REVISED SUBMISSION TO AEMO

RE: CSIRO 2024-2025 GenCost Report

Consultation Draft – December 2024

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General Comments.

It is pleasing to see that the nuclear option is now treated seriously and that the costing data is now far more realistic.

However, **there is serious concern that the results of the report in providing direct generating cost information are widely misrepresented as the cost of electricity supply**. It is only possible to draw conclusions about supply cost and the impact of the inclusion of individual generating technologies into the power generation system on the overall electricity supply cost by detailed modelling and economic analysis of the total system.

In this regard the Levelized Cost of Electricity (LCOE) is a stand-alone figure for each technology and does not provide any meaningful comparative value of the cost of energy supply. It may relate closely to the cost of generation but not to the total system required to supply energy to the consumer including energy storage and emergency generation.

Nuclear power does not need support services and if used as base load supply in conjunction with solar PV and wind can substantially reduce the amount of energy storage and emergency generation services required. This can effectively reduce the overall supply cost below that supplied by renewables alone with extended storage and other measures such as emergency generation using gas. Different technologies such as wind and solar can complement each other and the energy storage with a mix of the two can be lower than for each individual technology alone. Performance is dependent on location and the prevailing weather conditions and will vary from one place to another. This can only be evaluated by system modelling.

For this reason, it is suggested that LCOE should be highly qualified or removed from the report as a highly misleading figure as it is widely misinterpreted by politicians including the Minister for Energy and the Press as the cost of electricity supply from the various technologies, which it clearly is not. The report has attempted to modify LCOE by adding firming costs, but this is a futile exercise since it is the mix of generating technologies and supporting facilities and the interplay between the different technologies and location which determine the firming requirements and the final energy supply cost.

It is recommended that the report should include a clear statement on the difference between the cost of generation and supply, particularly for variable generation technologies, and make every attempt to deter such misrepresentations being made.

Section 2.1 Nuclear capital recovery and long operational life.

It is agreed that the annual generation costs for different technologies should be developed on a common basis and should be independent of subsidy considerations for any of the technologies. However, it is not accepted that long operational life has no major financial benefit to electricity customers relative to shorter- lived technologies. The GenCost report attempts to justify this position by various manipulations for costing energy at different stages in the life of the particular facility, initially and after various refurbishments over a common period of time. This is highly artificial and arbitrary and by no means realistic given the commercial basis used for electricity pricing normally applied.

Otherwise, the use of a standard 30 year life for all technologies penalises the costing of long life facilities such as nuclear and advantages solar and wind to some degree. The alternative of using actual project life has been criticised in the report since nuclear may require some refurbishment after 40 years and wind and solar PV can be constructed at the end of their normal lifespan at much lower cost than the original capital expenditure. This is valid, and to provide a common method of quantifying the annual capital recovery charge it is suggested that this may be best approached from the present value of all capital expenses over a long period of say 70 years including decommissioning costs at the end of that period. This can be expressed as an equivalent annual cost over that time or as a capital recovery factor applied to the original construction cost.

For example, a nuclear plant might have a life of 70 years and for a single initial outlay the capital recovery factor is 0.07062 at an interest rate of 7%. If the plant is refurbished after 40 years at a cost of 30% of the initial capital and decommissioned at the end of 70 years at 12% of initial capital, then the capital recovery factor is 0.07212. The annual capital recovery cost in that case is 2.1% higher than for the initial single outlay case.

For solar PV with a life of 25 years the single outlay capital recovery factor is 0.08581. For a project life of 70 years there will be a reconstruction in year 25 and another in year 50 at a cost of 45% of the initial capital expenditure. At year 70 decommissioning will cost 15% of the initial cost. This scenario will give a capital recovery factor of 0.07784 which is 10% lower than the single life case. Another consideration for solar PV is that the output declines with time at around 0.8% per year but is revived at each reconstruction. The average output over 70 years is then around 95% of nominal capacity.

For onshore wind the life is determined primarily by replacement of the blades at around 22 years and together with replacement of other mechanical parts will cost of the order of 25% of the initial capital expenditure. Decommissioning is taken as 20% of the initial capital cost. The single use capital recovery factor in this case is 0.09041 and the 70 year capital recovery factor is 0.07758 which is 16% lower than the single life case.

It is suggested that an approach along these lines would provide a more representative comparison of the generating costs considering differences in life of major components and the opportunity for reconstruction of the lower life technologies. On this basis the comparative cost of energy generation for solar PV, wind and nuclear would be as shown in the following Table.

	Solar PV	Wind	Nuclear
Energy generated kWh per kW installed	1830	2978	7884
Capital cost $/kW	1141	2491	8655
Amortization charge $pa per kW	88.82	193.25	624.2
Operating and maintenance $pa/kW	12.0	28	216
Fuel cost $pa			63.1
Total annual cost $pa per kW installed	100.82	221.25	903.3
Cost of generation $/ MWh	**55.1**	**74.3**	**114.6**
Normal single life LCOE $/ MWh	60.0	85.0	112.9
GenCost Report LCOE range $/MWh	35-62	56-96	150-245

Clearly it would appear that the GenCost Report significantly amplifies the generating cost of nuclear in comparison with wind and solar through the various manipulations. Unfortunately, this gives the continuing impression of bias against nuclear in support of the Government position.

Section 2.2 Nuclear capacity factor range.

The calculations given in the above Table for comparative generation costs assumed capacity factors of 22% for solar PV and 34% for on-shore wind and 90% for nuclear. This section of the GenCost Report discusses the appropriate capacity factors for nuclear and cites international experience and capacity factors for coal plants. This is experience from an electricity supply system based predominantly on thermal generation facilities using either nuclear or fossil fuels where those facilities need to follow demand variations. It is not relevant to the situation where nuclear is used to only provide base load power in a mix with solar PV and wind which together with storage can service the variable component of the energy demand. In that case the base load generator is able to operate steadily with a capacity factor of at least 90%. This significantly impacts the cost of energy generated depending on how nuclear is used within the energy mix, and since it is clear that nuclear is best used for base load supply, it is suggested that such a distinction needs to be made in the report. Again, this tends to demonstrate some bias against nuclear.

Section 6 Levelised cost of electricity analysis.

The report acknowledges that LCOE is "a simple screening tool for quickly determining the relative competitiveness of electricity generation technologies. It is not a substitute for detailed project cash flow analysis or electricity system modelling which both provide more realistic representations of electricity generation project costs and performance." This statement should be expanded and emphasised to the effect that the cost of generation represented by the LCOE **does not represent the cost of electricity supply**, particularly if the source is intermittent and variable as in the case of renewable energy.

Section 6.2 discusses the inclusion of the cost of 'firming facilities' such as storage and emergency gas into the LCOE for solar PV and wind, but it is contended that this is not feasible with a system composed of a number of different generation methods. Different technologies such as wind and solar can complement each other and the energy storage with a mix of the two can be lower than for each individual technology alone. Performance is dependent on location and the prevailing weather conditions and will vary from one place to another.

It must be appreciated that the requirement for energy storage is firstly a function of weather conditions which requires detailed modelling, but is also dependent on:-

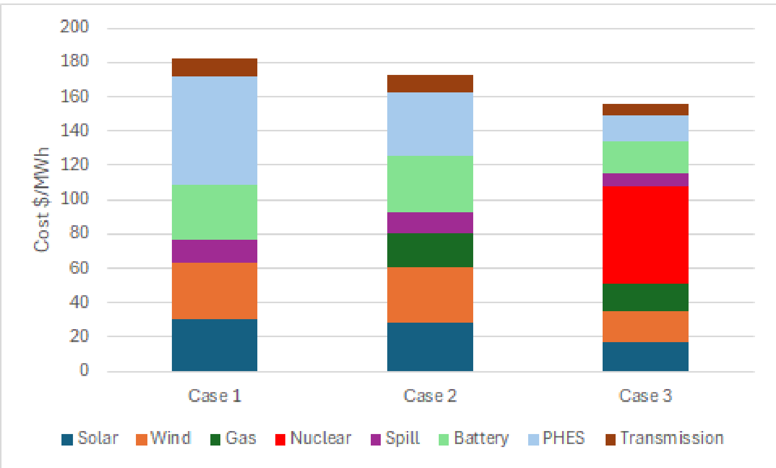
- The excess capacity of wind and solar installations above that needed to meet the average demand.
- The amount of base load generation provided.
- The amount of emergency generation available from hydro and gas turbines.

Storage will be provided primarily by batteries as suitable for short term storage of a few hours plus pumped hydro (PHES) for longer term storage to cover days of poor weather conditions.

Modelling is necessary to account for the variability of renewable generation due to weather conditions and to define the optimum mix of generating methods, storage needs and emergency generation, which will lead to the total cost of the system and energy supply. This is the only way to measure the contribution of each component to the system and whether nuclear base load is a worthwhile inclusion. As a simple example, the following provides the results of a simple model based on the weather data for Melbourne Airport covering three generation mix scenarios:-

1. Renewables (50% wind and 50% solar PV) alone
2. Renewables + emergency generation from hydro and gas (4% of total demand).
3. Renewables + emergency generation + base load nuclear (40% of total annual demand).

In each case the necessary energy storage is calculated to enable a typical daily and seasonal demand profile to be met at all times. The total annual cost and cost of electricity per MWh is calculated using cost data similar to that given in the GenCost Report with the exception of nuclear for which the capital cost was taken as $10,800/ kW installed. Results are shown in the following chart.



As illustrated, the cost of electricity generation increases significantly in moving from renewables only to the inclusion of nuclear base load. However, the decline in the cost of storage more than compensates and the overall cost of supply decreases from close to $180/ MWh for renewables to $155/ MWh with base load nuclear in the mix.

System modelling such as this for the NEM system is quite complex. It is not the remit of CSIRO and should be the role of AEMO. Based on the cost data provided, modelling also requires other data such as the demand requirements for the NEM and weather conditions at various generating locations, with the outcome of developing the total annual cost of the system and defining the optimum energy mix and path to net zero emissions. Unfortunately, that role is constrained by a requirement for AEMO to conform with government policies which does not include nuclear in the energy generation mix. This would appear to be an untenable situation and is why the present Government appears to rely on misrepresenting the LCOE as the cost of energy supply to justify the exclusion of nuclear without allowing proper evaluation through system modelling.

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