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Select Committee on Energy Planning and Regulation in Australia
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Parliament House
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Submitted online via www.aph.gov.au

Submission to Select Committee on Energy Planning and Regulation in Australia regarding Integrated System Plan Flaws

Dear Committee Members,

The Centre for Independent Studies (CIS) welcomes the opportunity to make a submission to the Select Committee on Energy Planning and Regulation in Australia regarding how the Integrated System Plan addresses government policies.

The CIS is a leading independent public policy think tank in Australia. It has been a strong advocate for free markets and limited government for more than 40 years. The CIS is independent and non-partisan in both its funding and research, does no commissioned research nor takes any government money to support its public policy work.

This submission has been prepared by the CIS Energy Team, with input from myself, Zoe Hilton, Alex Bainton and Michael Wu.

CIS submits that the Integrated System Plan (ISP) has several fundamental flaws that make it unfit as a planning document for the energy transition.

- The ISP gives considerable emphasis to large interstate connectors, despite weather systems being highly correlated across long distances, without adequately testing the obvious alternative for a renewables system: a catchment-based design around significant load centres, with a reduced focus on long-distance transmission, offset by more state-based storage and firming.
- The costs of Consumer Energy Resources and recycling of renewables and battery waste are excluded, as are their manufacturing emissions.
- The ISP model assumes perfect foresight of the weather, undervaluing the certainty provided by thermal generators.
- The analysis double-counts benefits of transmission projects, inflating their value to the system, which is reinforced by government-committed projects being treated as sunk costs.
- The process of scenario design and weighting has removed any meaningful baselines scenarios without binding emissions and renewables targets, leaving only ambitious scenarios with targets highly unlikely to be achievable.
- Hydrogen is used as an unrealistically flexible solar sink.

The opportunity to address these flaws was passed over by the Australian Energy Market Commission (AEMC), when it postponed its review of the ISP for two years.

CIS also submits that the Australia Energy Market Operator's (AEMO) role as both a transmission planner and proponent of transmission projects in Victoria creates a potential conflict of interest. AEMO's role as NSW Consumer Trustee also lacks transparency, putting consumers at risk.

These technical and institutional flaws bring into question whether AEMO should retain the ability to create the ISP and decide on the optimal development path for transmission planning. For the sake of transparency and social licence for the energy transition, these flaws need to be urgently addressed.

Yours sincerely,

Aidan Morrison
Director of Energy Program
Centre for Independent Studies

Executive Summary

The Integrated System Plan (ISP) is published by AEMO every two years and is the masterplan for building the transmission needed for the energy transition. However, the ISP modelling contains numerous flaws that seriously undermine its ability to plan for the future and recommend investments that are good for consumers. These flaws include:

1. Failing to test whether expanded REZs in catchments with adjacent storage connected to load centres is a better renewables plan than massive state interconnectors. Strong correlation in weather patterns between sites across the NEM means transmission is of limited use in ensuring reliability during bad weather;
2. Relying on rooftop solar and home batteries to provide generation and storage but excluding their costs from the model. This is a major issue, given non-solar customers effectively subsidise rooftop solar customers through outsized bill savings for solar exports and self-consumption;
3. Excluding the cost of recycling wind turbines, solar panels and batteries — thus making renewables appear cheaper than they are over their lifetime;
4. Excluding emissions from the manufacture of wind, solar and batteries, thus making them seem cleaner than they really are. This restriction of 'Scope 1' emissions means the ISP will increasingly export emissions to China, while creating the appearance of meeting net zero ambitions locally;
5. Using an overfit model that assumes perfect foresight of the weather decades in advance and builds just-in-time flexible gas capacity before years predicted to have poor weather for renewables. Overfitting occurs when models conform too closely to a limited set of inputs and fail to account for the variability of the real world. In reality, the grid will have to be prepared for almost any weather every year; requiring greater investment in firm capacity to ensure reliability, reducing the value of interstate transmission;
6. Double-counting benefits of transmission projects. The method used to determine the value of individual projects does not treat the energy system as an integrated whole (i.e. a system of smaller sub-systems) but rather a collection of parts largely independent of one another, allowing uneconomic projects to be approved and costs passed onto consumers;
7. Treating government-committed projects with costs yet to be sunk as locked in without assessing their benefits, making transmission projects that link these assets seem more valuable;
8. Manipulating the selection and weighting of scenarios to exclude the only baseline scenarios without a binding renewable energy or carbon target in favour of ambitious (and in some cases, practically unachievable) targets. This manipulation began in the 2022 ISP and has become more problematic in the 2024 ISP, forcing a faster timeline for transmission projects than necessary; and
9. Using hydrogen as an unrealistically flexible sink for solar energy.

A recent rule change also means these flaws are likely to avoid further scrutiny until the 2028 ISP. The AEMC was scheduled to conduct a comprehensive review in 2025, but will now do so in 2027. By the time recommendations from the delayed review are enacted, many transmission projects will have been approved and costs passed onto consumers.

Another related issue is AEMO's potential conflict of interest in their dual roles of transmission planner and proponent of transmission projects in Victoria. Their project authorisation role as NSW Consumer Trustee also lacks transparency that warrants further scrutiny.

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1. Introduction

Established after the Finkel Review in 2017, the Integrated System Plan (ISP) was introduced as part of a strategy to give AEMO a stronger role in planning the future transmission network.[1] It was intended as an integrated grid plan to inform future investment decisions and ensure interconnection between states was made from a NEM-wide perspective. AEMO was to recommend a list of potential priority projects in each region that governments could support if the market was unable to deliver the investment required to enable the development of renewable energy zones.

However, the ISP has significantly deviated from its original purpose. A rule change following the Finkel Review gave AEMO the power to designate projects as "actionable", transferring responsibility for the coordinated identification and assessment of investment options across the grid from TNSPs to AEMO.[2] The ISP has been increasingly shaped by government targets that are unlikely to be achieved, meaning projects have been designated as "actionable" that will likely provide no net benefits to consumers. AEMO has excluded significant costs and approached modelling in a number of ways that make the system appear more beneficial and less costly than it is likely to be.

AEMO has also used its judgement to accelerate a number of transmission projects ahead of the timing suggested by its models, resulting in unnecessarily early costs and additional pressure on Australia's supply chains and limited skilled labour in an already inflationary period. Unsurprisingly, this acceleration is increasingly leading to unnecessary cost blowouts and delays.

This submission is organised into sections based on the problems with the ISP and the actions of key institutions in relation to it. Most sections contain one subsection outlining the problem in the 2024 Draft ISP, and one outlining AEMO's response to stakeholder feedback from CIS and others in the Final ISP.

The ISP model, the plan derived from it, and the regulatory process that follows, are not on track to achieve the lowest cost net-zero grid for Australia and are misleading the public debate on the cost of the transition; putting both the grid and the energy transition at significant risk. These are good reasons to consider serious reform of the ISP and energy market bodies.

2. Alternative to interstate transmission untested

The ISP is critical for advancing major interconnection transmission projects that span large distances, often between states. These perform a different function to the new transmission connecting new renewable energy zones (REZs), which incorporate the bulk of new generation. Instead of simply connecting new generation to nearby load or grid centres, large interconnectors are built to allow energy to be distributed to more distant loads.

The underlying assumption that these large interconnectors are good value for the system isn't supported by AEMO's data, as shown in analysis by Professor Bruce Mountain, Director of the Victoria Energy Policy Centre.[3] The value proposition is that increasing interconnection allows loads to have access to a more diverse set of weather patterns, thereby increasing reliability of intermittent resources, and reducing the need for additional firming or storage. However, his analysis indicates the high level of correlation of wind and solar outputs in Australia, and the great distances that need to be achieved before this correlation subsides, suggests the value of weather diversity being unlocked by higher levels of interconnection is likely to be very low.

An alternative proposition for a more cost-effective transmission concept would be for the energy network to remain oriented around renewable 'catchments' centred around major load centres, such as major population centres in cities. Less interconnection between states would be required, and more localised firming and storage for each catchment would be utilised to provide reliability. As the cost and social license challenges of transmission projects continue to rapidly escalate, more localised alternatives with costs that have not risen (such as batteries) may be much more cost-effective.

Unfortunately, the construction of the ISP's potential development paths has not allowed for testing of such an alternative. The 2024 ISP Methodology states on page 26:

> When determining the economic benefits of a development path, AEMO must compare system costs against a counterfactual where no transmission is built. In this counterfactual, new transmission to increase REZ transmission limits is generally not allowed.

This approach prevents the model testing whether some REZ expansion without large interconnectors could be cost-effective. By assuming the only counterfactual is no transmission being built, for interconnectors or REZs, AEMO has effectively forced an interconnection backbone into all the credibly pathways for the grid. This fails to test the interconnection hypothesis against a more economical alternative based around state-localised renewables catchments.

As shown in the figures below, Australia's weather patterns show a moderate to strong degree of correlation, meaning electricity needs to be shifted across vast distances during bad weather for renewables, since adjacent states are likely to be experiencing similar weather patterns. In the case of solar, sites need to be more than 1000 km apart to reduce the average 5-day correlation to less than 0.5 (Figure 1).[4] At this level of correlation, the weather variance at one site explains half the weather at the other. Significant overlap of major weather patterns is inevitable. Even at a distance of 2000 km, correlation is generally significant, around 0.3.

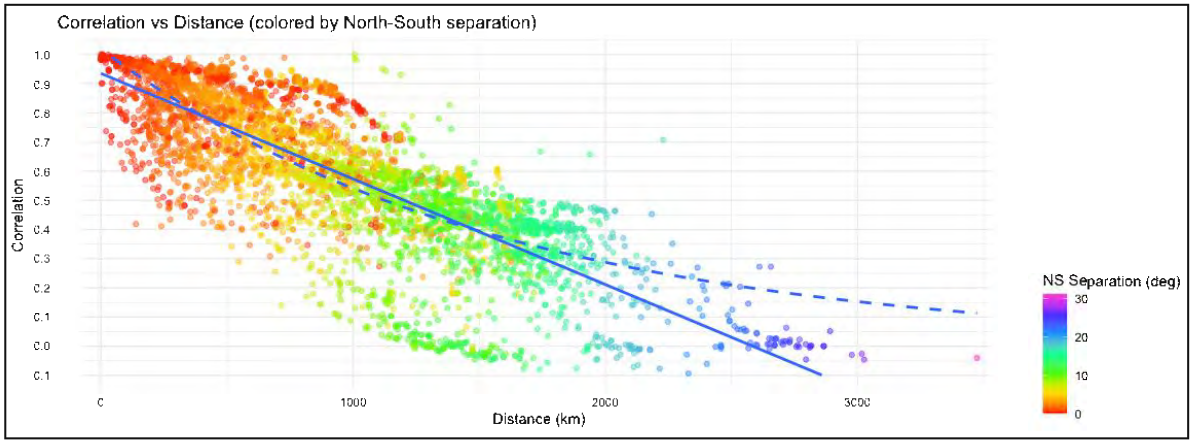

Figure 1. Correlation versus distance between all solar sites in 5-day aggregated 2022 ISP weather trace data. Each dot represents a pair of sites coloured by degree of north-south separation. R^2 = 0.64.

This is also a problem for wind sites, although the correlation is weaker than for solar (Figure 2).[5]

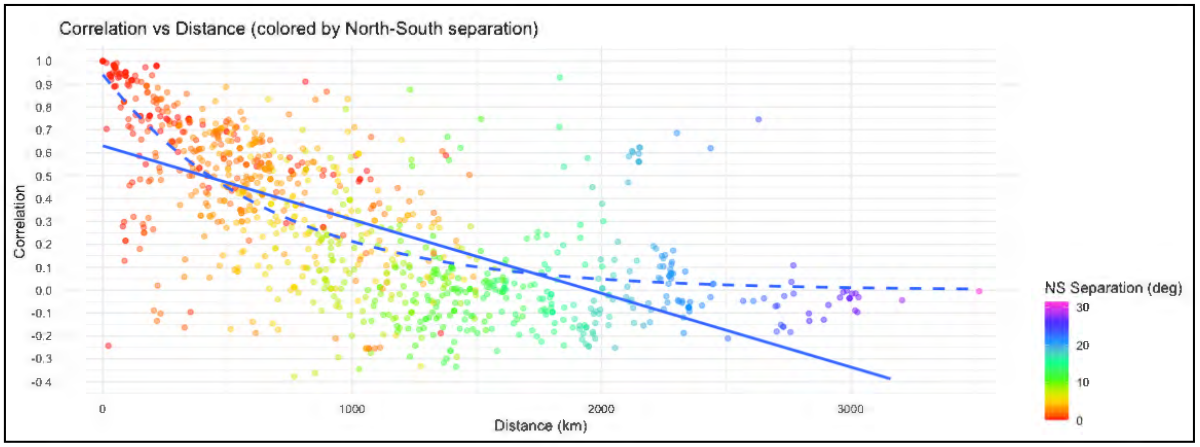

Figure 2. Correlation versus distance between all wind sites in 5-day aggregated 2022 ISP weather trace data. Each dot represents a pair of sites coloured by degree of north-south separation. R^2 = 0.44.

This strong correlation between solar generator output, and moderate correlation between wind generator output, means state interconnectors may not be useful for enhancing reliability during periods of bad weather. Put simply, a powerline would have to be run a very long way to get weather that is only a little bit different, and never reliably independent.

The degree of correlation that is visible at 5-day aggregation could be argued to be more easily mitigated with moderate storage, if within every 5-day period we could rely upon a very substantial amount of wind or sunlight, i.e. if wind and solar 'droughts' were strictly less than five days.

But data from the weather traces used for the 2022 ISP clearly refute this proposition. For almost all solar sites with traces, the worst 5-day period produces less than 25% of the output of the best 5-day period, and less than half the median (Figure 3).[6]

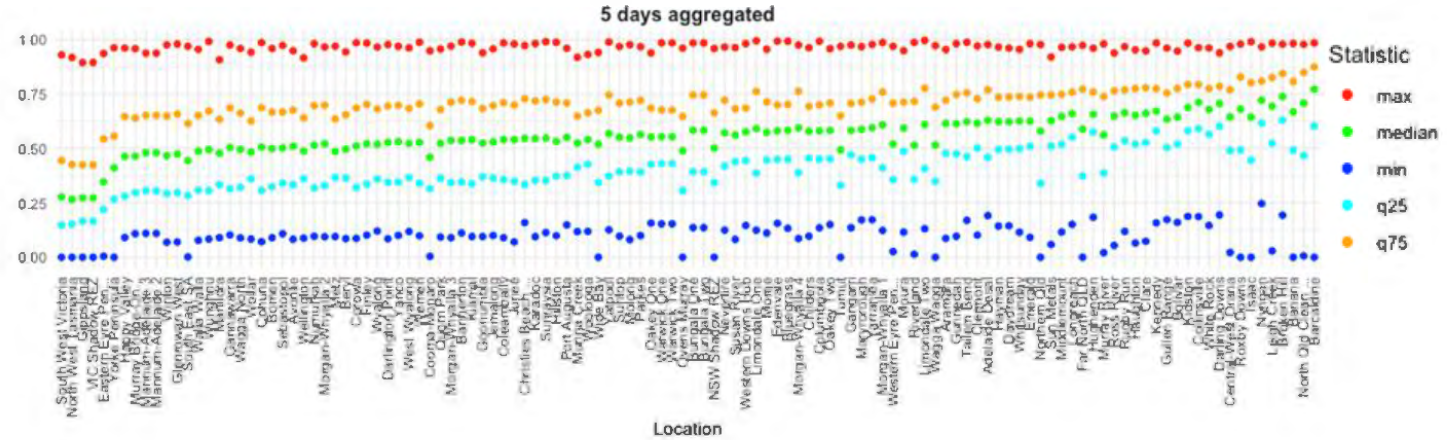

Figure 3. Summary statistics of the distribution of 5-day aggregated solar output from solar sites, normalised five days of the peak output.

Wind droughts indicate an even more acute concern over periods of five days, with almost every site showing five-day stretches that experience less than 10% of what maximum output could be (Figure 4).[7]

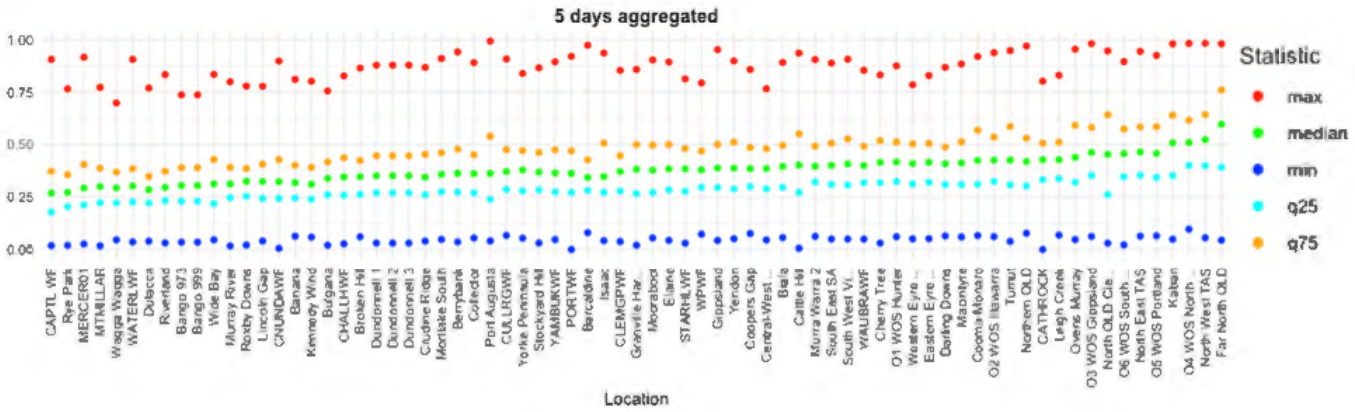

Figure 4. Summary statistics of the distribution of 5-day aggregated wind output from wind sites, normalised five days of the peak output.

In the current electricity system, thermal generators can be anti-correlated. This means maintenance can be scheduled at different times and, in the case of a unit unexpectedly shutting down, it is highly unlikely that other generators will be concurrently affected, making it much easier to ensure reliability at lower cost.[8] In a renewables-dominated system, storage (though costly) is likely a more effective solution to renewables' lack of reliability than transmission, since storage provides more anti-correlated energy output, at least until it runs out.

It is vital that the ISP's transmission plan is tested against a potentially far more cost-effective renewables plan involving enlarged REZs within catchments with storage connected to nearby load centres and very little build-out of state interconnectors. Without this counterfactual, there is no way of knowing what the best option would be for building a renewables-dominated grid in the NEM.

3. The model excludes costs for distributed energy resources and distribution network upgrades

Draft 2024 ISP

The ISP relies heavily on consumer energy resources (CER) such as rooftop solar, home batteries, and EVs to provide generation and storage in coming decades while at the same time excluding the costs of these assets to the system. This has resulted in a sub-optimal plan where potentially too little utility scale capacity and firming is built, and where the cost of the transition can be easily misrepresented in public debate.

Rooftop solar makes up the majority of solar capacity in the grid for the ISP's forward projections (Figure 5).[9] Likewise, coordinated CER storage (i.e. home and EV batteries connected to Virtual Power Plants [VPPs] that control their charge and discharge to the grid) makes up the lion's share of storage from the mid-2040s onwards (Figure 5).[10] Yet despite the forecast preponderance of CER, AEMO has "not included costs for household or residential batteries and solar PV because those are decisions that households and businesses make on their own" — the solar panels and batteries paid for by consumers are instead taken as an "input".[11]

This crucial assumption is glossed over in the ISP's executive summary, which states that the benefits of the Optimal Development Path include avoiding "$17 billion in additional costs to consumers", without any mention that the annualised capital cost of all generation, storage, firming and transmission infrastructure, estimated at $121 billion,[12] does not include the cost of CER.[13]

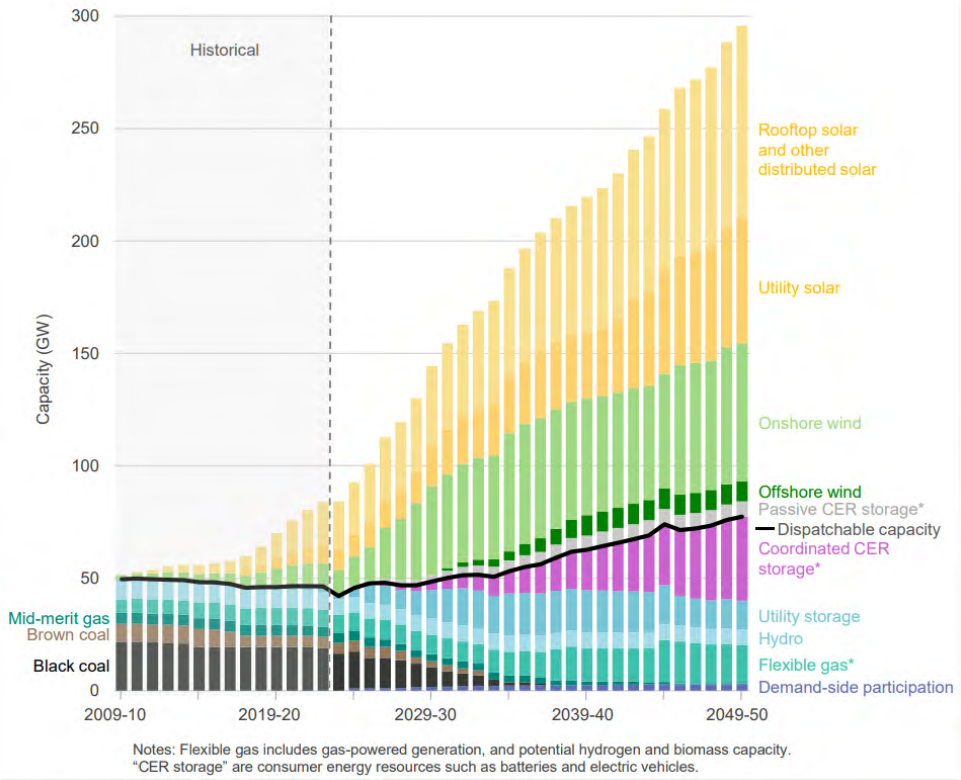

Figure 5. NEM capacity projections in GW in Draft 2024 ISP *Step Change* scenario from 2009-10 to 2049-50.

Excluding the cost of CER represents a significant omission in the ISP. The 2024 *Step Change* scenario indicates the installation of an average of 3.1 GW of new rooftop solar capacity and 9.1 GWh of new consumer batteries annually from 2024-25 to 2049-50.[14] Using 2023-24 GenCost capital cost figures, CIS estimates the total capital cost for CER over this period to be approximately $347.5 billion.[15] This is significantly higher than the estimated $83 billion capital cost for large-scale solar and batteries up to 2050, which the ISP does include.[16] In net present value terms, CER capital cost equates to $121 billion, annualised to 2050.[17] Given that adding this to the total nearly doubles the $122 billion headline capital cost figure reported in the ISP, omitting this figure significantly distorts the true cost of the renewable energy transition.

AEMO has responded to stakeholder concerns about the treatment of CER as a static input by stating that the ISP "doesn't try to dictate what consumers do" but rather adapts to consumer preferences.[18] However, these preferences are largely shaped by government policy that determines the financial benefit consumers expect when making those investments. When determining the forecast uptake of rooftop solar in the ISP model, AEMO takes into account government policies that provide financial incentives for consumers (e.g. Small-scale Technology Certificates and historically generous feed-in tariffs mandated by state governments)[19] — without including them as a system cost. AEMO also includes financial incentives for CER storage (i.e. home batteries and EVs) to forecast uptake,[20] including South Australia's $3,000 subsidy for new EVs,[21] which ended in January 2024.[22] Furthermore, AEMO makes the assertion that the "optimistic outlook for coordinated CER storage" will require "continual reforms of tariffs, market incentives and policies"[23] — without any attempts to estimate the associated costs.

Financial incentives are clearly needed to convince consumers to allow their batteries to be coordinated. The coordinated CER trial Project EDGE found that almost half of consumers had little to

no interest in joining a VPP (Figure 6).[24] The project report further stated that the ability of the widespread adoption of CER and VPP to reduce carbon emissions was "less valued by consumers relative to having a reliable supply of power, saving money and receiving good service."[25]

Thus, not only do consumers want to be adequately compensated, they also want to use their battery to maintain a reliable source of power (including during peak demand or a blackout). This is at odds with the way VPPs operate, as they are incentivised to sell power from customer's batteries back to the grid when spot prices are highest, which will occur during a period of peak demand or blackout. The contradictory incentives for CER customers and VPPs therefore make achieving the projected levels of coordinated CER storage difficult — and expensive.

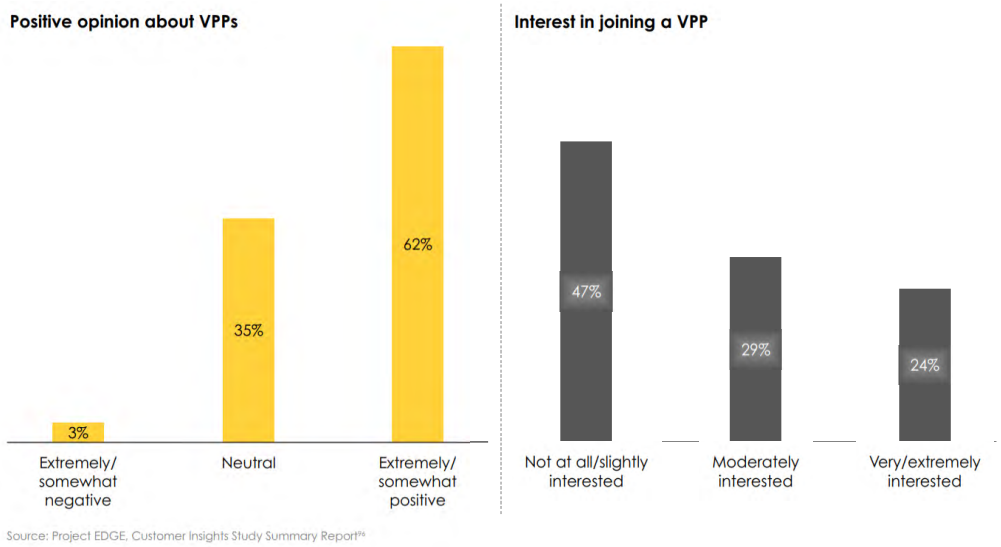

Figure 6. Consumer perceptions about VPPs and interest in joining a VPP from Project EDGE surveys.

Financial incentives are also needed to encourage consumers to change EV charging behaviour. The ISP models convenience charging (i.e. charging at home immediately upon arrival after work during peak time) as dropping from around 73% of the time in 2022-23 to below 36% in 2050, while coordinated charging (i.e. charging during non-peak times and discharging to the grid during peak times) rises from 0% to around 32%.[26] There is no opportunity cost modelled with this forecast — the ISP merely references the need for "right incentives and systems" that will encourage EV owners to relinquish control of their EV batteries and charging habits to serve the needs of the grid.[27] Research reveals less than 17% of EV owners would consider changing their charging time to between 10am and 2pm (i.e. when solar output is at its peak) without an incentive.[28]

Significant capital expenditure will also be required to upgrade distribution networks to ensure grid stability as CER installations grow. The cost of distribution network upgrades is significant, with an Energeia project paper estimating the total cost of mitigating over-voltage (when voltage goes above the design limit of the grid) due to solar installations over the next 20 years as being between $0.7 to $1.1 billion, depending on the level of CER adoption.[29] Yet, the ISP does not take these costs into account.[30] Flagging this issue, the ISP Consumer Panel stated: "While AEMO describe the ISP as a 'whole of system' plan, it is in practice, a 'whole of transmission' plan with limited involvement of distribution networks."[31]

AEMO's mischaracterisation of what is essentially a transmission planning exercise as a 'whole-of-system' plan contributes to policymakers such as Energy Minister Chris Bowen inappropriately using

the ISP as evidence that a renewables-dominated grid is cheap.[32] The Minister said the ISP "looked at… in current dollars, the total cost out to 2050 of the entire generation, storage and transmission and came up at $121 billion."[33] As this number excludes the $101 billion of CER calculated above and the associated costs of distribution network upgrades, the true cost would be greater than the figure quoted by Mr Bowen.

Policymakers need to be able to directly compare different mixes of technologies in the energy system to have accurate information about whole-of-system costs, as government incentives and programs greatly influence consumer and investor decisions. By excluding the costs associated with CER (such as capital, installation, maintenance, incentives to encourage uptake and behavioural shifts in charging, and the necessary distribution network upgrades), AEMO has not provided a fair comparison of the costs and benefits of CER versus large-scale solar farms and batteries. This lack of co-optimisation prevents policymakers from making informed decisions and obscures the true cost of electricity for consumers who, according to the ISP, should purchase rooftop solar and home batteries *en masse* and bear the associated cost of upgrading the distribution network, as part of AEMO's energy transition roadmap.

According to the CSIRO, large-scale solar and batteries are cheaper than small-scale rooftop solar and home batteries,[34] which means the ISP's heavy reliance on uncosted CER is likely to increase overall system costs for consumers. Indeed, network service provider Ausgrid has stated their "marginal expenditure typically occurs on low voltage distributors", the part of the network most affected by rapidly growing CER.[35] This raises the question of whether distribution network upgrades required by CER growth will drive up system costs far more than the transmission network upgrades needed by an equivalent amount of large-scale solar and batteries.

Despite the likelihood that CER growth will increase total system costs, AEMO continues to use CER to offset the amount of large-scale battery storage[36] and solar (Figure 5) that would otherwise be built — and thus costed — in the ISP. This heavy reliance on CER effectively hides the true system cost of renewables, undermining the ISP's relevance and usefulness as an objective planning document.

AEMO's response in the Final 2024 ISP

Despite concerns from stakeholders, AEMO has failed to adequately address these issues in the Final 2024 ISP.

In the Executive Summary of the Final 2024 ISP, AEMO clarified in a footnote that the present value of $122 billion (a slight increase from the Draft) representing the annualised capital cost of all utility-scale generation, storage, firming and transmission infrastructure in the ODP "does not include the cost of commissioned, committed or anticipated projects, consumer energy resources or distribution network upgrades." Although this clarification is welcomed, the relevance of the figure to consumers remains questionable given that, as discussed above, the utility-scale generation and storage costs are significantly offset by CER, for which costs are excluded from the ISP.

By continuing to exclude CER from the headline figure, AEMO provides political leeway for the Energy Minister to continue underestimating the costs of his energy transition plan. As Mr Bowen stated in his speech to the National Press Club:

> Last month the Australian Energy Market Operator released its Integrated Systems Plan. It showed we need $122 billion of investment in utility-scale generation, storage, firming and transmission infrastructure to keep the lights on and business going.[37]

This was the only cost estimate Mr Bowen cited for his plan in his speech. Excluding the substantial costs of CER that consumers and taxpayers will be expected to pay makes this statement highly misleading.

AEMO acknowledged the lack of co-optimisation of CER and distribution networks in the ISP model on page 38 of the 2024 ISP Consultation Summary Report:

> AEMO acknowledges that demand-side investments are currently an exogenous modelling input and not co-optimised against transmission and large-scale generation investments in the ISP… All demand-side investments such as CER, as well as any associated upgrades to distribution networks to support their integration, are assumed to be implicitly present in the counterfactual. The distribution network elements are non-differential costs for the purposes of the ISP, which do not contribute to net market benefits or count toward choosing the ODP.

In order to consider the value of CER coordination, AEMO undertook additional modelling for the Final ISP in the form of a *Reduced CER coordination* sensitivity, stating on page 41:

> AEMO considers this analysis to be an important guide for the benefit of achieving CER coordination, with the sensitivity results showing that the total system costs paid by consumers would increase by $4.1 billion with no further coordination of consumer batteries than exists currently. This would be due to higher levels of medium and long duration utility storages being required to compensate for the lack of coordinated embedded storage devices.

However, this sensitivity analysis did not consider the value of CER itself and what costs it would add to the system overall compared to other more economical options.

The Final 2024 ISP therefore contains the same core omission of cost optimisation for CER and distribution networks as the Draft ISP. It is unclear how AEMO will address the problems created by their approach in future ISPs, as only a vague commitment to pursuing co-optimisation was provided on page 38:

> Consideration of trading off supply-side investments with demand-side investment is an active area of consideration by AEMO and will be pursued in some form for the 2026 ISP as part of the implementation of the recommendations enhancement of the ISP agreed by Australia's Energy Ministers following the Federal Government's review of the ISP.

Likewise, AEMO did not confirm whether the plan to expand consideration of distribution networks in future would mean including CER-necessitated upgrades as a cost in the model, stating on page 41:

> AEMO will expand its consideration of distribution networks in the 2026 ISP to consider how distribution network investments and programs may impact CER and distributed resources development, and therefore the ODP (consistent with Australia's energy ministers' March 2024 response to the review of the ISP).

The Energy and Climate Change Ministerial Council's response to the ISP review only recommends enhancing demand forecasting through further consultation and analysis of CER and distribution networks.[38] This recommendation does not address the problems caused by the lack of co-optimisation of CER and distribution networks and the exclusion of their costs.

Outsized savings for rooftop solar customers much larger than averted system costs

The ISP's reliance on uncosted rooftop solar is particularly concerning given the way non-rooftop solar customers are currently subsidising those with solar. Rooftop solar customers save on energy bills through self-consumption (averted usage costs) and feed-in tariffs (payments for exported excess energy), but as CIS' analysis below shows, solar customer's bill savings are around three times larger than the system savings from rooftop solar generation, particularly for customers without home batteries.

Since rooftop solar produces power during daylight off-peak hours, the only savings it provides to the energy system are reduced fuel costs and marginal operating costs for coal and gas plants. Rooftop solar does not reduce capital costs for other generators, as there is currently sufficient coal, gas and hydro capacity to meet peak demand in the NEM, meaning additional solar capacity has not translated to reduced capital costs. Rooftop solar also does not reduce network costs, as it fails to lower critical peak demand, which typically occurs in the evening hours during weather extremes, and is the main driver of the need for network upgrades. In fact, in some areas, rooftop solar increases daytime network costs by stressing the grid when solar exports exceed demand.[39]

CIS estimates that the marginal fuel and operating cost savings from rooftop solar displacing coal and gas generation amount to 4c/kWh.[40] This implies that solar customers should receive around 4c in savings on their energy bills for every kWh of fossil fuel generation replaced by solar output.

The savings rooftop solar consumers enjoy are a combination of averted usage costs during daylight hours and feed-in tariff earnings from exporting excess energy, less any applicable solar meter fees. Figure 7 presents CIS' analysis of the median bill savings in c/kWh for typical rooftop solar customers without home batteries, under single rate and time-of-use tariffs across distribution networks in the NEM. The data is sourced from Vinnies Tariff-Tracking Reports, which compile solar market offers from retailers across all NEM distributors.[41] Assuming a 6.6 kW solar system with an export ratio of 77%, CIS estimates that rooftop solar customers are receiving bill savings of around 10 c/kWh on time-of use tariffs and 12 c/kWh on single rate tariffs for their solar generation. This is triple the actual system cost savings.

This discrepancy shows that non-solar customers are effectively subsidising solar customers, as solar customers are being compensated far beyond the actual cost reductions their solar systems provide to the energy system.

While one could argue for a higher figure than 4c/kWh by factoring in the value of emissions reduction, this presumes that rooftop solar is the most cost-effective way to reduce emissions. If this is not the case, non-rooftop solar consumers are effectively subsidising rooftop solar owners for an investment that may not be the optimal way to decarbonise the grid.

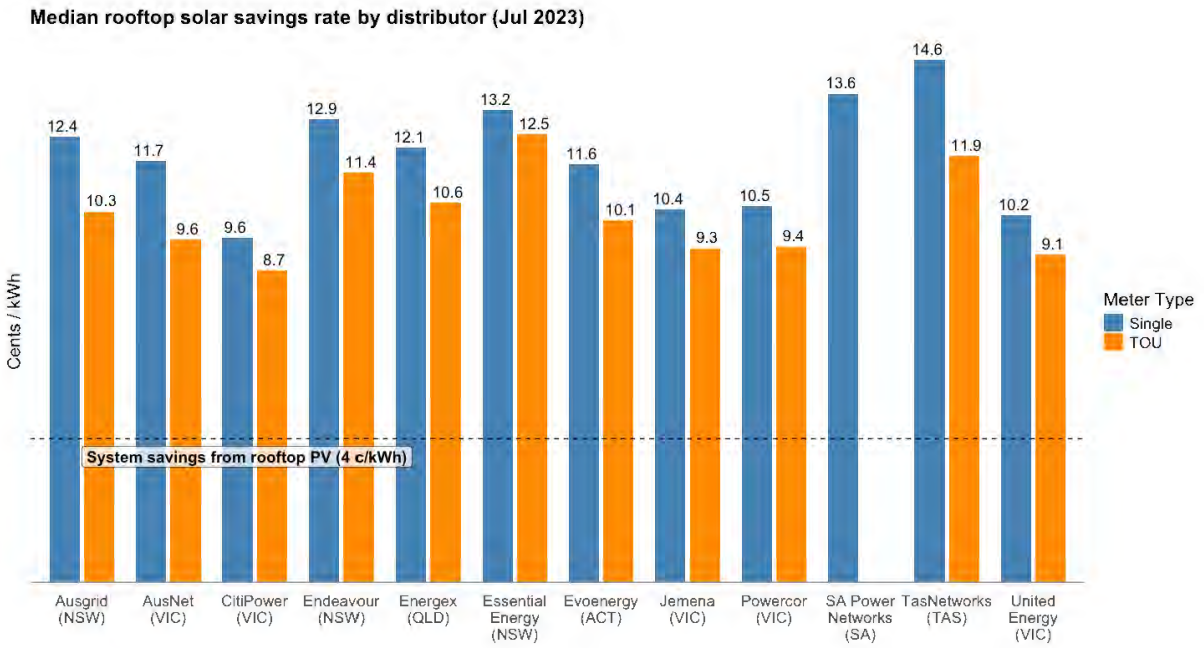

Figure 7. Median bill savings rate (c/kWh) for a 6.6kW rooftop PV system without a home battery on single rate and time-of-use tariffs across distribution networks in the NEM.

4. The model excludes significant end-of-life costs

Draft 2024 ISP

The costs associated with recycling wind turbines, solar panels and batteries are not included in the ISP, making renewables seem cheaper than they are over their lifetime.

Retirement costs for solar and on-shore wind in the Draft 2024 ISP were taken from a 2018 GHD report that does not include disposal or recycling of solar panels and wind turbines.[42] All large-scale battery retirement costs are excluded because "disposal cost data is not known."[43] AEMO also does not attempt to include any retirement costs for offshore wind facilities, claiming their long construction time means that "retirement costs would be incurred beyond the end of the ISP modelling horizon."[44] This reasoning is flawed, as an investor would be unlikely to start such a project without having a cost estimate for decommissioning and rehabilitating the site once the plant reaches the end of its life.

The omission of disposal and recycling costs essentially means the ISP has assumed all waste from solar panels, wind turbines and large-scale batteries is either abandoned on-site or taken to landfill at no cost. This is unrealistic, given Australia's legislative environment is increasingly making recycling the only option. In Victoria and South Australia, solar panels and batteries have been banned from entering landfill and must be recycled or stored until they can be recycled.[45] Western Australia has announced similar restrictions and the federal government is also developing a mandatory product stewardship scheme, which could make solar panel manufacturers and importers liable for recycling costs.[46] Queensland has recently announced a solar panel recycling pilot scheme, which will inform the national scheme.[47]

None of these costs are included in the Draft 2024 ISP, making the ISP's retirement and rehabilitation cost estimates for wind and solar appear low compared to coal, gas and pumped hydro (Figure 8).[48]

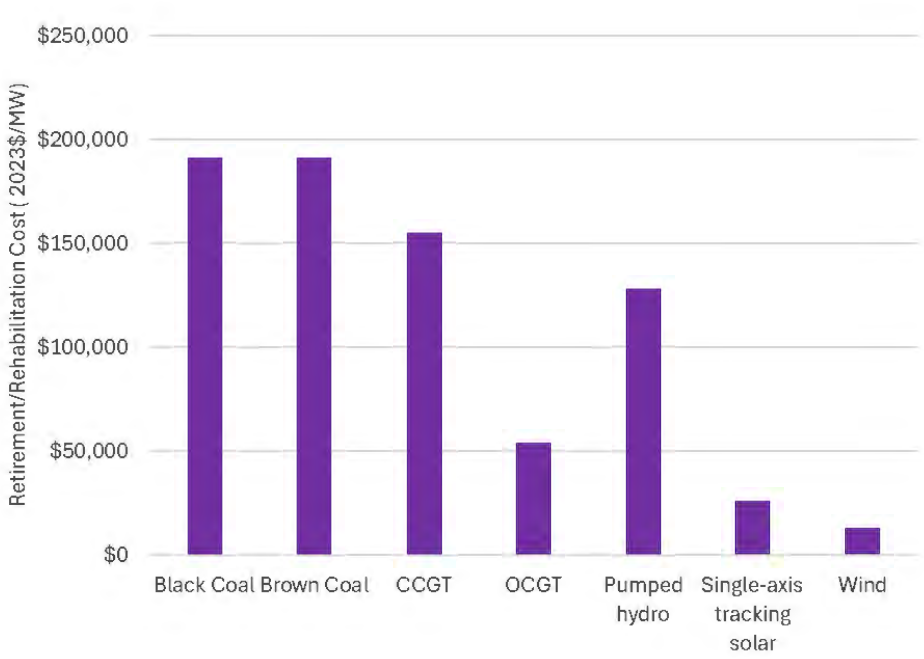

Figure 8. Retirement/rehabilitation cost estimates of different generation technologies in the Draft 2024 ISP.

Without the costs of disposal and recycling of solar panels, wind turbines and batteries – and the costs of retirement for offshore wind – being included in the ISP model, the total cost of the renewables plan for the grid will remain unclear.

AEMO's response in the Final 2024 ISP

Despite stakeholders advocating for the inclusion of recycling and disposable costs, AEMO has continued to exclude these costs in the Final ISP.

AEMO acknowledged that the retirement costs for solar and wind included in the 2024 ISP "do not include recycling" on page 59 of the Consultation Summary Report. For batteries and offshore wind, no retirement cost estimates were included due to "insufficient data available at the time of the 2018 GHD report". However, AEMO went on to state it will "endeavour to update generator retirement costs as new information becomes available."

AEMO then went on to explain their reasoning behind excluding retirement costs occurring beyond the ISP modelling horizon:

> In regard to the ISP modelling horizon, AEMO applies an annuity approach for all build costs, including retirement costs where data is available, associated with transmission, generation, and storage over the planning horizon. AEMO acknowledges that the net present value (NPV) of annualised costs could be lower than the NPV of the full build cost if the planning horizon is shorter than the economic life of a project, however annual benefits would also be under-estimated if limited to the planning horizon. This implies an assumption that annual benefits beyond the planning horizon are greater than or equal to annualised costs, which AEMO considers to be reasonable based on previous modelling experience and the expectation that the NEM will continue to progressively transition from fossil fuels to renewable generation.[49]

The problem with this reasoning is that offshore wind projects may have significant decommissioning costs that are so high as to exceed the benefits provided in the few years before their

decommissioning. If the modelling horizon ends a few years before the decommissioning date, there will be a net cost incurred beyond the horizon that the model will not recognise when determining the benefits of the project. There is clearly a risk that AEMO's assumption that benefits will equal or outweigh costs at the tail end of projects does not reflect reality. Ultimately, AEMO cannot have confidence in this assumption without any cost estimates for offshore wind decommissioning.

The cost of batteries, wind and solar therefore remains underestimated in the Final 2024 ISP because recycling costs are not considered and retirement costs are still excluded for offshore wind and batteries.

5. The model excludes lifecycle emissions

Draft 2024 ISP

The ISP does not include emissions arising from the manufacturing of wind, solar and battery systems, making renewables seem cleaner than they are. This approach means significant emissions will simply be exported to other countries whose emissions will increase.

The ISP accounts only for direct emissions (i.e. Scope 1), such as the burning of coal or gas, and excludes the emissions arising from the production of the steel, concrete, composites, silicon and electronics that comprise wind, solar and battery systems.[50] This results in the model assuming solar, batteries and wind are entirely emissions-free (Table 1).[51]

This exclusion of indirect (i.e. Scope 3) emissions in the ISP's accounting effectively exports large quantities of emissions to the countries that manufacture solar panels, wind turbines and batteries for Australian customers. For example, China is Australia's main supplier of solar panels[52] and a key supplier of wind turbines[53] and battery storage systems,[54] with an electricity grid highly reliant on coal, particularly for energy-intensive applications such as manufacturing.[55]

Table 1. Emissions intensity for new entrant technologies in the 2023 IASR.

Generator	Scope 1 emissions intensity (kg/MWh as-gen)
OCGT (small GT)	541.60
OCGT (large GT)	580.98
CCGT	377.67
CCGT with CCS	57.45
Biomass[1]	20.84
Large scale Solar PV	0.00
Solar Thermal (15hrs storage)	0.00
Battery Storage (1hr storage)	0.00
Battery Storage (2hrs storage)	0.00
Battery Storage (4hrs storage)	0.00
Battery Storage (8hrs storage)	0.00
Wind	0.00
Wind offshore (fixed)	0.00
Wind offshore (floating)	0.00
Pumped Hydro (8hrs storage)	0.00
Pumped Hydro (24hrs storage)	0.00
Pumped Hydro (48hrs storage)	0.00
BOTN - Cethana	0.00
Hydrogen reciprocating engines	0.00

Scope 3 emissions, including the emissions generated from the manufacturing process,[56] often account for more than 70% of a business' carbon footprint, as noted by Deloitte.[57] These indirect emissions are the only source of greenhouse gas emissions associated with solar panels, wind turbines and battery systems. By excluding lifecycle emissions of generation and storage technologies and only considering direct (Scope 1) emissions, the ISP likely over-represents the emissions reductions that would occur with a higher share of solar, wind and batteries. Figure 9 shows emissions intensity in the Optimal Development Path in the Draft 2024 ISP has the potential to be around 6 times higher than AEMO has forecast, if reasonable estimates of Scope 3 emissions are included from solar, wind and batteries.[58] Using the top end of Scope 3 estimates, emissions intensity could be 12 times higher.

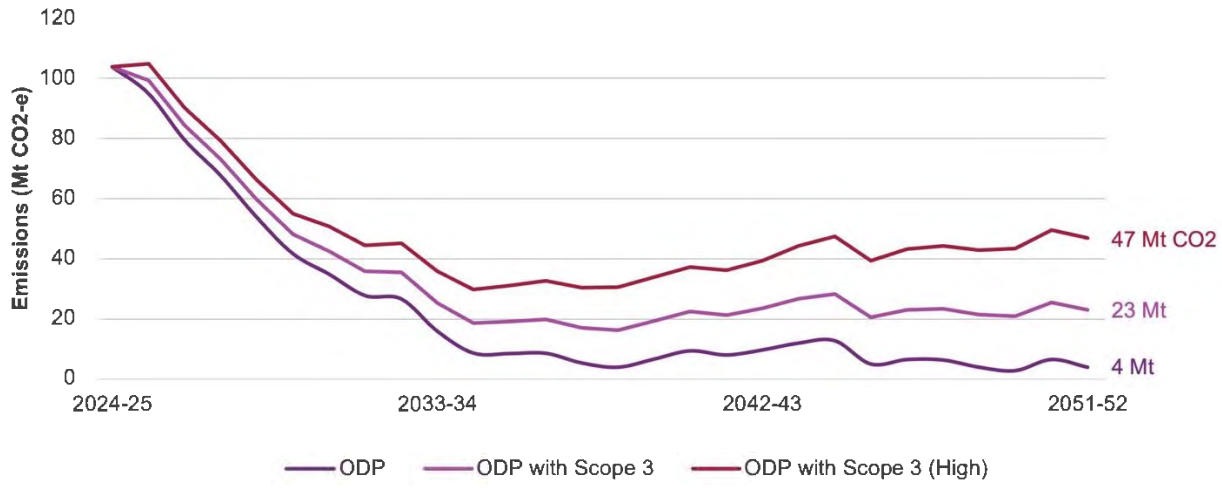

Figure 9. Projected emissions intensity in the ISP's Optimal Development Path, with CIS's central and high estimates of emissions intensity if lifecycle emissions for solar, wind, and batteries are included.

This raises doubt over whether the current energy transition plan will meaningfully achieve net zero by 2050. If Australia's carbon budgets are met mostly through installing solar panels, wind turbines and batteries manufactured in countries expanding their coal generation, the reduction in global emissions from implementing the ISP may be much smaller than presumed.

AEMO's response in the Final 2024 ISP

Nevertheless, AEMO has continued to exclude Scope 3 emissions in the Final ISP.

Specifically, on page 39 of the 2024 ISP Consultation Summary Report, AEMO dismissed this concern, stating that:

> Consistent with the *ISP Methodology* and 2023 IASR, the scenarios in the ISP contain NEM carbon budgets which are derived from a national carbon budget. AEMO acknowledges the scope 3 emissions involved in offshore manufacturing but maintains that the appropriate accounting for offshore emissions is within the carbon budget of the country of origin.

While it may be true that the manufacturing country is responsible for their own grid emissions, it is global emissions that ultimately matter. If Australia reduces its emissions by driving demand for renewables manufacturing, but in doing so incentivises the manufacturing country to expand coal-fired power to meet production needs, global emissions will increase. This approach undermines the very objective for which renewables are promoted in the first place.

6. The model assumes perfect foresight of the weather

Draft 2024 ISP

Overfit models conform too closely to a limited set of inputs and fail to account for uncertainty in the real world. AEMO has overfit the ISP's model by assuming perfect foresight of the weather for the next few decades, which underestimates the amount of backup generation and storage required by renewables, and undervalues the certainty provided by thermal generators.

AEMO does not test the ISP model against a range of potential weather conditions to ensure grid reliability. Instead: "AEMO's energy market modelling is optimised with the benefit of perfect foresight of VRE [i.e. wind and solar] output and operational demand within each simulated day."[59] This perfect foresight of the weather decades in advance does not reflect reality.

AEMO ensures unserved energy (i.e. blackouts) are avoided by "allowing the model to build flexible gas to take into account those chances of unserved energy".[60] Flexible gas capacity projections are thus overfit to a particular set of weather conditions.

This results in the pattern of flexible gas capacity for the next few decades being very lumpy, with some years having no new capacity built or reduced capacity from retirements, while other years have unprecedented amounts of new capacity built (Figure 10).[61] The biggest increase in one year occurs in 2045, when 4 GW of new capacity is built, reaching a peak in total capacity of 18 GW. To understand the scale of building 4 GW of flexible gas in one year, the largest power station in Australia (Eraring) has less than 3 GW of capacity.[62]

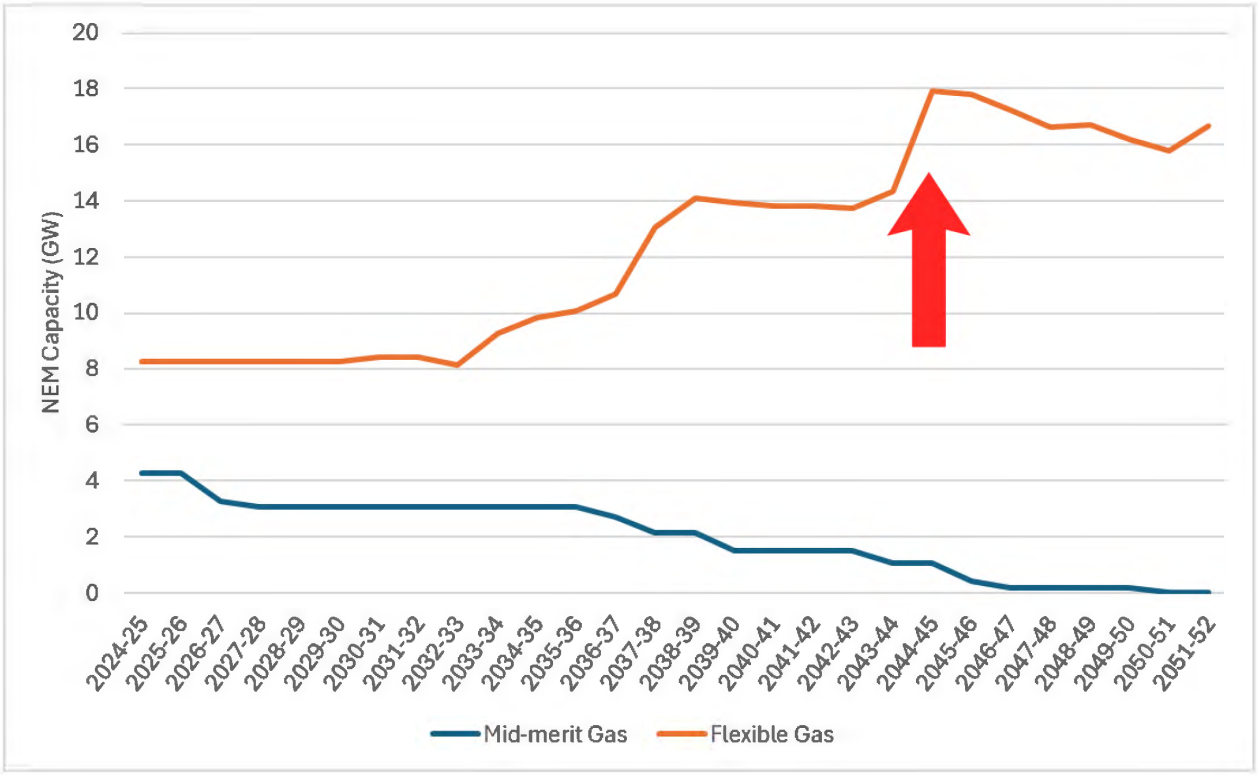

Figure 10. Gas capacity for mid-merit gas and flexible gas across the NEM in the Draft 2024 ISP ODP under Step Change.

The year of peak flexible gas, 2045, is conveniently the same year in which solar capacity factors across most solar farms experience a marked drop (Figure 11).[63] The ISP model builds just-in-time gas capacity to get through this apparently cloudy future year, with no consideration of what would happen if the bad solar year came one or two years earlier when gas capacity is lower.

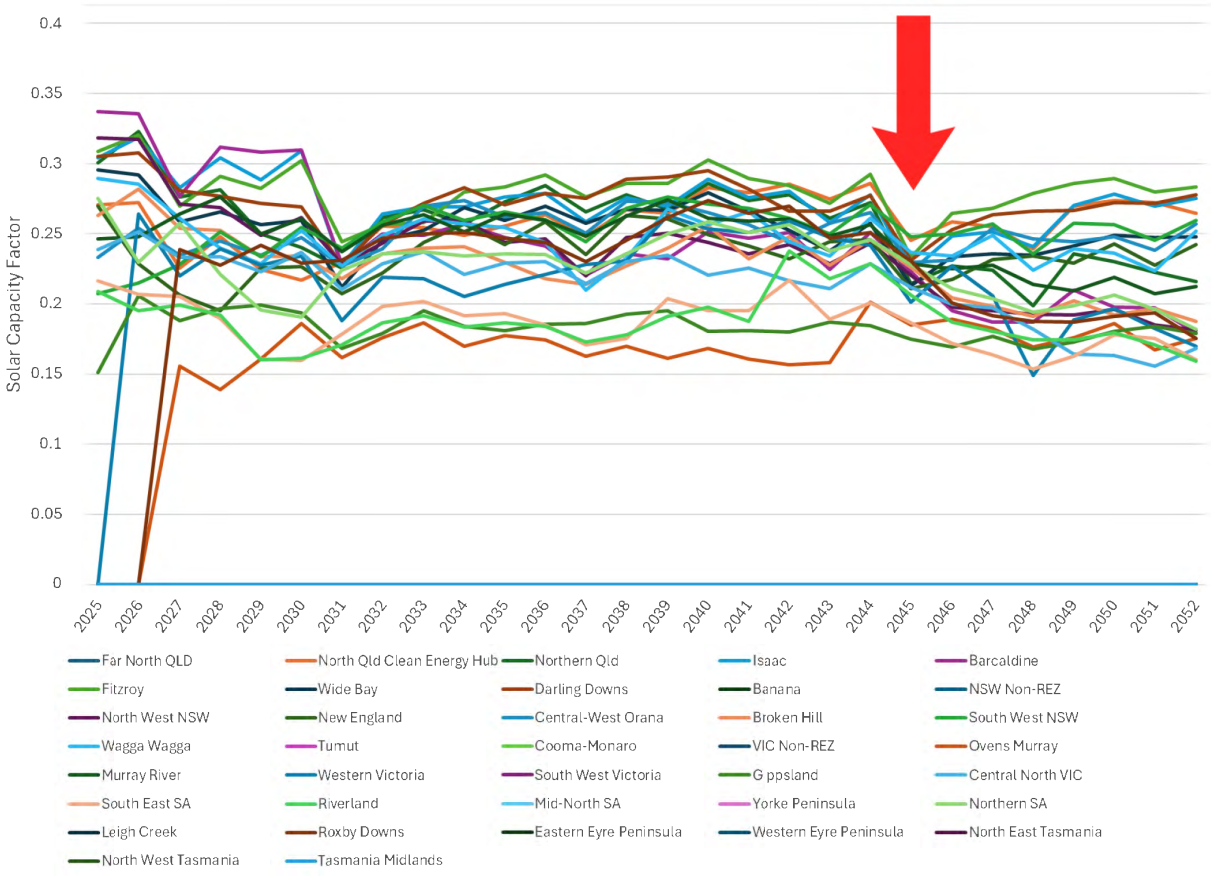

Figure 11. Solar capacity factors for solar farms across the NEM in the Draft 2024 ISP ODP under Step Change.

The ISP model also perfectly times large-scale battery construction and retirement so that extra storage capacity is available for apparently cloudy future years. The storage capacity forecast in the ISP grows steadily, apart from a curious dip in 2045-46 (Figure 12).[64] This occurs because shallow storage capacity (1-2 hour batteries) is assumed to halve in one year, falling from 8 GW in 2044-45 to 4 GW in 2045-46. This represents the retirement of the 4 GW of shallow batteries built in 2025-26, as they have an assumed economic life of 20 years.[65] The retirement of these batteries falls directly after 2045, the year assumed to have particularly low solar output, so they can be used to support the grid through the solar drought and then never replaced again.

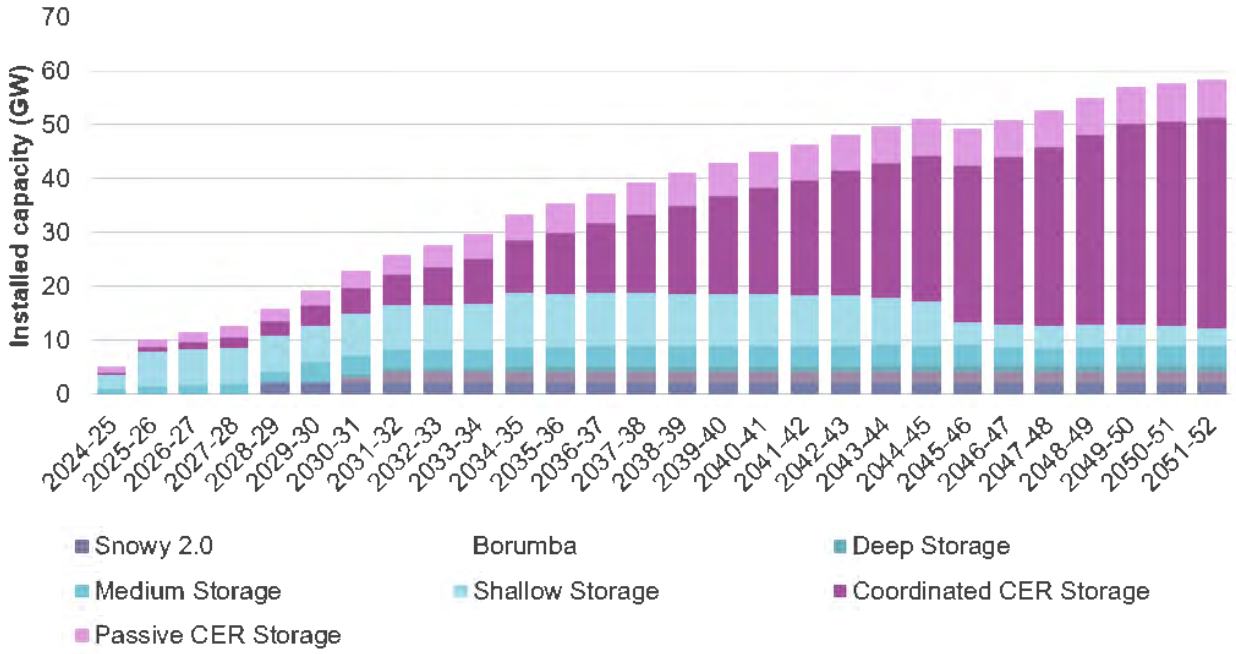

Figure 12. Draft 2024 ISP forecast for NEM storage capacity in GW by year under Step Change.

This means AEMO has, as in the case of flexible gas, overfit the construction of large amounts of battery storage in the ISP model by assuming a bad solar year will occur in 2045. The model choosing to build such a large amount of battery storage in one year instead of spreading construction to avoid sudden decreases in capacity is further evidence that the ISP's model is not fit for purpose and is likely to fail when faced with the unpredictability of real weather events.

AEMO's response in the Final 2024 ISP

AEMO attempted to fix this problem in the Final ISP, but the underlying perfect foresight assumptions remain in the model.

On page 38 of the Consultation Summary Report, AEMO acknowledged that the perfect foresight assumptions built into the model result in flexible gas expansion in preparation for weather sequences that cannot be predicted:

> AEMO acknowledges the impact of perfect foresight on modelling outcomes over both the short- and long-term horizons. AEMO accepts that perfect foresight over the long-term horizon results in pre-emptive expansion for the underlying weather sequence used to drive the model, and that in reality the weather cannot be known in advance.

However, AEMO did not acknowledge that its methodology was fundamentally flawed, stating:

> As per the ISP Methodology, AEMO tests numerous alternative weather sequences in the ISP capacity outlook model and selects a 'typical' sequence in terms of outcomes such as transmission and generation development to ensure the sequence chosen is not resulting in an outlier outcome. AEMO considers this to be a reasonable approach given the intractability of determining an ODP based off all possible sequences of weather years.[66]

In reality, the energy system must be prepared to withstand the 'worst' weather possible (within given bounds of probability) every single year. By merely selecting a 'typical' year and building projects in the model to handle that year's weather patterns, there is no guarantee that the energy

system will be able to meet demand every single year of the next few decades, making blackouts much more likely.

AEMO attempted to fix the issues with gas infrastructure modelling by putting in place "in all scenarios a limitation of approximately 1 GW of GPG per year (to reflect a reasonable market response with imperfect foresight of low VRE conditions)".[67] While this is more realistic than assuming 4 GW can be built in a single year, it merely spreads out gas development without addressing the problem of imperfect foresight. The Final 2024 ISP model is still able to ensure infrastructure is built prior to years assumed to have bad weather, without proper consideration of whether reliability will be maintained should bad weather years occur sooner. This means the amount of backup generation and storage required by renewables remains underestimated, and the certainty provided by thermal generators undervalued.

7. The model double-counts transmission benefits

Draft 2024 ISP

AEMO's method for determining the value of individual projects does not treat the energy system as an integrated whole but rather a collection of parts largely independent of one another. This allows uneconomic projects to be approved and costs passed onto consumers.

AEMO uses the take-one-out-at-a-time (TOOT) method to provide an estimate of the sensitivity of each transmission project in the Optimal Development Path to cost variations. This is supposed to determine each project's benefits and the threshold of cost increases that would lead to a project no longer being beneficial for the grid.[68]

TOOT analysis is performed by taking out a particular transmission project and any associated capacity augmentations from the Optimal Development Path (e.g. removing the transmission link that deepens the connection capacity between a Renewable Energy Zone and the rest of the grid, as well as removing the increased renewables capacity that would be built in that zone).[69] The TOOT results are crucial for the ISP to ensure final approval is not granted for previously recommended transmission projects facing cost blowouts that would make them uneconomical.

However, the TOOT analysis in the ISP is unsuitable to serve its intended purpose. This is made clear by the fact that the sum of the calculated net benefits of just a subset of transmission projects in the Optimal Development Path matches the total net benefits of all transmission projects. AEMO claims the total net benefits of the Optimal Development Path amount to $17 billion,[70] but according to the TOOT analysis, this $17 billion sum is exceeded by adding up the individual project benefits even before Queensland Supergrid North or QNI Connect have been added (Table 2).[71] This means individual projects have been valued as greater than logically possible given the total value of the system, thus artificially inflating their actual benefits to make them appear more desirable.

This issue has arisen because the TOOT analysis breaks down the integrated system into independent parts, many of which do not make sense to build unless complementary parts are also included.

Table 2. Net benefits of projects in Draft 2024 ISP.

Project	Net Benefits from TOOT $Bn
New England REZ Transmission Link 1	4
Sydney Ring Option 1	4.2
Gladstone Grid Reinforcement	4.9
Queensland Supergrid North Option 1	
HumeLink	1
Project Marinus Stage 1 & 2	0.3
QNI Connect Option 2	
Queensland Supergrid South Option 5	2.2
VNI West	0.7
TOTAL	**17.3**

By inflating the value of uneconomic projects through a faulty methodology, AEMO has ensured that consumers will be paying more than necessary to meet the requirements of the energy system.

AEMO's response in the Final 2024 ISP

AEMO has continued using the TOOT analysis in the Final ISP, despite its flaws.

On page 58 of the Consultation Summary, AEMO defended its methodology:

> AEMO considers the TOOT analysis to be a valuable method for assessing the net market benefits of individual actionable projects… AEMO acknowledges that the sum of individual TOOT net market benefits sum to greater than the total net market of the ODP. This is not unexpected and reflects the value that one project adds to others (like valuing individual links in a chain). As an example, Gladstone Grid Reinforcement is a pre-requisite for SuperGrid South, so it is impossible to perform TOOT analysis for Gladstone Grid South without also removing SuperGrid South. AEMO acknowledges the relationship between HumeLink and VNI West and could have performed TOOT analysis on these combined projects. Given the relationship was not assessed in previous ISPs, AEMO considers it prudent and transparent to assess the merits of each project in isolation, in line with previous assessments. AEMO considers it unlikely that two projects that deliver weighted net market benefits in isolation would add a net market cost when combined, and tests this explicitly through the development paths (which represents combinations of projects).

There are two contradictions in this argument.

Firstly, AEMO claims the additional benefits from TOOT analysis "reflects the value that one project adds to others (like valuing individual links in a chain)", contradicting their statement that "AEMO considers it prudent and transparent to assess the merits of each project in isolation." In fact, it is imprudent and opaque to double count the benefits that arise from linking two new parts.[72]

Secondly, AEMO claims (regarding HumeLink and VNI West) it is "unlikely that two projects that deliver weighted net market benefits in isolation would add a net market cost when combined" and yet also state that the "relationship was not assessed in previous ISPs."[73] The question remains as to how AEMO can be confident of this when the relationship (and the benefits arising from a combination of two projects) has not been assessed.

8. The plan locks in costs that are not yet realised

Draft 2024 ISP

The ISP treats government-committed projects with costs yet to be sunk as locked in and therefore makes no attempt to assess their benefits to the system. This, combined with the way the system is dismantled by the TOOT analysis, results in transmission projects that link these assets appearing more valuable than they would otherwise, paving the way for further projects to be locked in without the whole system ever being fully optimised.

Transmission projects that have not passed the required cost-benefit test, the Regulatory Investment Test for Transmission (RIT-T), can now be considered locked in by going through a less rigorous state government process that does not optimise the whole system. For example, the NSW government's new Transmission Efficiency Test allows transmission projects to bypass the more stringent RIT-T[74] and proceed by simply proving the project can be delivered efficiently, regardless of whether it is a good idea in the first place.[75] This sidestepping of the RIT-T has occurred with the Central-West Orana REZ Transmission Link.[76] Similarly, an amendment to the National Electricity (Victoria) Act 2005 allows the RIT-T to be bypassed at the Victorian Energy Minister's discretion.[77] Passing off responsibility for verifying the economic viability of a project to the states in this way essentially allows boondoggles to be built as long as they are built efficiently.

Treating committed projects as sunk costs has inflated the value of the major transmission projects linking NSW and Victoria: HumeLink and VNI West. Snowy Hydro 2.0 has been treated as a sunk cost in the ISP model because it is a federal government commitment expected in 2028,[78] despite, after a series of significant delays, only $5 billion of funds being spent, with $7 billion yet to be spent.[79] Even if just $6 billion of Snowy 2.0's costs were included in the model, the net present value of HumeLink without competition benefits would sink from $43 million to negative $4.9 billion,[80] meaning that consumers would seem to be better off if planning for HumeLink and construction for Snowy 2.0 ceased immediately.

Likewise, the Central West Orana Renewable Energy Zone (REZ) Transmission Link and the Western Renewables Link are considered to be locked in by the ISP model since they have been granted regulatory approval, pushing up the value of HumeLink and VNI West.[81] The Western Renewables Link has undergone the RIT-T[82] but without VNI West it would not have been worth building, since it needs VNI West to connect Melbourne to the rest of the grid.[83] The interdependent nature of these projects means treating one as a sunk cost will inflate the value of the other; making it impossible to determine whether building both is cost-effective. Worse is the treatment of the Central West Orana REZ Link as a sunk cost, given it has not undergone the RIT-T[84] and is crucial for connecting the REZ to HumeLink and VNI West, inflating their value further.[85]

There is also the temptation to expand the capacity of a declared project (i.e. a project greenlit by a state government without a system-wide cost-benefit analysis) as much as possible to inflate the value of the transmission links connecting it to the broader grid. This is because declared projects are considered locked in, so the cost of any added capacity will not be factored into the model. This has

already occurred for the Central West Orana REZ Link, with the original 3 GW capacity being doubled to 6 GW.[86] Due to side-stepping the RIT-T, there is no guarantee this added capacity would be economically viable if all parts of the system yet to be completed had been fully optimised.

The treatment of committed projects as sunk costs — especially those that have not gone through a rigorous cost-benefit analysis — means the ISP has been prevented from examining an alternative scenario where a whole set of projects (e.g. Snowy Hydro 2.0, HumeLink, and VNI West) are found to be uneconomic and do not proceed. In this scenario, states could have developed their own renewable energy zones, storage and gas firming with less interconnection — saving billions on transmission projects that could then be invested in other parts of the system.

AEMO's response in the Final 2024 ISP

AEMO continued to treat committed projects as sunk costs in the Final ISP.

On page 58 of the Consultation Summary, AEMO asserted this is best practice and required by the guidelines:

> AEMO notes that some transmission projects will not progress through the RIT-T framework but through a jurisdictional framework. AEMO considers that it is appropriate for these projects to be included as committed or anticipated projects once they have reached threshold requirements. The ISP is not a vehicle for evaluating government policy or historical investment decisions. This approach is considered best practice, is required by the AER's Cost Benefit Analysis Guidelines and is aligned with Infrastructure Australia's Guide to Economic Appraisal.

While the AER Cost Benefit Analysis Guidelines state on page 26 that committed projects should "form part of all states of the world", the Guidelines also state:

> There may be a valid reason for AEMO not to include an existing asset or committed/ anticipated project in any state of the world, and it can do so provided it presents corresponding rationale and/or evidence. For example, there may be an asset/project that is inefficient and consequently distorting the market development modelling results.

Snowy 2.0 is broadly understood to be an inefficient project.[87] Even with $5 billion already spent at the time of the Final 2024 ISP, it likely would still have been worthwhile for the grid to save the remaining $7 billion (and $5 billion for HumeLink) by halting construction of the pumped hydro project and spending the funds on more efficient storage options (e.g., large batteries located close to load centres). Even under the current Guidelines, best practice would have been to include some states of the world in which Snowy 2.0 is not completed to avoid the modelling distortions that inflate the value of HumeLink and VNI West. Had this been tested, the results would likely reveal all three projects were collectively uneconomic and should not proceed.

9. The plan excludes a baseline scenario

The scenarios in the ISP serve as the backbone for modelling future energy pathways. They represent possible futures, allowing AEMO to assess the optimal mix of investments, including transmission projects like HumeLink, under different future conditions. A balanced set of scenarios is critical to identify the best options for consumers, assess risks, and avoid premature or over-investment in infrastructure that might not be needed if market or policy conditions change. Scenarios without binding emissions or renewable targets are particularly important, as they provide a baseline against

which the costs and benefits of policy-driven pathways can be evaluated. However, AEMO has progressively removed any scenario that could be used as a baseline in successive ISPs.

2022 ISP

In the 2021 Inputs, Assumptions Scenarios Report (IASR), there are five scenarios — *Slow Change*, *Steady Progress*, *Progressive Change*, *Step Change* and *Hydrogen Superpower* — all of which assume a 26-28% reduction in emissions by 2030.[88] However, only the latter three scenarios assume a target of net zero by at least 2050 — *Slow Change* and *Steady Progress* do not have this constraint.[89]

The *Steady Progress* scenario was originally derived from the *Central* scenario in the 2020 ISP,[90] previously named '*Current Trajectory*',[91] and was consequently considered a highly relevant reference point. The other scenario derived from '*Central*' was initially called '*Net Zero 2050*'[92] before being renamed '*Progressive Change'*.[93] This scenario was very similar to *Steady Progress*, except for a much larger industrial electricity load and a binding emissions reduction target.[94] *Steady Progress* was the most realistic counterfactual to assess potential costs of transitioning to renewables, due to its lack of a binding carbon budget and use of 'central' estimates for technological and macroeconomic influences — particularly coal prices.

At the original Delphi Panel[95] for the 2022 ISP, *Steady Progress* was given the same weighting of likelihood as *Hydrogen Superpower*, an ambitious scenario assuming Australia becomes a major exporter of green hydrogen.[96] This meant that participants rated a scenario with no binding emissions reduction target as equally likely as an extremely optimistic scenario with "significant technological breakthroughs and social change to support low and zero emissions technologies".[97] Together with *Slow Change*, the Delphi Panel gave an 18% weighting to scenarios that did not include the binding net zero target.[98] *Slow Change* assumed slower-than-anticipated emissions reduction, depicting a future in which Australia did not reach the economy-wide decarbonisation objectives of the Emissions Reduction Plan.[99]

However, after the announcement of the 2050 Net Zero target at COP26, AEMO discarded the results of the first panel, calling on a new panel to develop new weights for the 2022 ISP.[100] There was no public consultation on the results of the second panel — even the official ISP Consumer Panel members were excluded — before these weights were adopted by AEMO as the Draft ISP weights.[101] Also, the size and composition of the panel was in breach of the official ISP Methodology.[102]

For the Second Delphi Panel, *Steady Progress* was removed from consideration, apparently due to its "failure to meet net zero ambitions".[103] However, no explanation was given for retaining *Slow Change*, which also did not have a binding net zero target. Given that *Slow Change* had far fewer votes in the first Delphi Panel (5% instead of 13%),[104] removing the least likely scenario that wouldn't meet the target would appear to be logical.

Since no coal plant refurbishments or new brown coal were allowed by AEMO's assumptions,[105] only new or refurbished gas plants or new black coal would be possible. However, by removing *Steady Progress* with its central price assumptions, the only scenario able to show how much coal and gas the cost-optimising model would recommend without a binding carbon target (i.e. *Slow Change*) was hamstrung by its use of coal and gas price assumptions higher than any other scenario.[106]

This may have been a critical factor in determining the eventual generation mix. Including *Slow Change*, and excluding *Steady Progress*, meant AEMO could present relatively uniform scenarios in the 2022 ISP that all eventually reached net zero without replacing coal or gas, with only a 4% weighting given to the *Slow Change* scenario with no binding emissions reduction target.[107]

In summary, AEMO's decision to re-run the Delphi Panel, without oversight from the Consumer Panel or public consultation, removed the only scenario that could have been used as an appropriate counterfactual in the 2022 ISP.

Draft 2024 ISP

This issue of a lack of neutral baselines becomes more problematic in the 2024 ISP, with AEMO removing *Slow Change*, the only scenario remaining without a binding renewable energy or carbon target.

The removal of *Slow Change* was consequential. In effect, most of the weights from the eliminated *Steady Progress* scenario were reallocated to *Step Change*, pushing *Progressive Change* down to second place. This substantially increased the overall weight of scenarios (*Step Change* and *Green Energy Exports*) that required the most rapid and ambitious uptake of renewables while assuming the fastest closures of coal.

The re-weighted scenario collection effectively shifted the optimal timings of three of the largest transmission projects previously listed as actionable: VNI West, Marinus Link, and HumeLink. The Consumer Panel maintained that, had the initial weightings from the first Delphi Panel been retained, with *Progressive Change* as the most likely scenario and *Steady Progress* equally weighted with *Hydrogen Superpower*, none of these projects would have advanced immediately as actionable projects.[108]

Given the multiple billions of dollars of investment that hinged on the shifting of scenario weights, it would be expected that any changes to the scenarios and weightings would undergo a rigorous, transparent process. However, this was not the case.

AEMO justified the removal of *Slow Change* on the basis it was "no longer consistent with the pace of transformation required by the collection of policies facing Australia's energy industry".[109] AEMO also asserted that "a majority of stakeholders supported the Slow Change scenario's removal, consistent with its very low relative likelihood in the 2022 ISP".[110]

However, that statement is incorrect. A majority of stakeholders did not support the removal of *Slow Change;* with 56% either agreeing the scenario is still relevant or not having an opinion either way (Figure 13).[111] In fact, the majority of comments from stakeholders in the consultation webinar were supportive of keeping *Slow Change* in the analysis, particularly as a "bookend", "benchmark", "baseline" or "counterfactual" which is "necessary to check for regretted investment".[112]

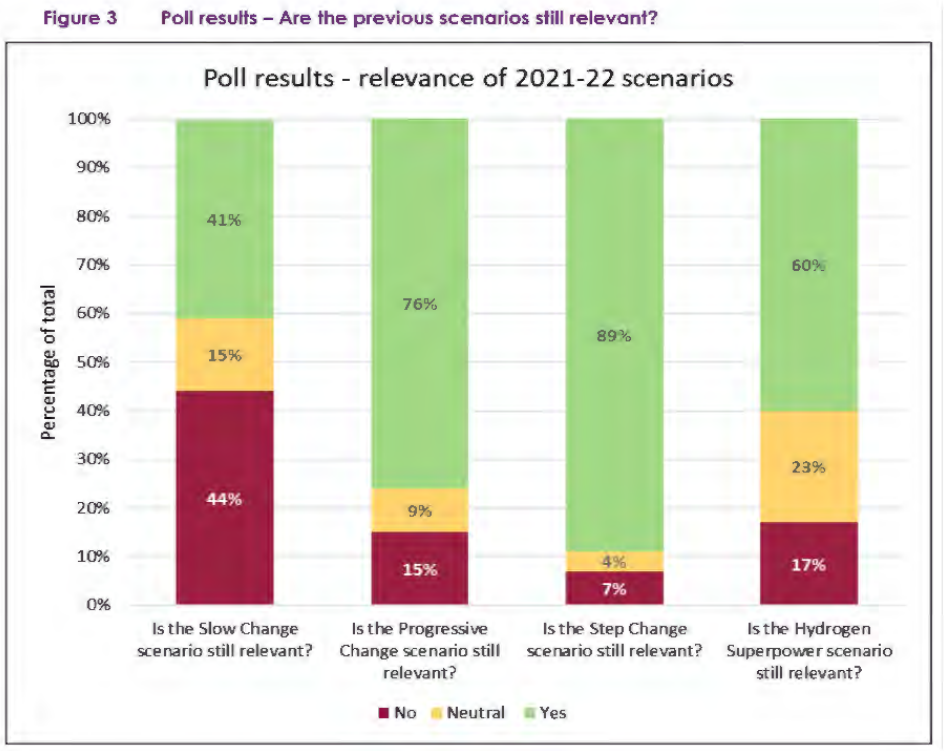

Figure 13. Poll results from 2023 Preliminary Scenarios Webinar feedback regarding the relevance of scenarios in the 2022 ISP to the Draft 2024 ISP.

Despite stakeholders' reluctance, AEMO unilaterally removed *Slow Change*, further skewing the model towards high-end emissions reduction and renewables capacity trajectories in the ISP. Moreover, AEMO did not perform sensitivity testing for situations where emissions reductions or renewables capacity fall short of government targets.

AEMO's response in the final 2024 ISP

In the Final 2024 ISP, AEMO defended its choice to remove *Slow Change* using the same flawed arguments as before.

On page 39 of the Consultation Summary Report, AEMO stated that "the majority of stakeholders considered that the *Slow Change* scenario was no longer relevant", which is an assertion not borne out by their own polling (Figure 13). AEMO further stated:

> AEMO acknowledges a *Slow Change* scenario has a non-zero likelihood, but does not consider it to be fit-for-purpose in the 2024 ISP. The purpose of the ISP is not to calculate the cost of the energy transition or government policy on emission targets. AEMO also recognises that applying no federal government policy targets would be inconsistent with the ISP framework and NER requirements to consider public policies when producing the ISP.

This demonstrates a misunderstanding of the NER requirements that AEMO consider government policy while guarding against the risk of premature and over-investment arising from uncertainty, including policy uncertainty (see the CIS submission to the Committee regarding the ISP's treatment of government policies). The lack of a meaningful baseline in the 2024 ISP means the costs and benefits of policy-driven pathways remain unknown to consumers and policymakers alike.

10. Hydrogen is used as a flexible solar sink

The 2024 ISP uses hydrogen production as a flexible solar sink while assuming the storage required to do this is free. AEMO themselves note that hydrogen capacity "could be substantial but depends on the development of domestic and global hydrogen industries".[113] If the sector does not develop as expected, the system could be more costly than modelled, and require additional measures to stabilise midday demand.

The 2024 ISP projects that hydrogen electrolysers will operate only when power is abundant, generally at midday, and avoid running on cloudy or windless days when wind and solar production is poor.[114] This makes the modelled system cheaper and lower cost.

Unfortunately, hydrogen use cases expect constant supply, and the model effectively assumes the storage required to make the intermittent supply into constant supply is free.[115]

Moreover, the ISP model balances hydrogen production over monthly timeframes, which also requires significant storage, as noted by submissions to the ISP: "most hydrogen use cases identified by Climateworks and CSIRO require a constant supply of hydrogen and there is no evidence base supporting the monthly balancing assumption without a significant volume of storage".[116]

To address these concerns, AEMO created a "low hydrogen flexibility sensitivity" where instead of satisfying a monthly hydrogen production target, it satisfies a daily target. The sensitivity finds that $6.5 billion spent on another 7 GW of solar, 1 GW of flexible gas and 1.8 GW of utility-scale electricity storage allow the model to meet these daily targets instead of monthly ones. It also finds a relatively minimal impact on the weighted net benefits ($200 million) and on the net benefits of *Step Change* ($500 million).[117]

However, having a daily target still means the ISP model assumes hydrogen production can load-follow solar output — i.e., on sunny days, production would occur during daylight hours and ramp down overnight. This gives a low capacity factor, which would be uneconomic for hydrogen production. Instead, an 80-90% capacity factor should be assumed, meaning hydrogen production would not act as a solar sink and load-follow during the day as assumed by the ISP model.

11. AEMC postponing planned review of the ISP for two years removes opportunity for scrutiny of ISP's flaws

Under NER 11.126.10, the AEMC was required to complete a comprehensive review of the ISP framework by 1 July 2025. However, as part of the *Bringing early works forward to improve transmission planning* rule change, this date was moved two years later to 1 July 2027.[118]

This rule change was requested by the state and federal energy ministers, with the purpose of delaying the AEMC's ISP review to "enable better alignment with the outcomes of the Energy and Climate Ministerial Council (ECMC) Supercharged ISP Review and the suite of rule changes to the transmission economic assessment process submitted by the Commonwealth Minister for Climate Change and Energy".[119] The ECMC further claimed, "Given the wide-scale change to the economic assessment process underway, a delay allows the AEMC to embed the current suite of rule changes and then assess in detail how the reforms have performed".[120]

However, this draft rule change drew strong opposition from consumer groups. The Justice and Equity Centre (JEC) wrote in their submission to the draft rule:

> The JEC does not support the decision to delay the review of the ISP and is concerned the delayed timeframes undermine any scope for the review to have a meaningful impact. We strongly support the need for a review and the role of the AEMC in conducting it. The coordination and planning needs of the NEM have changed substantially since 2018 and the initiation of the ISP in its current form. It is no longer fit for purpose and does not adequately promote the long-term interests of consumers in efficient investment in the energy system transition.[121]

They further argued that, given the high rate of regulatory churn, a 'lull' is unlikely in the near future, and by the time the review has been completed in 2027, the associated recommendations likely won't be realised in the ISP until 2030 given typical timelines for rule changes. Waiting until then would result in a review being completed that is of no value to consumers.[122]

Similarly, the CIS made a submission arguing for the existing 2025 deadline to be kept.[123]

Energy Users Association of Australia wrote in their submission that, while they were supportive of delaying a full review of the ISP until 2027 in light of current reforms being implemented, they would encourage the AEMC "to perform a shorter interim review of the ISP process in 2025, to provide consumers with confidence in the ISP including an update on the current reforms as they are implemented".[124]

Instead of keeping the current timeline for the review (or establishing an interim review), the AEMC proceeded with delaying the review in its entirety until 2027.[125] This was despite only AER, AEMO and Energy Networks Australia (ENA, the national transmission and distribution industry body) being supportive of a delay.

In its submissions, AEMO merely stated its support for a delay without justification,[126] the AER restated the reasoning given by the ECMC and the ENA called for an even longer delay with a 1 July 2029 deadline "to allow sufficient time for the learnings from the 2026 ISP and subsequent progression of the actionable ISP projects to be adequately considered".

The AEMC's decision to delay the ISP review at the request of the energy ministers, energy bodies and transmission networks undermines a critical consumer protection in the NER. This is because the ECMC's Supercharged ISP Review is insufficient to ensure consumers' long-term interests are being protected, and the ISP in its current form does not serve the long-term interests of consumers.

The terms of reference for the ECMC review state "the Energy and Climate Ministerial Council will approve the interim and final report and recommendations".[127] It is unclear to what extent the recommendations were shaped by political objectives, as energy ministers are not bound to consider the long-term interests of consumers in the same way the AEMC is.

This is especially important, considering the ISP in its current form is not primarily serving the long-term interests of consumers, as outlined in the previous sections of this submission and the CIS submission to the Committee regarding the ISP's treatment of government policies.

The ECMC review failed to address these fundamental flaws, including how government policies are locked into every scenario regardless of their achievability or cost to the system. The review's recommendations on government policies were concerned only with promoting transparency around the consultation process with jurisdictions and clarifying how policies are included. There were no recommendations dealing with the issues of *cost* transparency for policies.[128] An AEMC review needs to be implemented under the NER's current 2025 timeline to ensure this issue is resolved for the 2026 ISP.

As it stands, the ISP's planned path for the energy transition will not be affordable for consumers. As the ISP Consumer Panel stated on page 6 of their report for the Draft 2024 ISP, "many consumers will not be able to 'afford' the costs described in the Draft ISP…" The Final 2024 ISP makes five additional projects actionable under the ODP compared to the Draft,[129] making the question of affordability even more important.

As Samantha Christie, Manager Strategic Planning at AEMO, stated in the 2024 ISP post-publication webinar, AEMO has "undertaken close joint planning with transmission network service providers"[130] for these changes to the ODP. This same level of consultation was not afforded to consumers prior to projects being deemed actionable in the Final ISP.

Consumers need to have confidence AEMO is taking into account their long-term interests, and not primarily the interests and views of TNSPs, in the selection of projects for the final ODP. The AEMC review could have helped promote trust and transparency in the ISP consultation process and the resulting ODP. Following the recent rule change, the ISP will escape much-needed scrutiny for years to come, during which costs to consumers from sub-optimal investment decisions will only grow.

12. AEMO has significant conflicts of interest

Dual roles as transmission planner and proponent in Victoria create a conflict of interest

In Victoria, AEMO performs the function of designated transmission planner in addition to their regular functions as a market operator. However, AEMO has now taken on another role by creating a for-profit transmission company operating in Victoria. These dual roles create a potential conflict of interest.

On 24 February 2023, AEMO established a wholly owned subsidiary Transmission Company Victoria (TCV), a for-profit private company incorporated for the "sole purpose of undertaking early works" for VNI West.[131] In July 2024, AEMO received a $120 million fixed rate concessional loan from the Clean Energy Finance Corporation to fund TCV carrying out early works.[132] Financial statements for TCV are consolidated with the rest of AEMO, so it is unclear how much profit AEMO makes from its subsidiary. With AEMO being responsible for transmission planning in Victoria, as well as having a statutory function in approving the economic case for linked projects such as HumeLink, there is a clear incentive to reduce risk of the projects not proceeding for its subsidiary, which AEMO could do by manipulating the planning process. This conflict of interest is of great concern given the many flaws in AEMO's modelling to date as set out in this submission.

AEMO has stated its intentions to sell TCV at some point this year to a third party, which will work alongside TCV to complete early works for VNI West before transferring ownership to the new entity for the completion of the project:

> At the appropriate point in time prior to the conclusion of the early works, TCV will be transferred to a third party (New Owner) through a procurement process that is currently being developed by AEMO. After the transfer to the New Owner, the intention is that TCV will continue to develop and then build, own and operate VNI West… to enable the transition of the VNI West project to a proposed New Owner, AEMO will issue a tender (later in 2024) to engage with the TNSP market. Through this process, AEMO will seek submissions from tenderers to: continue to work alongside TCV during the early works development phase to

assist with the completion of the early works (that will continue to be led by TCV) (Development Phase); and late in the Development Phase, transfer TCV to the New Owner to enable construction commencement, delivery and the ongoing operation of the VNI West project (Delivery Phase).[133]

As of September, AEMO is reviewing Registration of Interest submissions, with a plan to award the contract to the development partner in "early 2025", procure an Engineering, Procurement and Construction (EPC) contractor in "the second quarter of 2025" and have the development partner "appoint financiers in the second half of 2025 to support the project's construction".[134] However, TCV "will continue planning, early works and community, landholder and Traditional Owner engagement, as well as the Environment Effects Statement (EES) process over the next 12-18 months".[135] Given the potential conflict of interest, further scrutiny of TCV's operations and governance is warranted to ensure AEMO is making decisions aligned with consumers' best interests and not seeking to maximise profits for its subsidiary, or the company value when sold.

AEMO's role as NSW Consumer Trustee lacks transparency

In NSW, AEMO performs the function of Consumer Trustee on top of their regular functions as a market operator. However, the lack of transparency and consultation around the functions of the Consumer Trustee may allow AEMO to make suboptimal decisions for consumers without appropriate scrutiny.

In 2021, the NSW Energy Minister announced the appointment of AEMO Services, a subsidiary of AEMO, as the NSW Consumer Trustee.[136] AEMO Services functions as the sole and independent decision-maker in the design and implementation of Long-Term Energy Service Agreements for project developers, and publishes an Infrastructure Investment Objectives (IIO) Report every two years. The IIO Report is similar to the ISP but for generation, storage and firming infrastructure needs in New South Wales, including a 20-year development pathways report, and a 10-year tender planning report.[137]

AEMO Services also has an authorisation function for REZ network infrastructure in NSW. Once EnergyCo submits a recommendation for a network project (and operator) to connect new renewable generation to the grid, AEMO Services assess whether the project is in the long-term benefit of NSW consumers and whether it helps achieve infrastructure investment objectives. If the project meets the requirements, AEMO Services authorises the operator to carry out the project and sets a maximum for the capital cost for the development and construction of the project. However, this upper limit is provided to the AER in confidence, meaning there is no opportunity for scrutiny from stakeholders.[138] AEMO Services will not undertake public consultation in making its authorisation decisions and only consider consultation undertaken by EnergyCo "to the extent that this consultation is relevant to AEMO Services' decision-making process", meaning that not just the end result but the modelling itself will escape scrutiny.[139]

It is also unclear what would happen if a project faced cost blowouts and exceeded the upper limit. Such a project would be unlikely to be stopped by AEMO or the AER, as occurred with HumeLink (see CIS submission to the Committee regarding HumeLink).

This lack of transparency is concerning, given AEMO has been known to change the assumptions and modelling in the ISP in ways that result in recommended projects having their benefits inflated. For example, there was a significant shift in wind capacity between the New England and Central West Orana REZs from the 2022 to 2024 ISPs (Figure 14).[140] Also, the 2022 ISP gives the Central West Orana wind resource correlation with demand a rating of B for 2029-30 and 2039-40 and C for 2049-

50, but the 2024 ISP uprates this to straight As.[141] These changes are likely to have contributed to HumeLink's benefits being inflated, allowing the project to be approved despite cost blowouts.

Given the lack of transparency of AEMO Services' authorisation decisions, a similar effect is likely to be seen in future with Central West Orana REZ projects, especially due to changes in scope and cost blowouts resulting in the initial estimate of $0.65 billion in the 2020 ISP increasing to $3.2 billion in the 2023 NSW Network Infrastructure Strategy,[142] with costs now expected to exceed $5.4 billion.[143]

Although AEMO must consult on the Optimal Development Path in the ISP, the confidentiality and lack of consultation on AEMO Services' authorisation decisions for New South Wales provides an avenue for AEMO to obscure costs in the ISP and make suboptimal investment decisions for consumers. AEMO Services' role as NSW Consumer Trustee therefore warrants further scrutiny.

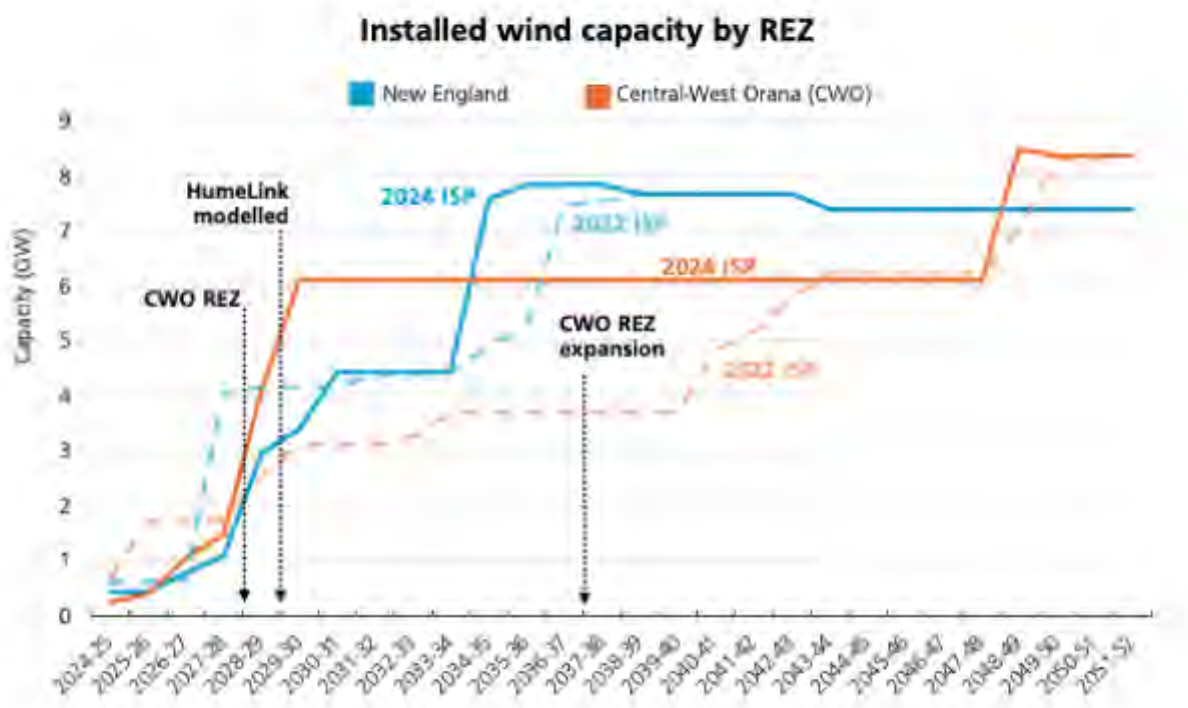

Figure 14. Installed wind capacity (MW) for New England and Central West Orana Renewable Energy Zones in 2022 and 2024 ISPs.

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[1] Finkel, Alan, Karen Moses, Chloe Munro, Terry Effeney & Mary O'Kane. 2017. "Independent Review into the Future Security of the National Electricity Market." Commonwealth of Australia. p 257. https://www.dcceew.gov.au/sites/default/files/documents/independent-review-future-nem-blueprint-for-the-future-2017.pdf.

[2] Energy Security Board. 2020. "Recommendation for National Electricity Amendment (Integrated System Planning) Rule 2020 Decision Paper". https://energyministers.gov.au/sites/prod.energycouncil/files/publications/documents/ESB%20Decision%20Paper%20–%20Actionable%20ISP%20Rule%20Changes.pdf

[3] Mountain, Bruce. "Is there a case for building new grid interconnectors? AEMO's own data suggests not." October 12, 2023. RenewEconomy. https://reneweconomy.com.au/is-there-a-case-for-building-new-grid-interconnectors-aemos-own-data-suggests-not/; Mountain, Bruce. "The diversity argument for this new

transmission link doesn't stack up." October 19, 2023. RenewEconomy. https://reneweconomy.com.au/the-diversity-argument-for-this-new-transmission-link-doesnt-stack-up/.

[4] Analysis performed in R using all solar traces in the 2022 ISP: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp.

[5] Analysis performed in R using all wind traces in the 2022 ISP: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp.

[6] Analysis performed in R using all solar traces in the 2022 ISP: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp.

[7] Analysis performed in R using all wind traces in the 2022 ISP: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp.

[8] Mukerji, R, H. M. Merrill, B. W. Erickson, J. H. Parker and R. E. Friedman. 1991. "Power plant maintenance scheduling: optimizing economics and reliability." *IEEE Transactions on Power Systems*. 6 (2). pp. 476-483. doi: 10.1109/59.76689.

[9] AEMO. 2024. Draft 2024 ISP. p 10.

[10] 2024 ISP, p 11.

[11] "Draft 2024 Integrated System Plan publication webinar part 2." 2023. YouTube. 1:15. https://youtu.be/uxDBxhsZXGc.

[12] Draft 2024 ISP, p 14.

[13] AEMO. 2023. "Draft 2024 ISP Webinar". https://aemo.com.au/-/media/files/major-publications/isp/2023/draft-2024-isp-publication-webinar-presentation.pdf?la=en.

[14] The calculation assumes that rooftop solar has an operational life of 30 years, while consumer batteries last 15 years, meaning they will need to be replaced periodically to maintain capacity over ISP's projection period, thus adding to the new capacity installed.

[15] The $347.5 billion total capital cost for CER is calculated by multiplying the new capacity of rooftop solar and consumer batteries installed under the *Step Change* scenario by the projected capital costs based on available data in 2023-24 GenCost. For rooftop solar, GenCost provides annual capital cost forecasts, which we used to project the total capital costs over the period. For consumer batteries, however, GenCost does not provide a forecast of future costs. It reports the current installation cost at $1,455/kWh (p. 58). As a result, we assumed this installation cost remains constant throughout the projection period for calculating the total capital cost of consumer batteries. If the learning rate of 1-hour utility-scale battery is applied to small-scale battery, this would reduce the total capital cost for CER to $211 billion.

[16] As the ISP does not provide a detailed breakdown of generator and storage capital costs, we estimated the $83 billion by calculating the annual increase in utility solar (GW), deep storage (GWh), medium storage (GWh), and shallow storage (GWh) in the *Step Change* scenario. These annual capacity increases were then multiplied by the corresponding capital costs from the 2023-24 GenCost report to derive the total capital cost for large-scale solar and batteries up to 2050.

[17] Calculated using the same 7% discount rate adopted in the 2024 ISP.

[18] "Draft 2024 Integrated System Plan publication webinar part 2." 2023. YouTube. 3:15. https://youtu.be/uxDBxhsZXGc.

[19] AEMO. 2022. "Forecasting Approach – Electricity Demand Forecasting Methodology". p 65. https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2022/forecasting-approach-electricity-demand-forecasting-methodology.pdf?la=en&hash=4620DDB841C4D61C0E63B2E95754AB9C.

[20] Ibid, p 66.

[21] AEMO. 2023. "2023 Inputs, Assumptions and Scenarios Report." p 27. https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf?la=en.

[22] Department of Treasury and Finance. 2023. "Incentives for electric vehicles." Government of South Australia. https://www.treasury.sa.gov.au/Growing-South-Australia/incentives-for-electric-vehicles.

[23] "Draft 2024 Integrated System Plan publication webinar part 1." 2023. YouTube. 26:44. https://www.youtube.com/watch?v=WUrvCioP5-s

[24] AEMO. 2023. "Project EDGE Final report Version 2." p 87. https://aemo.com.au/-/media/files/initiatives/der/2023/project-edge-final-report.pdf?la=en.

[25] Ibid, p 41.

[26] AEMO. 2021. "2021 Inputs and assumptions workbook". Battery & Plug-in EVs tab. https://aemo.com.au/-/media/files/major-publications/isp/2021/2021-inputs-and-assumptions-workbook.xlsx?la=en.

[27] Draft 2024 ISP, p 34.

[28] Lavieri, Patrícia and Gabriel Oliveira. 2021. "Electric Vehicle Charging Consumer Survey: Insights Report. University of Melbourne." https://www.researchgate.net/publication/355444278_Electric_Vehicle_Charging_Consumer_Survey_Insights_Report.

[29] Energeia. 2020. "Distributed Energy Resources Enablement Project – Discussion and Options Paper". https://renew.org.au/wp-content/uploads/2020/06/Energeia.pdf.

[30] AEMO. 2023. "Draft 2024 ISP Webinar". https://aemo.com.au/-/media/files/major-publications/isp/2023/draft-2024-isp-publication-webinar-presentation.pdf?la=en.

[31] Hughson, Bev, Craig Memery, Mark Grenning and Mark Henley. 2023. "ISP Consumer Panel Report on AEMO's Inputs Assumptions and Scenarios Report (IASR) for the 2024 Integrated System Plan – Final Report". 2024 ISP Consumer Panel. https://aemo.com.au/-/media/files/major-publications/isp/2023/isp-consumer-panel-report-on-2023-iasr.pdf?la=en.

[32] Bowen, Chris. "Energy Market Operator shows firmed renewables the path for a cleaner, cheaper, more reliable grid." December 15, 2023. Commonwealth of Australia. https://minister.dcceew.gov.au/bowen/media-releases/energy-market-operator-shows-firmed-renewables-path-cleaner-cheaper-more-reliable-grid.

[33] Bowen, Chris. 2024. "Interview with David Speers, ABC Insiders." Department of Climate Change, Energy, the Environment and Water. March 10, 2024. https://minister.dcceew.gov.au/bowen/transcripts/interview-david-speers-abc-insiders-1.

[34] Draft 2023-24 GenCost, p 25, 48; Aurecon. 2023. "2023 costs and technical parameter review." https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2024-

forecasting-assumptions-update-consultation-page/aurecon---2023-cost-and-technical-parameters-review.pdf?la=en

[35] Ausgrid. 2023. "Tariff Structure Statement Compliance Document." https://www.aer.gov.au/system/files/2023-12/Ausgrid%20-%20Revised%20proposal%20-%20Att.%208.1%20-%20Tariff%20Structure%20Statement%20compliance%20document%20%28pdf%29%20-%2030%20Nov%202023%20-%20Public.pdf.

[36] "Draft 2024 Integrated System Plan publication webinar part 1." 2023. YouTube. 27:48. https://www.youtube.com/watch?v=WUrvCioP5-s

[37] Bowen, Chris. 2024. "Speech to National Press Club, Canberra ACT." Commonwealth of Australia. https://minister.dcceew.gov.au/bowen/speeches/speech-national-press-club-canberra-act.

[38] Energy and Climate Change Ministerial Council. "Response to the Review of the Integrated System Plan." Commonwealth of Australia. https://www.energy.gov.au/sites/default/files/2024-04/ecmc-response-to-isp-review.pdf.

39 Sharma, Vanika, Syed Mahfuzul Aziz, Mohammed H. Haque & Travis Kauschke. 2020.

"Effects of high solar photovoltaic penetration on distribution feeders and the economic impact."

Renewable and Sustainable Energy Reviews. 131. 110021. https://doi.org/10.1016/j.rser.2020.110021.

[40] Averted expenditure was calculated using 2023 IASR data on fuel costs (under the *Step Change* scenario) and variable operating expenditure for existing plants. The weighted average of fuel costs and variable opex per unit of energy produced was calculated for each generation type (black coal, brown coal, OCGT, CCGT, gas-powered steam turbine, reciprocating engine, waste coal mine gas), with weighting determined by nameplate capacity of individual generators. Reciprocating engine fuel costs and variable opex was used as an estimate for waste coal mine gas, as the latter did not have available data. Given waste coal mine gas represents 0.4% of annual generation, this approximation is unlikely to significantly change total cost estimates. Total year-to-date generation from July 2023 to August 2024 for each generation type was sourced from OpenNEM and was used to calculate the contribution of each coal and gas generation type to annual coal and gas generation. The notional annual coal and gas generation displaced by rooftop solar was calculated by spreading rooftop solar generation proportionally over each coal and gas generation type according to each type's contribution to the annual generation. Fuel costs and variable opex ($/GWh) for each generation type were multiplied by the notional generation (GWh) for that type. The resulting estimated fuel and opex savings for each coal and gas generation type were added up, giving an annual total of $971 million, or 4 c/kWh.

[41] St Vincent de Paul Society. 2024. "Vinnies tracking cost changes." https://www.vinnies.org.au/advocacy/energy/tariff-tracking

[42] GHD. 2018. "AEMO costs and technical parameter review." https://aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/9110715-REP-A-Cost-and-Technical-Parameter-Review---Rev-4-Final.pdf.

[43] 2023 IASR, p 94.

[44] Ibid.

[45] Parliament of Australia. 2023. Question on notice no. 102. Portfolio question number: 92. 2020-21 Budget estimates. Environment and Communications Committee, Climate Change, Energy, the Environment and Water Portfolio.

[46] Department of Climate Change, Energy, the Environment and Water. 2023. "Wired for change: Regulation for small electrical products and solar photovoltaic system waste." https://storage.googleapis.com/files-au-climate/climate-au/p/prj2748908c878a1b4b81a54/public_assets/Wired%20for%20change%20Regulation%20for%20waste%20small%20electrical%20products%20and%20solar%20photovoltaic%20systems.pdf

[47] de Brenni, Mick and Leanne Linard. 2024. "Miles Labor Government delivering Australia's leading solar panel recycling scheme." Queensland Government. https://statements.qld.gov.au/statements/101195.

[48] AEMO. 2023. "2023 IASR Assumptions Workbook". Retirement tab. https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-iasr-assumptions-workbook.xlsx?la=en.

[49] 2024 ISP Consultation Summary Report. p 59.

[50] 2023 IASR, p 14.

[51] 2023 IASR Assumptions Workbook, Emissions intensity tab.

[52] Walden, Max. "Trade unions raise alarm over allegations of forced labour in Xinjiang production of solar components." ABC News, April 21, 2021. https://www.abc.net.au/news/2021-04-21/solar-panels-china-xinjiang-accused-forced-labour-links/100040134.

[53] Schlink, Scott. "Wind turbine manufacturing resumes in Australia." Holding Redlich, March 18, 2019. https://www.holdingredlich.com/wind-turbine-manufacturing-resumes-in-australia.

[54] Rae, Marion. "Australia has everything battery storage needs, except the ability to make them at scale". Renew Economy, November 17, 2023. https://reneweconomy.com.au/australia-has-everything-battery-storage-needs-except-the-ability-to-make-them-at-scale/.

[55] Wang, Seaver and Juzel Lloyd. 2022. "Sins of a Solar Empire." Breakthrough Institute. https://thebreakthrough.imgix.net/Sins-of-Solar_Report_v3.pdf.

[56] Australian Government Department of Climate Change, Energy, the Environment and Water. 2023. "Australian National Greenhouse Accounts Factors Workbook." p 5. https://www.dcceew.gov.au/sites/default/files/documents/national-greenhouse-accounts-factors-2022.pdf.

[57] Deloitte. "Scope 1, 2 and 3 emissions." 2024. https://www2.deloitte.com/uk/en/focus/climate-change/zero-in-on-scope-1-2-and-3-emissions.html.

[58] Note: The **ODP** emissions trajectory is taken from the Draft 2024 ISP ODP's projected emissions intensity under Step Change [2024 Draft ISP results workbook - Step Change. Summary Sheet. "NEM Emissions Trajectory"]. **ODP with Scope 3** is the same, but adds Scope 3 emissions for solar using Wang's assumptions [Wang, Seaver and Juzel Lloyd. 2022. "Sins of a Solar Empire." Breakthrough Institute. https://thebreakthrough.imgix.net/Sins-of-Solar_Report_v3.pdf. See "Solar PV Carbon Payback Period Analysis".] modified with ISP assumptions for rooftop solar (14%) and utility scale solar (25%) capacity factors [Derived from the ISP generation outlook files by taking generated output and dividing it by the installed capacity for each technology. The given capacity factors are the mean over the modelling period (2024-25 to 2051-52).] Scope 3 battery emissions are estimated using 72.9 kg/kWh from Dai and co-authors [Dai, Qiang, Jarod C. Kelly, Linda Gaines, and Michael Wang. 2019. "Life Cycle Analysis of Lithium-Ion Batteries for Automotive Applications" Batteries 5, no. 2: 48. https://doi.org/10.3390/batteries5020048.] assuming a lifespan of 20 years for utility-scale batteries [2023 IASR Assumptions Workbook, Fixed OPEX tab.] and 15 for consumer batteries [The ISP does not make assumptions around consumer battery lifespans. We have chosen 15 years as a reasonable estimate (e.g., Tesla Powerwall offers 10-year warranty but in some cases can be used

for 20 years).]. Scope 3 wind emissions intensity was taken from the UNECE [United Nations Economic Commission for Europe. 2022. "Carbon Neutrality in the UNECE Region." https://unece.org/sites/default/files/2022-09/Technology%20Interplay_final_2.pdf.]. **ODP with Scope 3 (High)** assumes 174 g/kWh for solar, taking the "worst case" presented by Mariutti [Mariutti, Enrico. "The Dirty Secret of the Solar Industry." Substack, 12 April, 2023. https://bfrandall.substack.com/p/the-dirty-secret-of-the-photovoltaic.] (but excluding the emissions of batteries and transmission from the solar estimate), and taking the same assumptions as ODP with Scope 3 for wind and batteries.

[59] AEMO. 2023. "Appendix 4: System Operability." p 30. https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/appendices/a4-system-operability.pdf?la=en.

[60] "Draft 2024 Integrated System Plan publication webinar part 2." 2023. YouTube. 0:17. https://youtu.be/uxDBxhsZXGc.

[61] AEMO. 2024. "Draft 2024 ISP results workbook - Step Change." Summary tab, CDP 11 (ODP). https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/supporting-materials/draft-2024-isp-generation-and-storage-outlook.zip?la=en.

[62] Origin Energy. 2024. "Eraring Power Station." https://www.originenergy.com.au/about/who-we-are/what-we-do/generation/eraring-power-station/.

[63] Solar capacity factors calculated using data from Draft 2024 ISP results workbook - Step Change, REZ Generation & REZ Generation Capacity tabs.

[64] Draft 2024 ISP results workbook - Step Change.

[65] 2023 IASR Assumptions Workbook. New Entrant Data Summary tab.

[66] 2024 ISP Consultation Summary Report. p 38.

[67] Ibid. p 21.

[68] AEMO. 2023. "ISP Methodology." p 103-104. https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/isp-methodology-2023/isp-methodology_june-2023.pdf?la=en.

[69] Ibid.

[70] Draft 2024 ISP, p 6.

[71] 2024 Draft ISP results workbook – Step Change; AEMO. 2023. "Appendix 6. Cost

Benefit Analysis." https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/appendices/a6-cost-benefit-analysis.pdf?la=en; We have considered the $7.1 billion combined value of SuperGrid South with Gladstone Reinforcement spread across those two projects.

[72] These are "superadditive" benefits. A system is "superadditive" where the value of the whole is greater than the sum of the parts. Electricity networks are one example of such a system, and AEMO's role is to maximise the value (net market benefits) of the system as a whole. CIS does not object to including superadditive benefits. We object to including these benefits two, three, or more times.

[73] 2024 ISP Consultation Summary Report. p 58.

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[88] 2021 IASR workbook, Scenarios tab.

[89] Ibid.

[90] ISP 2022 Consumer Panel. 2021. "ISP Consumer Panel Report on AEMO's Inputs Assumptions and Scenarios Report (IASR) for the 2022 Integrated System Plan". p 40. https://aemo.com.au/-/media/files/major-publications/isp/2021/isp-consumer-panel-report-on-2021-iasr.pdf.

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[94] 2021 IASR. p 6.

[95] According to AEMO's methodology for the 2022 ISP, the Delphi Panel technique draws on an anonymous panel of up to 10 subject matter experts, both internal and external to AEMO, to rank the relative likelihood of each scenario using a questionnaire. Panel members provide reasoning for their selection. Responses are collected, analysed, common and conflicting views identified, and shared with the panel. Panel members then have the opportunity to modify their original views based on the varying positions of other panel experts, with the goal being to reach consensus where possible. Following this process, a stakeholder workshop provides the opportunity for discussion with a broader range of stakeholders, seeking feedback on the reasonableness of weights proposed through the Delphi technique.

[96] 2022 ISP. p 33.

[97] 2021 IASR. p 5.

[98] ISP 2022 Consumer Panel. 2022. "ISP Consumer Panel Report on AEMO's Draft 2022 Integrated System Plan". p 34. https://aemo.com.au/-/media/files/major-publications/isp/2022/isp-consumer-panel-report-on-draft-2022-isp.pdf.

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[103] 2022 ISP, p 33.

[104] ISP 2022 Consumer Panel Report, p 34.

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[112] Ibid, pp 7-8.

[113] AEMO. 2024. 2024 ISP Appendix 4: System operability. p 12.

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