# The AEMO 2024 ISP Will Not Deliver Reliable Power

## AEMO’s numbers just do not add up

A Report by Independent Engineers, Scientists and Professionals 31 July 2024

## *Introduction*

Our 9 February 2024 submission to AEMO and CSIRO concerning the *draft* ISP identified serious potential reliability problems resulting from AEMO’s electricity grid design. Our inputs were largely ignored.

The final version of the ISP, released on 26 June 2024, essentially reveals the same deeply flawed model of the NEM electricity grid.

## *Failure to Address Clearly Stated Reliability Issues*

AEMO’s ISP suffers from severe deficiencies in capacities of both energy storage and baseload back up power, starting in the next few years and lasting throughout the entire period to 2050. It shows no evidence of rigorous system design engineering required for high reliability systems based on worst case conditions and healthy reserve margins.

By 2030, the dispatchable reserve margin falls from historic levels in excess of plus 20% to minus 19% and in subsequent years it is substantially worse. It cannot deliver adequate power when NEM-wide grid demand is maximum and when overnight solar is zero and wind output is close to nothing.

Furthermore, the negative reserve margin provides no allowance for facility outages for maintenance and repairs. The grid design also suffers from insufficient power capacity to quickly recharge the energy storages to prepare for the next set of worst case conditions.

AEMO’s own historical NEM data demonstrates periods of very low renewable energy production lasting 3 or more consecutive days and dramatic falls occur many times in a month. Periods of several months, when wind and solar outputs are well below long term averages, are evident in both Australian and overseas data. May 2024 witnessed several major droughts.

The energy storage capacity in the ISP is too low by at least a factor of ten. Adding more batteries and additional renewable generation to recharge them is completely unaffordable.

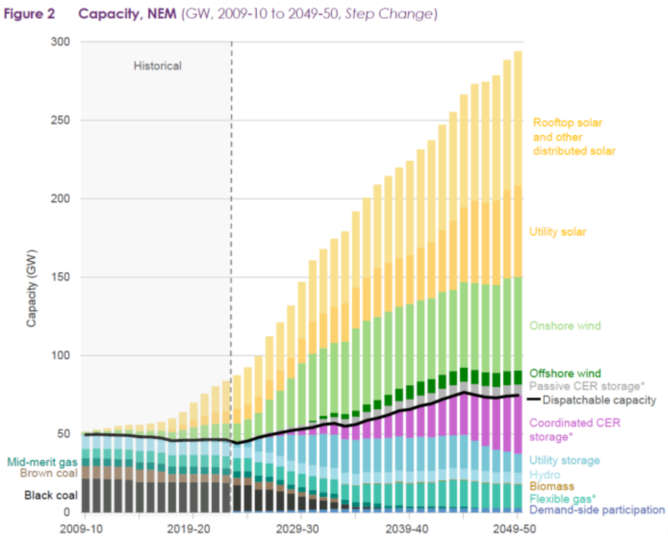
## *Deceptive Data Concerning Dispatchable Power*

Figure 2 in the ISP is a graphical chart showing power from various generation sources and storages by year until 2050 (see next page).

It shows impressive growth to 2050 but almost all growth is in renewables which have very low capacity factors (25-32%). Similarly, energy storage outputs show remarkable growth but most of these provide power for just a few hours. Much it is from coordinated home resources which may be uncertain. The dispatchable black line climbs to above 75 GW by 2050 but in truth, it is meaningless because much of it cannot be used to back up the grid when solar and wind power are largely absent for periods of multiple days and significantly below average for periods of months.

This deceptive portrayal is merely a summation of maximum power outputs from all sources. A truthful depiction would, as a minimum include warnings to the effect that renewables provide less than one third of maximum power on average and not all dispatchable power provides practical levels for grid back up.

Figure 2.4 in our submission (see below) provided an alternative version of this chart showing the true dispatchable power over various periods based on ISP data for energy storages (ISP Figure 20). By 2040, the dispatchable power of AEMO's ISP design falls to just 30 GW for backup durations of one week but at the same time it indicates that for 16 hours overnight, it is only 37 GW. However, a proper engineering design with a 20% dispatchable reserve margin will require over 60 GW by 2040.



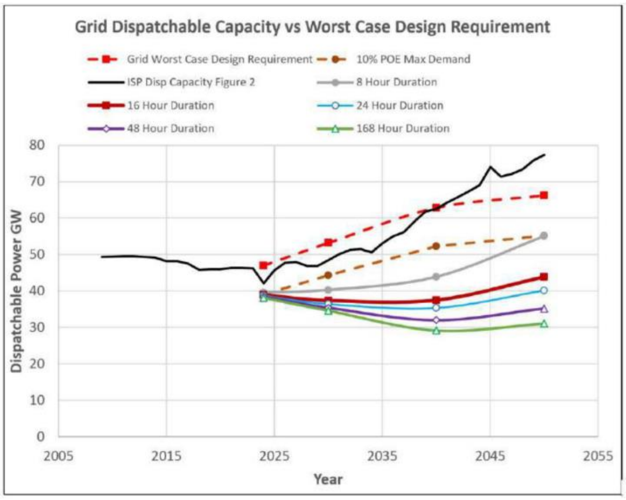




Figure 2.4 Dispatchable Power Capacity vs Grid Design as a Function of Duration

## *A Whole-of-System Power Budget Shows Failure of Reliable Power at Night*

A whole-of-system power budget is fundamental to understanding the viability of the AEMO ISP and making a counterpoint to the CSIRO GenCost report, however, the ISP provides no system level power budget data. In fact, the ISP does not contain any data on maximum demand. Instead it forecasts average annual energy production figures. This is no way to design a high reliability system.

Proper high reliability engineering design requires use of worst case conditions plus a margin for facility outages for maintenance and repairs. A whole-of-system power budget table (on the next page) is based entirely on AEMO's ISP data.

Our power budget uses maximum grid demand data from the August 2023 AEMO ESOO report because the ESOO update of March 2024 did not contain this data.

We show that by 2030, the dispatchable reserve margin falls to minus 19% on a single 16 hour overnight period when solar is zero and wind falls very close to zero. Any facility outages for maintenance or repairs will make this figure worse. There is simply not enough baseload power nor energy storage capacity.

To restore the dispatchable reserve margin to at least plus 20% would require an additional 17.4 GW of baseload or stored energy outputs in 2030, rising to 28.1 GW in 2040 and 2050.

In the event of multiple day wind and solar drought conditions, there is not sufficient surplus power during daytime to completely recharge expanded energy storages sufficient to handle another overnight period under worst case conditions.

Blackouts are inevitable. The AEMO ISP cannot deliver reliable power under worst case conditions. This is not a matter requiring fine tuning of the grid design. It is a massive failure.

**2024 FINAL ISP Top-Down Whole-of-System Power Budgets**

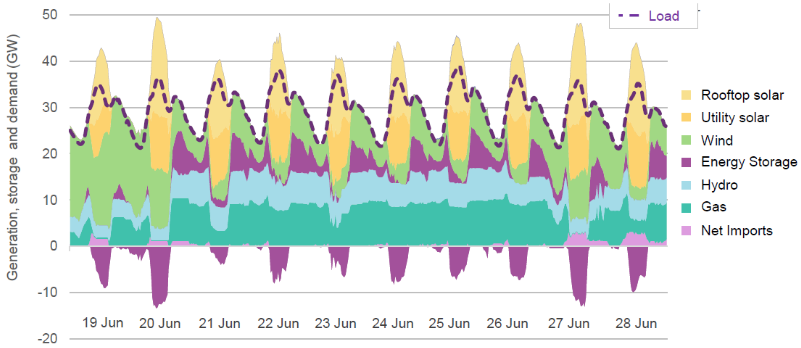
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AEMO NEM Grid Design per 2024 FINAL ISP** | | | | | | | | | | | | | | |
| **Worst Case & 20% Reserve Margin** | | | **2024-25** | | | **2029-30** | | | **2039-40** | | | **2049-50** | | |
| 24 hr Top-level Whole-of-System Power Budget | | | **Capacity** | **Night** | **Daytime** | **Capacity** | **Night** | **Daytime** | **Capacity** | **Night** | **Daytime** | **Capacity** | **Night** | **Daytime** |
| **Duration hours** | | | | 16 | 8 | | 16 | 8 | | 16 | 8 | | 16 | 8 |
| **NEM Power Demand** | | | | **GW** | **GW** | | **GW** | **GW** | | **GW** | **GW** | | **GW** | **GW** |
| 10% POE Max Demand (ESOO 2023) | | | | 39.1 | 39.1 | | 44.3 | 44.3 | | 52.3 | 52.3 | | 55.2 | 55.2 |
| Dispatchable Reserve Margin | 20% | | | 7.8 | 7.8 | | 8.9 | 8.9 | | 10.5 | 10.5 | | 11.0 | 11.0 |
| **Total Power Design Requirement** | | | | **47.0** | **47.0** | | **53.2** | **53.2** | | **62.8** | **62.8** | | **66.2** | **66.2** |
| **Power Sources** (Fig 2 2024 ISP) | **Capacity Factors** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | |
| **Baseload Power** | **Night** | **Daytime** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** |
| Coal - Black & Brown | 100% | 100% | 21.2 | 21.2 | 21.2 | 11.44 | 11.4 | 11.4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gas - Mid Merit & Flex | 100% | 100% | 12.54 | 12.5 | 12.5 | 11.62 | 11.6 | 11.6 | 15.89 | 15.9 | 15.9 | 15.0 | 15.0 | 15.0 |
| Hydro | 100% | 100% | 6.84 | 6.8 | 6.8 | 6.84 | 6.8 | 6.8 | 7.14 | 7.1 | 7.1 | 7.07 | 7.1 | 7.1 |
| Biomass | 100% | 100% | 0 | | | 0 | | | 0.45 | | | 0.45 | | |
| DSP | 100% | 100% | 0.95 | | | 1.64 | | | 2.5 | | | 2.90 | | |
| **Total Baseload Dispatchable** | | | **40.6** | **40.6** | **40.6** | **29.9** | **29.9** | **29.9** | **23.0** | **23.0** | **23.0** | **22.1** | **22.1** | **22.1** |
| **Energy Storage** Fig 20 2024 ISP) | | | **GWh** | | | **GWh** | | | **GWh** | | | **GWh** | | |
| Snowy 2.0 + Borumba | | | 0.0 | | | 349.80 | | | 397.75 | | | 397.75 | | |
| Deep | | | 6.27 | | | 6.27 | | | 42.10 | | | 77.81 | | |
| Medium, Shallow, Coord CER | | | 12.27 | | | 55.27 | | | 102.30 | | | 170.42 | | |
| **Total Storage Capacity** | | | **18.5** | | | **411.3** | | | **542.2** | | | **646.0** | | |
| | | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | |
| **Storage Max Power Capacity** | | | **GW max** | **GW** | **GW** | **GW max** | **GW** | **GW** | **GW max** | **GW** | **GW** | **GW max** | **GW** | **GW** |
| Snowy 2.0 + Borumba | | | 0.0 | 0.0 | 0.0 | 2.2 | 2.2 | 2.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 |
| Deep (limited by max power output) | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 1.1 | 1.1 | 1.1 | 1.3 | 1.3 | 1.3 |
| Medium, Shallow, Coord CER (avg output overnight) | | | 3.9 | 0.8 | 0.0 | 14.0 | 3.5 | 0.0 | 31.5 | 6.4 | 0.0 | 44.7 | 10.7 | 0.0 |
| **Total Max Storage Power** | | | **4.1** | | | **16.4** | | | **36.8** | | | **50.2** | | |
| **Avail. Storage Power Dispatchable** | | | | **1.0** | **0.2** | | **5.9** | **2.4** | | **11.7** | **5.3** | | **16.2** | **5.5** |
| **Total Dispatchable Power** | | | | **41.5** | **40.8** | | **35.8** | **32.3** | | **34.7** | **28.3** | | **38.2** | **27.6** |
| **Surplus/Deficit(-) wrt 10% POE Demand** | | | | **2.4** | **1.6** | | **-8.5** | **-12.0** | | **-17.6** | **-24.0** | | **-17.0** | **-27.6** |
| **Dispatchable Reserve Margin** | | | | 6.2% | 4.2% | | -19.3% | -27.1% | | -33.6% | -45.8% | | -30.8% | -50.1% |
| | | | | | | | | | | | | | | |
| **VRE Renewables** (Fig 2 2024 ISP) | **Capacity Factors** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | | **Capacity** | **Delivered** | |
| | **Night** | **Daytime** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** | **GW** |
| Wind: Onshore | 0% | 0% | 13.0 | 0.0 | 0.0 | 39.26 | 0.0 | 0.0 | 51.87 | 0.0 | 0.0 | 59.53 | 0.0 | 0.0 |
| Wind - Offshore | 0% | 0% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.0 | 0.0 | 0.0 | 9.0 | 0.0 | 0.0 |
| Solar Utility | 0% | 0% | 9.5 | 0.0 | 0.0 | 15.58 | 0.0 | 0.0 | 31.17 | 0.0 | 0.0 | 58.26 | 0.0 | 0.0 |
| Solar Distributed VPP | 0% | 0% | 23.48 | 0.0 | 0.0 | 36.06 | 0.0 | 0.0 | 60.16 | 0.0 | 0.0 | 85.74 | 0.0 | 0.0 |
| **Non-dispatchable VRE** | | | **46.0** | **0.0** | **0.0** | **90.9** | **0.0** | **0.0** | **152.2** | **0.0** | **0.0** | **212.5** | **0.0** | **0.0** |
| **Total Dispatchable + VRE Power** | | | | **41.5** | **40.8** | | **35.8** | **32.3** | | **34.7** | **28.3** | | **38.2** | **27.6** |
| **Surplus/Deficit(-) wrt 10% POE Demand** | | | | **2.4** | **1.6** | | **-8.5** | **-12.0** | | **-17.6** | **-24.0** | | **-17.0** | **-27.6** |
| | **Efficiency** | | | | **GW** | | | **GW** | | | **GW** | | | **GW** |
| **Req'd Daytime Recharge Power** | **80%** | | | | **2.4** | | | **14.6** | | | **29.2** | | | **40.4** |
| **Avail. NEM Daytime Recharge** | | | | | **1.4** | | | **-14.4** | | | **-29.3** | | | **-33.1** |
| **Recharge Power Surplus/Deficit(-)** | | | | | **-1.0** | | | **-29.0** | | | **-58.5** | | | **-73.5** |

## *AEMO's Attempt to Demonstrate System Reliability is Misleading*

In Section 6.5 "Reliability and security in a system dominated by renewables", the ISP acknowledges the challenge as renewables approach 100% of generation. But it claims: "*Consumers should be confident that the NEM's mix of technologies will keep electricity supply secure and reliable during normal operation, extreme peak demand and renewable droughts*."

In the ISP, Figure 24 (p72) attempts to illustrate operability through an eight-day renewable drought for the "NEM except Queensland". ISP Appendix 4 (Figure 15 p 26) reveals that this simulation test involved an "extended VRE drought event running from 21 June 2040 to 28 June 2040 (reflective of conditions observed historically in June 2019)."

Figure 24 Operability through eight-day renewable drought, NEM except Queensland




This one-off test looks impressive but is merely an illustration far short of what a proper statistical engineering analysis would require. A detailed examination of the data behind this test revealed the following:

1. It assumes imports of power from QLD yet represents a partial system.
2. It assumes maximum power continuously from all dispatchable resources.
3. It assumes extreme VRE drought conditions were for 6 days not 8.
4. It assumes wind capacity factor was 10% in daytime; 13% overnight – not worst case.
5. It assumes solar capacity factor was 13-15% - not worst case.
6. Non-daytime grid demand in early evening was 32 GW decreasing by 31% after midnight to 22 GW; this profile is speculative in the face of increasing EV demand for overnight charging; worst case is a flat maximum demand.
7. The ISP admits that "reliability risk would be elevated, particularly if major generator or transmission outages occur" i.e. no facility outages were taken into account.

These are certainly NOT rigorous worst-case conditions. Instead of illustrating the reliability of the NEM grid design, this test indicates the extent to which the AEMO ISP misrepresents its viability.

## *Conclusions*

Despite its impressive appearance, the ISP contains fundamental technical drawbacks. From an engineering perspective, the AEMO ISP is seriously flawed and fails to provide assurance that the NEM grid design has been developed in accordance with modern system engineering principles for high reliability systems.

We therefore conclude the AEMO ISP, which underpins the entire national economy, will not serve Australian consumers and businesses with reliable electrical power. It is clear this plan has been driven by changes to National Electricity Rules by non-technical politicians and bureaucrats to set artificial goals for renewables divorced from engineering realities.

It is critically important and urgent that an ongoing review process be implemented with advice and input by independent experts to oversee AEMO and CSIRO work on the future NEM.

## *Independent Engineers, Scientists and Professionals*

This report has been prepared and supported by independent engineers, scientists and professionals who have many decades of relevant experience and requisite qualifications without any monetary conditions, employment or conflicting interests.

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