GENCOST SUBMISSION

To draft 2023 Inputs Assumptions and Scenarios Report consultation documents

A: Twenty Points

4/02/23

Dear AEMO/CSIRO,

I wish to contribute my thoughts to your GenCost analysis which is open at the moment.
I appreciate that understanding the dispatch of electricity generation and operation of a grid under a wholesale market framework is extremely complex. I do not profess to be knowledgeable of these. My background is in business and making operational and investment decisions.
The GenCost studies are exhaustive and detailed and must take hours to produce. From the perspective of someone like myself, I believe there are some matters which would make these more relevant and user friendly. I submit the following suggestions:

1. 29% is the actual NEM capacity factor for wind in 2014 and still in 2022, and likely to fall as the best sites have already been taken. Your choice of 35% to 44% really casts doubt on the rest of the report.

2. Solar also has a capacity factor. I believe solar is averaging 19% in 2022 although actual solar capacity factor for RTPV systems in NEM in 2018-2019 was about 22%. As such values up to 32% are not achievable.

3. Solar generation during the day is fairly well known in advance based on physical parameters whereas wind is extremely variable and largely non-predictable other than for a few hours ahead.
   To the extent that wind is synchronous with solar production, it may be curtailed under some market conditions. Details of actual NEM correlation between solar and wind would be useful. Is there some way you can detail this? To have synchronous and non-synchronous wind data against the solar daily cycle is important for decision making otherwise large amounts of wind could be undispatchable and thus uneconomic.

4. Solar may cannibalise wind. The jeopardy that wind suffers is a cost.

5. Transmission losses are high, but these are difficult to differentiate in the report.
   AEMO, *Loss Factors and Regional Boundaries*, says: "The losses are equivalent to approximately 10% of the total electricity transported between power stations and market customers."
   The transmission losses are directly related to the location of generator in the electricity network. Wind and solar tend to be located further away.
   As the associated transmission loss factor is calculated in advance for each year, will GenCost please display the range and provide an average by dispatched generation, and take these into account in the LCOE estimates.

6. Zero operating costs for wind and solar are unbelievable. Turbine fires are about 0.1% p.a. for each turbine. Wind Turbine maintenance costs are about 0.1%. Farms typically have staff of at least 6 full timers. An internet search says solar inverters last ten years. And decommissioning costs need to be amortised from year one. The toxic nature of the blades and panels is going to be expensive for disposal.

Hosts get paid around $30,000 per turbine, the NSW Government gives $10,000 pa for each KM of transmission line easement, community funds range from $100K to $1M pa, neighbours may be paid $10K each.

7. Presumably we are trying to make decisions about what to support and which coal to decommission. The costs of new coal fired power stations seems to me irrelevant. Of greater relevance would be an analysis of the current actual running cost of coal without the sunk capital.
Can you do this for some or many individual coal plants. I remember seeing on your site a review by a QLD Senator, I think, who provided actual coal costs and a capacity factor of around 92%. It would be useful to have this example, and others.

8. The decommissioning costs of the coal fired power stations would be interesting, and maybe some sort of way to express that over an expected timeline, maybe a) total grid output, b) current wind output, c) current solar output, etc, as these are a cost of introducing wind and solar.

9. The **big issue for the future** is energy storage systems, ESS

10. Battery storage and stabilisation costs for 15Min or 1 hour are useful.
Batteries are expensive. Reference:https://stopthesethings.com/2023/01/24/simply-staggering-gobsmacking-cost-of-using-batteries-to-store-wind-solar-power/Today Tesla charges about US$650,000 per MWh just for the batteries, much less whole facilities. And costs are now rising.
I believe Hornsdale now costs over $1,000,000 per MWh.
2 hour to even 48 hours are quite unlikely and may be ignored or displayed separately.
I think it would help to at least express firmly that batteries are very expensive.

11. Hydro and Pumped Hydro.
"In 2021, global installed hydropower electrical capacity reached almost 1400 GW, the highest among all renewable energy technologies" and "In 2021 pumped-storage schemes provided almost 85% of the world's 190 GW of grid energy storage"
"Hydropower Special Market Report – Analysis" IEA. Retrieved 2022-01-30.
Knowledge of the actual Snowy 2.0 and Shoalhaven costs and capacity would help. I am advised that Reversible Francis Turbines used in most pumped storage hydro systems have turbine efficiency of around 85% = turnaround efficiency of about 72.2%.
Transmission losses occur in both directions thus overall losses from a solar farm near a large load sending surplus energy to/from Snowy 2.0 could be as high as 40%.

12. Where are the formula that go with Table B.6?

13. This is a wild card suggestion.
Australia has a mindset of having hydro generation from large head heights. (Even ANU's recent list of possible hydro sites used a minimum head of 300M). More recently in the Mekong "run of the river" generation uses lower heights. Much lower. The large Xayaburi complex has a head height of 18M. Of the other 89 facilities, I believe some have even lower heights.
An analysis of low height hydro costs with pumped storage may stimulate finding sites, if the costs came out well.

14. CCS, carbon capture and storage is unlikely. The one operational plant in the world is associated with geothermals unavailable in Australia.
I appreciate CCS needs to be considered by AEMO even if the possibility is low. The presentation of CCS attached to so many different generation systems seems to exaggerate its likelihood. Could you just present it as a possibility by itself.
The Economist, 7-1-23, p52 writes that "more than 70 CCS facilities are in various stages of development in Europe", but that no project has yet received operational approval, and the only physical work to date has been by Equinor drilling an injection well near Bergen. So it is a possibility - a distant possibility. Even Wikipedia describes CCS as an "attempt". And it has been discussed for more than 25 years.

15. Uranium large scale is **quite likely** an entrant and missing from your work. Nuclear like coal has restrictions on max gen, min gen, rate of change etc and thus not really suitable for load cycling (ignoring all the other issues) to balance against solar. Nuclear would make sense for supply to a large continuous load like an aluminium smelter or green hydrogen, etc.

16. The proven HELE coal technology is not listed.

17. VRE, variable renewable energy; wind, scale solar.
The use of tables with up to 90% is misleading.
As soon as jurisdictions moved over 55% of VRE as a % of consumption, all sorts of problems and complications started to emerge. I am sorry that I cannot give a reference, other than to refer to South Australia, Texas, California, UK; all of which luckily have neighbours.
The theoretical limit before overbuild or spillage is the capacity factor of wind, 29%, plus about half the capacity factor of solar, say 8%, being about 37% maximum share in the NEM (of VRE as a % of consumption). The economics change significantly beyond that, and cost data before and after that inflexion point would be telling.
Europe is celebrating reaching 22.3% in calendar 2022 after 25 years.
More relevant than up to 90% would be 35% to 60%, with gradually larger costs for firming and stabilising as the % increased. There is a big issue of determining the amount of energy storage systems needed and the amount of power system control needed for many technical factors. There is no table that specifies the amount of ESS in MW and GWh for various levels of renewable energy supply on a year by year basis into the future, nor the technical factors.

18. Extensive tables yearly from 2020 to 2050 impart a sense of precision and exactitude. Four lines by 10 year steps are more readable.

19. May I recommend you detail where the table B.8 and 9 formulae are, rather than hiding them in columns U to AD.

20. Now, this is difficult for me to express, and to express diplomatically.
I think the report is biased and contains too many straw men.
I notice from prior reports and review processes that people get bogged down in discussions at a micro level, like whether solar has a life of 25 years, etc. But from a macro or wholistic point of view, the report gives the appearance of being very biased in favour of wind and solar.
Recently I was trying to advise my niece who was having difficulties calculating capital gain cost bases on inherited shares. I suggested she write down her calculations and reasons, and make a reasonable estimate which favoured neither herself nor the tax commissioner.
Likewise, it would be more believable if you presented figures which did not favour any

particular generation. Wind and solar will require capital, dismantling of coal, are more distant, require a REZ, require 11,000KMS new transmission, vast amounts of firming and switching and grid management, etc.

I thank AEMO and the CSIRO for allowing me the opportunity to make suggestions.

B: THE BURDEN OF WIND AND SOLAR

14/2/23
To The Australian Energy Market Operator Ltd.
Dear Sirs,

GenCost takes no account of the cost of **backup**
in its cost for wind and solar. The grid will need 100% back up, apart from a little help from storage.

When introducing renewables into a grid such as the National Energy Market (NEM), which was in a relatively stable state, the cost of the system **must always rise** because of a second generating facility.

Said another way, renewables without blackouts, always require 100% back up.

The backup will come initially from batteries, hydro, and pumped hydro, but only to a small extent, and then **principally** from gas turbines.

Base load coal generation will gradually be replaced by equivalent gas recycling. Alinta Head Jeff Dimery, Oct 2022, calculates to replace their $1Bln coal fired power stations will cost $8Bln with firmed renewables.
And so, with wind and solar being introduced to a system, costs in the grid **must rise substantially**.

Now I wish to establish some premises:

In the NEM, wind has an average capacity factor of 29%, and solar 19%(AEMO 2022). And these will necessarily **fall** (as the best sites go first). There are four distinct times to consider. 1.When the wind blows and the sun shines 2. when the wind blows without sun 3.when the sun shines without wind and 4. when neither the wind blows nor the sun shines.
Of the 19% of current solar capacity I estimate 8%(at best) is non synchronous with wind.
So, 29 + 8 being 37%, is an inflexion point. Beyond 37% penetration (of demand) means that you have **overbuilt** and means that capital is duplicated, and that electricity is spilled.(Breakthrough Institute writers Jenkins and Trembath, 2015)(Also Note 3.)
When you have NO wind and NO solar you need gas. (It makes no difference how many times you duplicate wind and solar.) And the amount of gas needed is equal to the **full** demand of the system.
As demonstrated in South Australia, California, Texas, and the UK, wind and solar **have never** been able to exceed 55%, except with the help of neighbours. Due to stability requirements. I defy the study authors to prove otherwise. (Note 1)(Note 2).
Batteries are only good for stabilising, or for getting to the end of a 5min bid, otherwise exorbitant in cost, but great for gaming the system, as Hornsdale demonstrated in making $1M in 2 days (Wikipedia 'battery storage').
When wind and solar are both producing, the solar will jeopardise the wind (MORGAN 2015 "less than the Sum of Its Parts")

Now I proceed to my conclusions.

IT IS MY BELIEF, that the GenCost project tries to do too many things at the same time. It creates a time series, puts in unlikely scenarios, has high/low outcomes and varying diverse technologies, Carbon Capture and Storage (CCS), batteries for storage

I THINK GenCost needs to strip out these matters, and be stripped down to its basics.

Strip out storage batteries, CCS, rooftop, unlikely generators, premiums, time series of combined generators, penetration other than 35 - 55%, offshore (Note 4.), hydrogen, scenarios etc. I call these strawmen distractions.

Stripped to its basics, it would show:

- what happens when wind and solar are introduced to a grid
- what happens when baseload coal is replaced by gas recycling in the grid
- what happens before and after the inflexion point of 37% wind and solar
- what happens when solar trumps wind

For the moment let us keep our eye on the larger picture and not get hung up on the incidentals. We can do the refinement later. A time series is useful for each individual element. But allow the reader to combine elements and spread out individual combinations for themselves, like choosing Tetris blocks and putting them where you want.

The NEM is only just managing to date because it is utilising the previous 20% slack in the system (or 25% surplus 80+20=100).

Please read the following 1-5 slowly, because it is the opposite of what GenCost is doing now.

For decision making purposes, a correct analysis will:
For wind and solar:

1. The cost of curtailment of coal is a cost to VRE
2. The cost of demolishing coal is a cost to VRE
3. The cost of building gas recycling is a cost to VRE

If GenCost is not prepared to do this, **then** GenCost should itemise these costs separately. They should **definitely** not deduct the costs in the above three instances, from coal, coal and gas.

As minor points:

4. Batteries are a cost of firming to wind and solar.
5. The cost when solar curtails wind is a cost to solar.
6. Disposal of toxic substances in VRE is a cost to VRE.
7. Wind and solar do have operating costs. (Note 4.)
8. The LCOE for dispatchable and non-dispatchable technologies **must** be separated with warnings about comparisons (Note 5).

When doing a GenCost analysis, you cannot work with a mindset positively skewed towards wind and solar; you need to have a neutral or agnostic mindset; and if you cannot do that, you need to have a mindset that WIND AND SOLAR WILL ALWAYS BE A BURDEN on the system.

Dear GenCost, I appreciate my comments are sweeping and broad. I do appreciate how much work you have put into it, but I do not think you have the public with you. If anything, amongst those interested in the subject, the feeling is one of antagonism.
It would really help if we had a believable report.

Note 1.

Monckton January 2023.
An electrical civil engineer consulted widely among grid operators, generators and academic experts. He found widespread puzzlement that after a certain point – varying from species to species and grid to grid – adding more renewables either did not increase that species' share

of total grid output or resulted in ever-growing capacity-constraint payments or do-not-generate orders to renewables generators at times of high wind, strong sun or low demand.

Note 2.

Europe renewables have reached 22.3% in calendar 2022 after 25 years. In the USA 2021 renewable energy sources accounted for about 19.8% of total utility-scaled electricity generation.

Note 3.

The best wind farm in Australia got up to 48.4%, and best solar got 26.4%. BUT don't get carried away by the extremes. The 15th best wind was only 35% and solar was 22%. And there are at least 100 each. In fact actual NEM are wind 29%, and solar 19%. Even with 10% overbuild, we only need 32% wind and 21% solar penetration. **These are small numbers**. And we are well passed these. So Australia is now wasting capital and electricity.

Note 4.

There is a guest article by Bill Ponton
2023 February 11
The Cost of Virtue Signaling – the Impact of Doubling UK Wind Power on the site
https://wattsupwiththat.com/2023/02/11/the-cost-of-virtue-signaling-the-impact-of-doubling-uk-wind-power/
In the UK, the 28GW of wind power has a capacity 25.1% (including the windy North Sea) producing 245,000 GWHr, being 24% of demand. Combined cycle gas turbine (CCGT) produces 43%. If wind generation were to be doubled and gas turbine reduced, wind will sometimes be spilled and the turbines must be kept running at a minimum 2GW (but that is only for 0.25% of the time), 31,000 GWHr or 51% of the new wind generation will be curtailed and the proportions of wind/gas will change from 24%/43% to 36%/31%. The writer concludes that (add financing and deduct gas saving for 20 years) the cost of US$185B must be disappointing to true believers in the virtue of wind power. Moreover, the cost of this scheme **dwarfs** the cost of a scheme that includes battery storage as a way of increasing the contribution from wind power generation.
Table 4 itemises the costs to double wind generation in the UK.
The capital cost of building wind power generation, excluding financing expense, is $6,041 USD/kW for offshore and $1,718 USD/kw for onshore(eia). An additional 14 GW offshore and 14 GW onshore would cost in capital $84,574,000,000 and $24,052,000,000, respectively. The additional wind power generation O&M cost is $115 USD/kW-y for offshore and $27 USD/kW-y for onshore(eia). An additional 14 GW offshore and 14 GW onshore would cost in O&M $1,610,000,000/year and $378,000,000/year, respectively, as shown in Table 4.
Table 4

		Wind Power Capital Cost		Wind Power O&M Cost	
	GW	USD/kW	USD	USD/kW-y	USD/yr
Offshore Wind (UK)	14	$6,041	$84,574,000,000	$115	$1,610,000,000
Onshore Wind (UK)	14	$1,718	$24,052,000,000	$27	$378,000,000
Total Wind (UK)	28		**$108,626,000,000**		**$1,988,000,000**

The direct reference to eia is:
https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf (note 4 in article) which is from Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2022 by USEIA.

Note 5.

The US EIA warns that LCOE comparisons are not applicable between dispatchable and non-dispatchable technologies. From

https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf:
Because load must be balanced on a continuous basis, generating units with the capability to vary output to follow demand (dispatchable technologies) generally have more value to a system than less flexible units (non-dispatchable technologies), or than units using intermittent resource to operate. The LCOE values for dispatchable and non-dispatchable technologies are listed separately in the tables, because comparing them must be done carefully. … The direct comparison of LCOE across technologies is, therefore, often problematic and can be misleading as a method to assess the economic competitiveness of various generation alternatives because projected utilization rates, the existing resource mix, and capacity values can all vary dramatically across regions where new generation capacity may be needed.

C: Comments to the online Australian newspaper 2022

16/2/23
Mr Paul Graham
The Convenor
AEMO NEM
Dear Sir,

I attach a submission to the GenCost study into 2023 Inputs Assumptions and Scenarios Consultation When the GenCost study came out last year, a journalist wrote an article in the Australian which received 102 comments. I have chosen the more substantial ones and distilled them down and set them out below. I am including the site reference.
Will AEMO and the CSIRO please respond to these comments, not just in a broad brush manner, but one by one respecting each individual and their concerns.

Renewables 'the cheapest and getting even cheaper': CSIRO GenCost report
By MATT BELL
BUSINESS REPORTER
https://www.theaustralian.com.au/business/renewable-energy-economy/renewables-the-cheapest-and-getting-even-cheaper-csiro-gencost-report/news-story/6ab903ceda5a21f78308352b20a61ef8
COMMENTS TO THE ONLINE AUSTRALIAN NEWSPAPER 2022

- Michael
  - How does the CSIRO justify technologies getting cheaper the more aggressively the world deploys them. Economies of scale are likely the reason. But the scale is truly enormous, the time frame relatively short, and the demand for new supply of critical materials, and the factories to manufacture products, to transport and install them will likely overwhelm supply.
- Jim
  - The true comparative costs should be the **System** Levelised Costs of (new-build) Energy, which includes all the add-ons, such as the necessary backup 24/7 fossil based generation facilities that are essential to make a comparable 24/7 available grid.
  - Secondly, renewables are too expensive at any price, because they cannot provide a 24/7, 50Hz grid.
- Jim
  - Community batteries are only one small step less dangerous and grid destabilising than rooftop solar with batteries. Please comment particularly so as GenCost proudly boasted that Australia has the world's largest penetration of rooftop solar.
- A+A
  - How come there is a direct positive proportionality between the price of electricity in a country/state and the % of "renewables" in the system?
- Peter
  - I live in South Australia. If renewables are so cheap why has my electricity bill gone up?
- Geoff
  - It might be true that "renewables are holding steady as the lowest cost source of new-build electricity" , but it doesn't account for additional network costs and costs involved to install and operate back-up generators when renewables are either not generating or generating negligible amounts of power.
- Snoopy

    - Renewables are only viable as long as somebody else has to pay for the gas fired power station to sit on standby earning no money when the wind blows and the sun shines, but if this cost was sheeted home to where it belongs intermittent wind and solar become uneconomic as well as a shocking waste of space.
- Diogenes
    - "Renewable" energy is not becoming cheaper. Rather, it is becoming cheaper than its competition, fossil-based electricity. This has been achieved by the social engineers, who have tripled the cost of fossil-generated power by reducing the latter's supply.
- Blair - one
    - The need for clean energy depends on emissions of CO2 causing global warming. So, it is not prudent to risk on unproved speculation. There is an urgent need for a **Science Commission** to first prove that (i) Emissions of carbon dioxide (CO2) are the trigger for global warming and (ii) scientifically prove that warming is the trigger for any adverse climate change, and (iii) lay out the empirical evidence that reducing emissions of CO2 will improve the climate.
- Blair - two
    - He asserts that renewable energy is only cheaper than fossil fuels, with (a) subsidies (b) ignoring fossil fuel back-up and (c) ignoring the cost of new infrastructure. What are the costs with these?
- Michael
    - You will need a least 5x the installed capacity for renewable technology due to their inherent high/low generation cycles. If you install a kW of solar, you are lucky to get 200W out of it on a sustained basis.
    - A kW of coal fire power will give you a kW.
    - If you multiply the renewable costs by 5 and add the backup cost of baseline power or big batteries, then the costs skyrocket.
- Chris
    - The Chinese Communist Party has cartel control over renewables hardware supply chains, that can and will be leveraged globally. The current low prices of wind/solar will be history when it comes time for replacement. It is the giant panda in the room**.**
- Robert
    - Looks like one of those extremely complicated models in which the modellers can come up with any scenario and cost they want.
- Peanuts
    - Renewables can't provide reliable base load. Renewable storage is inefficient. Renewables have frequency problems.
- Graeme#4
    - But all they have generated here is a political report, with an outcome to match the current government aspirations. I believe that the Australian public has been badly let down.
- Howard
    - No mention of the environmental issues and massive cost of disposal.
- Graeme#4
    - Adding even a modest level of backup to wind increases its cost difference to over 2.5 times that of USC coal, and solar blows out to over three times more expensive.
- Shane
    - To compare costs, you need the same product, so the intermittent renewables need to add the costs of storage to make them deliver service 24 hours a day 7 days a week.

- Andrew
    - Another deceptive report.
      Solar and wind, need to be at least 9x cheaper than coal or gas before they are cost competitive on a like basis with fossil fuels.
    - Renewables need to be backed up with a huge battery, and to recharge the battery from overnight use, you need 100% excess solar power during the day.
    - To replace every GW of steady fossil fuel power in a 24 hour period, you need 3GW of renewable capacity (2xsolar and 1xbattery)
    - But batteries and panels last about 15-20 years max, whereas fossil fuel power plants last about 50 years.
    - So you need to rebuild your renewables capacity 3x over every 50 years, compared to conventional power, thus, 3x3=9 times the cost.
    - There will never be a battery big enough to do this, so renewables can't work.
- Timothy
    - How can wind energy improve its capacity factor over time?
- David
    - The cost of the **whole system** should be compared. Generation costs plus distribution cost, new infrastructure, grid stabilisation costs and of course back up costs. Then we would have a fair comparison.

END OF STATEMENTS TO BE ANSWERED.

D: GenCost - Tell It Like It Is.

Dear GenCost,

How about coming clean with the Australian Public and tell it like it is.

Tell us:

1. That the addition of wind and solar to the grid adds cost.
2. That when solar and wind are producing at the same time, the solar will cannibalise the wind generation.
3. That beyond the capacity limits of wind and solar the grid steps up further in expense from overbuilding or curtailment.
4. That batteries are humongously expensive, only good for firming and stabilising or for a few minutes.
5. That wind and solar require backup generation for when the wind does not blow and the sun does not shine.
6. That hydro and pumped hydro are good but provide just a small amount of backup.
7. That instantaneous backup requires construction of expensive new gas fired generators which makes the grid even more expensive.
8. That it is technically extremely difficult to get beyond 50% of wind and solar, and very expensive.
9. That the NEM has just about managed so far because of the previous built-in 25% surplus capacity.
10. That it is inaccurate that you are allowing to be perpetuated on the Australian Public that "wind and solar are the cheapest form of electricity" except -
11. That "cheap" wind and solar electricity can only provide about one third of our needs, when there is sun or wind, but the level of power will be unreliable, and continuity of supply be intermittent.
12. TWELVE Written by Francis Menton 8th February, 2023

Could anybody possibly be stupid enough to believe the line that wind & solar generators can provide reliable electricity to consumers that is cheaper than electricity generated by fossil fuels? It takes hardly any thought about the matter to realize that wind & solar don't work when it is calm & dark, as it often is . . .Thus a wind/solar electricity system needs full backup, or alternatively storage — things that add to & multiply costs. Surely, our political leaders & top energy gurus are fully aware of these things & would not try to mislead the public about the cost of electricity from a predominantly wind/solar system.