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AEMO
Via email: ISP@aemo.com.au

Clean Energy Council submission on AEMO's draft Integrated System Plan 2022

The Clean Energy Council is pleased to provide a submission in response to AEMO's draft Integrated System Plan (ISP) 2022. The draft ISP is an impressive document, backed by further appendices and underpinned by an array of sophisticated analysis. We commend AEMO for its work.

The Clean Energy Council (CEC) is the peak body for the clean energy industry in Australia. We represent and work with over 900 of the leading businesses operating in renewable energy, energy storage and renewable hydrogen. We are committed to accelerating Australia's clean energy transformation.

General comments on the scenarios in the draft ISP

The Draft 2022 Integrated System Plan (ISP) makes it clear that Australia is on the path to a rapid transition to renewable energy. It clearly demonstrates that we must leave no stone unturned in getting the renewable energy transition done right and getting it done fast. Turning these projections into reality means governments around the country setting policies that deliver the scale of investment needed in renewable generation and storage, as well as transmission assets.

In particular, we welcome the inclusion of a clean energy superpower scenario ('Hydrogen Superpower') that is much more ambitious than the Step Change scenario that was the most ambitious in the 2020 ISP. The Step Change scenario is now effectively a base case – not only because the Delphi panel rates it as being the most likely but also because of the pace of change that we have already witnessed in recent years. As noted in the draft ISP, there is now 40 per cent more renewable energy committed or anticipated to be connected to the NEM by 2023-24 than was forecast in the 2020 ISP.

If realised, the Hydrogen Superpower scenario will involve a transformation of Australia's energy system that is orders of magnitude beyond the already ambitious Step Change scenario. Specifically, while the Step Change scenario would involve a three-fold increase in the total size of the NEM generating capacity, the Hydrogen Superpower scenario would involve a ten-fold increase.

The scale of this difference means that Australia, and particularly the NEM jurisdictions and relevant institutions, will need to build in flexibility and optionality into the planning and reforms that are under way today, to ensure that we can more nimbly and efficiently scale-up to seize the opportunities of a global clean energy economy.

Further, there is a clear asymmetry of risk associated with the transition described in the Step Change and in the Hydrogen Superpower scenarios. Put simply, the sheer speed of the transition means there are greater risks associated with responding too slowly, as opposed to moving earlier. The CEC welcomes AEMO's preference for this approach to system planning, with its acknowledgement of the likely net benefits of moving earlier on transmission infrastructure build. We urge AEMO to continue to

Phone: +61 3 9929 4100
Fax: +61 3 9929 4101
info@cleanenergycouncil.org.au

Level 15, 222 Exhibition
Street, Melbourne, VIC
3000, Australia

cleanenergycouncil.org.au

ABN: 84 127 102 443

account for this risk asymmetry in all its decision related to system planning, including how it transitions its operational approaches through the Engineering Framework.

System operability and system strength

The CEC welcomes AEMO's detailed analysis of the key operational and security challenges that will need to be addressed to deliver a safe and reliable transition. We consider that this analysis highlights three key factors:

1. The significant system risks associated with earlier than expected coal closure, which demonstrates the urgency of reducing system reliance on these ageing assets
2. The critical role that transmission infrastructure will play in maintaining reliability and security, and
3. The importance of storage, as a complement to renewable generation and transmission investment.

We consider that each of these three factors plays out across the various issues identified by AEMO in its analysis of system operability and security.

AEMO's analysis in Appendix 4 of the ISP highlights the impacts of minimum demand and correctly identifies this is already one of the most pressing issues on the system. The CEC considers the minimum demand issue must be managed through a combination of solutions, including:

1. Supporting the rollout of storage, both at the transmission and distribution level, to soak up the excess rooftop PV solar generation that correlates with these low demand periods. Smart/controllable electric vehicle charging could play a significant role in this. Controllable loads such as electrolysers may play a limited role here as well (see discussion in hydrogen technologies below).
2. Better DER governance frameworks and better frameworks to reward flexibility and increased capability from DER (see section below)
3. Moving away from a reliance on thermal synchronous generation to manage system security and operability on the high voltage network. The minimum demand 'limits' are in part associated with the aggregate min-gen limits of the multiple thermal coal units on the power system. Replacing these old synchronous thermal coal units with other technologies that are less affected by these same minimum generation limitations, such as synchronous condensers, synchronous storage or wind, solar and batteries operating as virtual synchronous machines, will help to ameliorate the impact of these minimum demand periods.

The CEC also welcomes AEMO's detailed analysis of reliability issues. The figures on page 12 of Appendix 4 are particularly telling, given that they appear to demonstrate no meaningful reliability shortfalls out until 2040.

The CEC urges AEMO to factor this analysis into the ESB's assessment of the need for a capacity mechanism, and the AEMC Reliability Panel's assessment of the reliability standard and settings. AEMO's analysis must be used to inform and quantify the currently qualitative descriptions of reliability 'problems' relied on as a justification for the introduction of blunt capacity mechanisms. This detailed analysis is crucial to ensuring that regulatory frameworks are adapted in a manner that is appropriate given the actual physical drivers of any reliability problems, and are proportionate to the materiality of the problem identified.

In particular, AEMO should bring its excellent analysis of dunkelflaute ('the dark doldrums', or extended periods with minimal wind and sunshine)-type events into this analysis. As AEMO quite rightly points out on page 12 of Appendix 4: *"Within the range of weather modelled and considering the geographic and technological diversity forecast in the Draft ISP, AEMO does find severe dunkelflaute-type events tend to be localised, with lesser risk of a NEM-wide event. The diversity of resources is a strong benefit* *of the REZ expansions forecast in the ISP; transmission that enables this diversity will improve the operability of the grid during these conditions".*

The CEC agrees that diversified renewable generation, coupled with strategically located storage assets (operating as virtual transmission), as well as investment in transmission line infrastructure, is what is needed to address any reliability issues associated with a dunkelflaute event. For this reason, any new regulatory frameworks introduced should be carefully structured to reflect these specific physical drivers of reliability risk, and to drive targeted investment in the specific capacity needed to address them.

The CEC also welcomes AEMO's identification of the early exit of coal as a critical risk to system reliability and security. As AEMO correctly identifies on page 20 of Appendix 4, it is more likely than not that thermal coal exit will happen earlier than expected, bringing with it increased risk of system security and reliability issues. This reinforces the need for bringing forward investment in transmission, storage and new renewable generation, to ensure the system is ready before these thermal assets retire.

The CEC does raise question with AEMO's assertion that gas generation will necessarily play a major role in the transition. In particular, we urge AEMO to undertake further studies to explore how greater diversification of renewable generation and transmission, purposefully coupled with storage, could form a zero-carbon alternative to reliance on gas powered generation. We expect gas fired power generation to be required for some time, but this will be in a small and declining role (increasingly for 'insurance' purposes), as batteries are further deployed (acting as clean peaking plant) and pumped hydro capacity steadily grow.

AEMO should also undertake more granular modelling and assessment of gas fuel and pipeline capacity availability. Availability of gas-fired generation will be impacted by the dual usage of gas as a direct fuel itself, particularly in the southern states for space heating (and potentially as LNG feedstock in Queensland). AEMO should then assess the correlations of gas availability due to this dual fuel use for heating, against demand for gas as a fuel for gas fired generation on low wind/solar availability days, to thoroughly test whether gas generation would form a viable alternative to more renewables, transmission and storage.

Finally, we welcome AEMO's detailed analysis of likely system strength and inertia issues. This highlights several factors:

1. The importance of the recently made *Efficient management of system strength on the power system rules,* which will address these current shortfalls in the medium term. We look forward to working with AEMO to implement these rules through 2022.
2. The need to accelerate the rollout of storage, including batteries with VSM capabilities and synchronous hydroelectric pumped storage. These renewable assets can provide system strength and inertia services, supporting system security and operability, as well as improving power transfer capability on the system
3. The significant risks associated with reliance on synchronous thermal generators to maintain system inertia, stability and system strength. Given the propensity for these assets to exit the system earlier than their planned retirement dates, this creates a major potential gap in managing system operability and security. Again, it is critical to bring forward new investment to replace these assets, before they exit.

Projections for Virtual Power Plants and controllable Distributed Energy Resources

We consider the projections of DER included in the ISP to be an optimistic goal, the achievement of which would do much to lower consumer costs and reduce emissions. However, a lot of policy reform remains to make these projections plausible.

Specifically, we consider the projected uptake of virtual power plants (VPPs) and controllable distributed energy resources (DER) is a significant overestimate that would not be achieved under current policy settings. Without an incentive framework and a clear understanding of what they will receive in exchange for what they are giving over, customers will be reluctant to give over control of their assets.

The steps to addressing this should include:

- Clarifying the governance framework for DER policy and technical standards.
- Establishing a policy framework that makes it clear who controls what and under which circumstances
- Developing and implementing tariffs and multi-sided trading platforms that recognise and reward the value of DER
- Establishing market frameworks that will enable DER to supply new energy services
- Allowing DER to have the same market access as utility-scale assets, wherever practical
- Reforming the roles and responsibilities in the electricity market, moving toward the distribution system operator (DSO) and distribution market operator (DMO) model, and
- Developing alternative network revenue models and tariff structures that allow for increased grid-enabled value exchanges such as peer-to-peer trading, network service provision by DER and VPP activity.

Analysis of workforce development

The Draft ISP notes that global and national infrastructure and renewable energy investment over the next two decades will substantially increase demand for skilled and unskilled labour. This increase presents tangible supply chain risks that could drive up project costs while also delaying or stalling construction. A trend of such disruptions could affect investor confidence.

The renewable energy sector already faces a skills shortage across both the professional and trade workforce with unmet demand especially for engineers, grid connection managers, blade and turbine technicians and electricians. Many of the skills and occupations that support the sector are the same as those needed across other large infrastructure projects, such as transmission or public works, or construction supporting an emerging hydrogen sector. The competition for skills across these various industries could ultimately affect the quality, safety, and viability of projects.

The Draft ISP suggests that these supply side challenges will likely be felt over the next three years. However, the pressures are being felt already. There are currently around 30,000 people employed across renewable energy and an additional 80,000 are estimated to be part of projects already in the pipeline across wind, solar, batteries and hydro. Constraints on skills imports and state border closures due to COVID policy measures have heightened the challenge of meeting the demand for workers over the last two years. As these policies are relaxed, it will take several years for the systems to recover.

At the same time, state governments are looking to impose workforce and local content requirements to renewable energy proponents bidding for both pure energy developments and transmission augmentation and strengthening projects such as in the Renewable Energy Zones, for example. The workforce and local content requirements include minimum apprenticeship percentages, minimum local content requirements and a desire to employ locally. There is a concern that the availability of local workers or the capacity to train and develop that workforce may not exist to satisfy all these demands.

In response to these concerns, the Draft ISP proposes four solutions, including:

- coordinating "the timing of ISP transmission projects and development opportunities to smooth out the construction schedule and avoid peaks and troughs in labour and skills demands," and
- the development of "more detailed projections of skills needed over the next 10-20 years for the build out of the electricity system".

These projections exist. In 2020, the Clean Energy Council commissioned the first comprehensive study of the Australian renewable energy workforce. The results and methodology from this study are publicly available on the CEC website.[1] In particular, the study projected the skills needs of the renewable energy sector by occupational clusters over the next decade and developed employment factors for each megawatt of installed generation capacity by technology. These employment factors were applied to the scenarios of the Draft ISP 2020.

Rather than recognising the supply side risks of worker shortages and then deferring responsibility for addressing them, the 2022 ISP scenarios and modelling could, and should, adopt the CEC employment factors and produce employment demands for each of the scenarios. A similar approach was successfully applied by Transgrid in their *Energy Vision* report.[2] This would allow constraints to be applied to the increase or decrease in employment demands as a means of smoothing the profile of employment over time. This would force the model to sequence deployment over time and geography to improve the economic and social outcomes in regional Australia and nationally.

Greater role for offshore wind

We note that the draft ISP finds little role for offshore wind – it is only considered to be part of the optimal development path in the event that transmission is delayed or does not occur, and only then coming online around 2040 (Figure 27 of the draft ISP). While we acknowledge the current cost premium associated with offshore wind compared to onshore wind, we still see offshore as being a very likely contributor to the NEM's mix of generation well ahead of the 2040s.

The scale of offshore wind developments globally will serve to continue to bring these projects down the cost curve. Scotland has just announced winning bids amounting to 25 GW of new offshore wind developments. This is part of the UK's aim to deploy 40 GW of offshore wind by 2030. The US has a target of 30 GW of offshore wind by 2030.

We anticipate the potential for multiple offshore wind projects being operational in Australia by 2030. Even at a higher levelised cost of energy, we see these projects as likely to proceed due to a combination of major strides in the development of the global offshore wind industry over the past five years, higher capacity factors, a counter-correlation to onshore winds, relatively easier social licence pathways and government support (linked to investor interest, local job opportunities in key regions and utilisation of existing network assets).

To reflect the benefits of offshore wind in the ISP, we recommend that the above factors are incorporated into the modelling as sensitivities. This will allow for a more accurate assessment of the real price of offshore wind projects by quantifying the unique benefits the technology can bring to the NEM.

Challenges of delivering transmission infrastructure

We note the draft ISP's finding that the transmission infrastructure needed to deliver the Step Change scenario would deliver net market benefits of $29 billion and return 3-4 times the investment value. This quantum of benefits is also limited to *market* benefits, and that broader societal benefits (such as regional job creation and reduced emissions) will be add to this figure.

We agree with the draft ISP's statement that *"all of the ODP projects are needed – the only question being when"*. We submit that low regrets planning work should commence now on all ODP projects (including those identified as future ISP projects) because, as the draft ISP notes, some transmission

[1] https://www.cleanenergycouncil.org.au/advocacy-initiatives/workforce-development/clean-energy-at-work
[2] https://www.transgrid.com.au/about-us/network/network-planning/energy-vision

projects are already experiencing delays and this trend may well continue. These early works are relatively low cost in the context of the overall project cost and provide flexibility and robustness against changing circumstances.

Further, while we see the attraction to an approach of “last possible moment” decisions on approvals/upgrades, it makes these large projects more challenging from an investment perspective. Shifting projects from “actionable” to “staged actionable”, as happened to HumeLink from the 2020 ISP to the 2022 draft ISP risks undermining important investment decisions.

In terms of project timing, we see a 2031 delivery date for VNI West to be too late, especially noting the potential (as found in the modelling) for all Victorian coal to have retired by 2032. In that eventuality, even a slight delay to the completion of VNI West could be very problematic.

It would also be interesting for AEMO to consider the potential implications for transmission delivery should the Federal election deliver a Labor government that seeks to implement its $20 billion “Rewiring the Nation” commitment. Obviously the election outcome will be known by the time the ISP is finalised, but it would make sense to start assessing the potential impact now rather than waiting until late May.

A role for governments in ensuring social licence in REZs

We acknowledge AEMO’s view that "the land needed for major VRE, storage and transmission projects to realise these goals is unprecedented" and that "proactive engagement and integrated land-use planning is also needed at a jurisdictional level". We are pleased to see AEMO’s recognition, and incorporation into the ISP, of the social licence considerations and risk involved in the clean energy transition.

While the geographic concentration of projects with REZs provides clear benefits in terms of efficient use of network infrastructure as well as many economic benefits to regional communities, it does also mean a greater concentration of impacts.

Individual project proponents and operators are already very active in engaging with near-neighbours and wider host communities, but we also consider it critical that state governments play an active role in building and maintaining social licence, especially as projects are funnelled into Renewable Energy Zones.

We would also support the consideration, in future ISPs (as noted on p15 of the draft), of the broader public benefits provided the energy transition, as inputs to the selection of the optimum development path.

Emissions associated with different scenarios

Figure 8 in the Draft ISP sets out emissions trajectories for each of the four scenarios. It is interesting to note that the Step Change scenario results in approximately twice as many cumulative emissions through to 2050 as the Hydrogen Superpower scenario. It is not clear from the chart, however, how the Progressive Change scenario (932 MT) emits only slightly more than Step Change (891 MT), given the much larger shaded area for Progressive Change.

The accompanying text in that section refers to work conducted by AEMO with CSIRO and ClimateWorks. Given the significance of Australia’s electricity sector to national emissions and the importance of clean energy as a means of decarbonising other sectors (such as transport and heat), we would welcome in the final ISP the inclusion of more details about the emissions trajectories and carbon budgets for each scenario.

In particular, the final ISP could include analysis on the extent to which each scenario is consistent with the objectives of the Paris Climate Agreement of keeping warming “well below 2 degrees” and "to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius”. This should specify the *likelihood* of achieving the Paris objectives with a given volume of emissions, eg. a 50% chance of staying under 1.5 degrees. While this would naturally involve assumptions about the rate of decarbonisation outside the NEM and in sectors other than stationary energy, we submit that this additional detail is very important context for understanding the implications of different scenarios.

Hydrogen superpower

Development of a global renewable hydrogen market appears to be moving ahead of earlier expectations

The prospect of accelerated global action on climate change, driving technology cost reductions and a faster phase-out of fossil fuels, is the wild card that distinguishes the Step Change and Hydrogen Superpower scenarios.

High levels of electrification and renewable hydrogen (or other renewable gases/fuels) could and would ultimately eliminate fossil-based molecule fuels including natural gas, diesel and ‘grey’ hydrogen. In Australia, which is in pole position to leverage its abundant renewable energy resources, this could dramatically expand our energy-intensive manufacturing opportunities and low-carbon exports.

While the renewable hydrogen industry is in a pre-commercial phase, dependent on government support for economic viability, there are indications that progress towards the threshold for cost-competitiveness with fossil fuels (approximately ~$2/kg) is accelerating. For example, in November 2021, a coalition of major green hydrogen proponents – including a number of Australian producers – announced a commitment for 45 GW of electrolysers to be developed with secured financing by 2026, with targeted commissioning in 2027. This represented an almost-doubling of the capacity that had been deemed deployable within those same timeframes just 12 months prior.[3]

With the strong momentum for global action building at the Conference of the Parties to the UN Framework Convention on Climate Change in Glasgow (COP26), including the acceleration in voluntary emissions reduction commitments by the private sector over the past year, international markets for renewable hydrogen may develop at-scale more quickly than previously expected.

The potential for an Australian hydrogen export market should be acknowledged within the Step Change scenario

With its rich solar, wind and hydro energy resources, Australia has the potential to produce renewable hydrogen at globally competitive prices. However, given the energy associated with the compression, conversion and transportation of hydrogen (or its derivatives), there has been some uncertainty about the size of a potential hydrogen export sector.

In recent months however, there have been a couple of studies[4] undertaken which indicate that the cost of shipping Australian hydrogen to Europe for example (via the Port of Rotterdam) are likely to be a relatively modest component of the total supply costs.

These findings suggest that an Australian-based hydrogen export market, incentivised by the policy support and incentives emerging among a number of our trading partners, is a realistic scenario. We

[3] Green Hydrogen Catapult Initiative, https://rmi.org/press-release/the-green-hydrogen-catapult-announces-expansion-of-world-leading-green-hydrogen-deployment/

[4] See HySupply report https://www.globh2e.org.au/_files/ugd/8d2898_2778fbb92232442ba17942dc47b5f845.pdf, and South Australia to Port of Rotterdam study https://energymining.sa.gov.au/latest_updates/study_shows_first_exports_of_hydrogen_from_south_australia_to_port_of_rotterdam_feasible_this_decade

note however that the Step Change scenario assumes there to be zero hydrogen exports in either 2030 or 2050.

A key question therefore emerges as to whether the existence of a hydrogen export market – a scenario that the CEC regards as highly possible if not probable – should therefore place Australia on a 'Hydrogen Superpower' pathway, or whether in fact the Step Change scenario should be updated to include some degree of hydrogen exports. The CEC's view is that more nuance is required within the Step Change scenario to reflect a degree of exports, rather than a depiction of all (Superpower) or nothing (Step Change).

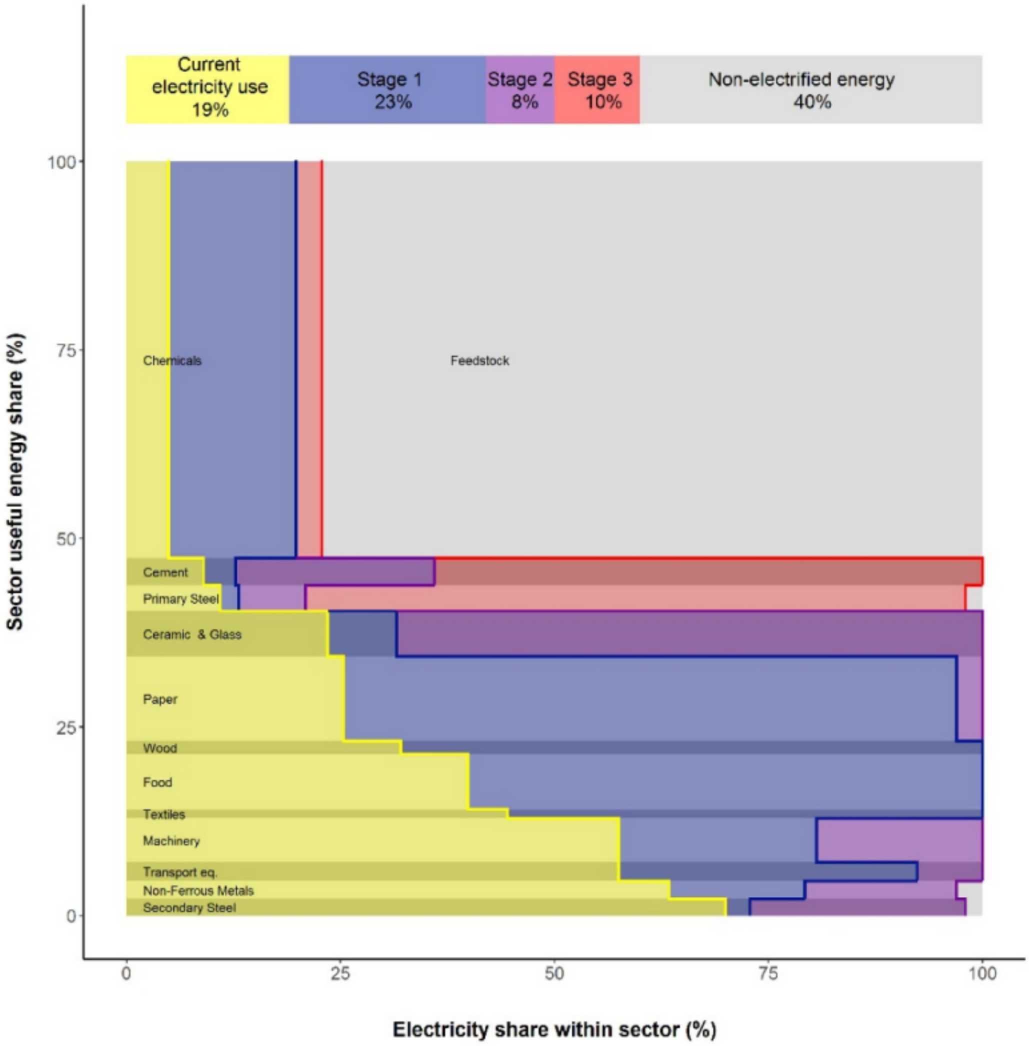
A select number of heavy industries represent the most compelling use cases for domestic consumption

Beyond exports, the most compelling use cases for hydrogen within the domestic economy are for 'hard-to-electrify' industrial sectors, first among which are chemicals (as a green feedstock), steel and manufacturing processes requiring high-temperature process heat.

Figure 1 below summarises a 2020 study by Madeddu et al from Potsdam Institute for Climate Impact Research[5] into the role and potential for direct electrification in European industry. The study found that 78 per cent of industry's energy demand was electrifiable with technologies which are already established. Energy use which is hardest to electrify is shown in 'Stage 3', and some of these represent the priority opportunities for hydrogen and its derivatives, or other renewable gases.

[5] Silvia Madeddu et al, 2020, Environmental Research Letters, 15 124004, *The CO_2 reduction potential for the European industry via direct electrification of heat supply (power-to-heat)*. https://iopscience.iop.org/article/10.1088/1748-9326/abbd02/pdf

Figure 1: Analysis of the current role and potential for direct electrification in European industry[6]



Notes: Stage 1 and Stage 2 show possible stages of electrification which involve technologies that are already fully developed and established in industry. Stage 3 indicates the maximum achievable electrification potential if technologies that have higher uncertainties and lower technological maturity are also included (ie. 'hard to electrify').

Residential and commercial energy use can be readily electrified

While some segments of heavy industry pursuing their decarbonization goals will require renewable gases/fuels as feedstocks or to achieve high temperature process heat, the energy needs of households and light commercial businesses, which typically require energy for space or water heating and cooling, can be readily electrified with renewable electricity.

Not only is direct electrification readily available, but it delivers energy efficiency and financial benefits for consumers, and can leverage our growing share of households with rooftop solar. This, in our view, makes it the most compelling strategy for the decarbonization of household and business energy use. For example, in the case of space heating, which represents the largest share of home energy use in

[6] Ibid. Note that the stages of electrification represented in the chart reflect the relative maturity and electrification solutions/technologies, with Stage 3 projects representing the sectors which are most difficult to electrify.

the ‘average’ Australian household, Rewiring Australia found that *‘a fully electrified home powered by renewables will need less than 40 per cent of the energy of its fossil-fuelled counterpart’*.[7]

While one alternative approach to electrification could be to replace reticulated gas with 100 per cent renewable hydrogen – which would deliver emissions benefits compared to the use of natural gas – we note that this would require significantly higher volumes of electricity than a strategy of direct electrification. One study by the leading German energy research institution, Fraunhofer IEE, found that the amount of renewable electricity needed to produce green hydrogen for space heating would be 5-6 times greater than the amount needed to power an equivalent number of heat pumps.[8]

Given these considerations, which suggest that the most energy-efficient outcome will be electrification, the CEC therefore questions AEMO’s assumption that reticulated gas networks would be converted to 100 per cent hydrogen in a Hydrogen Superpower scenario.

While the CEC considers that a case can reasonably be made for small amounts (eg. 10-15 per cent) of renewable gas blending into existing gas networks in the interests of scaling up the development of the domestic green hydrogen and renewable gas markets and making a start in lowering emissions from our gas networks – all at a relatively modest cost – we consider the case for a 100 per cent green or clean hydrogen transition to be a much more challenging proposition.

Firstly, there is a question of timescales in the likely cost reductions. Today, renewable hydrogen production costs are estimated at between A$3-9/kg[9], which equates to roughly A$21-$63/GJ. Prior to the existing global energy crisis, natural gas on the east coast market was priced at around $4/GJ. Even with the current elevated gas prices of over $10/GJ, hydrogen remains multiple times more expensive than natural gas, and it is likely to be many decades before cost parity is reached[10].

With the gas price sensitivity that we have already witnessed since 2017 along the eastern seaboard, it is a considerable leap of faith to suggest that households will begin to willingly switch to a significantly more expensive fuel source in the form of hydrogen from as early as 2025 – as suggested in the *Inputs, Assumptions and Scenarios Report* – when a significantly cheaper alternative for heating and cooking needs is available via electrification. We consider that such a shift would only occur with significant government subsidisation.

A second important consideration in relation to timing is the time it would take to roll-out an appliance replacement program. While existing appliances are believed to be able to operate on around a 10 per cent hydrogen and natural gas blend, they cannot run on 100 per cent hydrogen and would therefore need to be replaced with hydrogen-ready appliances, which are not readily available on the Australian market today. A replacement campaign would take many years, if not decades, to deliver. The CEC considers that this is time that Australians may not be prepared to wait in order to shift to low or zero emissions alternatives for their energy supply, in the context of increasing public concern relating to climate change.[11] Nor are Australians likely to be incentivised to wait for hydrogen adoption to become accessible if the ultimate fuel source will result in higher energy bills than the alternatives.

On these grounds, the CEC does not consider a wide-scale fuel switching program from gas to 100 per cent hydrogen across existing gas networks to be a likely scenario even in a future where Australia is a globally-significant hydrogen exporter. We consider that it’s more likely that we may see some degree of hydrogen gas blending into existing networks over the coming decade as well as the use of hydrogen

[7] *Castles and Cars,* Rewiring Australia, 2020; https://global-uploads.webflow.com/612b0b172765f9c62c1c20c9/615a513770739cc6477e67f4_Castles%20and%20Cars%20Rewiring%20Australia%20Discussion%20Paper.pdf

[8] *Hydrogen in the Energy System of the Future: Focus on Heat in Buildings,* July 2020, https://www.iee.fraunhofer.de/content/dam/iee/energiesystemtechnik/en/documents/Studies-Reports/FraunhoferIEE_Study_H2_Heat_in_Buildings_final_EN_20200619.pdf

[9] https://www.globh2e.org.au/_files/ugd/8d2898_2778fbb92232442ba17942dc47b5f845.pdf

[10] BloombergNEF estimated in 2021 that renewable hydrogen would reach cost parity with natural gas by 2050 in 15 countries, https://reneweconomy.com.au/green-hydrogen-will-be-cheaper-than-natural-gas-by-2050-bnef/

[11] https://www.abc.net.au/news/2021-08-06/australians-three-times-more-worried-about-climate-change-covid/100354008

in new gas networks, assisting to deliver some degree of emissions abatement and market activation of the domestic hydrogen sector. However, we expect that electrification will become the compelling choice for most households over time, spurred on by the continued uptake of household solar, increasing levels of battery deployment and rising sales in electric vehicles.

The role, operation and costs of electrolysers on the NEM
The Draft ISP acknowledges that electrolysers could play a valuable role within the NEM in assisting to balance the power system. We note that a study by the Australian-German Energy Transition Hub in 2019[12] found that hydrogen electrolysers operating across the NEM would have the effect of lowering electricity prices for consumers because of this power system balancing role, providing helpful frequency control services and reducing the need for storage and transmission.

The Draft ISP assumes that all electrolysers will operate flexibly to avoid operation during high-price periods. We note that this is likely to be true when lower electrolyser costs are achieved, but that in the early days of a domestic renewable hydrogen sector when the price of plant is high, electrolysers may be less responsive to electricity prices given the need to operate at higher capacity factors.

That said, the electrolyser costs assumed for the Draft ISP appear to be substantially higher than recent studies suggest. Cost estimates for PEM electrolysers, which are considered a preferred technology due to their greater flexibility (though we note the dominant and growing market share of alkaline electrolysers[13]) are assumed to be around $3,000/kw.

The CEC notes however that a recent analysis by RMI (formerly the Rocky Mountain Institute) on behalf of the Green Hydrogen Catapult initiative, has estimated the 2021 total system cost of PEM electrolysers – including the stack and balance of plant at around A$1000-$2000/kw (US$700-$1400/kw). It also forecasts that a 50-70 per cent cost reduction is achievable between 2026-2030 through *'a combination of economies of scale, system design improvements, manufacturing optimisation and power system optimisation'*.

Further contact

We thank the team at AEMO for producing an invaluable piece of work that will guide industry and policy-makers in this critical decade of the energy transition. We look forward to working with AEMO as you work towards the final 2022 ISP.

Thank you again for the opportunity to make a submission. If you would like to discuss any of the points raised in this submission, please contact me at the email address below.

Regards,

Dr Nicholas Aberle
Policy Director – Energy Generation & Storage
Clean Energy Council
naberle@cleanenergycouncil.org.au

[12] *Australia's power advantage: Energy transition and hydrogen export scenarios,* 2019, https://www.energy-transition-hub.org/files/resource/attachment/australia_power_advantage_0.pdf
[13] https://about.bnef.com/blog/hydrogen-10-predictions-for-2022/