Submission on Draft 2024 ISP to AEMO by David Bowen

Written submissions providing feedback on the Draft 2024 ISP should be sent in PDF format to ISP@aemo.com.au and are required to be submitted by 6pm (AEST), Friday 16 February 2024.

Submission

Thank you for the opportunity to evaluate and comment on the AEMO draft electrical network plan, aimed at providing the people of Australia secure, reliable, and affordable electrical energy, and achieve Australia's net zero emissions targets by 2050.

I believe we are providing an answer to the first question as we consider use of renewables and batteries to be an expensive option.

Japan has followed a strategy of building pumped hydro to absorb the peaking and varying demand profile whilst base load generation with Coal and Nuclear is far more cost effective for the continuous base load demand.

We look forward to your response.

Regards

David Bowen MBA, BE(Electrical), BSc

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Essential Service

The electricity supply utilities are charged with playing their part in delivering a safe and dependable Essential Service to our community. Failure to deliver has serious consequences for all concerned including the consumer and should be avoided at all costs.

We know that new infrastructure takes considerable time to plan, approve, order, deliver, install, and commission. Forward planning is critical to identify what will otherwise be described as unforeseen demand or irregularities in supply, adverse weather conditions and natural disasters, etc. Think tsunami.

The system design and engineering of the infrastructure, protection and controls need to address these occurrences and other contingencies, so that grid supplied electricity is truly reliable, robust and dependable. This is an upfront cost that must be accounted for in the design stage. Any subsequent rectification costs will be a magnitude higher.

Stress Testing

Stress testing is critical, and Figure 23 is a good example of that but there are some vulnerabilities reflected in the following observations:

- 'rooftop solar' generation continues at full capacity through all eight days,
- 10 to 20 GW of 'wind' runs for the first few days,

- 30 to 70 GW of 'deep storage' are delivered over the full period,
- 'hydro' delivers 2 to 7 GW for all 8 days,
- 'energy storage' only kicks in after several days,
- the 'gas turbines' are running at more than 50% of their capacity over the full period.

The Millenium drought ran for 13 years from the late 1990's to 2010. Major dams across Australia were at record lows, causing much concern and precautionary action. Certainly not a good time for Snowy 1 hydro. We have had droughts before and they will come again, so a rigorous stress test would take this into account.

The fossil fuel turbines are working as a power generator, hiding the inadequacies of energy storage, rather than system firming.

Major Vulnerabilities of ISP

Major vulnerabilities identified include:

a. High cost of using renewables for base load v's low comparative cost of fuel based generators. Some examples follow.
b. System demand could be much higher, due to
    i. Simply underestimating demand growth
    ii. Over estimating new efficiencies
    iii. Population growth
    iv. Transitioning of other industries
    v. New industry growth
c. Not accounting for the possibility of extended "droughts"
    i. A solar drought in major population centers
    ii. An extended water drought over the Snowy mountains
d. Excessive use of Natural gas turbines to compensate for insufficient stored electricity or pumped Hydro. Natural gas emits about 50% CO2 emissions compared to Coal and there are other issues.
e. There is a significant capital cost benefit in using gas over battery, as demand increases gas might well be used increasing emissions.
f. Efficiencies are encouraged by cost pressures, which will act as a brake on growth of the Australian economy. It will encourage industry to seek global locations that are more welcoming. That is a concern. A much better framework for a country like Australia is to encourage growth and economic development, by keeping electricity abundant and cheap. Is there a way?

Solar drought in major population centers flip grid supply to grid demand

We noted in our comments on Figure 23 that the 'rooftop solar' generation continues at full capacity through all eight days of the renewable drought.

If a 'solar' drought were to occur concurrently and extend across the main population centers of greater Sydney and/or Melbourne, we might well have a problem. If the household rooftop solar generating capacity is shut down, then about 80 GW of household PV is taken from the system.

Those households still need power to charge their EVs and to otherwise go about their normal business. As a result, householders might first use the limited stock of stored energy causing the storage to quickly deplete. As a result, a portion of that grid supply capacity now flips and becomes additional demand on the grid.

Potential electricity demand increases

There are four major areas of potential growth in electricity demand to consider:

1. **Transitioning of traditional fossil fuel energy users across Australia.**

   Today, Australia's annual use of energy is seven times that of our use of electricity.

   Some things we can reasonably expect by 2050:

   i) The transport sector uses a significant proportion of petroleum oils which are 2.5 times use of electrical energy: 560 TWh pa in today's terms.
   ii) Transitioning of gas accounts for 27 % energy use in Australia, emissions are half that of coal, so the pressure to transition is lower, but the need is there. There is already pressure with governments banning new installations and this will grow. We could reasonably expect a 50% transition accounting for some 210 TWh in increased demand, in today's terms.
   iii) Coal accounts for a similar portion of energy supply as a gas so the electricity transition to renewables so the opportunities for transitioning is more limited, but the pressure is significantly higher, so it would not be unreasonable to set an objective of 200 TWh.

   In all the increase in demand for electricity supply due to Fossil fuel could be as high as 970 TWh of electrical energy for business and industry across Australia.

2. **Return to heavy industry and manufacturing because of global forces.**

   We are now experiencing prolonged supply issues with many construction materials and we are no longer able to sustain basic industrial requirements in many product lines. The main reasons for these industries closing or otherwise transferring production to Asia could largely be attributed to antiquated designs and processes, aging manufacturing plant and equipment and cost pressures. If electricity is cheap and abundant and the business environment is encouraging and receptive, there is good reason to expect new investment in existing industries such as secondary processing of our natural resources, particularly where electrical energy or natural gas use is significant and new industries such as renewable equipment and hardware are in high local and overseas demand.

   Tomago Aluminium plus up and down-stream businesses, for example uses a gigawatt of energy continuously – which translates to over 8 TWh per annum.

   Given the right conditions we could well expect a growth in industrial demand of 200 TWh through to 2050.

3. **Securing potable water infrastructure across Australia.**

Sydney has a desalination plant that is capable of delivering about 10% of Sydney's water in today's terms. The plant was built on time and to budget, by local contractors.

The major inputs are simply sea water (which is abundant) and low cost electricity.

A desalination plant like that at Kurnell, typically requires about 3 KWh of electricity per KL, or for a plant capacity of 125 ML per day, daily energy usage is 375 MWh; or 136 TWh per year, which might well be required when the city experiences another severe and prolonged drought. This electricity demand should be included in any of the current network stress testing.

Subject to availability and a suitably low cost of electricity supply, we would have a significant opportunity to set a program in place to meet and exceed population growth needs and to future proof our nation against severe and prolonged droughts.

If a program was put in place to build a similar plant each five years, we could potentially see a further load of 680 TWh per annum.

4. **Population growth through to 2050**

   Population growth figures have been published to the year 2071. Given a related policy framework, it would not be unreasonable to expect a population growth of as much as 40% by 2050.

In all we are talking about a potential growth in electrical demand of some [(970+200+680) = 1850 TWh per annum.

The total projected electricity demand that might be seen in 2050 could be as high as 2200 TWh. That is about seven times the projected demand. Cost pressure could ensure that would not happen.

Most new industry, like data centers, manufacturing, smelting, and mining will need to work long hour to recover costs and compete globally. Much of the above growth will be **base load** and there will be some peaking.

2200 TWh translates into about 250 GW system base load demand.

We could expect the demand profiles that are presented in Figure 8 to be much the same because the variable component is largely driven by people's behaviour and grow with population growth. That profile would then sit significantly higher reflecting the additional base load.

On a stressed grid system where the maximum demand peak increases by 1 GW over a thirty-minute period after sunset, we will need new capacity.

Demand Peaking in the variable demand component and that will grow considerably and needs to be addressed if we pursue a growth strategy. First consider servicing an increase of 1 GW in peak demand. This can then be scaled up to the required multiple.

Peak demand rises by 1 GW:

Option 1. Gas turbine

The gas turbine needs to run for just 30 minutes per day – the asset will be underutilized.

- 1 GW Gas turbine will <u>cost about $1.7 billion</u>.

Option 2. Grid Battery

The selected battery is rated to be fully utilized.

- 1 GW / 500 MWh Battery will <u>cost about $300 million</u>.

The Grid battery does the job for less than 20% of the cost.

This clearly demonstrates that renewables and storage have a useful role in any grid system, because they are very good at addressing system peaks. We can conclude that new peaks in demand are not a great issue for the proposed system.

To service such a base load demand we have three options

Base load rises by 1 GW:

Option 1. **Gas turbine**

The gas turbine will use its full capacity for the full 24 hour period

1 GW Gas turbine will <u>cost about $1.7 billion</u>.

There are two major problems in choosing the use of **natural gas** as a fuel when it will potentially scaled-up 250 times. First and gas pipe network would not cope and secondly the carbon emissions would be at least five times the amount currently being released by our coal fired plant.

Option 2. **Grid Battery plus solar panels** emulating the performance of the gas turbine – servicing the full 24 hours and assuming full sun shines 6 hour per day.

4 GW PV panels will cost about $1.2 billion

1 GW / 18 GWh Battery will cost about $10.8 billion.

Total cost $12 billion

Option 3. **Nuclear Power Station**

The cost per gigawatt for a nuclear power station is typically between $US2.1 billion and $US 7 billion. The higher cost is because Westinghouse USA has limited capacity because of such a long drought in construction experience. I will speak to this further.

Total Cost $4.2 billion

Addressing increases in the base load is a very much more expensive exercise and the preferred option switches away from renewables and batteries to clean thermal nuclear generator, which does the job for about a third of the cost. That cost is further enhanced by the fact that the economic life is 60 years, more than twice the life of the other options.

The renewable base load option is more expensive and remains inherently less reliable because it must be fully recharged on the following day, so that it can do its work the following night. If 'Huey' is not smiling: the renewable system will be under stressed conditions, and a full recharge of the battery is not assured.

The problem for most batteries is that stored energy is finite. Possibly that cannot be said for Snowy 2.

For this reason the claim made in dot point 4 under the heading **1.3 Significant and diverse benefits** on page 28, is difficult to justify.

- "A vast new economic opportunity for Australia" is what we all want, but the cost of financing base load growth with renewables is prohibitively expensive because there is so much energy storage involved.

Nuclear **power stations**

✓ **Conventional safe nuclear power stations**

- At COP28, 22 countries have pledged to triple nuclear capacity by 2050. That implies a global increase of about 800 GW of installed capacity, or about 30 GW per year to 2050.
- It is with this level of new nuclear plant in the pipeline that there is high hopes and expectation that capital costs will come down.
- A recent study of the costs of some 49 Nuclear Power Plants completed in the last 3 decades is of interest.
- The cost ranges between $US 2,030 per KW and $US 13,610 per KW.
- Life expectancy is typically 60 years and the low-end pricing is particularly interesting.
- A 1 GW unit might have a capital cost of $US 2.1 billion.
- They are capable of running near capacity delivering a combined total of more than 8 TWh per year and do not have the same stability and reliability issues as renewables.
- The 50 or so nuclear plant that currently run in the USA run with an average Capacity Factor of 91 %. The coal fired plant run on an average Capacity Factor of 54%, similar to the now retired Liddell Power Station.
- The difference in price is largely related to the larger number of plant being installed by low cost providers. These units are made in South Korea typically cost between $US 2 and 4 billion per GW, because South Korea have had a program of progressively installation new plant since the 1980's. Other countries in a similar low-cost position are India, China and Japan.
- Westinghouse USA have indicated that their objective is to be able to come in at that price range, but in a later time frame.
- Five Nuclear Reactors were completed in 2023 with the one in Slovakia being delayed many decades for administrative reasons, whilst the other four were each completed in about ten years.

Now we have two scenarios to consider at the site of any one of the old retired coal-fired power stations.

1. Consider first, the scenario of ordering a 2 GW Nuclear Power Plant at a disused Power Plant site in 2024 and commencing construction in 2026 and having it operational in 2037.

    - The plant would generate 2x24 = 48 GWh of saleable energy each day 24/7 independent of all weather conditions. Construction time is typically 10 years.
    - Say the plant costs $AU 4 billion then the approximate cost of energy would be about 2c per KWh or $ 20 per MWh.
    - This energy price is cheaper than what we were able to provide with coal and will provide safe, secure, reliable and abundant, cheap reticulated energy that will attract business development and stimulate industrial growth with many of new, modern and desirable industries.

2. Now consider the second option of renewable plant of similar capacity:

    - Assume the installation has an economic life of 25 years then the costs must be recovered in less than half the time.
    - And say the sun shines every day all year, so we get an average of 6 hours of generation each day.
    - We have 2 GW of PV panels and inverters costing say $ 250 per KW = $ 500 million, installed.
    - 2 2 GWh of Li batteries costing $ 1.2 billion.
    - Total cost of renewables = $ 1.7 billion
    - Our PV system generates 6x2 = 12 GWh per day
    - Some of that generated power is used to top up the battery system so by sunset we have a full battery. Which is then used under time shift to supply night time energy needs.
    - In all, we dispatch 12 GWh each day (or one quarter of the nuclear option), assuming no losses:
        - 2.2 GWh of time delayed power over night
        - 9.8 GWh over the sun lit hours of the day
    - Our capital cost for providing 12 GWh $1.7 billion, so the approximate cost of energy would be 8c per KWh or $ 80 per MWh.
    - Because of periods of renewable droughts, 8c per KWh is probably not adequate to recover capital costs.

Clearly, the nuclear option can produce four times the saleable energy in any year and the energy is available at a considerably lower price than the renewables option. If we were to choose to pursue this option the best strategy would be to initiate a program of progressive installation of “identical” units, each learning from the previous plant, until all the existing coal fired sites are renewed. The replacement and capacity growth program should settle to a continuing flow of growth and renewal.

This strategy lends itself to an orderly and managed retirement of vehicles, plant and equipment of all industries that are currently reliant of fossil fuel.

In this process, Australia would acquire many new and enhanced skills that could be used to development new nuclear related industries and our own nuclear export markets, including:

- Fuel rod refurbishment in Australia

- Waste processing and disposal using the Australian developed Synroc process

✓ Strategy for implementation

Place conditional order for **twenty 2 GW nuclear power plant** of a proven design and implementation track record.

That is, we install 40 GW of nuclear plant mainly at the previous coal fired plant over a 20 year period. Give a preference to development Australian involvement nuclear capabilities and scale up as industry is attracted to the pledge of safe, secure, reliable, abundant and cheap electrical energy, and achieve Australia's net zero emissions targets by 2050.

Submitted by David Bowen

Focused Quality Systems

Dee Why

Fqs99@bigpond.com

0499 160 120