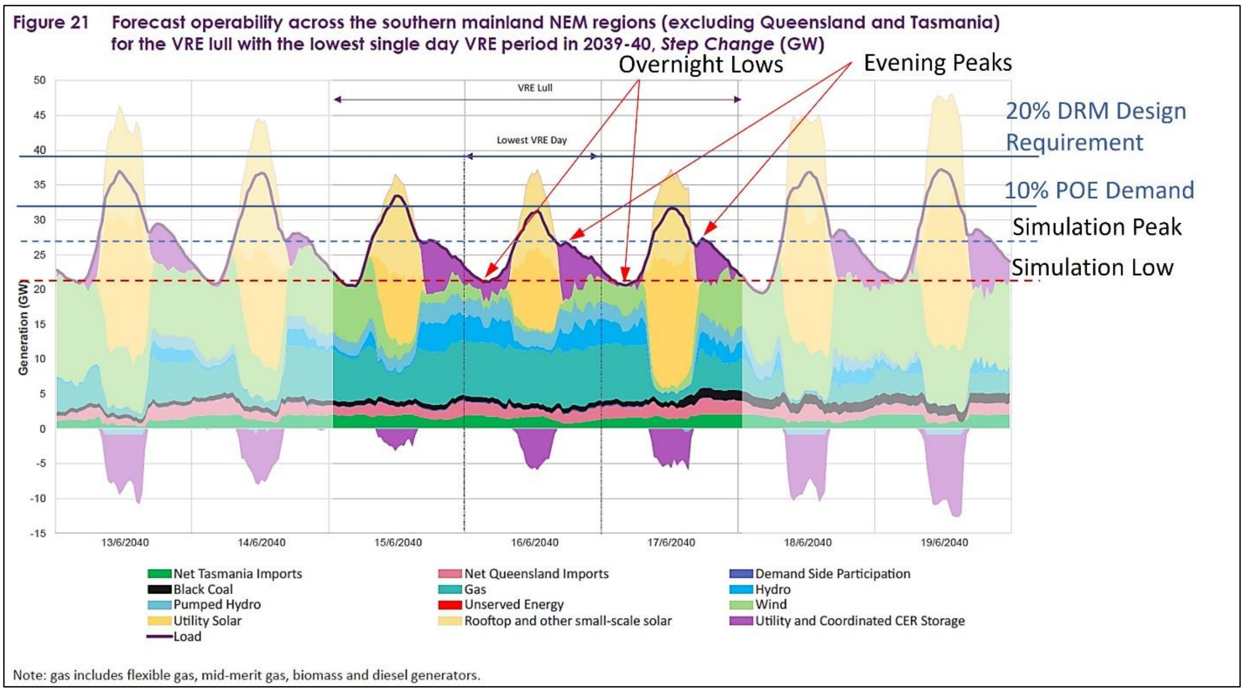


Figure 21 Forecast operability across the southern mainland NEM regions (excluding Queensland and Tasmania) for the VRE lull with the lowest single day VRE period in 2039-40, *Step Change* (GW)

Note: gas includes flexible gas, mid-merit gas, biomass and diesel generators.

Figure 6 Assessment of Appendix 4.6 Simulation Analysis

It is therefore concluded that the simulation does not represent worst-case design and in fact provides evidence that the draft ISP will not deliver reliable power under proper worst-case conditions required for high reliability. The power budgets for these two days are shown in Table 5.

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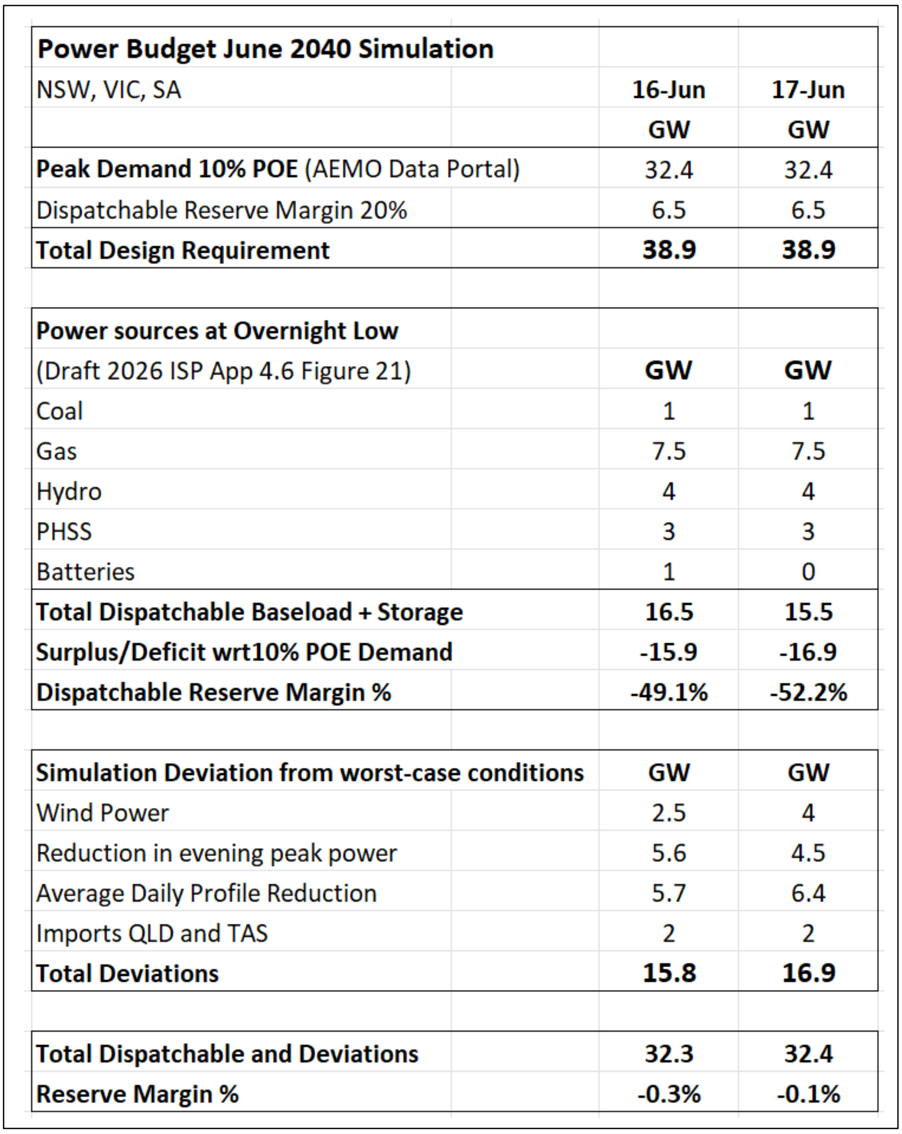
[49] Draft ISP App 4.6 P35 Operating the power system during long, dark and still conditions



Power Budget June 2040 Simulation		
NSW, VIC, SA	**16-Jun**	**17-Jun**
	GW	**GW**
Peak Demand 10% POE (AEMO Data Portal)	32.4	32.4
Dispatchable Reserve Margin 20%	6.5	6.5
Total Design Requirement	**38.9**	**38.9**
Power sources at Overnight Low		
(Draft 2026 ISP App 4.6 Figure 21)	**GW**	**GW**
Coal	1	1
Gas	7.5	7.5
Hydro	4	4
PHSS	3	3
Batteries	1	0
Total Dispatchable Baseload + Storage	**16.5**	**15.5**
Surplus/Deficit wrt10% POE Demand	**-15.9**	**-16.9**
Dispatchable Reserve Margin %	**-49.1%**	**-52.2%**
Simulation Deviation from worst-case conditions	**GW**	**GW**
Wind Power	2.5	4
Reduction in evening peak power	5.6	4.5
Average Daily Profile Reduction	5.7	6.4
Imports QLD and TAS	2	2
Total Deviations	**15.8**	**16.9**
Total Dispatchable and Deviations	**32.3**	**32.4**
Reserve Margin %	**-0.3%**	**-0.1%**

Table 5 Appendix 4.6 Simulation Analysis Power Budgets

What is clear from this table is that dispatchable power is only about half of 10% POE demand, a whopping negative DRM of about minus 50%. The shortfall to get to 10% POE is about 16-17 GW; to get a design to plus 20% DRM would require a total of 22.5 – 23.5 GW, a massive design failure.

Some might argue that wind power should be considered dispatchable – it is not[50]. Some might argue that the average daily profile should be applied and that imports should be included as dispatchable. Can AEMO guarantee that these conditions will always be available? Certainly not.

As for the reduction in evening peak power from AEMO's own forecast for 10% POE demand, that is clearly an error in setting up the simulation.

The simulation provides a useful indication that the draft ISP is not based on proper high reliability engineering design principles. This must be rectified if confidence is to be restored in the most consequential public infrastructure program in Australia's history.

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[50] Miskelly Wind Farms in Eastern Australia – Recent Lessons

2 Capital Cost Analysis

2.1 Introduction

The estimate for the full cost of the program to transition the critical NEM system to intermittent renewables has become a sensitive topic in public discourse.

The GenCost reports provide useful future capital cost factor projections, even if they appear to some critics as somewhat optimistic concerning renewables and pessimistic on nuclear in particular. While it is often said that predicting the future is a fool's errand, it is nevertheless a necessity across many fields of endeavour.

The GenCost capital cost factors are most accurate when addressing current costs for which there are abundant sources of real data. One point needs remembering: the further into the future, the less accurate these projections are likely to be. Reasonable accuracy (10-15%) may be expected over a 5 year projection, although sudden project blowouts[51] are a frequent reminder of caution. But over a 25 year projection, estimates can easily be off by 50-100%. Using cost projection data without stating allowances for uncertainties is not recommended. The ISP does not provide estimates of uncertainty for its predicted costs.

The ISP contains an amortised capital cost estimate of present value $128 Billion[52] and this ISP version also includes a limited breakdown[53]. The total present value of the assets is estimated at $156 billion, the difference being to amortisation of the asset costs beyond 2050. The ISP repeatedly claims its Step Change design is optimised as the "*least cost way to supply secure and reliable electricity to consumers, while meeting government policies."*[54] **The caveat to government policies is important since it excludes consideration of alternative grid designs, which may be considerably less costly without meeting the government's dictate for renewable energy targets placed in the NEO**.

The ISP explains[55] how AEMO's "*legislated purpose is to supply secure and reliable power to consumers… while meeting government policies*." For some reason, AEMO feels it is not necessary to include in its draft ISP, a comparison with other grid design alternatives that may not entirely meet existing government policies but would help inform the government and public of the impact of meeting current government energy policies.

Surely, it is in the national interest to avoid misleading claims such as the ODP is the least cost pathway. As Section 2 demonstrates, the ISP design is probably more than twice as expensive in terms of capital costs than other alternatives, which offer better reliability.

Most readers outside the financial sector would not understand the meaning of 'present value', which is a discounted cash flow method of estimation used widely by governments and industry as part of net present value (NPV) accounting to compare future investment opportunities in terms of both cost and future income. **It's use in the context of the draft ISP is questionable since no attempt has been made to estimate future revenues**. However, applying it to future costs has the effect of reducing the cost figure dramatically, which may please some government officials, who are facing rising public anxiety and anger over ballooning power costs.

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[51] Snowy 2.0 for example and several transmission projects

[52] Draft ISP P93 Capital costs for the ODP investments, and changes since 2024 and P18

[53] Draft ISP P94 Figure 2.3 and Draft 2026 Draft ISP Chart data

[54] Draft ISP P3 CEO Preface

[55] Draft ISP P90 Section 10 The ODP contributes to the National Electricity Objective

The discount rate used is 7%[56] according to ISP Appendix 1. Over a 25 year period of assumed project spending approximately the same amount each year, the method divides each year's cost by a factor of 1.07^n where n is the number of years from now. This has the effect of making the present value cost approximately half (46.6%) of the sum of the actual cash flow costs each year (Capex). Non-uniform spend rates will shift this figure. In addition, the ISP explicitly amortises the capital costs[57] over the lifetimes of the assets, which results in some capital costs falling beyond 2050 and hence not included.

However, the draft ISP also appears to have taken steps to considerably reduce cost estimates by not only optimising the design of the program to find the optimum development path (ODP) but also by not including many significant elements. The rationale for this approach remains undisclosed.

The ISP states in footnotes that the capital cost estimate "*… includes transmission and distribution augmentation, and utility scale generation and storage Capex … and does not include the cost of commissioned, committed or anticipated transmission projects*." In other words, sunk costs that are already hitting consumer power prices, as well as future and committed costs that have yet to be expended, but will also hit consumer power bills, are inexplicitly excluded. This is certainly not the full cost to the economy! But these exclusions will have a major impact in reducing the stated capital costs, as seen in this analysis.

Carefully omitted from the $128 billion present value cost is the cost of CER[58]. The ISP states that consumers are forecast to invest around $50 billion (amortised present value) in rooftop solar, batteries and EV chargers (but not the cost of EVs) through to 2050. While some readers may mistakenly believe that the CER cost is included in the stated $128 billion, it is clearly not. The rationale provided is that these unpredictable decisions are made by households and businesses and so the ISP cannot attempt to optimise them. In fact, the ISP has actually flagged a total amortised present value cost of $178 billion and this excludes $28 billion in amortised present value cost beyond 2050[59].

What has not been provided by AEMO or any government agency is an estimate of the full cost to the economy and this has generated much criticism. The sheer size of the NEM transition program and its criticality to the health of the entire economy and the well-being of all Australians, in addition to national security concerns, makes it imperative to rigorously examine and reveal the full costs on a whole-of-system whole-of-life basis.

While there is no doubt that AEMO and its consultants have undertaken detailed financial modelling and estimation methodologies, there remain substantial concerns for the uncertainty and integrity of the capital cost estimate of amortised present value $128 Billion in the Draft ISP and the estimate for $50 billion in CER costs.

This submission undertakes to formulate an estimate based on ISP figures for power generation and energy storage capacities and GenCost capital cost factors plus relevant costs for transmission and distribution. To provide a range of uncertainty for each estimate, the most accurate GenCost current capital cost factors of 2025 are projected flat over the next 25 years in addition to the projected GenCost figures.

Given limited resources and time to make this submission, the following estimates are based on top-level WOS/WOL methods for the entire cost to the economy. This methodology is likely to be less

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[56] Draft ISP App 1 P26

[57] Draft ISP P93 "..the annualised capital cost in present value…$128 billion.." and P94 Figure 23 "..amortised capital costs…" and "Consumers to invest around $50 billion (present value of amortised costs…"

[58] Draft ISP P94 Consumer Investments

[59] Draft ISP P93 "..the assets have a technical life beyond 2050, the total present value of these investments as 'upfront capital investment' is $156 billion. This is $28 billion more than $128 billion.

precise than more detailed models. However, given the inherent uncertainties in projecting future capital costs over 25 years, this approach will be sufficiently accurate for use in system planning and particularly useful for making comparisons with alternatives.

The following subsections provide:

- a baseline Step Change WOS/WOL capital cost estimate
- comparative costs for improving the reliability of the draft ISP grid design, and
- comparative costs for four alternative grid designs with various technology mixes.

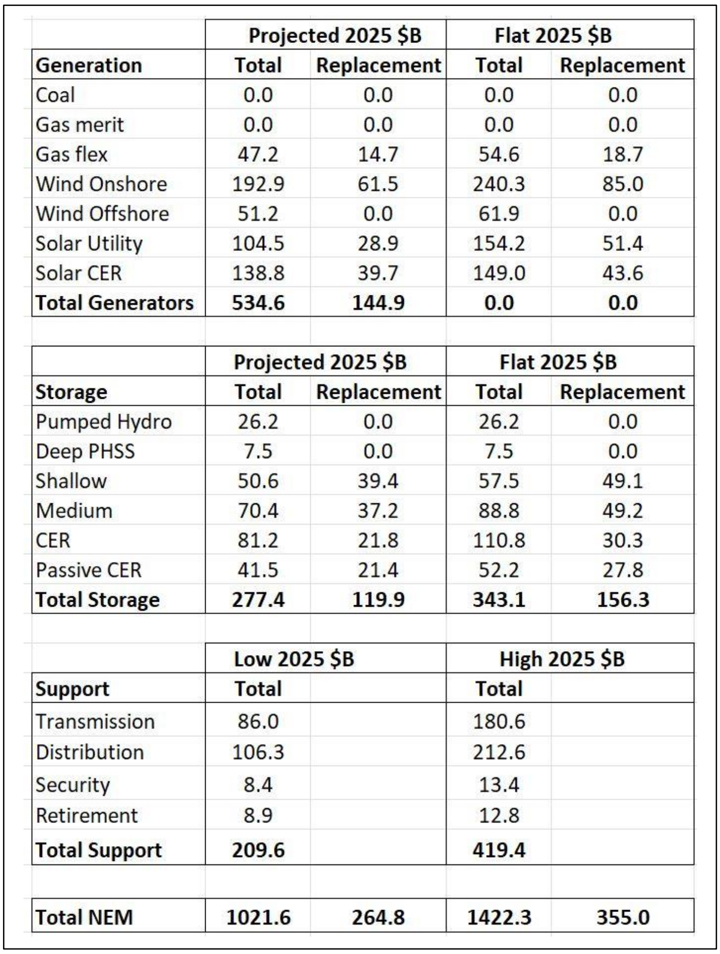
2.2 Baseline Step Change Full Capital Cost to the Economy

The baseline Step Change NEM design is costed independently in this submission in three parts: generation, storages and support. Table 6 provides a summary of the breakdown costs.

Generation and storages are costed using the capacities from the ISP and the capital cost factors from the draft GenCost report. Projected costs use the full projection of GenCost; Flat costs use the 2025-26 GenCost factors flatlined to 2050 to provide an upper estimate.

Replacement costs are those for equipment that has reached end-of-life and is replaced. The assumed lifespans for solar and wind generation are 20 years; gas is 30, coal is 50 and nuclear is 80. Pumped hydro lifespans are 80 years and batteries are 10 years. Totals include replacement costs but these are also broken out for further information.

Note that the ISP provides no data on lifespans. It does, however, recognise that *"..additional storage development is required to replace storage projects*[60] *that reach their end of technical life*.."



	Projected 2025 $B		Flat 2025 $B	
Generation	**Total**	**Replacement**	**Total**	**Replacement**
Coal	0.0	0.0	0.0	0.0
Gas merit	0.0	0.0	0.0	0.0
Gas flex	47.2	14.7	54.6	18.7
Wind Onshore	192.9	61.5	240.3	85.0
Wind Offshore	51.2	0.0	61.9	0.0
Solar Utility	104.5	28.9	154.2	51.4
Solar CER	138.8	39.7	149.0	43.6
Total Generators	**534.6**	**144.9**	**0.0**	**0.0**

	Projected 2025 $B		Flat 2025 $B	
Storage	**Total**	**Replacement**	**Total**	**Replacement**
Pumped Hydro	26.2	0.0	26.2	0.0
Deep PHSS	7.5	0.0	7.5	0.0
Shallow	50.6	39.4	57.5	49.1
Medium	70.4	37.2	88.8	49.2
CER	81.2	21.8	110.8	30.3
Passive CER	41.5	21.4	52.2	27.8
Total Storage	**277.4**	**119.9**	**343.1**	**156.3**

	Low 2025 $B		High 2025 $B	
Support	**Total**		**Total**	
Transmission	86.0		180.6	
Distribution	106.3		212.6	
Security	8.4		13.4	
Retirement	8.9		12.8	
Total Support	**209.6**		**419.4**	
Total NEM	**1021.6**	**264.8**	**1422.3**	**355.0**

Table 6 Top-level WOS estimates for Full Capital Costs to the Economy of the ISP

CSIRO's draft 2025-26 GenCost report provides optimistic lifespan data for wind (25 years) and solar (30 years) generation but pessimistic data for coal (30 years, nuclear (30 years) and gas (25 years). Nothing is provided on storage batteries, which are the most expensive element and has the lowest lifespan. CSIRO tries to justify its data by defining it as *"..economic life or the period of financing*." as opposed to total operational life or design life.

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[60] Draft ISP App 2 P27 Dispatchable capacity to firm renewables

There are numerous reports that describe significant output degradations (typically 1-2%/year) over time and reductions in operating lifespans for solar[61] and wind[62] generation. Solar panels with proper maintenance have expected lifetimes of about 25 years, assuming damaging weather such as hailstorms do not hit them – another risk factor. It is financial trade-offs against output degradation that determines when replacement should occur. Wind turbines are generally described as having 20-25 year design lifespans, but operating experience indicates significant problems emerging well before that time.

Batteries experience aging effects of about 3%/year, which limits practical lifetimes to about 10-12 years (based on manufacturer warranties). These lifetimes are contingent upon on operating restrictions to prevent over discharge below about 20% and rapid charging beyond about 85%. Given the evidence of practical issues with achieving the optimistic renewables lifespans promoted by manufacturers and others, this submission takes a slightly more conservative approach to lifespan assumptions.

Hydro is not costed since the draft ISP does not envisage any expansion beyond the current facilities. Likewise, coal and merit gas are not costed since existing facilities are being phased out without replacement.

Costs are assessed for four periods: to date in 2025-26, 5 years to 2029-30, 10 years to 2039-40 and 10 years to 2049-50. GenCost cost factors for 2025-26 and the mid-points of the other three periods are multiplied against the capacity installations and replacements in each period.

Support costs include transmission line expansion based on ISP total distance and cost factors reflecting recent reports of high inflation in construction costs. Distribution network costs are based on an estimate of total CER connections, and grid stabilisation costs were estimated for installations of about 120 synchronous condenser facilities. Preliminary retirement cost estimates were made for decommissioning, recycling and site remediation.

These estimates are unamortised cash flow expenditure (capex) costs to 2050, which include full CER costs and distribution network costs. Comparison with the draft ISP present value cost estimates[63] of $128 billion and an additional $50 billion for CER (a total of $178 billion) reveals a staggering difference that demands explanation. Most people outside the finance industry are unfamiliar with present value methods but do understand cash flow costs.

Reconciliation of these two cost models provides seven major reasons for this completely different result:

1. The ISP calculates cost in present value terms (discounted cash flow), which at 7% over 25 years reduces estimates to about 46.6% of actual cash flow costs.
2. The ISP estimate is based on amortisation of capital costs, which extend beyond 2050 by $28 billion present value. ($156 billion estimate)[64].
3. The ISP costs do not represent all costs prior to 2025.
4. The ISP approach probably does not take into account the limited lifetimes of some assets (mainly wind, solar and batteries), which necessitates replacement before 2050.

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[61] UNSW 6Jan2026 Cracking the 'long tail' problem hidden solar panel issue;

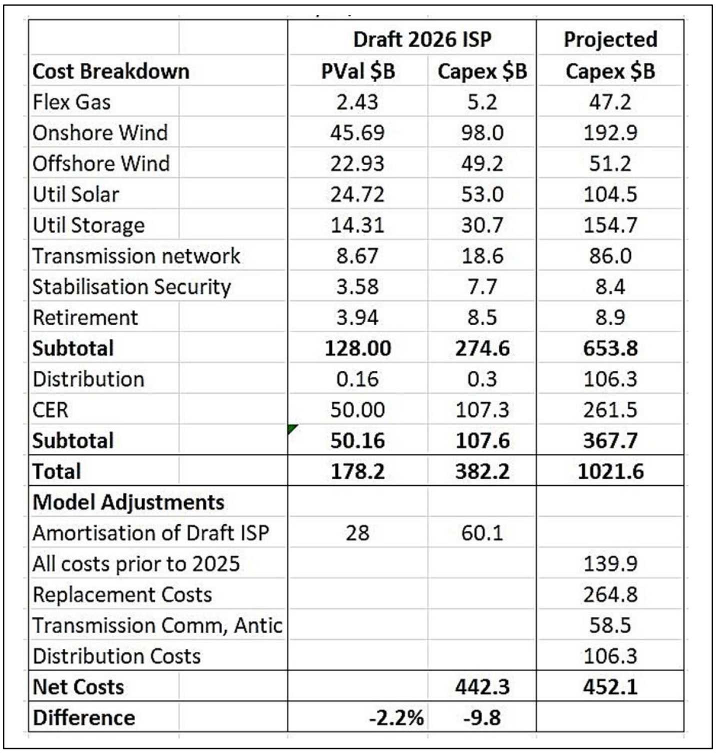
[62] Richard 14May2020 Turbine output drops steeply after ten years: US research; Institute for Energy Research 28Feb2024 Wind Turbines and Solar Panels are Aging Prematurely; Staffell & Green 2014 How does wind farm performance decline with age?

[63] Draft ISP P93 Capital costs for the ODP investments…

[64] Draft ISP P18 Delivering the optimal development path and P93

5. Committed and anticipated transmission project costs are excluded despite being expenditures subsequent to 2025.
6. The ISP does not include any appreciable distribution network costs.
7. The ISP estimate of $128 billion present value does not include CER costs.

Using breakdown cost information from the ISP[65], a more detailed comparison can be made as shown in Table 7.



	Draft 2026 ISP		Projected
Cost Breakdown	**PVal $B**	**Capex $B**	**Capex $B**
Flex Gas	2.43	5.2	47.2
Onshore Wind	45.69	98.0	192.9
Offshore Wind	22.93	49.2	51.2
Util Solar	24.72	53.0	104.5
Util Storage	14.31	30.7	154.7
Transmission network	8.67	18.6	86.0
Stabilisation Security	3.58	7.7	8.4
Retirement	3.94	8.5	8.9
Subtotal	**128.00**	**274.6**	**653.8**
Distribution	0.16	0.3	106.3
CER	50.00	107.3	261.5
Subtotal	**50.16**	**107.6**	**367.7**
Total	**178.2**	**382.2**	**1021.6**
Model Adjustments			
Amortisation of Draft ISP	28	60.1	
All costs prior to 2025			139.9
Replacement Costs			264.8
Transmission Comm, Antic			58.5
Distribution Costs			106.3
Net Costs		**442.3**	**452.1**
Difference	**-2.2%**	**-9.8**	

Table 7 Reconciliation of Projected Capital Costs with Draft ISP

The 'amortised present value' of the ISP cost estimates of about $178 billion is first converted to capex costs of $382.2 billion, by using the 46.6% factor. The ISP also presents a present value estimate of $156 billion for the assets without amortisation. The difference with $128 billion is $28 billion present value, which is converted to $60.1 billion capex and added to $382.2 billion to provide an estimate of unamortised real capex cost of $442.3 billion for comparison on the same basis with Projected capex costs made by this submission.

The Projected capex costs, the lower of the two estimates in Table 6, is unamortised cash flow costs, which total $1,021.6 billion based on using projected GenCost factors. Four reductions are made (items 3, 4, 5 and 6 above) to match the basis of the draft ISP cost estimate. The result is $452.1 billion capex – only 2.2% different than the adjusted draft ISP estimate. This excellent alignment validates the top-level WOS/WOL methodology used by this submission and the identification of significant factors for the understating of the total costs by the ISP.

The ISP estimate of $128 billion ($122 billion previously), which are widely touted by government as a true statement of costs for the transition of the NEM to primarily renewable energy sources, are in fact a small partial system estimate expressed in amortised and discounted cash flow terms. They appear designed to minimise the total cost, which results in grossly misleading information.

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[65] Draft ISP P94 Figure 23 and Draft 2026 ISP chart data file

Any reasonable person would be concerned that the full costs to the economy of the NEM transition are almost ten times higher than the widely quoted figure of $128 Billion.

Some might decry the methodology of this submission estimate as a less precise top-level system approach. But precision and detail do not guarantee accuracy, when the forecast data over 25 years in the future is highly imprecise. The difference of just 2.2% is a good indication that the top-level methodology is a reasonably good approximation to the ISP estimate. The fact is that this method is based on ISP capacity numbers and GenCost capital cost factors.

The differences for the massive understatement of actual real costs by the draft ISP are fairly clear from this analysis. **AEMO must disclose a more realistic assessment of cost estimates to better inform decision makers and the public.**

'Sunk costs' prior to 2025 are ignored by the draft ISP. These costs are now part of consumer power bills and were incurred to support the transition of the NEM to renewables. They are legitimately part of the total cost to the economy of the NEM transition, which all Australians deserve to know.

Ignoring replacement costs also cannot be justified – facility lifetimes are an essential parameter. Operating solar panels and wind turbines beyond their 20 year lifetimes will incur significant reductions in efficiency and therefore capacity factor. The grid will lose its safety margins. Operating batteries beyond their lifetimes of 10-12 years will result in about 30% less storage capacity and their rate of decline will increase substantially. Since batteries are critical to overnight reliability, grid performance will degrade markedly.

Failure to include many transmission projects that have been 'committed or anticipated' and will incur future costs, which will inflate consumer power bills, is simply incomprehensible. Most transmission projects have been excluded.

Distribution upgrades are not optional. The ISP has rationalised no responsibility for significant distribution upgrades aside from[66] *"..$160 million for voltage management optimisation to facilitate more CER generation*." It appears to expect that DNSPs[67] will take the lead to invest in most distribution upgrades. "*AEMO recognises that DNSPs may be required to invest in demand-driven augmentations across the period to 2049-50 as consumers' demand for electricity grows. AEMO assumed that these types of augmentations will naturally support operation of a given proportion of new CER uptake* (Section A9.2.2)." Distribution upgrade costs are estimated in this submission from data in Tables 3 and 6 in A9.2.2 and A9.2.3 respectively as being in excess of $100 billion, which DNSPs will pass to consumer power bills. Clearly, these costs are part of the total cost to the economy. Regardless of who will be paying, these costs will end up on power bills.

It must also be kept in mind that the cost estimates in this subsection are for a ISP system design that is incapable of delivering reliable power, according to Section 1 of this submission. This has already become widely apparent among both businesses and the public that the transition plan for the NEM to intermittent and highly volatile power will not likely deliver reliable power to consumers and power bills are skyrocketing as the rollout continues. These perceptions cannot be ignored.

2.3 Cost Estimates for Modifications to Improve Reliability

The Step Change plan needs improvements to provide a credible high reliability grid design. This can be achieved in two ways, by adding additional baseload generation using flex gas or by adding

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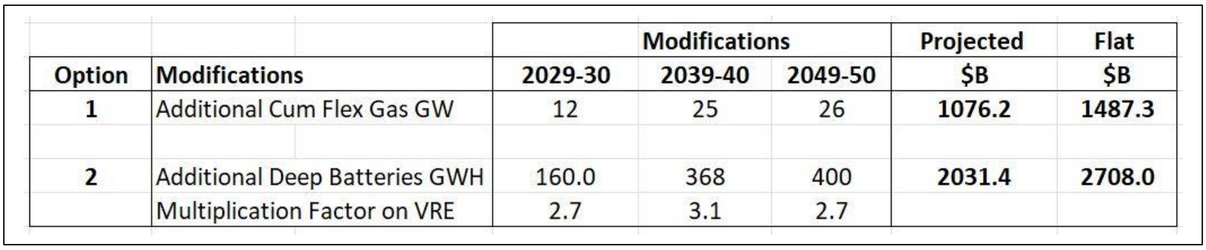
[66] Draft ISP App 9.2.3 P25 Distribution network developmental opportunities…

[67] Distribution Network Service Providers

additional storage capacity and the requisite expansion of VRE to recharge it. Table 8 shows the capital cost estimates for these two options.



		Modifications			Projected	Flat
Option	**Modifications**	**2029-30**	**2039-40**	**2049-50**	**$B**	**$B**
1	Additional Cum Flex Gas GW	12	25	26	**1076.2**	**1487.3**
2	Additional Deep Batteries GWH	160.0	368	400	**2031.4**	**2708.0**
	Multiplication Factor on VRE	2.7	3.1	2.7		

Table 8 Options for Reliability Improvement for DRM 20% and Resulting Total Costs

Adding additional flex gas capacity is the least expensive in terms of capital costs. It costs about $55-65 billion more than the baseline Step Change estimate and, being a baseload source, <u>it is available continuously for as many days as needed</u>.

Adding deep batteries to restore the DRM to 20% just for one 16 hour overnight period is considerably more expensive. It adds about $1,010-$1,286 billion to the baseline Step Change estimate, a doubling in cost and makes it completely unaffordable. The increased battery size requires a considerable expansion of VRE under worst case conditions on the following day to recharge them.

Increasing battery capacity to back up to handle multiple consecutive days for up to a week, as does Snowy 2.0, would incur enormous costs and makes this option impossible.

2.4 Comparison with Alternative Grid Designs

It is clear that seeking to meet government decrees for Net Zero emissions by 2050 imposes very large costs on the NEM transition at the expense of both reliability and affordable power rates. **This is not a design, which complies with the NEO on any of its requirements for reliability, affordability and Net Zero emissions**.

The intermittent and highly variable nature of weather-dependent wind and solar power generation poses extreme challenges to power grid design. Back up by pumped hydro, batteries and limited amounts of hydro and gas cannot result in a reliable system. More batteries are simply not affordable nor practical. Additional gas capacity (Option 1 above) is the only feasible means to assure reliability but entails more emissions. However, when the actual emissions from mining, processing and manufacture or wind, solar and batteries and decommissioning are properly considered, Option 1 may be quite attractive.

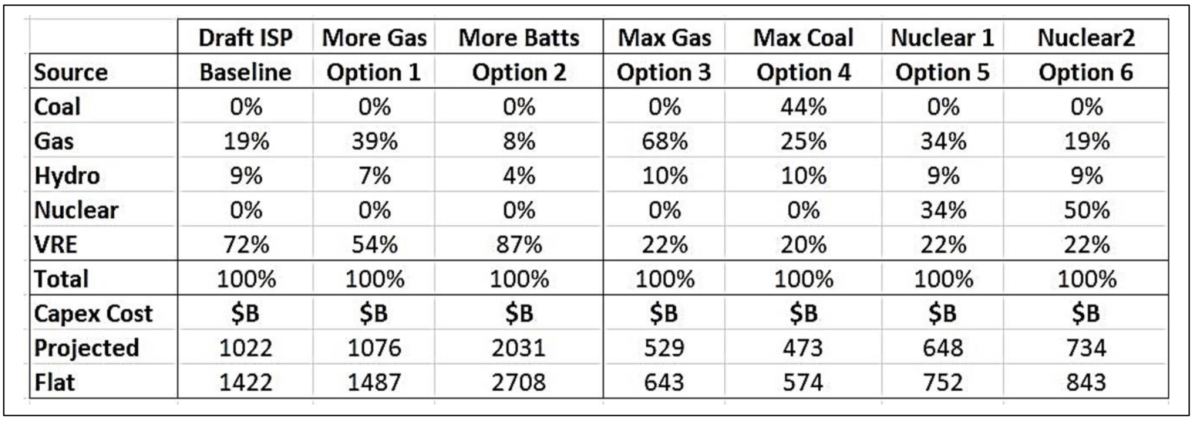
However, intermittent and highly variable VRE also imposes severe technical problems with grid security in terms of frequency, voltage stabilisation and system restart capabilities. CER installations also require very expensive upgrades to local power distribution networks. It also causes havoc in the wholesale power market with prices varying from deeply negative around midday to astronomical in times of grid shortages when wind and solar disappear. **The necessity to create an entire backup system for VRE means major duplication, which results in these facilities operating at vey low and completely uneconomic utilisation rates and disastrous productivity**.

Wind and solar capacity factors are inherently very low, compared to baseload power plants as evidenced by the ISP Step Change design calling for 207 GW of wind and solar power capacity in 2050, when the maximum grid demand plus 20% DRM is only 65 GW. This is the lowest productivity for any electricity grid. But the concentration of solar power in one third of the daily cycle typically produces massive oversupply at midday causing wholesale prices to plummet to negative values and the need for curtailment since the small storages cannot absorb the surpluses. It is little wonder that investors are unwilling to build VRE facilities without government guarantees of return on investment, such as the Capacity Investment Scheme.

Grid designs based primarily on baseload power plants (as in the past) are capable of operating at 85-90% capacity factor continuously, matching supply to demand and would not require the expensive back-up generators, transmission and network planned upgrades, grid-scale batteries and the rollout of large wind and solar farms with huge land footprints, which are causing tremendous anger and resistance in rural communities. Baseload-powered grids inherently provide reliable power without back ups and help stabilise the grid, avoiding costly system service support facilities. Lower wholesale market prices would return to stability, restoring high efficiency and productivity to the economy.

Four baseload alternatives (Options 3-6) were explored to provide a comparison to the ISP grid design. All these alternatives save costs by avoiding transmission line expansion, reducing most distribution network upgrades and avoiding grid stabilisation costs. Future large-scale wind, solar and battery facilities would be cancelled; the existing ones would not be replaced at end-of-life. CER resources however, remain an option for consumers, who wish to generate some of their own power, thereby resulting in renewables to remain a part of the grid mix but subsidies will not be necessary. They constitute about 22% of the grid capacity in these alternative grid design options.

Table 9 defines the mix of power sources in the draft ISP baseline and modified options together with the four alternative grid. It also presents a comparison of capex costs using both CSIRO's projected cost factors and their 2025 cost factors flatlined to reflect uncertainties in future projections. Figure 7 provides the data in graphical format.



	Draft ISP	**More Gas**	**More Batts**	**Max Gas**	**Max Coal**	**Nuclear 1**	**Nuclear2**
Source	**Baseline**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Coal	0%	0%	0%	0%	44%	0%	0%
Gas	19%	39%	8%	68%	25%	34%	19%
Hydro	9%	7%	4%	10%	10%	9%	9%
Nuclear	0%	0%	0%	0%	0%	34%	50%
VRE	72%	54%	87%	22%	20%	22%	22%
Total	100%	100%	100%	100%	100%	100%	100%
Capex Cost	**$B**	**$B**	**$B**	**$B**	**$B**	**$B**	**$B**
Projected	1022	1076	2031	529	473	648	734
Flat	1422	1487	2708	643	574	752	843

Table 9 Configurations and Capex Costs for Baseline and Optional Grid Designs in 2050

2.5 Cost Estimation Conclusions

This cost analysis has revealed important information, which is not widely known outside of government and industry circles. The often repeated claim by government ministers that the cost of the NEM transition is $122 billion (now pegged at $128 billion) is revealed at best as disingenuous. There is little doubt that AEMO's cost accountants are aware of the full cost implications.

This submission takes a principled stand in favour of a rigorous whole-of-system whole-of-life approach to estimation of all relevant costs to the economy, no matter who is paying them. The following conclusions summarise this analysis:

1. The draft ISP cost estimate is based on present value and amortisation of costs from date of installation to beyond 2050, which produces a result of less than half the full Capex costs. This methodology may be familiar to financial managers, but not the vast majority of the public (and even politicians).

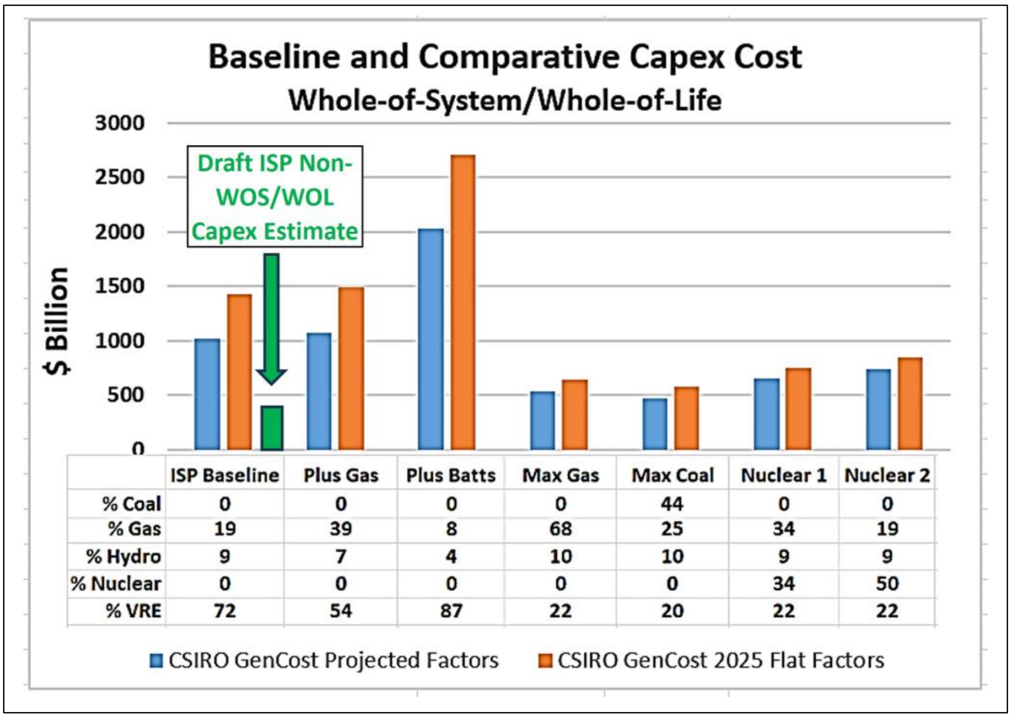


Figure 7 Comparative WOS/WOL CAPEX Costs for Baseline and Alternative Grid Designs

2. The draft ISP cost, based on amortised present value of $128 billion plus $50 billion for CER resources, when adjusted using a 7% discount factor to ‘unamortised Capex costs’, is actually $442 billion.
3. The draft ISP cost estimates cover only a part of the whole system, ignoring without justification, costs incurred prior to 2025, replacement costs of facilities which have reached their end-of-life before 2050, transmission line projects committed and anticipated, which will incur future costs and virtually all distribution network upgrade costs.
4. The inclusive top-level WOS/WOL analysis of this submission puts the estimate of actual Capex cost at $1,022 – $1,422 billion. When this estimate was adjusted to exclude the items missed by the draft ISP, the result matched by 2% the draft ISP estimate as converted to unamortised Capex, which validates the methodology used in this analysis.
5. The Step Change baseline NEM design is now widely perceived as a critical reliability risk. Adding more gas power capacity to the grid to essentially duplicate it with baseload power is both feasible and the least cost approach at $54-65 billion. Adding more batteries is simply not feasible since the entire VRE capacity needs drastic expansion to be able to rapidly recharge the larger storages[68]. The costs to do so even for one overnight period in worst-case conditions more than doubles total costs, adding $1-1.3 trillion; adding enough for several days is astronomically expensive.
6. Four baseload grid design alternatives were costed using the exact same methodology. VRE continued to play a role at about 22% of generation capacity, a level which many experts have identified as feasible without causing significant grid operating problems. The total costs are about half of the real costs for the full Step Change estimate and the four designs all produce reliable power, as evidenced by DRMs higher than 20%.
7. The nuclear options offer the longest lifetimes (60-80 years) well beyond 2050, which would make their amortised costs far less than all other options.

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[68] Miskelly Storage Requirement for 100% Renewables

3 Environmental Issues

3.1 Emissions

The widely stated claim that renewable solar and wind power generators are zero emissions is nothing more than disinformation. It is at best a partial truth considering that operating emissions are very close to zero but the emissions from the entire manufacturing and installation processes and those from end-of-life decommissioning and recycling make the WOS/WOL emissions far from zero.

Here's why:

1. The construction of solar panels and wind turbines requires mining, processing, manufacturing, transportation and installation, all of which involve substantial emissions up front. They also have shorter life-times of 15-25 years compared to baseload generation plants at 30-45 years. And at end-of-life, significant emissions are required for decommissioning and disposal/recycling.
2. Most renewable products are imported – many from China where coal power is needed in their production. They are Scope 3 emissions are not mandated under Australia's National Greenhouse and Energy Reporting scheme. Saving the planet is the stated goal. If so, it is simply not ethical or honest to ignore them.
3. Their low average capacity factors of 25-35% of maximum rated power require 4-6 times more power capacity than conventional baseload systems. The required amount of raw materials is estimated to be over 800 times that for equivalent baseload power stations.
4. For use in a reliable electricity grid, intermittent, highly variable, weather dependent renewables require massive back-up systems, which are not required for conventional baseload power systems. Major emissions result from building and operating them.
5. Renewables require essentially 100% backup from energy storages and conventional baseload sources when prolonged periods of wind drought lasting 4-7 days and restricted solar power (zero every night for about 16 hours and multiple days of cloudy conditions). AEMO's ISP plan has nowhere near enough back-up capacity to ensure a reliable system.
6. Pumped hydro schemes involve huge amounts of civil works resulting in major emissions up front. Environmental opposition and high costs have stymied most of these projects.
7. Batteries, the highest cost of any form of energy storage, are needed to cope with rapid fluctuations in wind and solar power. They are particularly high in up front emissions. A typical EV battery takes 8 years of use before breaking even on emissions and their short 10 year lifetimes demand frequent replacements. Disposal or recycling causes more emissions.
8. Wind and solar power require electronic inverters to produce AC grid power. Many synchronous condenser units are needed to stabilise the grid and again, upfront emissions are the result.
9. Remote wind and solar farms require massive amounts of new transmission line construction involving more upfront emissions.
10. Roof-top solar requires massive upgrades to low voltage distribution networks, again with more up front emissions.
11. Many new gas-powered baseload plants are required in addition to storages. They essentially duplicate the entire grid, but are forced to run at uneconomic low utilisation rates to back up wind and solar and again, they produce emissions which must be counted.

None of the above is required for a grid designed with conventional baseload power sources which have facility lifetimes of 35-50 years. Nuclear power has zero operating emissions, very long lifetimes, very low footprint and *provides baseload power that requires none of the back-up facilities outlined above.*

Common sense alone is sufficient to disregard claims that renewables are zero emission technologies.

The ISP, for the first time, presents charts showing NEM emission reductions in terms of Mt CO_2-e (megatonnes of CO_2 equivalent). The basis for this data is not explicitly stated but its fall to near zero by 2050 is a strong indication that is confined to operating emissions alone. This hides the full truth about Australia's emissions to satisfy government ministers and advocates but is substantially misleading. It is of little value and prevents proper comparison with other grid design alternatives which have far less upfront emissions but some operating emissions.

3.2 Environmental Impacts

The environmental consequences of the rollout of wind turbines and solar panels together with associated transmission lines and energy storages is only now becoming widely understood. Activists previously supporting wind and solar renewables are now turning against them. Nuclear power is gaining new support.

The transition to renewables is inflicting increasing environmental damage in six ways:

1. Massive land use impacting communities, tourism and reducing agriculture
2. Wildlife habitat disruption and direct threats
3. Potential contamination of land, domestic animals and the food chain
4. Toxic waste byproducts and emissions from mining, processing and manufacture of massive amounts of required materials
5. Increased fire risks
6. Decommissioning, disposal/recycling and site remediation issues

Land Use Over 1.7 million hectares of land are needed for AEMO's Integrated System Plan, which cannot deliver reliable power. This includes prime agricultural land and forested areas, particularly along elevated heights such as the Great Dividing Range where the destruction of forests for road access is massive. Farm productivity and therefore farmers' economic security, is affected. Noise complaints from turbines are an ongoing problem. The loss of scenic beauty causes significant social discontent and reduces property values over a much larger region surrounding the installations. It may also have negative effects on tourism.

The ISP's inadequate energy storages prevent delivery of reliable power. Augmenting storages could more than double land use by increasing wind, solar and transmission lines for recharging purposes.

Wildlife Wind turbines kill many bird and bat species. They especially pose threats to migrating flocks. The damage to wildlife involves major losses of habitat and the ruination of local ecologies. Renewables and transmission lines cause an increased risk of bushfires, which pose major threats to all land animals. The ISP makes no mention of wildlife concerns, not even once.

Contamination Fibreglass wind turbine blades suffer from erosion, shedding microplastic particles over wide areas. Animals ingest this contamination and pass this threat to human food chains. Electric vehicles, which are considerably heavier than conventional vehicles, create particulate contamination due to increased tire wear.

Mining, Processing and Manufacturing Renewables require more than 800 times the amount of materials needed for reliable baseload generation plants. This requirement is greatly amplified by the need for firming facilities such as pumped hydro, batteries, grid stabilisation systems and extra transmission lines – all of which are unnecessary for reliable baseload generation plants. Global mining capacity would need to expand tenfold to meet the needs of renewables across the world.

The required materials include concrete, steel, aluminium, iron, copper, silicon, cadmium telluride, copper indium gallium diselenide, rare earth elements, fibreglass, resins, plastics and lubricants. Battery storages also require lithium, cobalt, nickel, manganese, graphite and many other materials.

The emissions and waste products generated by mining and processing of these materials are never accounted for because China is the source of most renewable energy products. Processing for some of these materials results in extremely toxic waste products, which are not adequately controlled in many countries. Some of these materials cannot be practically or economically recycled.

Fire risks Installation of renewables and extra transmission lines across huge areas of rural Australia carries a significant increased risk of bush fires. High winds are a well known risk causing failure of transmission lines which ignite fires. Adding to that is the risk of wind turbine fires which can destroy both the rotating machinery and the fibreglass blades. Firming batteries in both rural and urban environments also introduce new risks of fires from thermal runaway conditions, which cannot be extinguished by conventional firefighting methods.

Decommissioning and Disposal The relatively short lifetimes and massive use of materials for solar and wind (20 years) and batteries (10 years) pose huge end-of-life problems. Inadequate mechanisms are in place to ensure owners of these facilities cannot just walk away. Decommissioning and site remediation can cost well over a million dollars for a single wind turbine, leaving land owners to clean up. Many of the materials cannot be recycled either technically or economically. Efforts to recycle them also involve difficult, hazardous and toxic operations.

Summary The ISP talk of 'earning' social licence for use of such vast areas in regional Australia amounts to little more than hope. Local community angst in the last few years has built up to a high level of resistance to renewables projects. Community complaints include insincere consultations, withholding information, illegal trespassing of private land, divisive use of compensation for landowners, inadequate compensation for all affected, strong-arm government tactics and lack of guarantees for the costs of decommissioning and site remediation at end-of-life.

The reality is that governments are pushing projects on accelerated schedules with little to no social licence. Political leaders are reluctant to admit to the environmental damage their energy policies are creating. It is time for an honest appraisal of the real environmental issues caused by so-called renewables. Figures 8 – 10 provide a glimpse of what is happening.

Figure 8 Solar/wind/transmission systems cover vast areas

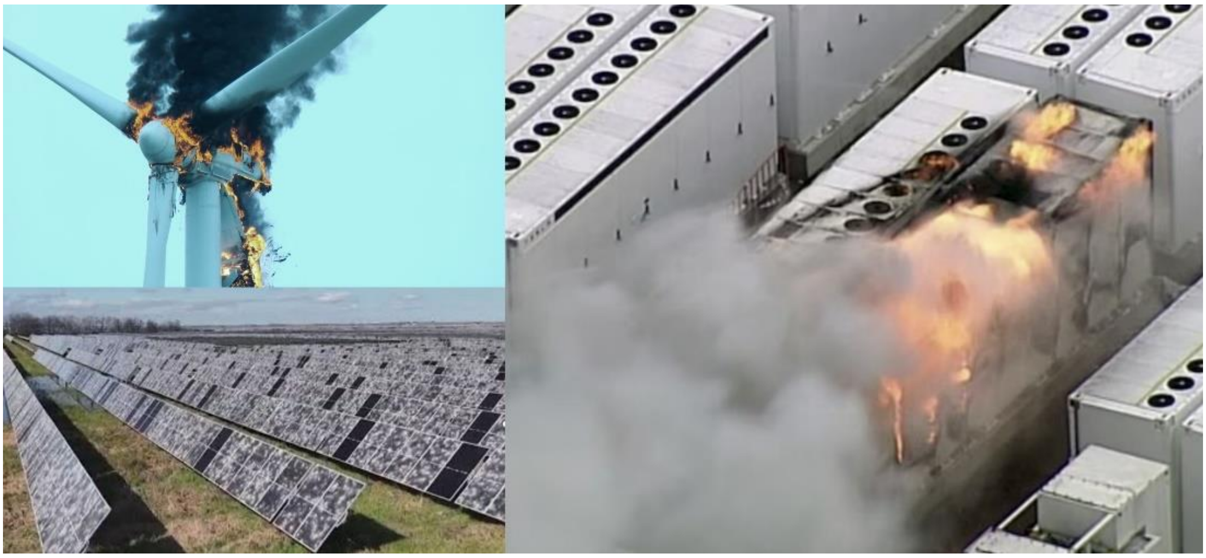

Figure 9 Risks of damage to solar and wind include hail and lightning; battery fires are caused by thermal runaway

Figure 10 Waste sites are the inevitable result

4 Consumer Impacts

The foundation of the transition to renewables sits on the shoulders of homeowners – a key premise of the AEMO’s ISP. How else to explain that 58% of all solar generation in the ISP is from CER? And so is 47% of all planned battery storage capacity.[69] “*These resources are indispensable to the future NEM..*”[70]

The ISP defines “..net market benefits to consumers as those deriving from “..*transmission projects.*”[71] But the claimed $24 billion in reduced costs to consumers is reduced from what? Clearly it is the costs of alternative plans *all of which still meet government policies*. However, as Section 2.4 shows, alternative plans unconstrained by unrealistic government policies can provide benefits by halving the total capital costs, thus saving hundreds of billions of dollars.

What do consumers actually see? Power prices rising continuously in the last 15 years as more renewables are installed in the NEM.

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[69] Draft ISP Figures 15 and 18

[70] Draft ISP P31 ISP Explainer: Consumer energy resources (CER)

[71] Draft ISP P92 Net benefits of the ODP

4.1 Finding Investors to Power the Transition to Renewables

The government simply does not have the capital to finance the transition – it must rely on private sector investors. While the financial community is willing to step up, sophisticated investors do the numbers before making commitments. They can see the financial chaos in the grid caused by the intermittent and highly variable renewables, the massive subsidies needed that could be withdrawn at any time, and increasing worries about grid reliability. Reliance on reluctant professional investors is therefore problematic and has only been possible by negotiating long term contracts, which guarantee their return on investment, such as the Capacity Investment Scheme. The risk to the viability of the ISP is obvious.

The government's solution has been to resort to extravagant subsidies for all investors at every turn. Without major subsidies, commercial investors would stay away. The risks of investing billions of dollars in an unreliable, unstable and financially chaotic market are far too great.

Secondly, it recruits legions of less knowledgeable investors – the great majority of consumers, both home owners and businesses. They have been persuaded with generous upfront subsidies and rich feed-in tariffs to spend their own money to install solar panels and now batteries (despite home batteries twice as expensive as utility-scale batteries, according to CSIRO!). And most are on short term contracts.

However, not all has gone well. As solar uptake rapidly expanded, the cost of subsidies exploded. Baseload generators were forced to buy renewable energy certificates to partially fund the subsidies and power bills rapidly escalated. More than a decade ago, feed-in tariffs were more than four times the rate charged to consumers! This unsustainable subsidy promised to lower consumer bills. But today, most consumers find their feed-in tariffs have been scaled back year-by-year to be negligible and power bills have doubled.

Today, homeowners are once again being lured into highly questionable home batteries with 30-40% up front subsidies and marvellous feed-in tariffs, when the grid withdraws their stored energy. How long will this subterfuge go on before the benefit disappears?

The Cheaper Home Battery subsidy program began with a $1 billion budget. Recently it has blown out to $5 billion with over 400,000 batteries installed by end of 2025. The draft ISP expects half of all homes with solar by 2050 will install a battery[72] which will amount to millions of homes. And every 10-12 years every battery will need replacement. The battery subsidy program will soon be unsustainable and will have to be scaled down.

4.2 Homeowner Costs with Solar and a Battery

Consider some typical costs to homeowners in 2025 dollars:

- Costs for home solar and a battery system are about $10K and $15K respectively.
- Subsidies bring that down to about $17K total.
- While solar lifetime is 20 years, a replacement battery will be needed after 10 years.
- A subsidy for the replacement battery? One certainly cannot count on it. Subsidies cost the government over $5 billion for every million batteries installed.
- The total cost of solar and two batteries amounts to $32K, after subsides for the solar and first battery.
- The lost opportunity to earn a return on investment of this upfront money costs about $13K.
- Amortised over 20 years, the homeowner's cost is about $2250 per year plus an annual grid connection fee of about $800.

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[72] Draft ISP P85 Generation, storage and network investments in the proposed ODP

- When extended wind and solar droughts empty the battery, consumers will pay for back-up grid power and their total annual cost for their energy will easily amount to $4000 or more. That “free energy from wind and solar” is an illusion.
- But what about those feed-in tariffs? (“Tell him he’s dreaming” Darryl Kerrigan in The Castle.)

The bottom line is that governments are luring homeowners into using their savings to finance a large part of the entire transition to renewables without the long term guarantees of returns being paid to multi-billion dollar companies in the Capacity Investment Scheme. The promise of reduced homeowner energy bills is an illusion.

Endless promises by government ministers and activists that wind and solar are the lowest costs of electricity generation belie the fact that without the subsidies, the total cost of the example above would be $56K and annual cost over $5000. The average annual electricity bill for homeowners without solar and batteries and a daily consumption of 15 KWh is about $3000 in 2025 (double that from 2013).

4.3 Demand Side Participation – Admission of Grid Design Failure

The primary job of all businesses is to meet the needs of customers. For electricity suppliers, **this means delivering reliable power in the full amount needed, when it is needed**. The draft ISP manifestly is not designed to do this well. The inherent risks identified in the draft ISP itself make it probable that blackouts will occur under worst-case conditions and when facility outages occur.

The Demand Side Participation (DSP) scheme is intended to compensate, at least partially, the power shortages that are inevitable. The draft ISP is full of fine sounding words to deflect from the truth about the shortcomings in the ODP NEM design. In fact, it disguises DSP as an “*ISP development opportunity*” for generation capability instead of what it is – a method of rationing[73].

This ISP avoids mentioning DSP at all in the main document, aside from a definition in the Glossary, preferring to discuss demand-side factors, which are vaguely defined as “..*moves by consumers to invest in their own energy systems and to be more energy efficient*..”[74] and “*demand management*”.

However, Appendix 9 is titled Demand Side Factors Statement. Again, vague wording and grouping with many other factors makes DSP almost invisible, until Tables 7 and 8, where it lists “Voluntary and Involuntary Load Shedding”[75].

An alternative source for information on DSP is the September 2025 ESOO. It discusses “*demand flexibility*” in more detail but is short on implementation measures[76]. **But, here is the admission: the probable need to implement rationing (demand management) in the face of “*forecast peak demand*” for which the grid has not been properly designed.** i.e. anticipated shortages are baked into the NEM design.

The Wholesale Demand Response program operates with business to recruit companies, which are willing to shut down (with generous reimbursement) at times of worst-case conditions. The DSP program operates through DNSPs with homeowners to achieve demand flexibility. These measures are described as voluntary, of course. But, Tables 7 and 8 in Appendix 9 includes involuntary load shedding. If the NEM runs short of power in any particular region, AEMO obviously has no recourse but to resort to involuntary regional blackouts.

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[73] Draft ISP App 2 P10 and P16 2.1 A Changing Generation Mix Table 1 and App 9

[74] Draft ISP P8 The ISP’s optimal development path

[75] Draft ISP App 9 CER coordination impacts broader investment needs P36 Table 7 and P42 Table 8

[76] ESOO 2025 P38 2.5 Flexible demand can enhance the NEM’s ability to meet forecast peak demand

The fact that these DSP systems are being implemented now is a dire indication of a lack of confidence in the design and cost of a complex power system, based primarily on intermittent weather-dependent sources of power.

The impacts on consumers are not adequately spelled out in AEMO's documents. The Australian Energy Regulator approved new technical standards in late 2021, enabling and mandating centralised control of electrical energy in order to protect the grid from excessive power inputs from solar at midday. This rule enabled 'smart' inverters to be curtailed through DNSPs via the internet.

As was identified by the standards documents and previous versions of the ESOO and ISP, this control would be extended to controlling major loads in the home, such as water heaters, air conditioners, pool pumps and others such as EV chargers. The degree to which this is already being implemented is not revealed by the ISP. DSP was allegedly intended for voluntary participation but in the event that grid capacity fails to keep up with demands, how long before it becomes mandatory?

The reality, according to basic thermodynamics, is that turning off a heater or air conditioner for a mooted short period of an hour or two to save energy will only result, when it is turned back on, in the same amount of energy demanded by the home's thermostat in a shorter period of time to restore the temperature.

Time-of-use tariffs are another subject that the ISP appears reluctant to address after previous versions identified it as a tool to change consumer behaviour. Resorting to high penalty rates in times when the grid experiences potential shortages has been used in the distant past in many jurisdictions but is now being rolled out across Australia. Most consumers report that their bills have gone up. The future of a renewables dominant grid will turn low overnight power rates into high rates since solar is now producing huge midday surpluses and is unable to deliver any power overnight.

How is it the function of grid design to change (or inconvenience) consumer behaviours to serve the grid rather than the other way around?

Overnight charging of EVs is well recognised as the preferred time for consumers, who need to use their vehicles during the day. Telling people to leave their cars on charge during the day when they need to travel is unlikely to gain traction.

The government has dispensed with power system engineers, instead using financial engineering to compensate for poor system design.

Australians are unwittingly signing up to an Orwellian system of state monitoring and control of their homes; a system that intrudes into homes and businesses to take control of privately paid energy resources and deny power to users just when they need it most.

DSP is not required in a system that is mainly powered by reliable baseload generation.

5 National Security

AEMO's plan to transition the NEM grid to intermittent renewable sources poses four types of significant risks to national security:

1. Rapidly increasing power prices and unreliability are weakening the economy for future generations, reducing productivity, damaging competitiveness, harming exports, degrading our terms of trade and leading to deindustrialisation. A weakened economy will render unaffordable a full range of means to protect Australians.
2. Over 80% of wind turbines, solar panels and batteries are sourced from China, the major geostrategic threat in our region according to many government reports in the last two decades. A grid built with materials and products sourced from China greatly magnifies a risk of economic coercion, trade sanctions and interference, which have already occurred.

3. The intermittency and extreme variability of weather-dependent renewables, together with literally millions of distributed consumer power sources, require the entire grid to be integrated via internet-based monitoring and control networks. The cyber vulnerability of our national electricity system is therefore guaranteed, aided in large measure by the software embedded in all China-sourced products. Our entire grid could be compromised and shut down within seconds to paralyse our economy.
4. The intended electrification of all aspects of the economy in pursuit of Net Zero targets will leave our military forces in a weakened state since the irreplaceable fossil fuels needed for military operations will become restricted and more expensive. Our lack of national reserves and dependency on maritime-delivered foreign fossil fuels leaves us vulnerable to blockade, which could neutralise our entire national defence force within weeks.

These risks alone demand a complete rethink of national energy policy.

Power and energy underpin the well-being of every person and every business in the country. The doubling of power prices in the last 15 years and continuing steep rises are not just a coincidence, as unreliable renewables penetrate our national electricity grid. Our top-level cost modelling in Section 2 shows the real capital cost of the government's NEM transition plan to 2050 is twice that of grid designs using reliable baseload power generation. And the majority of the capital costs – in excess of $900 billion – is yet to hit our electricity bills.

It should be self-evident that economic strength is vital to maintaining our sovereignty. Without it, a country cannot afford to invest in the military and economic means to protect its sovereignty.

China's success at dominating world markets for materials and products used for renewables turns Australia into a client instead of an independent state.

China does not share Australian values, acts aggressively towards other countries, has already been identified as a major geostrategic threat and has enacted trade sanctions against us. With the largest navy in the world, China is now in a position to blockade Australian trade routes, should Australia refuse to acquiesce to China's future demands.

While national security is not AEMO's responsibility, it does have an obligation to identify potential threats to Australia's security. ISP Appendix 7 details internal security threats to the NEM; external threats are potentially catastrophic in a system design that is completely dependent on computer networks and is not resilient. Where is Plan B?

Pervasive transnational cyber attacks have grown over the last two decades. China is widely acknowledged to be a top instigator, continuing to inflict economic damage and probe for weaknesses in our critical infrastructure for future exploitation. Chinese products in our telecom networks have been restricted; cameras in key government facilities have been removed to reduce the risk of malware. Yet Chinese power inverters (some made by the banned Huawei company), equipped with networking communications to make our 'smart grid', are now being installed in the national electricity grid. Yet incredibly, the rush continues to transform our entire electricity grid into a networked system oblivious to cyber vulnerabilities. AEMO's ISP fails to mention the word 'cyber', despite it being an issue in the 2021 documents asking for new technical standards to enable a smart control network.

Chinese EVs are also loaded with software and communications technologies, which enable these vehicles to be remotely disabled, and are now pouring into Australia's market at state subsidised predatory prices intended to wipe out competition.

The government's energy policy, which is focused on meeting Net Zero targets, is aimed at the elimination of fossil fuel use throughout the economy. That will leave our defence forces with tanks, ships and aircraft which cannot be powered by batteries, in a completely untenable position. Modern military operations use large amounts of high energy density fuels requiring a secure supply chain.

There is no substitute whatsoever. And furthermore, military equipment depends on the availability of thousands of metals, chemicals, substances and materials, which can only be derived from and processed with fossil fuels.

Numerous Defence White Papers and Defence Strategic Reviews in the last 25 years have documented rapidly rising military capabilities and expanding aggressiveness of China throughout the Indo-Pacific region. Yet our current energy policy is unswervingly directed at making Australia completely dependent on China for making our national electricity grid high cost, unreliable and vulnerable.

National security is not just an abstract topic, good for periodic reviews but ignored in favour of more pressing issues. We are a population of 25 million living on a large continent full of natural resources, which makes us one of the luckiest countries in the world. To think that others might envy what we have and what we have worked hard to develop, would be naive in the extreme.