To The GenCost Committee,

Attached is an annotated copy of the GenCost Draft 2024-2025. I respectively submit my comments for consideration. Also attached is a similarly annotated copy of AEMO's ISP.

I have been modelling energy systems since early 2016. My capital cost assumptions for onshore wind, PV solar and batteries closely match GenCost prices. Assembling components in my modelling to build a reliable VRE energy system results in a dramatically different mix than AEMO's ISP. I do not understand the AEMO ISP model. I cannot see that it will be reliable. I am puzzled by this and would like to know more.

I am not and have never been a utility power engineer. So, I cannot claim any in-depth expertise. However, as the GenCost and ISP reports have invited comments, I am pleased to present my thoughts for consideration. I have added detailed annotated comments in the attached PDF of the GenCost and ISP reports.

Some key takeaways from the reports for me have been:

1. Utility power systems are designed, costed, built, maintained and run by engineers. No doubt the GenCost 2024-2025 Draft report authors, two scientists and an economist, are eminent in their fields, it would be good to have had a utility power engineer as a prominent contributor and co-author to the GenCost report. No doubt power engineers are included among the references. However, the only two references listed that I have checked, Prof. S Wilson and IEA, both clearly indicate nuclear power LCOE is cheaper than VREs, contradicting the GenCost findings.
2. I would please request that my comments be evaluated by engineers.
3. AEMO must employ many very experienced utility power engineers. I cannot begin to comprehend how my modelling suggests totally different energy strategies than those in the ISP report. I assume I have made some bad assumptions – but I have checked and double checked and can not find where the discrepancies lie.
4. Both the GenCost Draft and the AEMO ISP are too complicated. Utility power systems have always been complicated. And changing Australia's energy generation from baseload to something else, plus electrifying almost all industry must be by far the largest and most complicated engineering feat the country has ever contemplated. But the direction of these reports is to dramatically increase complexity by assembling a mix of not-so-complimentary, and definitely not equally competitive, energy generation and storage components, and in a way no other nation has succeeded in doing so far. Is Australia biting off more than it can chew?
5. Having spent the last 50 years shutting down much of Australia's manufacturing the country is not really an engineering superpower. Australia is ill equipped to handle such a large number of projects particularly without some central coordinating control. The Australian Government probably cannot see this. This applies whether Australia goes with VRE, nuclear, gas or whatever. The Federal Government has confidence it is going the right way. But to borrow an old phrase, confidence is what people have before they fully understand the gravity of the situation.
6. Experienced engineers know that changes, even seemingly innocuous small changes, can lead to sometimes devastating, major, unforeseen consequences. Australia is making so many energy changes and in such a short time that disasters must surely follow. VRE systems are not particularly robust. Is Australia being reckless?

7. Australia MUST replace coal power as plants reach end-of-life, not sooner. If anthropomorphic carbon emissions are not responsible for global warming, as increasingly more scientists are starting to claim, then Australia will not only look silly but will pay a huge financial penalty for charging at the head of the pack down the wrong path. In this case the answer is direct substitution of coal with gas. Simple, cheap, reliable. Long run nuclear is said to be cheaper but gas will be needed in the interim.
8. If anthropomorphic carbon emissions are a concern, and must be significantly reduced, then none of coal, gas, diesel, petrol, biomass, etc can be used to any extent. The amount of gas needed to back up renewables systems will be way more extensive than the 15GW represented in the ISP for 2050. Gas back up will jeopardise net zero emissions.
9. Deliberately developing a market with numerous, diverse technologies, simultaneously competing and yet having to cooperate is fanciful. Rooftop solar, utility solar, onshore wind, offshore wind, gas, hydro, Li ion batteries, redox flow batteries, pumped hydro, cannot possibly all be viable. Competition will certainly sort out the sheep from the goats, but – there will be many losers and investment disasters. Getting the mix right will be an expensive iterative process. The Government cannot underwrite the profitability of all the various power options. Everything would become as expensive as the least competitive option! (Bit like AEMO now) This may expose governments to massive damages claims in the future. The problems will become more obvious as capacity rises. It seems improbable that there will ever be enough private investment to achieve the ISPs 300GW capacity by 2050. Private investment may be forthcoming for the first 150GW of capacity but the remaining 150GW, which will be redundant to some extent, will surely have to be funded by taxpayers.
10. The ISP has 80GW rooftop solar, plus about 35GW of CER storage. That represents 38% of total ISP capacity. Logically rooftop should not be cost competitive with utility power, a fact recognised by the IEA. The differences between rooftop haves and have-nots will be a nightmare for government to handle with fairness. And subsidising rooftop will cause problems for the viability of some, if not all other VRE investments.
11. If carbon emissions must be eliminated, then the most straight forward option will be to aim to directly substitute nuclear power generated electricity for all fossil fuel applications. It will not be simple. It will not be cheap. And it will take time. But in the long run it will be the cheapest, reliable, emissions free solution. It will be far more manageable than the complex VRE with gas back up mess. And a market based predominantly on one type of generation will be easiest to manage.
12. GenCost P9 says VRE costs include costs of firming, called integration. These include storage, transmission, system security and spilled energy. But on P14 the report says it does not seek to describe the set of electricity generation and storage technologies included in detail. This means to me as a modeller:
    - it is not possible to validate/understand the costings provided for the LCOE comparison.
    - It is not possible to plug GenCost VRE infrastructure costs into a model because key detail is missing. A modeller cannot assume the integration costs included with VREs are adequate. It would be better to show stand-alone VRE costs and let modellers add integration separately.
13. GenCost LCOEs are inconsistent with IEA LCOEs. In particular, GenCost LCOE tables show nuclear power at double the cost of renewables while IEA publications show long run nuclear to have the lowest LCOE. This seems a significant discrepancy which deserves explanation.
14. GenCost capacity factors are confusing – seem to use an inappropriate minimum CF for nuclear but equally inappropriate maximum CFs for VREs. Capacity Factor CF must be less

than or equal to Availability Factor. Some figures in the report do not seem to follow that rule.

15. Simplify GenCost, and the ISP by only considering what is realistically going to be feasible to start working on immediately, even if not completely installed in the next 25 years to 2050. Work towards the most effective and achievable zero emission system, however long it takes. It makes no sense try to build a hugely complicated infrastructure array that will be unreliable, extremely expensive, will increase electricity costs, without achieving net zero targets, because of being bound to a time limit that the rest of the World is obviously not going to meet. So leave out hydrogen, carbon capture, SMR nuclear, from current thinking and reconsider if rooftop should be included. The ISP needs serious rethinking.
16. Rooftop power (27% of the ISP capacity) will be unreliable, because it only has 25% Capacity Factor and produces zero power at night. The reason rooftop should not be included in the ISP is analogous to why governments do not encourage private water tanks in areas serviced by utility water supply. There is a conflict of interests which can only get governments into difficult situations.
17. Hydrogen seems to be considered both as an energy storage technique and separately as part of a hydrogen gas fuel mix in both GenCost and ISP reports. Normally hydrogen comes either from electrolysis of water or steam reforming of methane from natural gas. The high electricity demand for electrolysis results in an, electricity in/electricity out, efficiency of as little as 30% when it is used as fuel. Batteries (90% eff.) and pumped hydro (70% eff.) make hydrogen a poor choice for storage. Steam reforming methane means removing carbon atoms from methane using steam (water vapour). Hydrogen is produced and carbon dioxide emitted. This is an energy intensive process. The hydrogen can embrittle and damage most materials it comes in contact with. So all pipes, storage tanks, pumps, compressors , etc. used to handle hydrogen must be specially designed. So why after using so much energy to produce steam, to react it with methane, and with all the extra expense of handling reactive hydrogen, would anyone think it would be a great idea to mix it back in with some of the gas it was originally derived from, and then burn it to produce more steam. Perhaps someone knows why that would be worthwhile but it is bewildering. Just cut out the hydrogen and simply burn the methane/LNG. The total carbon emission will be exactly the same either way. So hydrogen/natural gas technologies seem improbable for electricity generation. (That is not to discount use of hydrogen for applications other than energy storage or blending with other gas for fuel).
18. Carbon capture technologies seem unlikely to become mainstream. The amount of CO2 that escapes (~10%) plus extra energy required to capture, compress, transport, then sequester the CO2 effectively destroys the usable energy density of the coal, gas, biomass, etc. The mass of carbon dioxide if solidified as in dry ice, will be roughly 4 times the mass of the coal (carbon) it came from. Handling that amount of CO2 and burying it securely seems improbable and not part of a current ISP for the next 25 years. And if instead of capturing pure CO2 and absorbing it on some solid instead, the volumes to be handled and disposed of will be dramatically bigger still.
19. Small modular nuclear reactors (SMRs) are not yet commercial. So it seems somewhat cynical to include them with huge prices that cannot begin to be verified. For the moment, these technologies do not help the report's credibility. Their time will probably come.
20. Robustness – Traditional baseload power plants face little threat from hail, dust, cyclones, tornados, earthquakes, floods, wildfires, volcanic ash clouds and most are not subject to risk from tsunamis. By contrast solar farms are vulnerable to all these threats. Wind is not as vulnerable. Both wind and solar and VRE storage systems are vulnerable to Dunkelflaute,

something that also does not affect baseload power stations. All electricity storage that is filled by VREs is intermittent and provides very short term but otherwise unreliable back up. Transmission systems are a weak link for all power. Distributed power systems include significantly more transmission than base load systems. So this bigger transmission footprint is an extra cost and risk for VREs in any comparison. Wind and solar capacities are not rigorously complimentary. If energy supply is concentrated to just electricity then instead of planning for 1-20: 1-50: 1-100 year disasters we need to consider 1-500; 1-1000; 1-5000 year disasters. An example was the 1815 Mt Tambora eruption which would knock out a VRE system for many months. Disruptive disasters, even a 1-5000 year event could happen this year.

21. VRE proponents aim to replace extremely robust baseload power infrastructure with dramatically less sturdy and vulnerable wind and solar structures. Electric power is the lifeblood of Australian civilisation and will become even more vital as we turn from using fossil fuel. This is a security risk that is hard to quantify. But because VREs are vulnerable to such a range of threats, they demand extraordinary back up, which is also hard to quantify. Storage is prohibitively expensive. So, it seems a gas back up system capable of meeting full market demand is an imperative. It too will be very costly and will compromise net zero emission targets to a level which also cannot be easily quantified.
22. A gas back up system would be mandatory for a truly robust VRE system. AEMO's ISP shows flexible gas capacity at about 15GW in 2050. But the gas capacity would need to be maybe 10 times greater to meet full market demand, which in 2050 may be up to 150GW. Once installed such a gas system would have to be used to some extent to remain operative and to repay the finance cost. This would snooker any chance of net zero emissions. GenCost does not seem to indicate the premium cost for security in VRE systems with integration. They are expensive and with sufficient gas back up, definitely not emissions free.
23. Clearly the chosen mix of VRE components and level of redundancy, affect the specifications of the transmission system. But the cost to dramatically expand the gas distribution must be added to the cost of the gas back up system. New connectors will also be required to feed from the gas plants into the grid.
24. GenCost leaves it up to AEMO and other modellers to add everything to make a system robust. But it is hard to see that AEMO has done that. The ISP shows a 2050 system with 300GW capacity. That is to replace the recent system where Australia had 50GW baseload capacity to service and average demand of about 20GW. Allowing for electrification and population growth, average demand should be closer to 60GW in 2050. The demand will be 24/7 as new industries electrify, and the traditional peaks and troughs should smooth out somewhat. As an example most electric transport will charge batteries at night. A lot of electrified industry will run 24/7. The ISP shows in 2050 there will be 135GW of solar, representing 35% of the NEM capacity. For as much as 16 hours every night in winter, none of the solar power capacity will be available. That leaves wind, 80GW, as the sole VRE generator for a major part of every day. But the Capacity Factor for wind is typically 25 – 35%. (eg Macarthur wind farm VIC – nominal cap 420GW; design CF 35%; actual recorded CF ~25%) So, to be generous, only about 25GW of the installed wind capacity will be available to supply the market. That is against an average demand for 60GW. The ISP does have 10GW of utility storage and 15GW of gas by 2050. So total utility power will be 50GW **IF** the wind is blowing and we completely deplete all utility storage every single night. That is still a ~10GW shortfall EVERY SINGLE NIGHT. There will be about 30GW of CER storage. But that is only if the sun was shining all day and if private citizens are happy for the government to borrow energy from them every single night. Surely this is a disaster just waiting to happen? Just a

couple of sun and wind free days will cause outages. And there is absolutely nothing in the ISP to cope with major catastrophes as depicted below, which will take weeks, months or years to rectify:

     

25. GenCost puts prices on energy system components but not on full systems. Modellers who add to costs of wind and solar farms, things such as; cost of extreme redundancy, battery storage, regular replacement costs of turbines, solar panels and batteries, extra transmission, pumped hydro schemes, end of life costs, site rehab, etc can clearly show such systems are far more expensive than any baseload system. This is not apparent at all from the GenCost report nor from AEMO's ISP. The current government refers to GenCost to substantiate its claims as to what form of electricity generation system is cheapest. And the public believe the Government. But GenCost doesn't really show that!

I am not and have never been a member of any political party. I am a member of the Australian Nuclear Association, and Australian Radiation Protection Society. I have investments in an oil & gas supplier, rare earth, graphite, and uranium exploration plus uranium enrichment technology. I have been modelling utility energy systems since 2016 with the specific initial objective of showing we do not need nuclear power. We still don't need nuclear if we build our entire energy supply around gas. That could be OK if climate geologists who say anthropomorphic emissions are insignificant in affecting climate change, are right. But long run nuclear is still cheaper than gas and emission free. So it is the most sensible way forward.

Best regards

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