



Level 27, 35 Collins St,
Melbourne VIC 3000

P: +61 3 9902 0741

info@climateworkscentre.org

climateworkscentre.org

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Australian Energy Market Operator

Submitted via email to: forecasting.planning@aemo.com.au

To whom it may concern,

Climateworks Centre submission to the 2025 Inputs Assumptions and Scenarios Report (IASR) consultation

Climateworks Centre welcomes the opportunity to provide a submission to the Australian Energy Market Operator (AEMO) in response to the *2025 IASR Scenarios – Consultation paper*.

Climateworks bridges the gap between research and climate action, operating as an independent not-for-profit within Monash University. We develop specialist knowledge to accelerate emissions reduction, in line with the global 1.5 degrees Celsius temperature goal, across Australia, Southeast Asia and the Pacific.

In 2023, AEMO engaged CSIRO, supported by Climateworks, to conduct multi-sector modelling to quantify the dynamic influences that would shape electricity demand under different emissions reduction scenarios. The recommendations in this submission draw on insights from that process and will contribute to a robust and optimised Integrated System Plan (ISP).

The rapid decarbonisation of the electricity and energy system is essential for Australia to meet its obligations under the Paris Agreement. Electricity generation is the nation's largest source of greenhouse gas emissions. The adoption of renewables will reduce emissions by approximately one-third (CSIRO 2023) and will have powerful flow-on effects for other sectors of the economy.

However, the transformation is complex. It requires forecasting and planning that considers evolving energy generation, transmission and storage technologies, changing market and regulatory conditions, and emerging opportunities in renewable energy and resource exports. AEMO must also ensure the electricity supply contributes to increasingly ambitious jurisdictional emissions reduction targets and remains reliable, secure, safe and affordable.

In March 2024, the Energy and Climate Change Ministerial Council (ECMC) recognised AEMO's evolving role and directed it to play a more active part in guiding the energy transformation (Commonwealth of Australia 2024). Climateworks supports this approach, and the recommendations in this submission will help facilitate that shift.

The energy system in Climateworks' 1.5 degree aligned decarbonisation scenario

In 2023, Climateworks published [least-cost emissions reduction pathways for Australia](#). Our report shows a Paris-aligned least-cost pathway for limiting warming to 1.5°C reaches emissions reductions of 68 per cent below 2005 levels by 2030 and net zero before 2040.

In our 1.5°C-aligned scenario, renewables make up 83 per cent of total electricity generation by 2030 and close to 100 per cent by 2050. Clean electricity generation capacity would expand from 55 GW today to around 151 GW by 2030 and 398 GW by 2050. All coal-fired power generation would cease by 2035, and gas-powered generation would be reduced by 69 per cent by 2030 and 96 percent by 2050 (Climateworks Centre 2023).

Submission summary

Climateworks suggests AEMO consider the following recommendations as they develop the 2025 IASR and prepare to deliver the 2026 ISP. The submission body includes specific details on each point. Climateworks recommends AEMO:

- integrate key findings from the *Multi-sector energy modelling 2022: Methodology and results Final report* into the 2025 IASR scenario parameters and narratives
- revise its role in system forecasting and planning from responding to trends and transformations to providing evidence that enables governments and energy market operators to shape them
- expand the IASR multi-sector modelling to include an additional 1.5°C-aligned scenario or additional sensitivity analysis on the *Green Energy Exports* scenario
- expand IASR multi-sector modelling to include analysis of a broader range of sensitivities across all scenarios
- outline contingency pathways that offer alternate responses where there is low confidence in the pace and characteristics of change within scenarios
- broaden the scope of the IASR analysis, particularly for gas and consumer energy resources (CER), to fully align with the ECOMC's directive and intention
- design an energy system that will enable Australia to become a 'renewable energy superpower', including analysis to enable forecasting and planning supply, storage and transmission solutions for 'regional ISPs'.

Recommendations for the 2025 IASR

Recommendation 1: Integrate key findings from the *Multi-sector energy modelling 2022: Methodology and results Final report* into the 2025 IASR scenario parameters and narratives

In 2022 AEMO commissioned CSIRO and Climateworks to undertake multi-sector modelling to quantify the changing influences that will affect energy demand under different emissions reduction targets. Following that process, CSIRO and Climateworks produced the [Multi-sector energy modelling 2022: Methodology and results Final report](#) (CSIRO and Climateworks Centre 2022). The report included a series of findings that Climateworks recommends AEMO consider as it develops its approach to scenarios for the 2025 IASR. The following are key insights and suggestions on how they could be incorporated into the 2025 IASR planning.

The modelling reaffirmed that changes occur across all four pillars of decarbonisation on least-cost pathways to meet the Paris Agreement goals. The 2025 IASR narrative and parameters would benefit from continuing to include economy-wide analysis on how energy efficiency, electricity system decarbonisation, electrification and non-energy emissions reductions and sequestration unfold under each scenario, and how that affects different aspects of the energy system.

Our modelling has repeatedly shown that high levels of energy efficiency across sectors underpins least-cost decarbonisation pathways for a wide range of scenarios (including for AEMO and those released as part of Decarbonation Futures 2020 and Decarbonisation Scenarios 2023). This is an area where current policy and markets are not creating the level of change seen in modelling of least-cost pathways of Paris-aligned scenarios and is one in which we see sensitivity analysis to be particularly useful. This would allow AEMO to explore the benefits of higher levels of energy efficiency to reduce energy system costs.

The modelling also showed electrification was cost-effective in a number of sectors to reduce economy-wide emissions. Across all scenarios, there are no-regrets strategies for decarbonising buildings, industry and transport. The IASR narrative and parameters would benefit by exploring how different levels of electrification interact with the scale of investment needed in electricity infrastructure - to understand better how additional investment in the electricity sector unlocks emissions reductions in other sectors.

The report also discusses the findings that alternative fuels, such as hydrogen and biomethane, have only a limited role under all scenarios – even where this was explored further through sensitivity analysis. Some adoption may occur in the industrial sector in circumstances where electrification is not viable. Climateworks expects that a high uptake of alternative fuels would require overcoming significant technical barriers, such as infrastructure upgrades, and would still be unlikely to displace electrification as the least-cost option.

Furthermore, Climateworks supports continuing to publish the details of the equivalent national carbon budgets, and how these relate to global warming limits, for all scenarios as part of the IASR.

Recommendation 2: Revise AEMO’s role in system forecasting and planning from responding to trends and transformations to providing evidence that enables governments and energy market operators to shape them

An AEMO that actively steers the energy transition will result in greater confidence for investors, stronger economic outcomes, reduced emissions, and a more robust grid. If AEMO rethinks its approach to IASR scenario selection and sensitivities to deliver its forecasting and planning functions to outline what ‘could and should’ happen in the energy system, it will assist governments and the energy market agencies to meet their objectives.

The Australian electricity and energy landscape is undergoing unprecedented change. All levels of government have implemented policies aimed at reducing emissions while ensuring a prosperous economic future. These policies, including the six net zero sector plans, Future Made in Australia, National Consumer Energy Resources Roadmap, National Energy Performance Strategy, National Hydrogen Strategy and increasingly ambitious jurisdictional emissions reduction targets, will significantly impact the nature and requirements of the National Electricity Market (NEM).

The *National Electricity (South Australia) Act 1996* (Government of South Australia 1996) and *National Electricity Rules* (Australian Energy Market Commission 2024) confer a range of statutory obligations and discretionary powers to AEMO. It is required to consider the National Electricity Objective (NEO), which now includes a greenhouse gas emissions reduction ambition, and to ‘plan, authorise, contract for, and direct, augmentation of the declared shared network’ (Government of South Australia 1996). In determining how the ISP will contribute to the NEO, AEMO must consider jurisdictional emissions reduction targets and may take into account the array of environmental and energy policies across jurisdictions (Australian Energy Market Commission 2024).

AEMO has a highly complex task in planning an energy system that ensures reliability, security, safety, affordability and quality while also helping jurisdictions achieve emissions reduction targets. It also has scope – within the bounds of electricity laws and rules – to modify the balance it strikes between responding to energy system trends and transformations and providing the information that shapes them.

In its ‘Response to the Review of the Integrated System Plan’ in March 2024, the ECMC noted ‘AEMO’s role is changing as the energy market rapidly evolves’ and ‘governments and energy sector participants now look to the ISP for guidance on issues across the energy value chain’ (Commonwealth of Australia 2024). The ECMC direction means that AEMO, alongside its statutory power, now has the prerogative to support governments to shape Australia’s energy transformation.

Recommendation 3: Expand the IASR multi-sector modelling to include an additional 1.5°C-aligned scenario or additional sensitivity analysis on the *Green Energy Exports* scenario

Climateworks recommends AEMO commission modelling of an additional 1.5°C-aligned

scenario or additional sensitivity analysis for the *Green Energy Exports* scenario. A key variable to tune would be the scale of renewable energy and resource exports, which will have extensive implications for the magnitude and composition of grid infrastructure.

In its 'Net Zero Emissions by 2050' scenario, the International Energy Agency (IEA) (2024) projects that the international market value of minerals critical to the energy transition will more than double by 2040, reaching US\$770 billion. The ambition of the Future Made in Australia policy is to capitalise on that opportunity by building an Australian economy powered by clean energy and the nation's abundant mineral resources (The Treasury 2024). The ISP's *Green Energy Exports* scenario could enable that vision, delivering an NEM with 583 GW of dispatchable capacity and 26,000 km of transmission by 2050, capable of powering the mining and industrial processes needed to position Australia as a 'renewable energy superpower' (AEMO 2024).

Climateworks supports *Green Energy Exports* as the scenario to guide Australia's energy system transformation. It promises significant economic benefit and is consistent with a least-cost pathway to limiting warming to 1.5°C. However, we acknowledge that uncertainty in international demand for renewable energy and resources may diminish the confidence of governments and energy system stakeholders in planning for and investing in the substantial additional infrastructure required.

To address this uncertainty and ensure flexibility, Climateworks proposes modelling multiple 1.5°C-aligned scenarios or sensitivities. This will offer more comprehensive insights and recommendations on the scale of transformation and investment required. By giving greater consideration to the uncertainties inherent in projecting such significant changes, AEMO can create credible evidence for 1.5°C-aligned investments and a broader range of options for the sector.

Recommendation 4: Expand IASR multi-sector modelling to include analysis of a broader range of sensitivities across all scenarios

A range of factors will influence grid size and composition during the energy transition. Sectors across the economy, including industry, buildings, and transport, will depend on having sufficient capacity to electrify. In turn, AEMO must ensure the grid's expansion is rapid enough to instil confidence in these sectors but not so fast as to overspend on infrastructure. It is a complex 'chicken and egg' situation, compounded by various national and international economic, political, technological, and social uncertainties.

Climateworks and CSIRO's whole-of-economy modelling provided scenarios for the 2023 IASR. The assumptions in that modelling included projections across a range of energy generation, storage and distribution factors, such as the economic and technical feasibility of widespread hydrogen uptake and investment in electrification, energy efficiency and biomethane. However, sensitivities were predominantly applied to the below-2°C-aligned *Step Change* scenario, rather than the scenario with a 1.5°C-aligned emissions trajectory (AEMO 2023). Consequently, the ISP optimal development path does not fully account for the range of variables, such as CER coordination or non-transport electrification, that could influence future

grid capacity and energy mix. Climateworks recommends expanding the multi-sector modelling to include analysis of a broader range of sensitivities for all Paris-aligned – below-2°C and 1.5°C – scenarios, rather than only for the scenario selected as ‘most likely’.

We note that the *Progressive Change* scenario from the 2022 IASR is not consistent with Australia’s increasingly ambitious jurisdictional net zero targets and policies.

Recommendation 5: Outline contingency pathways that offer alternate responses where there is low confidence in the pace and characteristics of change within scenarios

AEMO has to plan an energy system in an environment of acute uncertainty. However, by employing sensitivity analyses and a range of assumptions, it is possible to pinpoint areas of low confidence and outline how scenarios might unfold under different conditions. This presents an opportunity for AEMO to better navigate unknowns and adopt a more active role in energy system planning.

Climateworks recommends that AEMO identify areas of low confidence in its scenarios and conduct sensitivity analyses to understand how different assumptions affect energy system requirements. The anticipated path, and alternate responses where change is not consistent with expectations, would be transparently detailed in forecasting and planning materials. This would enable governments and energy system stakeholders to plan and allocate resources in alignment with the expected pathway and to understand the implications of changing conditions.

For example, Climateworks’ modelling indicates that CER, industrial and building electrification, demand management, and energy efficiency all play crucial roles in achieving a 1.5°C-aligned energy system. However, uncertainties remain regarding the pace and scale of their adoption and the behaviour of actors within the system. In such cases, AEMO’s forecasting and planning materials could trigger alternative approaches if changes are not in line with expectations, such as increased investment in grid-scale generation and storage.

This approach has two significant benefits. Firstly, it will enable AEMO to pursue a 1.5°C-aligned scenario with the confidence that contingencies will guide governments and energy system stakeholders if assumptions do not unfold as expected. Secondly, it will help achieve the first recommendation: providing the information that enables governments and energy system stakeholders to shape trends and transformations.

Recommendation 6: Broaden the scope of the IASR analysis, particularly for gas and consumer energy resources (CER), to fully align with the ECMC’s directive and intention

Climateworks supports the ECMC directive for AEMO to better integrate CER and gas into the ISP (Commonwealth of Australia 2024) and, by extension, the IASR. Climateworks’ multi-sector modelling and analysis consistently demonstrate that electrification, energy efficiency and demand flexibility are among the most cost-effective emissions reduction strategies (Climateworks Centre 2023). While these strategies will certainly impact the pace CER are

deployed and gas is phased out, details of that interplay are unclear.

CER and larger distributed energy resources, such as community batteries, offer a significant opportunity to transform how electricity is generated, traded, delivered and consumed. By integrating analysis on CER more effectively into AEMO's planning and forecasting tools, governments and energy system stakeholders will be better equipped to implement policies that support CER deployment and encourage consumer participation in orchestration programs. Climateworks recommends that AEMO's scenario planning account for the expected levels of CER adoption and the complexities of incorporating CER into the grid, along with implications for operational demand for all scenarios. Moreover, we recommend AEMO also detail how CER could be enabled by electrification, energy efficiency and mechanisms to promote demand flexibility to reach optimal adoption levels.

Similarly, the scale and pace of decarbonisation mechanisms – renewable energy deployment, fuel switching in buildings and industry, and energy efficiency and demand flexibility – will influence the proportion of gas in the energy system. Climateworks modelling indicates that a significant switch from gas to electrification is essential for least-cost decarbonisation and this would help jurisdictions meet their emissions reduction targets. AEMO can support an ISP optimal development path aligned with the NEO and build confidence in the orderly and rapid phase-out of gas by providing detailed analysis of these decarbonisation mechanisms. This analysis can give governments and energy system stakeholders a more comprehensive understanding of the future of the reticulated gas network and gas usage for electricity generation. Additionally, Climateworks recommends undertaking modelling alongside the IASR and ISP to outline the likely sequence, location, and causal factors of gas asset and distribution network closures.

Climateworks' decarbonisation scenarios show modelled levels of CER deployment and gas phase-out under well-below-2°C and 1.5°C scenarios (Climateworks Centre 2023). Under the 1.5°C scenario, generation from distributed solar PV increases from around 30 TWh today to 69 TWh by 2030 and 111 TWh by 2050. Gas provides 15 per cent of end-use energy demand by 2030 and 5 per cent by 2050, reduced from 24 per cent in 2022. Concurrently, the share of energy demand met by electricity grows from 23 per cent in 2022 to more than 30 per cent by 2030 and almost 60 per cent by 2050. Industry gas demand falls 46 per cent by 2030 and 86 per cent by 2050, relative to 2022 levels, and building gas demand falls 53 per cent by 2030 compared to 2022 levels.

Recommendation 7: Design an energy system that will enable Australia to become a 'renewable energy superpower', including analysis to enable forecasting and planning supply, storage and transmission solutions for 'regional ISPs'

Climateworks supports the establishment of net zero industrial precincts across Australia. Precinct-scale planning for industrial regions will provide long-term guidance for industry and assurance to communities transitioning to net zero emissions. The effectiveness of this strategy will be enhanced if each major industrial region has a 'regional ISP' or equivalent, enabling improved understanding of the levels of renewable energy that would support ambitious

decarbonisation. This would assist with the integration and sharing of resources, workforces and clean energy alternatives. Through a place-based approach, policy-makers can leverage a region's comparative advantages and unique characteristics and establish Australia as a 'renewable energy superpower'.

Heavy industry, such as iron and steel, aluminium, copper, nickel, zinc, lithium, chemicals, and liquified natural gas, accounts for around 44 per cent of Australia's total emissions. Mining and manufacturing processes consume 44 per cent of total energy and 40 per cent of electricity. Most emissions come from burning fossil fuels to power boilers, turbines, and haulage and electricity usage (Climateworks Centre and Climate-KIC 2023).

The transition away from fossil fuels will significantly increase industry's reliance on electricity, as well as green hydrogen, bioenergy and, to a much lesser extent, gas with carbon capture and storage in some sub-sectors. For this shift to be successful, industry and investors need confidence that there will be sufficient renewable energy supply that is affordable and reliable.

That confidence does not currently exist. The ISP *Step Change* scenario plans for moderate levels of industrial electrification and new renewable energy and resource exports, with generation capacity (excluding rooftop solar PV) reaching 85 GW by 2030 and 150 GW by 2050 (AEMO 2024). To fully capitalise on the economic opportunities presented by low emission exports and to electrify industry consistent with a 1.5°C pathway, the Australian Industry Energy Transitions Initiative report indicates a NEM generation capacity of 141 GW by 2030 and 341 GW by 2050 (Climateworks Centre and Climate-KIC 2023). Similarly, the ISP *Green Energy Exports* scenario projects grid generation capacities of 124 GW by 2030 and 396 GW by 2050 (AEMO 2024).

Climateworks recently conducted an analysis in the Gladstone region, showing that even the *Green Energy Exports* scenario may fall short of the electricity capacity needed to rapidly decarbonise existing industries and establish new low emission export sectors. Our analysis projects demand could reach 74 TWh/year by 2040, whereas the industrial forecast under the *Step Change* scenario is only 44 TWh/year (AEMO 2024). If future analyses of industrial precincts across Australia tell a similar story, it may be that even the *Green Energy Exports* scenario would not provide enough generation capacity to support the industrial energy transformation. It is for this reason that detailed region-based energy system planning is critical.

Climateworks recommends that AEMO develop forecasting materials in tandem with precinct-scale energy system planning to better guide the deployment of energy generation, storage, and transmission technologies. Localised planning, which provides detailed insights into the specific electricity and energy needs of different regions and sectors, is essential for directing investment, allocating resources, and securing social license. Integrating regional planning into the IASR and subsequent forecasting and planning materials, such as regional ISPs, or utilising government-conducted analyses (such as the regional modelling

commissioned by the Department of Climate Change, Energy, the Environment and Water under the National Energy Transformation Partnership) will help ensure that regional industry actors, investors, and communities have the confidence to transition away from fossil fuels.

Thank you for taking the time to consider our submission. We would welcome an opportunity to brief your team to provide further insights from our work.

Yours Sincerely,

Matthew Benetti
Policy Manager - Energy, Climateworks Centre
matthew.benetti@climateworkscentre.org

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