Submission on the Planning and Forecasting Consultation on Inputs, Assumptions and Scenarios 2020-21

Senator Gerard Rennick

It is a pleasure to make this submission to the Planning and Forecasting Consultation on the Inputs, Assumptions and scenarios relating to the CSIRO's GenCost 2020-21 draft.

Every two years, CSIRO and AEMO release an updated estimate of the projected costs to generate electricity in Australia. The stakeholder engagement, and drafting phase is an important part of ensuring that the projections are based on practical assumptions and take into account all criteria relevant to the cost of electricity within Australia.

The cost of electricity, and power generation, particularly when comparing that of renewable energy and alternatives remains at the forefront of Australian politics. At a time where energy prices are soaring across the nation it is vital that any projections are based on realistic assumptions taking into account all relevant factors accurately.

It is not in the best interest of the nation and would be indeed be detrimental to the nationwide belief and understanding of renewables if these projections and assumptions are shaped around a prejudicial mind set. It is therefore important that the projections are created without bias for or against particular forms of energy generation.

The stakeholder engagement with respect to the validity and practicality of the assumptions gives an important opportunity for external sources to scrutinise the GenCost 2020-21 document and relevant assumption. As a Senator for Queensland, I am grateful for the opportunity to hear the views expressed by a wide range of people, from various professional and social backgrounds on a number of issues every year.

While many opinions and views expressed only relate to particular parts of public policy there are a number of issues and concerns that a great many Queenslanders share, and I will be drawing on some of these within this submission.

I submit the following recommendations for both the GenCost 2020-21 document and the relevant assumptions for consideration of AEMO:

1. That many assumptions within the document be reconsidered and adjusted to reflect practical scenarios, rather than the apparent bias currently present with the GenCost 2020-21 report. Currently these assumptions do not consider current research in the fields and present a bias against particular sources of energy production. Key assumptions that should be reconsidered and adjusted include:
    - I) Future government policy, particularly focussing on the carbon pricing and risk premiums quoted in GenCost 2020-21;
    - II) The capacity factor for energy sources;
    - III) Lifetime of a battery and underestimation of associated costs;
    - IV) The level of SMR reactors in any low emission scenarios
    - V) The cost of fuel, particularly for coal and
    - VI) The use of economic life rather than technical life
2. Costs for various environmental and social impacts related to various alternative technologies.

Assumptions

I) Future government policies

The paper has assumed a standardised carbon pricing scheme that increases up to \$386.7/ton CO_2 by 2050, in conjunction with a 5% risk premium also being applied to all fossil fuels. In the GenCost document the carbon pricing for 2020 is listed at between \$18.1-\$30.7/ton of CO_2.

At present, in 2021 there is no carbon price, nor is it the policy of the current government to implement a carbon price at any point. To assume that by the end of the decade, pricing could reach \$30.7/CO_2 is to assume radical deviation from both major party policies, neither of which have proposed carbon pricing schemes.[1]

It is not the role of the CSIRO to insert their own policy beliefs into policy documents when estimating future costs.

In Australia our constitution divides our three key powers of government, the legislature, those who create the laws, the executive, those who enforce the laws, and the judicature those who conclusively

[1] Climate Council, *Climate Policies of Major Australian Political Parties* (Report, May 2019)

determine disputes with the law.[2] It is clearly defined in the constitution that a separation of powers exists whereby the executive does not create laws unless delegated to do so by the legislature.[3]

As members of the public service, acting under the statutory authority constituted and operating under the provisions of the Science and Industry Research Act 1949 the CSIRO forms part of the executive branch of government.[4] To overreach into non-delegated policy creation as the CSIRO have done within the GenCost 2020-12 report, is to break the foundational pillar of the Australian constitution.

Therefore, it is the recommendation of this submission that assumptions on climate policy be based on directions given by relevant government ministers, not what unelected public officials believe the government should be doing.

This is not to say that recommendation of public policy by the CSIRO is not a necessary feature of our scientific body, quite the contrary. However, these recommendations belong in separate reports that clearly outline their purpose as *policy advice*.

a. Risk premiums

The 5% risk premiums applied to fossil fuel has sound scientific reasoning and is not the focus of this recommendation, rather it is the lack of risk premiums added to renewable sources be of concern. It is well established that within Australia the integration into renewable energy and subsequent closure to fossil fuel power stations, in particular coal, has come with a substantial cost increase in electricity prices Australia wide.

In the past few year's issues with the integration of renewable energy have become more prominent.[5] This issue has arisen primarily due to relatively weak transmission networks available for renewable energy sources.[6] It is not being disputed that fossil fuels will have a certain level of risk in the future. However where an issue arises, is that while a risk premium has been added for potential issues with fossil fuels, no risk premium was added to the adoption of renewables, which currently cause major increases in the cost of electricity as they integrate into the national energy grid.

For example, since the closure of the Hazelwood cost of electricity has more than doubled from $52 per MWh to over $126 per MWh in 2019.[7] A similar situation can be seen across the world. A key

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[2] *Commonwealth of Australia Act* 1900 (cth). ('*The Constituion*')
[3] Ibid.
[4] *Science and Industry Research Act* 1949 (cth); *The Constitution* (n 2).
[5] Australian Energy Regulator *State of the Energy market* (Report, 2020).
[6] Ibid.
[7] Ibid

example can be seen in Germany who announced that it would phase out baseload nuclear energy in 2011, and subsequently shutdown 8 power stations. Since this announcement the cost of electricity in Germany has risen from approximately 115 euros per MWh in late 2010 to over 155 euros per MWh in 2014 where it has remained since.[8] It is worth noting that the German government placed significant focus on transitioning renewable into the energy market in the same period of time which as predicted resulted in the single greatest yearly increase in electricity cost in the last decade, increasing from 143.5 euros in per MWh in 2013 to 155.3 euros per MWh in 2014(these prices do not include taxes or levies, actual cost have since exceeded 300 euros per MWh).[9] Therefore as a result of the adoption of renewables and subsequent closure of non-renewable power stations such as coal and nuclear Germany has the highest electricity price in Europe. [10]

A similar occurrence is currently being witnessed in Belgium and should continue to be observed to record the effects of removing baseload energy for renewable sources and determine an accurate risk premium for renewable energy sources. [11] Currently Belgium supports the third most expensive electricity in Europe.[12]

It is a recommendation of this submission that the risk premiums also be applied to renewables to reflect the inevitable cost increase following the phase out of fossil fuel power stations. It is also recommended that more research is placed into determining the consequence of rapid replacement of fossil fuels with renewable energy technologies to apply the most appropriate risk premium to future reports.

II) Capacity factor

The capacity factor of a power generator measures the overall utilization of a power generation facility.[13] It is measured as a percentage of actual generation compared to the maximum possible generation in a given period of time without interruption.[14] It plays an obviously important role in determining the cost associated with energy production as it is the key statistic used to determine a

[8] N. Sönnichsen, *Germany: Industry Prices of Electricity 2008-2019* (Report, October 2020)
[9] David Buchan, *The Energiewende – Germany's gamble* (The Oxford Institute for Energy Studies, 2012)
[10] EuroStat, *Energy Statistics* (Report, 2020) ('*EuroStat*')
[11] Nuclear Power in Belgium, *World Nuclear Association* (Web Page, January 2021) <https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/belgium.aspx>
[12] *EuroStat (n10)*
[13] Jorge Morales Pedraza *Conventional Energy in North America: Current and Future Sources for Electricity Generation*, (Elsevier Inc.)
[14] Ibid

power plants reliability.[15] Obviously a more reliable power plant will have lower costs associated with it then a less reliable plant. The given range provided by the GenCost 2020-21 is as follows:

- Coal and Nuclear energy all have a stated capacity factor of 60% to 80%;
- Solar power has an energy capacity is listed at 22% to 32%;
- Wind power has an energy capacity is listed at 35% to 44%.

Firstly, the assumption associated with the capacity factor for coal powered energy is grossly underestimated. Coal without Carbon Capture storage (CCS) is commonly given an average capacity factor of 82-90% for many studies worldwide. When carbon capture storage is applied this range lies between 81-89%.[16] To place the highest possible capacity factor for coal fired power stations below the average 80-85% range is unrealistic and should be corrected for future calculations. Listed below are capacity factors for Australian coal power, published in a submission to the 2017 Finkel Review in the future security of the NEM.

Table 1

Power station	Type of Fuel	Capacity factor	Financial year
Bayswater	Black Coal	93.30%	15/16
Power Station	**Type of Fuel**	**Capacity Factor**	**Financial year**
Gladstone	Black Coal	91.10%	15/16
Kogan Creek	Black Coal	91.40%	15/16
Millmerran	Black Coal	86.50%	15/16
Stanwell	Black Coal	95.60%	15/16
Tarong	Black Coal	96.00%	15/16
Tarong North	Black Coal	98.00%	15/16
Average	92.85%[17]		

Based on the above data, the GenCost LCOE calculation assumptions for the capacity factor of black coal powered fire stations should more accurately reflect that which is present in Australia currently, rather than the underestimations currently present in report.

Secondly Nuclear Small module reactors have one of the highest capacity factors in the world. According the United States Energy Information Administration nuclear energy averages a capacity

[15] '*Capacity Factor – A Measure of Reliability*', Duke Energy, (Web page, 18 February 2015) <https://nuclear.duke-energy.com/2015/02/18/capacity-factor-a-measure-of-reliability>
[16] Solstice Development Services Pty Ltd, *Prospects for a HELE USC Coal-Fired Power Station* (Report, June 2017)
[17] Walter Gerardi and Pan Galanis, *Report to the Independent Review into the Future Security of the National Electricity Market – Emissions mitigation policies and Security of electricity supply* (Report, 21 June 2017) ('*NEM security*')

factor of 93.5%.[18] According to Duke Energy in 2015 the average capacity factor for Nuclear is also about 93%. However, based on the GenCost document the highest listed capacity factor is 13.5 points less than this, listed at 80%. Nuclear energy produces reliable, carbon free energy with the highest capacity factor in the world. To suggest that newly built small module nuclear reactors would have a capacity factor 13.5 points less than the world average is a flawed assumption and therefore should be adjusted to reflect the accurate capacity factor of nuclear energy.

The AEMO annual report card for Renewable energy zones uses nine reference years to grade certain geographical zones based on their capacity factor. The average grade for solar power in the renewable energy zones in Australia was between 26% and 28% leaning for towards the 26% range.[19] For wind the average range was between 35% and 40% once again tending to lean more towards the 35% range. [20] This report was published in June 2020. It should be noted that the current GenCost report lists the range of solar PV within this stated range so the capacity factor of solar will not be discussed. However, in the GenCost 2020-21 report the capacity factor of wind has a minimum of 35%. It should be noted that the lowest grade received for wind was a D representing the 30% range. Therefore, the high and low assumptions for the capacity factor of wind power should reflect this. [21]

It is also an important point to make that that LCOE assumptions do not take into account the reliability of the renewable energy. Based on the afore mentioned report card the average grade for the correlation between regional demand and energy availability in the 2020 report, was between and an E and an F representing the lowest possible grades. Given such a low correlation, the need for constant firming factors or storage capacity should be given increased weight. It is therefore the recommendation of this submission that the correlation between supply and demand of energy for all energy source be included to accurately reflect pricing.

III) Lifetime of a battery and associated costs of renewables

The cost of battery usage is largely dependent on a number of factors. Discharge time, lifetime or maximum number of cycles of a battery and the technology used within the battery. While not explicitly stated within the CSIRO GenCost 2020-21 document, it is assumed that the battery type

[18]'What is Generation Capacity?', *Office of Nuclear Energy* (Web page, 1 May 2020) <https://www.energy.gov/ne/articles/what-generation-capacity>
[19] AEMO, *2020 ISP Appendix 5. Renewable Energy Zone*, (Report, July 2020)
[20] Ibid
[21] Ibid

referred to is a lithium-ion battery. There are several key errors within the current inputs and assumptions workbook in relation to the cost of batteries.

The first issue is that the allowable minimum state of charge is 0% and the maximum allowable state of charge is 100%. Similar studies into cost of large sale lithium ion batteries generally use a depth of charge(DoD) of around 80% .[22] Reducing a battery to 0% shortens the lifetime of a battery.[23] Likewise, it is suggested that for lithium ion batteries, a partial charge(not 100%) is often more optimal for the lifetime of the battery. As such, if AEMO are to use a maximum state of charge of 100% and minimum state of charge of 0%, the lifetime assumption should reflect this. It is the recommendation of this submission that the lifetime of the battery reflect the stated depth of discharge i.e. If the discharge remains at 100% the lifetime assumption of the battery should be reduced.

The second issue is that the stated economic and technical lifetime of the batteries, ranging from 1-8-hour batteries, is 20 years. A 2018 US study showed the lifetime of Lithium-Ion batteries to be approximately 10 years or 3500 cycles at a DoD of 80%.[24] The largest lithium ion battery in the world, Tesla's Hornsdale Power Reserve located in South Australia has a lifetime of 15 years.[25] There is currently no available data to support the assumption of a 20 year technical lifetime. It is the recommendation that the CSIRO GenCost document and the Inputs and Assumptions workbook be revised to reduce the lifetime of batteries and include the maximum number of cycles a battery can go through. The pricing would therefore be adjusted to reflect the time taken and cost associated with replacing the batteries after a specific number of cycles or 10-15 years of use.

a. Additional network costs are ignored.

The final key point is that significant network additional network costs, due to a higher reliance on renewables is ignored.

These costs include more transmission lines, a greater need for security services such as inertia control, frequency control, dispatchability capability and recycling.

[22] K Mongird et al., US Department of Energy, *Energy Storage Technology and Cost Characterization Report* (Report, July 2019) ('*Mongird et al.')*

[23] Kerry Thoubboron, 'Depth of Discharge (DoD): What does it mean for your battery, and why is it important?', *Energsage* (News Feed, 3 June 2019)

[24] *Mongird et al. (n22)*

[25] 'Our Process', *Hornsdale Power Reserve* (Web Page, 2020) <https://hornsdalepowerreserve.com.au/our-process/>

Renewables require a much larger transmission network then is currently in place. This will not only incur greater capital and running costs but also increase the volatility of the grid as energy will need to be transported greater and greater distances more frequently.

Baseload power also provides security services such as frequency control, inertia control and system strength. To overcome the loss of these services as coal is removed from the network more synchronous condensers and batteries will be needed.

These additional costs have not been included. It is expected that these costs will rise exponentially as the grid relies more and more on unreliable renewable power and less on baseload energy.

IV) The assumption that nuclear energy will have no future role

Nuclear energy has consistently been the most efficient source of energy available.[26] Its emission free, reliable cheap energy makes it the most suitable form of electricity for a world which is rapidly driving towards net 0 emission by 2050. Without the role of nuclear power, it is a well-established fact that combatting climate change and driving down emissions is a much more difficult and costly process. The high VRE scenario is defined within the GenCost report as a situation where we are in "a world driving towards net zero emissions by 2050". The high VRE scenario assumes that there is a high level of coal, gas and oil-based generation plant retirement as a result of the earlier deployment of renewable energy. The exclusion of Nuclear options in this scenario is a major flaw in the GenCost assumptions.

The ability for nuclear energy to immediately replace coal, gas and oil-based generation plants makes it an ideal candidate in an emission free environment. The international energy agency has stated that "alongside renewables, energy efficiency and other innovative technologies, nuclear can make a significant contribution to achieving sustainable energy goals and enhancing energy security".

France has one of the smallest per capita emissions in the G20 and excluding Argentina is the lowest total emissions out of all G20 nations.[27] France's electricity generation is approximately 71% nuclear energy.[28] In 2019, when comparing costs of electricity for other G20 nations within the

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[26] Bob van der Zwaan, 'The role of nuclear power in mitigating emissions from electricity generation' (2012) 1(4) *Energy strategy Reviews*
[27] Muntean Marilena et al., *Fossil CO2 emissions of all world countries* (Report, 2018) ('*Emissions report')*
[28] 'Nuclear Power in France', *World Nuclear Association* (Web Page, January 2021) <https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx>

European union, France also has the cheapest electricity.[29] To put in perspective, in comparison with these same nations, France also has the second lowest renewable energy share after the UK.[30]

France is not an isolated case; Hungary gains approximately 55% of its total energy from nuclear energy. It has approximately the same emission per capita as France and in 2017. It also had similar total emissions as Finland and Sweden, both nations which rely heavily on renewable energy sources for electricity production. [31] Hungary is also recognised as having some of the lowest electricity prices in Europe, with energy prices at approximately 112 euros per MWh (incorporating tax and levies). To draw a comparison Germany, which as previously discussed phased out nuclear and coal-based energy to drive towards a more renewable focussed energy market has electricity prices almost 3 times that of Hungary with prices exceeding 300 euros per MWh.[32]

Sweden a nation with approximately 50% renewable energy (thanks to hydro) also gains about 40% of its electricity generation from nuclear energy.[33] Once again Sweden has one of the lowest emissions per capita and total emission in Europe while also maintaining relatively low electricity costs in comparison to the rest of Europe. [34]

It is widely accepted, that the large-scale usage of Nuclear energy allowed for the rapid adoption of renewable energy within Sweden. This is also the case in Finland (32.4% nuclear power), Spain (20.4% Nuclear power), Bulgaria (34.7% nuclear) and Switzerland(37.7% nuclear power) all supporting high percentage of renewable energy(many global leaders in renewable energy generation) at a low cost in comparison to the rest of Europe.[35] This supports the conclusion that any pathway towards net zero emissions should incorporate an increased adoption of nuclear energy, thus also allowing for increased research in the field.

Overall, without Nuclear energy, the firming factors needed to support the cost-effective implementation of renewable energy are either not present or too expensive to be economically viable. The only other valid alternative is the adoption of large-scale hydro power which in some cases is not an option due to the specific geographical needs of a hydro power station. [36]

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[29] *Emissions report* (n 27)
[30] Ibid
[31] 'Top 15 Nuclear Generating Countries', *NEI* (Web Page, June 2019) <https://www.nei.org/resources/statistics/top-15-nuclear-generating-countries> (*'NEI'*)
[32] *EuroStat* (n 10)
[33] *NEI* (n 31)
[34] *EuroStat* (n 10)
[35] *NEI* (n 31)
[36] *HydroPower study report – A technical report to the Australian Government from the CSIRO North Austrlia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessment* (Report, 2017)

In conclusion without the adoption of nuclear power it is unlikely that a high VRE scenario is achievable and therefore the adoption of SMR reactor should be included in this scenario.

V) The cost of fuel, particularly for coal

Because the cost of coal as a fuel per GJ is not readily available, rough estimations were used to draw a comparison within this submission. The calculations are based off the energy production and cost of coal per metric tonne for the 18/19 financial year. The values used to estimate the cost per GJ were taken from the ABS energy account data and are shown below:

- Australia used 1463 PJ worth of black coal for domestic use (not including exports);
- This black coal is estimated to cost a total of $3.628 billion.

Based on this data it can be determined that this coal on a national scale was approximately $2.479/GJ.

In the GenCost 2020-21 document fuel prices for black coal are listed at $2.8-4.1/GJ a 13%-60% mark-up from the latest available data. Based on the 1463 PJ used in the latest available ABS, this value of $2.8-$4.1 per GJ would have added approximately $0.48 – $2.3 billion in total cost for coal used.

Over the last 10 years the cost of coal per metric tonne has seen an average declining trend.[37] Based on the current trend of coal prices, within the next 5-10 years coal prices are expected to continue following a falling trend. This should correlate into a reduced cost/GJ for the fuel of coal fired power stations.

Since the 2018/19 data was published coal prices have substantially declined to the lowest levels per metric tonne since 2016. It is expected that the price of coal will remain at this low level for at least the next 3 years as demand for coal remains low. [38]

The most comparable year to 2020 with respect to the cost of coal per metric tonne, is 2016. [39] Acknowledging this the most accurate estimation for the current cost of fuel per GJ would be the 2015/16 financial year. The 15/16 financial year was used for submissions to the independent review into the future security of the NEM by Alan Finkel which estimated cost of fuel per GJ. In a

[37] Ibid
[38] 'Coal', *Trading Economics* (Web Page, 2021) <https://tradingeconomics.com/commodity/coal>
[39] Ibid

submission to the Finkel review, the cost per GJ of fuel for coal fired power stations ranges from $0.8 to $2.2 per GJ, with most prices falling within the range of $1-$1.6 per GJ.[40] It is noted in particular that the highest cost of black coal per GJ is lower than the GenCost lowest fuel cost assumption for coal fired power stations.

A shift away from coal would see higher priced coal powered generators shut down. This would reduce the cost of coal power as the cheaper coal generators take a larger slice of the market.

For example, Millmerran power station costs are estimated at around $1.2/GJ and Kogan Creek costs are estimated at $1.4/GJ. These costs are significantly less than the estimated $2.8/GJ. On the other hand, Mt Piper, Eraring and Vales Point have costs greater than $3/GJ and a shorter mine life than the former. As the more expensive coal powered fire stations close down the cost of coal will reduce significantly.

It should be noted that the coal that feeds the Kogan Creek coal mine is owned by the Queensland State Government and is not subject to market fluctuations. There is a resource at Kogan Creek of over 400 million tonnes. The current generator currently burns approximately three million tonnes a year implying that the Kogan Creek power station will be an inexpensive source of energy for years to come.

The overestimation of fuel costs for fossil fuels provides a bias for renewables that should not be present and can be easily resolved.

VI) Assumptions regarding lifetime of energy generation places a major bias towards renewable energy sources

According to the inputs and assumption workbook the economic lifetime refers to the period of time required for the project to recover build costs. The technical lifetime is defined as the period of time the project is operational before life extension refurbishment or retirement. Based on these definitions, while both factors are relevant to some extent, the most relevant factor in determining cost of a particular type of station would be the technical life of a station. This is because once the technical life finishes the cost of replacement, decommissioning or upgrading comes into play.

For unknown reason the GenCost 2020-21 document instead chooses to use the economic lifetime of these power station, placing great bias on renewable energy.

[40] *NEM security* (n 17)

The use of the economic lifetime, using the conventional definition, the lifetime where an asset is economically viable, would make sense. However, based on the definition used by the inputs and assumptions workbook, the technical lifetime of a power station is more suitable for the purposes of determining cost projections.

Based on the inputs and assumptions workbook, coal fired power stations have a technical life of 50 years, 20 years greater than their economic lifetime. Gas has a technical life of 40 years, 15 years greater than the economic lifetime. Nuclear power is not listed in the inputs and assumptions workbook, however the technical lifetime of a nuclear power station is generally given an average of approximately 50 years but can be longer in some cases.[41] In comparison both wind and solar have little to no difference between the technical and economic lifetimes.

There are large costs are associated with the replacement, decommissioning and upgrade of gas, coal and nuclear power stations. Therefore, undervaluing the greater lifespan of these stations would result in much larger cost projections for non-renewable sources.

This is particularly relevant because gas, coal and nuclear power stations have significantly higher build cost then renewable sources, particularly if technology such as carbon capture storage are incorporated into the plant.

On the other hand, it can be argued that the estimated lifetime of wind and solar has been overestimated, especially solar whose performance diminishes over time. The 25-year life cycle of solar panels are yet to be proven given significant uptake of solar has only occurred in the last two decades.

It is the recommendation of this submission that the technical life, not the economic life of the power stations be taken into account before the final version of the GenCost 2020-21 document is published.

Other factors

There are many other factors that are not included in the GenCost 2020-21 report that would either increase cost, increase risk or damage the environment. These factors should increase the risk premium or cost of renewables in future GenCost reports. These additional factors are listed below.

[41] 'What's the Lifespan for a Nuclear Reactor? Much Longer Than You Might Think', *Office of Nuclear Energy* (Web Page, 16 April 2020)

I) Mining of rare earth minerals

Rare earth metals are used in solar panels, windmills and batteries. As the need for renewables increases so does the need for batteries and consequently the need for more of these rare earth metals. Cobalt mines, predominantly based in Congo, continue to be the basis for serious human rights violations as well as serious environmental violations including:

- The use of child Labor in the mines, in 2012 it was estimated that in excess of 40,000 boys and girls many of whom are under the age of 12;
- Large scale exploitation of miners who make a maximum of $2-$3 a day working in deplorable conditions;
- The forced relocation of villages and;
- Serious cases of water pollution.[42]

The worldwide need for cobalt means that these violations are currently overlooked. However, with the increased demand for these resources it is likely that this oversight will not continue, resulting in a much greater cost as companies are forced to either solve the problem, which would incur a great cost, consequently increasing the cost of the resource or look elsewhere for these resources, also resulting in a likely increase in cost.

The issue of scarcity is also overlooked. A letter authored by Natural History Museum Head of Earth Sciences Prof Richard Herrington and fellow expert members delivered to the Committee on Climate Change explains that to meet UK electric car targets for 2050, it would be necessary to produce just under two times the current total annual world cobalt production, nearly the entire world production of neodymium, three quarters the world's lithium production and at least half of the world's copper production. A 20% increase in UK-generated electricity would be required to charge the current 252.5 billion miles to be driven by UK cars.

The UK has less than 1% of the world's population. It is extremely questionable if there are enough rare earths minerals in the earths crust to build enough renewable generation and storage to meet the worlds demand.

Given such scarcity, the cost of rare earth minerals will be expected to increase dramatically as demand increases. The level of emissions generated from mining rare earths will also rise dramatically. These impacts have been overlooked in the Gencost 2020-21 report.

[42] Todd C. Frankel, 'The Cobalt Pipeline' *Washington Post* (online, 30 September 2016) < https://www.washingtonpost.com/graphics/business/batteries/congo-cobalt-mining-for-lithium-ion-battery/>

II) Disposal of solar panels also associated with high cost

Solar panels upon retirement, and subsequent removal are toxic, if they are left in landfill the toxin could leach into the groundwater and get into water system, greatly damaging the environment and costing the tax payer a large sum in order to prevent this issue from arising.[43] Currently there is only one recycling facility in Australia that is currently operating, with the increased need to recycle solar panels, in order to avoid the toxins leaching through the ground water, many more facilities will need to be constructed. [44] Therefore, as they are directly related to the production of solar energy these construction costs should analysed and included within the GenCost LCOE assumptions.

III) Fire risk

There is a large fire risk associated with transmission lines. 2009, 1977 and 1969 represent the largest electricity asset induced bushfires. [45] The production and use of renewable energy require large increases in the amount of transmission lines in order to function effectively and reliably.[46] Increased cost of maintenance and replacement for these transmission lines, ideally underground, would be required to prevent repeats of these major bushfire incidents, incurring a greater cost. Therefore, it is a recommendation of this submission that these costs be included in the additional costs section of the LCOE cost assumptions.

IV) Additional land usage

Renewable energy requires at least ten time more land per unit of power produced than fossil fuels.[47]Land plays an important role in global cycles of greenhouse gases.[48] The development of land in order to facilitate the much greater need of renewables is not currently considered within the LCOE cost assumptions. Developing land for renewable energy creates areas of impervious surfaces. This development is likely to increase water runoff, which can result in an increased level of pollutants making it into the ways.

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[43] Emilia Terzon, ‘Australia’s solar industry is booming, but so is the amount of valuable waste doing to landfill’ *ABC News* (online, 23 July 2019) < https://www.abc.net.au/news/2019-07-23/solar-power-waste-landfill-environmental-impact/11336162#:~:text=%22We%20have%20estimates%20that%20by,water%20systems%2C%22%20he%20said>
[44] Ibid
[45] The Hon. Bernard Teague AO, *Fire Preparation, Response and Recovery* (Royal Commission, July 2010)
[46] ‘Transmission’, *American Wind Energy Association* (online, 2020)
[47] Samantha Gross, *Renewables, Land Use, and Local Opposition in the United States*, (Report, January 2020)
[48]‘Introduction to Land use’, *United Nations Climate Change* (web page, 2014) <https://unfccc.int/topics/land-use/the-big-picture/introduction-to-land-use#:~:text=Land%20plays%20an%20important%20role,greenhouse%20gases%20from%20the%20atmosphere>

Depending on where the development is located this could result in damage to natural habitats such as the Great Barrier Reef. [49]

It is therefore a recommendation of this submission that land development costs and the associated environmental impacts of the development be included in future LCOE cost assumptions.

V) Greenhouse Gas emissions

Solar panels and transmission lines require the use of complex synthetic molecules such as Nitrogen Trifluoride and Sulphur Hexafluoride. These molecules have a global warming potential of 17,000 and 23,000 times greater than Carbon Dioxide. While the concentrations of these gases in the atmosphere are considerably lower than Carbon Dioxide, they can remain in the atmosphere for up to 1,000 years. As the use of renewables grows, the concentration levels of these man-made molecules will eventually become a threat just as serious as Carbon Dioxide.

Summary

In summation it is the opinion of this submission that the currently adopted assumptions in the CSIRO's GenCost 2020-21 report and the Inputs and Assumptions Workbook have been made with heavy bias towards renewable energy.

The assumptions surrounding the cost of coal, the lifetime of base load power stations, storage and security requirements and the scarcity and environmental cost of rare minerals need to be revised.

The current assumptions in the GenCost 2020-21 report are completely divorced from reality.

Thank you for the consideration of this submission.

Gerard Rennick
LNP Senator for Queensland

[49] 'Land Use: What are the trends in land use and their effects on human health and the environment' *Environmental Protection Agency US Government* (Web page, 16 September 2020)