# SOS submission to IPCN on The Hills of Gold Wind Works Proposal

## Contents

## Introduction

Save Our Surroundings (SOS) presented to the IPCN Hills of Gold Wind Works meeting on 1 February 2024. A transcript of the presentation is shown at Appendix A. The Presentation addressed three specific issues, namely:

1. Failure to respond to SOS issues

2. Replacement of Liddell closure to justify its project

3. Unsustainable material requirements

It was indicated that more detail of each point would be provided. This submission provides that detail. In addition, other facts will be presented in this submission.

## Failure to respond to SOS issues

Briefly, in our 3 page submission on the 7 December 2022, shown at Appendix B, SOS raised many issues, including a comparison with Liddell Power Station, which the Proponent used as justification for their project. Subsequently, on release of the Response to Submissions, we wrote to the DPE Planner on 7 March 2023 in which we said:

*" Appendix G does not show SOS as raising any issues. We raised at least 11 categories of issues with the EIS, none of which were addressed by the Proponent's response. This is unacceptable and we request that you obtain full and complete responses to the issues we raised as an addendum to the Proponent's Response to Submission under 11 headings."*

A copy of the SOS email sent to the Planner is shown at Appendix B.

The response from the Planner was that they will take our concerns into account in their assessment. Thus, other submitters and the general public were denied the opportunity to assess the Proponent's responses that should have been made. Apparently, the EP&A Act requirement that a Proponent has to respond to all submissions did not apply in our case.

A copy of the Planner's reply is shown at Appendix C and our further correspondence stating that we believe that the Proponent's actions are a breach of all of s 4.15 of the EP&A Act. Also, "Section 10.6(1) of that Act provides "A person must not provide information in connection with a planning matter that the person knows, or ought reasonably know, is false or misleading in a material particular". It appears that neither of these EP&A Act compliance conditions were adhered to by the Proponent.

## Replacement of Liddell closure to justify its project

The Proponent claimed under its strategic benefits section of the EIS (page 356) that the project will *"...provide a significant amount of new generation capacity, which will be required when the 2000MW Liddell Power Station located in the NSW Hunter Valley closes in 2023."*

Just a cursory comparison that was performed by SOS for its submission demonstrates, using just the actual capacity of Liddell at the time, this claim by the Proponent to '*provide a significant amount of new generation capacity*' to be greatly exaggerated, especially when also considered with related claims of electricity generation (intermittent), capacity factor (initial year only) reliability (wind strength dependent), ongoing jobs (few), lifespan (short), land space required (large) and capital cost (double and little Australian content), as summarised in Table 1.

**Table 1 - Proposed Wind Project comparison with Current Liddell Operation**

| Parameter | Hills of Gold Wind | Liddell | How wind compares |
|---|---|---|---|
| Capacity | 420MW | 1260MW | One third the capacity |
| Annual output | 1100GWh | 6000GWh | 18.3% of the output pa |
| Capacity factor | 29.9% | 54.4% | 55% less reliable |
| Households supplied | 185,000 intermittently | 750,0000 on demand | 75.3% fewer houses supplied |
| Operating workers | 28 | 200 approx. | 86% fewer jobs |
| Operational life | 25 years claimed | 50 years actual | Half the life |
| Land utilised | 68km2 | ~22km2 excl the Lake | Three times more land |
| Number of equivalent wind projects to match Liddell's output | 2,289MW, 153 operations workers, 371km2 of land and a $4.1 billion cost (over $3b imported equipment) | | **5.45** times more wind projects needed, plus new transmission lines and up to 100% additional source of electricity provision from gas/coal or storage |

The Hills of Gold recent project cost is stated as $826m for a nominal capacity of 420MW, a capacity equivalence of less than 84MW (420MW, 30%CF, 30y life vs a HELE 90%CF, 50y life). According to SDS/GHD (7/2017) a modern HELE power plant cost is A$2.2 billion per 1000MW capacity built on a brownfield site (apo.org.au/node/96821). Applying 23% inflation from June 2017 to December 2023 yields an approximate cost of $2.7 billion/1000MW for a modern HELE. A 750MW HELE should therefore cost about 75% of 2.7b i.e. $2b.

The then state-of-the-art Kogan Creek 750MW supercritical HELE power plant, coal mine and infrastructure cost a total of A$1.2b to construct on a greenfield site in 2004-2007. (Kogan Creek: a king-size supercritical project for Queensland - Modern Power Systems). Applying 67% inflation since December 2004 yields a replacement cost for Kogan Creek HELE of approximately $2b. This figure is the same as in the previous paragraph. We can have confidence in using $2,700m in the following comparison with the Hills of Gold project cost of $823m.

Both the Wind works and the HELE sell the same standard product to the NEM. Comparisons based on generated megawatt hours are therefore valid. Over 30 years the 420MW Hills of Gold project may produce less than 33,112,800 MWh, based on the project's first year 30% capacity factor. A modern 420MW HELE (90%CF and capital cost $1,134m, 50 years life) may produce 165,564,000 MWh i.e. 5 times more for a similar nameplate capacity.

Thus, the recovery of capital cost for the Hills of Gold project is $24.95/MWh. The HELE recovery cost is $6.85/MWh.

Over 50 years the 420MW Hills of Gold project would need to be duplicated at an additional cost of $826m in today's dollars. The wind works may produce 55,188,000 MWh, based on the project's first year 30% capacity factor, which the Proponent projects will fall to 20.7% after 25 years. A modern 420MW HELE (90%CF and capital cost $1,134m, 50 years life) may produce 165,564,000 MWh.

Thus, the recovery of capital cost ($1,652m) for the Hills of Gold project over a still optimistic maximum of two 25 years lifetimes is $29.94/MWh. The HELE recovery of capital cost ($1,134m) is $6.85/MWh. Clearly, a major increase in electricity costs would result by proceeding with the project, even before considering the related costs of new transmissions lines, back up energy sources when insufficient wind blows and the replacement of these, and large scale decommissioning and rehabilitation costs.

Also, the Hills of Gold project would be subsidised by taxpayers and electricity consumers through free Large Scale Renewable Energy Certificates (LSREC) at a government guaranteed surrender value of $40/MWh, NSW minimum wholesale floor price and the proposed Federal government underwriting of a minimum wholesale price for any electricity produced. The Proponent's claim of putting downward pressure on electricity prices is a falsehood when all related costs are included.

Also, their claim that their project is sustainable is also a falsehood as described below.

## Unsustainable material requirements

Unlike stand alone projects often considered by the Commission, such as a lithium mine, residential skyscaper or a seaport expansion, the Hills of Gold Wind project is part of an electricity network. The Project is of its self not a reliable generator due to weather dependency, does not result in significantly lowering emissions, especially as the components will likely be sourced from China, and adds to the overall cost of the electricity network so increasing energy costs to all consumers.

The project should be evaluated not as a standalone project, but on how well it contributes to achieving the objectives set for the electricity network, namely to achieve cheap reliable energy and significantly lowering greenhouse emissions. How efficient and effective will this project be in meeting these objectives, compared to say other wind or solar works projects?

The Proponent was proposing to build over 60 of the largest structures in Australia. What do we get for this? How much material is required to generate the same quantity of electricity as alternative generation sources?

We have applied the methodology referred to previously to The Hills of Gold proposal using their information as contained in their EIS, a VESTAS 6MW turbine specification and concrete base data from the Bowmans Creek EIS.

### Comparison based on the same capacity

Firstly, we look at just a comparison based on the same 400MW capacity. In the case of The Hills of Gold project it would require 166,518 tonnes of materials for just 66 wind turbines and their reinforced concrete bases. This tonnage is 3.2 times more than the 52,000 tonnes of steel used in the Sydney Harbour Bridge.

This calculation of 166,518 tonnes excludes all other infrastructure, such as batteries, transmission lines, roads, operating and maintenance materials, and external backup infrastructure. It also excludes the 31% decline in efficiency over 25 years as provided in a Hills of Gold EIS case study. All of the omitted infrastructure, etc. may result in double or more tonnage of materials required if included. Despite these omissions the results are already conclusive as shown in Table 2. The project and other Wind Works require many more tonnes of materials for the same capacity as other generator types.

**Table 2: 400W capacity generators material requirements over 60 years**

| Generator Type | Land Req'ts Ha | Capacity Factor % | Output MWh/Year | Availability | Material Req't Tonnes# | Expected Life Years | Materials Over 60 Years t |
|---|---|---|---|---|---|---|---|
| Stubbo Solar EIS^ (partial materials) | 1772 | 25.2 | 883,008 | Daylight Hrs | 73,400 | 30 | 146,800 |
| Industrial Solar (ave) | 1280 | 25.5 | 893,520 | Daylight Hrs | 61,457 | 25 | 184,371 |
| Rooftop Solar (CW) | 0 | 24.5 | 858,480 | Daylight Hrs | 13,550 | 25 | 40,650 |
| Wind Works (average) | 10,160 | 30.1 | 1,054,704 | Wind dependent | 148,970 | 20 | 446,910 |
| Wind Works 1 EIS^ (partial materials) | 12,734 | 34.2 | 1,176,471 | Wind dependent | 158,472 | 30 | 316,944 |
| Wind Works 2 EIS^ (partial materials) | 19,905 | 35.0 | 1,226,190 | Wind dependent | 178,534 | 25 | 535,602 |
| Hills of Gold Wind Works^ (partial materials) | 6,806 | 30.0 | 1,040,688 | Wind dependent | 166,518 | 30 | 333,036 |
| HELE (Qld) | 30 | 82.3 | 2,915,328 | 24hrs/7days | < 78780 | 50 | 157,560 |
| CCGT-CCS (NSW) | 146 | 90 | 3,153,600 | 24hrs/7days | < 78780 | 25 | 236,340 |
| Nuclear (average) | 169 | 91.3 | 3,199,152 | 24hrs/7days | 78,780 | 60 | 78,780 |

^ main components only included: solar panels and steel supports; turbines and concrete bases; all others include all materials for that operational generator type.

### Comparison based on the same output and same timeframe

Secondly, we consider how much materials are needed to produce the same output as modern alternatives, such as High Efficiency Low Emissions (HELE) power plants and nuclear power plants, both of which are currently being installed extensively in many countries.

The methodology contained in our paper "Wind and Solar Works Resource Requirements are Unsustainable" (Appendix F) was applied to the Hills of Gold Wind Works proposal. The data sources and calculations are shown at Appendix G.

All electricity generating types sell the same standard product into the National Energy Market, namely alternating current electricity. SOS is able to assess, for different electricity

generator types, how many tonnes of materials per equivalent Mega Watt Hour generated is required over say, 60 years at a scaled capacity for each generator type of approximately 400MW. A highly enlightening exercise. The results are summarised in Table 3.

The total materials requirement for the Hills of Gold wind works for **only the wind turbine and its reinforced concrete base over two life-times is 1,023,777 tonnes or equivalent to the weight of over 20, and possibly 40 or more, Sydney Harbour Bridges.** This is the materials required to match the electricity output of just one fully operational modern 400MW HELE plant over 60 years.

This is already 5.9 times more than an operating HELE power plant and 13 times more than an average operating nuclear plant. The proposed Hills of Gold project will be a very inefficient and extremely wasteful use of resources.

Compared to two other Wind works proposals, the Hills of Gold Wind project materials of 932,949t is 30% more tonnes of materials than Bowmans Creek Wind Works (WW1), which is 785,396 tonnes and 20% less than Winterbourne Wind Works (WW2), which is 1,273,421 tonnes, as shown in Table 3.

All three are substantially more material intensive than the other generating sources. They all output the same standard product. Which of these wind works are most effective in meeting the electricity network objectives? Which should be rejected? Why such variation? Such variations are not addressed in the DPIE Assessment Reports, yet each project would part of an integrated network and would be dependent on other parts to make up for their deficiencies.

**Table 3. Comparison of material needed based on output (adjusted to 400MW)**

| Electricity Generator type | Output MWh/year | Output Over 60 years MWh | Materials Over 60 years t | Material Tonnes/ MWh | Materials to Equal HELE output t | Materials to Equal Nuclear output t |
|---|---|---|---|---|---|---|
| Stubbo Solar EIS^ | 883,008 | 52,980,480 | 146,800 | 0.002771 | **484,673** | **531,859** |
| Industrial Solar (ave) | 893,520 | 53,611,200 | 184,371 | 0.003439 | **601,556** | **660,120** |
| Rooftop Solar (CW) | 858,480 | 51,508,800 | 40,650 | 0.000789 | **138,044** | **151,483** |
| Wind Works (average) | 1,054,704 | 63,282,240 | 446,910 | 0.007062 | **1,235,313** | **1,355,578** |
| Wind Works 1 EIS^ | 1,176,471 | 70,588,260 | 316,944 | 0.004490 | **785,396** | **861,859** |
| Wind Works 2 EIS^ | 1,226,190 | 73,571,400 | 535,602 | 0.007280 | **1,273,421** | **1,397,395** |
| **Hills of Gold Wind Works^** | **1,040,688** | **62,441,280** | **333,036** | **0.0053336** | **932,949** | **1,023,777** |
| HELE (Qld) | 2,915,328 | 174,919,680 | 157,560 | 0.000901 | **157,560** | **172,899** |
| CCGT-CCS (NSW) | 3,153,600 | 189,216,000 | 236,340 | 0.001249 | **218,483** | **239,754** |
| Nuclear (average) | 3,199,152 | 191,949,120 | 78,780 | 0.000410 | **71,791** | **78,780** |

^ main components only included: solar panels and steel supports; turbines and concrete bases; all others include all materials for that operational generator type.

It can be concluded from just the partial analysis, that is, turbines and concrete bases only, that the Hills of Gold project:

- does not meet the sustainability requirement, especially as the requirement for very energy intensive mining and processing of a greater variety of minerals, including for polymer materials, glass/carbon fibre composites, steel and iron, aluminium alloys, lubricants, copper, electronics, rare earths and cement, is many times greater than other electricity generating sources

- will result in significant loss of available resources for future generations, as, for example and as stated in the EIS, the concrete bases will remain in situ after decommissioning and currently each multi-tonne blade is buried at the end of its life

- must logically result in higher electricity costs as many times more tonnes of materials are required to generate each MWh of electricity generated compared to other generating sources

- has, from its own figures, an initial capacity factor under 30%, which declines to under 21% by year 25; this decline will require to be offset by additional sources of electricity generation over time, so causing the need for even greater material requirements.

Based on the Proponent's EIS and that of Bowman's EIS the project already requires an environmentally damaging and unsustainable quantity of tonnes of materials, just for part of its project, compared to alternative fully built and operating electricity generating sources.

The ramifications of such extremely high quantities of additional tonnes of materials means for example, more mining, more global habitat and ecological destruction, significantly greater upfront generation of greenhouse gases, increased end-of-life waste, loss of resources for future generations, higher energy costs, greater impacts on visual amenity and landscape character, adverse social impacts and increased transport disruption to name a few.

Clearly, the Hills of Gold Wind Works proposal does not satisfy the sustainability requirement or many other criteria. It should not be approved.

## Other facts

Apart from the poor consultation, obvious lack of comparison with alternative generation types and unsustainable material requirements, the project has many other shortcomings, including:

1. Poor consultation and response to submissions

2. Poor performance when compared with other electricity generating sources, including industrial solar, small scale (rooftop) solar, HELE, nuclear and even other

wind works projects.

3. Ecologically unsustainable material requirements per megawatt hour of electricity generation with the consequential impacts on both local and remote ecologies.

4. No social licence achieved as the majority of submissions object to the project.

5. Impacting visual amenity adversely but ignoring the just as important the changing of the landscape character from rural and wilderness to a highly intrusive industrial complex that will be unattractive to residents and visitors and will lead to the decline of tourism and desirability to live in the region.

6. Its intermittent, part-time and unpredictable generation of electricity will cause instability in the NEM resulting in brownouts, blackouts and higher electricity prices for consumers, which is not in the Public interest.

7. Invalid claim that it will generate enough electricity for 185,000 when the Proponent knows at times it will generate zero electricity and on average over 12 months initially generate less than 7.2 hours a day and falling to 5 hours a day after 25 years.

8. Production significant embedded greenhouse emissions, which are ignored in the assessment

9. Not specifying the source of its components, when in all likelihood they will be made in China, the World's major manufacturer and exporter of all solar panels, industrial wind turbines and industrial lithium batteries and the highest greenhouse gas emitting country by far (>30%).

10. Admits to the destruction of wildlife habitat and threatened species but ignores the impact of upsetting the balance of local ecologies by this destruction, possibly leading to their total demise.

11. Only being economically viable providing it receives taxpayer subsidies, minimum prices for its output and favourable treatment compared to alternative electricity generators.

12. The addition of a 100MW/four hours BESS that may or may not provide electricity during peak demand times once charging is almost exclusively reliant on unreliable, intermittent non-fossil fuel generators.

13. The addition of a 100MW/four hours BESS that will consume up to 30% more electricity than it can ever deliver to the NEM as well as requiring total replacement within 14 years if charged/discharged just once a day.

14. The addition of a 100MW/four hours BESS that will, the Proponent misleadingly claims, be fully charged when there is excess electricity generated during the day but

knowing this will occur infrequently.

15. Claiming it will offset the 800,000 tonnes of greenhouse gas emissions annually knowing that it will do no such thing over the project's life-time, as more and more old coal-fired power plants are closed down; eventually they will not even be able to offset their own embedded emissions.

16. Despite a recent global study of 40 years of data on wind turbine audible and inaudible (infrasound) noise, which concluded that both had adverse effects on human health, there is no reference to these effects in the EIS or the Assessment; infrasound could travel up to 13 kms from the source and actually be amplified once it penetrated a residential structure.

17. The AGL 12 months study of its operating Macarthur wind works found that on average over 10 birds per 140m tall turbine were killed; their turbines are much smaller than the proposed 230m tall Hills of Gold turbines; we can expect many more birds to die annually if this project were to proceed; on a cumulative basis we can expect tens of thousands of birds to die annually just in the New England area.

18. A totally inadequate requirement that end-of-life decommissioning, disposal and land rehabilitation will occur within 18 months with nothing more than assurances by a Proponent who will not be the ultimate owner at the required time; no upfront bond, no skin in the game, no penalty if not done; not the legacy we should be leaving current younger generation and future generations.

19. Increased fire risks to fire-fighters, residents, visitors, farmland, flora and fauna that cannot be eliminated; e.g. toxic smoke from burning wind turbines and burning lithium batteries have been ignored. Yet another wind turbine fire occurred near Redhill SA on 7/2/2024, requiring six CFS fire-fighting crews who put out multiple spot fires and just watched the turbine burn and collapse. Reportedly, 30 hectares of grassland were burnt and a $2.2 million turbine destroyed.

20. Much of the $836m "investment" in the region is in fact payments made to the overseas suppliers of the components; the very little actual Australian content, which is not disclosed. Typically the Australian content is only about 12.5%.

21. Much being made of local economic benefits but ongoing local employment is miniscule and some specialists will still be temporarily imported to the region as required; no inclusion of lost agricultural production and jobs lost or diminished tourism.

22. Disruption to everyday life, not just for two or three years but cumulatively for decades; imposition of labour camps occupied by non-local culturally different backgrounds to local rural and regional people, inadequate local pharmacy, health, police, fire, accommodation, and trades services that will all be even further stretched by influxes of non-local workers; it is the local residents who will suffer

even further.

23. Community funds, lease and compensation payments to a select few, and voluntary payment agreements with Councils are a pittance compared to the value the project owners receive from taxpayers and electricity consumers; where is the inter-generation equity in passing on the massive debts and interest payments to future generations?

24. Energy and sovereign risk are both increased with this project; the project will only produce electricity less than 30% of the time on average, sometimes none for days on end during wind droughts; all the components and subsequent maintenance items will be sourced from overseas, probably from an unreliable trading country, so increasing sovereign risk.

Dozens of legitimate issues are raised by affected communities but all can apparently be mitigated. Mitigation is not the same as elimination. "Where practical", 'best endeavours', 'as far as possible', "will address in the detailed design" (post approval), etc. are weasel words, not solutions. Residents and others continue to be frustrated, angry, upset, disillusioned, fatigued and feel ignored by a long planning process designed to divide communities, favour developers and wear down objectors.

Already built or under construction solar and wind works have broken some of their commitments. Would this project be any different?

## Conclusion

The NSW government policy on reducing the impact of climate change states that what is required is "...an emission reduction technology that will grow the economy, create jobs and reduce the cost of living; ...". In addition, it must be a sustainable development, apply the precautionary principle, address inter-generational equity, and conserve biodiversity. Clearly, for the reasons presented in this submission the Hills of Gold project will not meet any of these requirements.

In summary:

1. **Emission reduction technology:** embedded emissions in the project are upfront and substantial and repeated every couple of decades; global emissions continue to rise despite decades of constructing wind works and solar works globally and in Australia; this project will have zero effect on reducing global emissions and hence global temperature, especially as the components will likely be made in China, the world's biggest emitter.

2. **Grow the economy:** business failures have occurred and are occurring at increasing rates with the growing cost of electricity being cited as a factor in many cases e.g. Alco Kwinana alumina refinery announced it will close in 2025 resulting in over 1000 job losses; little of the project capital cost is actually Australian content and so adds much less to the economy than claimed. Our economy needs base-load power if we

are to support our rapidly growing population but this project cannot achieve that.

3. **Create jobs:** 28 operational jobs, only some of which are local onsite positions, is miniscule when thousands of jobs have already been lost across the industry and thousands more will be lost elsewhere. We need reliable and available power to support job creation but this project cannot produce electricity when required.

4. **Reduce the cost of living:** Inflation has risen sharply only recently but electricity costs have risen steeply for a decade as more and more wind and solar is added to the NEM grid. Every jurisdiction globally has the same experience, especially once 30% or more of capacity is wind and solar; during construction road traffic will be delayed so adding to the cost of travel, especially for agricultural transport and services.

5. **Sustainable development:** requiring many more tonnes of materials per KWh generated than even an equivalent capacity industrial solar works is not sustainable, especially when most of the materials will be buried on retirement.

6. **Precautionary principle:** should apply as the project will add to grid instability, reduce energy security, reduce national security, create a need for 100% duplication due to intermittency of output and vulnerability to adverse weather, likely become a stranded asset as better and cheaper technologies emerge in the next few years.

7. **Inter-generational equity:** future generations will be left with an inferior electricity system than previously existed, left with a massive waste problem as wind works retire after 20 years, left with less agricultural land to grow food, left with higher national and state debts to service and repay due to billions of dollars in subsidies paid out each year; left with a country-side fundamentally different to the rural character their ancestors enjoyed.

8. **Conserve biodiversity:** biodiversity will not be conserved as mitigation is not elimination, but local bats, birds, flora and fauna will be eliminated in and around the project site as admitted by the Proponent; excessive material requirements will damage other environments, especially overseas, due to increased and varied mining, processing, manufacture and transport.

Clearly, the Hills of Gold Wind Works proposal is not fit for purpose. For the IPCN to grant consent to the project it would have to deny the facts presented in this submission.

Yours sincerely
Save Our Surroundings

## APPENDIX A: SOS Presentation to IPCN: Hills of Gold Wind Works with BESS 1/2/24

### INTRODUCTION

Thank you for the opportunity to address the Commission.

Save Our Surroundings (SOS for short) started researching and publishing its findings in mid-2019. Our aim was to assist and support rural and regional groups faced with the negatives of the transition to "renewables".

We have appeared as expert witnesses at federal joint parliamentary hearings into proposed climate bills and into Australia becoming a green energy super power.

We have analysed many solar, wind, and battery environmental impact statements and made submissions on many of them, often highlighting the deficiencies, omissions, misleading and unsubstantiated claims made by Proponents.

We have taken the research and experiences learned from overseas and, as far as possible, applied them to the proposed and actual installed industrial wind, solar and batteries projects in Australia thus far.

We now use the information from Proponents, manufacturers, government sources and tested studies. In addition to developing a capacity equivalence measure, we have recently assessed the materials requirements of several different electricity generating types.

The Hills of Gold project has many adverse impacts, including on visual amenity, on changing landscape character, on disruption to community life, on loss of endangered species, and on potential health impacts to state just a few. Others will no doubt raise those and other matters.

However, this presentation will address three different issues, namely:

4. Failure to respond to SOS issues

5. Replacement of Liddell closure to justify its project

6. Unsustainable material requirements

**Failure to respond to SOS issues**

The Proponent failed to respond to the issues in our submission. In addition the DPE Assessment report makes no mention of SOS as a submitter.

We made a submission on 7 December 2022 during the exhibition period for the Hills of Gold Wind Project. We raised many issues covering 11 categories in our three page submission.

We hope the Commissioners have read our submission. The Proponent only included our name in Appendix G of the EIS and:

- did not include any of the issues we raised
- did not respond to any of those issues in its RTS
- did not even acknowledge that we objected to the project.

We believed this avoidance to be a breach of the SEARS requirement to respond to all issues and concerns raised by submitters. We raised this with the DPE Planner . The response from the Planner was that they will take our concerns into account in their assessment.

However, SOS, other submitters and the general public are denied the opportunity to assess the Proponent's responses that should have been made. More detail will be included in our written submission to the Commission.

**Replacement of Liddell closure to justify its project**

I will now consider the Proponent's justification for its project.

All generator types produce the same standard product of alternating current electricity. There was not a direct comparison between similar generating types, such as wind works, let alone different generating types.

The Proponent stated on page 356 of the EIS as justification for its 420MW project was to quote "...provide a significant amount of new generation capacity which will be required when the 2000MW Liddell power station ...closes in 2023." unquote. The 52 year old Liddell power station closed fully in April 2023. At that time the capacity was 1260MW, capacity factor 54.4% and output was 6000GWh annually. The Proponent provided no substantiation or comparison for its claim.

SOS did do a comparison in its submission and the Hills of Gold Project compared very poorly on multiple measures. Comparing individual electricity generating types was difficult. Since then SOS has developed a simple method of comparing projects.

SOS has developed the concept of Capacity Equivalence, which uses stated capacity, capacity factor and expected project life. Our paper " Chinese Manufactured PV Solar Panels Increase GHG Emissions" was provided previously to the Commission and includes detail of our capacity equivalence methodology (Appendix H).

Applying this method using the Liddell capacity factor of 54.4% and the life of 50 years the 420MW Hills of Gold capacity equivalent is 115MW, hardly the significant capacity replacement as claimed by the Proponent for the 2000MW Liddell .

In other words, the Hills of Gold project would need to be 3.6 times larger at 1528MW to match just 420MW of Liddell's capacity. Clearly, this highlights the extravagant use of the Earth's resources and multiplies the increased negative aspects of the project.

It also, raises the issue of sustainability. One aspect of sustainability is the quantity of materials required by different generating sources to produce equivalent amounts of electricity over a given period.

SOS has also recently developed a method of comparing the tonnes of materials used by different electricity generating types to produce the same output to the National Energy Market. The methodology is described in our paper "Wind and Solar Works Resource Requirements are Unsustainable". I assume the Commissioners have read our paper as we emailed it to the meeting organiser on 18 January.

**Unsustainable material requirements**

Unlike stand alone projects often considered by the Commission, such as a lithium mine, residential skyscraper or a seaport expansion, the Hills of Gold Wind project is part of an electricity network.

It should be evaluated not as a standalone project but on how well it contributes to achieving the objectives of the electricity network, namely cheap reliable energy and significantly lowering greenhouse emissions. How efficient and effective will this project be in meeting these objectives, compared to say other wind or solar works projects?

The Proponent was proposing to build over 60 of the largest structures in Australia. What do we get for this? How much material is required to generate the same quantity of electricity as alternative generation sources?

We have applied the methodology referred to previously to The Hills of Gold proposal using their information as contained in their EIS, a VESTAS 6MW turbine specification and concrete base data from the Bowmans Creek EIS.

All electricity generating types sell the same standard product into the National Energy Market, namely alternating current electricity. SOS is able to assess for different electricity generator types, how many tonnes of materials per equivalent Mega Watt Hour is required over, say, 60 years at a scaled capacity for each generator type of 400MW. A highly enlightening exercise.

In the case of The Hills of Gold project it would require 166,518 tonnes of materials for just 66 wind turbines and their reinforced concrete bases. This calculation excludes all other infrastructure, such as batteries, transmission lines, roads, operating and maintenance materials, and external backup infrastructure. It also excludes the 31% decline in efficiency over 25 years as provided in a Hills of Gold EIS case study. Despite these omissions the results are already conclusive.

The total materials requirement for the Hills of Gold wind works for only the wind turbine and its reinforced concrete base over two life-times is 1,023,777 tonnes. This is the materials required to match the electricity output of a fully operational HELE plant over 60 years.

This is already 5.9 times more than an operating HELE power plant and 13 times more than an average operating nuclear plant.

Compared to two other Wind works proposals, the Hills of Gold Wind project is 30% more tonnes of materials than Bowmans Creek Wind Works, which is 785,396 tonnes and 20% less than Winterbourne Wind Works, which is 1,273,421 tonnes.

All three a substantially more than the other generating sources. Which of these wind works are most effective in meeting the electricity network objectives? Which should be rejected? Why such variation? Such variations are not addressed in the DPE Assessment Reports.

Although the arithmetic is relative simple it is not appropriate to present the details verbally today. We will include the calculations and results in our SOS submission to the Commission.

However, we can conclude from just the partial analysis, that is, turbines and concrete bases only, that the Hills of Gold project:

1. does not meet the sustainability requirement, especially as the requirement for very energy intensive mining and processing of a greater variety of minerals, including polymer

materials, glass/carbon fibre composites, steel and iron, aluminium alloys, lubricants, copper, electronics, rare earths and cement, is many times greater than other electricity generating sources

2. will result in significant loss of available resources for future generations, as, for example and as stated in the EIS, the concrete bases will remain in situ after decommissioning and currently each multi-tonne blade is buried at the end of its life

3. must logically result in higher electricity costs as many times more tonnes of materials are required to generate each MWh of electricity generated compared to other generating sources, including roof top solar systems

4. has, from its own figures, an initial capacity factor under 30%, which declines to 21% by year 25; this decline will require to be offset by additional sources of electricity generation over time, so causing the need for even greater material requirements.

**CONCLUSION**

In conclusion, our presentation has demonstrated that:

1. the Proponent has not adequately responded to the submissions

2. using the then planned closure of Liddell power plant as justification for its project was based on misleading and unsubstantiated information, which SOS highlighted in its submission, but which the Proponent ignored in its Reply to Submissions and was not addressed by the Assessment Report

3. based on the Proponent's EIS and that of Bowmans Creek's EIS the project already requires an environmentally damaging and unsustainable quantity of tonnes of materials, just for part of its project, compared to alternative fully built and operating electricity generating sources

4. the ramifications of so much additional tonnes of materials means for example, more mining, more global habitat and ecological destruction, significantly greater upfront generation of greenhouse gases, increased end-of-life waste, loss of resources for future generations, higher energy costs, greater impacts on visual amenity and landscape character, adverse social impacts and increased transport disruption.

Commissioners, the Proponent has proposed to build 60 plus of some of the largest structures in Australia. Just these structures produce relatively little electricity over their lifetimes, but require inordinate quantities of materials in comparison to other electricity generating sources.

We therefore recommend that the Commission not consent to the Hills of Gold Wind Works proposal.

Do you have any questions of me?

## APPENDIX B: Save Our Surroundings (SOS) Objection to SSD-9679 Hills of Gold Wind Works

The Team Leader Energy Assessments Energy Assessments 7 December 2022
Development Assessment
Department of Planning and Environment
Locked Bag 5022
Parramatta NSW 2124

Submission uploaded: www.planningportal.nsw.gov.au/major-projects
From: saveoursurroundings@outlook.com

Dear Team Leader
**SOS Objects to Amended SSD-9679 Hills of Gold Wind Project**
Save Our Surroundings (SOS) is a network of community groups across multiple states that share their experiences about, and research into, industrial wind, solar, BESS and pumped hydro proposed and developed projects and their impacts on affected individuals and regional communities.

SOS strongly objects to this project as a simple analysis shows it is not "fit for purpose" and is environmentally damaging.

**Project summary:**
Up to 70 (or 65?) 6MW 230m high turbines i.e. capacity of 420MW (or 390MW?);
Cover 24km of mountain tops;
Up to 1000GWhpa (or 1100GWhpa);
23km of new transmission infrastructure;
Generate enough electricity for 185,000 homes;
8km south of Nundle;
6,806ha site (68km2);
211 construction jobs and 28 operational jobs;
Project value $750m;
Original EIS Nov 2018 by Wind Energy Partners ;
Engie bought out Wind Energy Partners on 28/11/2020;
25 year life;
Claim the project output is needed to offset the closure of Liddell power station.

Based just on the project summary above:

- inconsistency of information on the proponent's web-site and documentation, a typical issue with most proposals; it can't be 65 or 70 6MW turbines and still have a capacity of 420MW

- which is it, 1000GWh or 1100GWh annually; 420MW and 1100GWh equates to a capacity factor of 29.9%, very close to the average of all wind works across the National Energy Grid

- in addition to scarring 24km of bushland mountain tops it further scars the landscape with 23km of transmission lines and associated infrastructure

- claims it will supply electricity to 185,000 homes; however, what homeowner only wants electricity available on average 7 hours a day (i.e. 30% of the time) with none on some days and nights when in a wind drought or too little or too much wind blows?

- audible noise can travel long distances; however infrasound (inaudible low frequency sound) can travel, according to some studies, a lot further (up to 13km); elephants can pick

up infrasound through their feet over tens of kms away and whales sense infrasound over vast distances; both audible and infrasound have been shown to be detrimental to human health; the nearby residences and the villages of Nundle and Hanging Rock (3-8kms away) are well within the range that 65 or 70 skyscraper size wind turbines, under certain conditions, may adversely affect the health of these people and animals

- 68km2 appears an enormous waste of resources and destruction of bushland and agricultural land for such an intermittent, unreliable, weather impacted source of electricity generation; especially when much more electricity can be produced 24/7 from generators requiring very little land and materials by comparison e.g. HELE, CCGT or SMRs

- 28 operating jobs is a poor return for the communities around this project, especially as it is very unlikely all the jobs will be drawn from them; the cumulative impacts of this project, the Liverpool Ranges, Liverpool Plains and numerous CWO REZ projects that will result in years of disruption to their lives, damage to roads, loss of tourism, traffic delays, etc.

- a project value of $750M, based on NREL modelling and other studies, indicates that about 75% ($563m) is for imported equipment; 12.5% capital cost ($94m) and 12.5% ($93m) for construction; not much Australian content in this project!

- it has been observed that wind and solar works change ownership before, during and after construction; Beryl solar works changed owners three times in three years, so is this current project owner for Hills of Gold Wind in it for the long haul of 25 years plus decommissioning/rehabilitation time or are they just a typical construction firm that builds and sells, like several other such projects?

- does the claim that the wind project is necessary to replace the output of Liddell power station when it closes completely in April 2023 stack up? AGL states (4/12/22) that Liddell is currently a 1260MW available capacity power station, has an output of 6000GWh annually, supplies 750,000 average family households and employs about 200 people. Several other wind and solar proposals make the same claim; table 1 compares this proposed wind project with the current 50 years old Liddell power station.

**Table 1 - Proposed Wind Project comparison with Current Liddell Operation**

| **Parameter** | **Hills of Gold Wind** | **Liddell** | **How wind compares** |
|---|---|---|---|
| Capacity | 420MW | 1260MW | One third the capacity |
| Annual output | 1100GWh | 6000GWh | 18.3% of the output pa |
| Capacity factor | 29.9% | 54.4% | 55% less reliable |
| Households supplied | 185,000 intermittently | 750,0000 on demand | 75.3% fewer houses supplied |
| Operating workers | 28 | 200 approx. | 86% fewer jobs |
| Operational life | 25 years claimed | 50 years actual | Half the life |
| Land utilised | 68km2 | ~22km2 excl the Lake | Three times more land |
| Number of equivalent wind projects to match Liddell's output | 2,289MW, 153 operations workers, 371km2 of land and a $4.1 billion cost (over $3b imported equipment) | | **5.45** times more wind projects needed, plus new transmission lines and up to 100% additional source of electricity provision from gas/coal or storage |

From Table 1 it is evident that:

1. the capacity of the wind works is not equivalent to a similar base-load power plant e.g. the 420MW for the wind project equates to only about a 140MW base-load power station

2. it is even more evident that the intermittent output of the wind works (1,100GWh) is much less than an equivalent 24/7 base-load power plant (2,000GWh based on Liddell's output)

3. the wind works capacity factor (29.9%) is vastly inferior to even a 50 years old based-load power station (54.4%); modern base-load power stations have capacity factors above 90%. [capacity factor is the ratio of actual or estimated output to the potential 24/7 output over a year based on the stated maximum capacity of the power plant]

4. the wind works operating staff of 28 is much lower than a base-load power station, which also provides such jobs for at least twice as long (> 50 years)

5. to even get close to the same output as Liddell, a wind works would need to be nearly 5.5 times larger, so requiring nearly 17 times more land and $4.1billion in expenditure plus other costs specifically needed to be incurred for the wind works to be constructed and operate (e.g. new/upgraded roads, new transmission infrastructure, compensation payments, higher subsidies).

The non-equivalence of capacity values results in misleading the general public and others, as does the omission of capacity factors. The SEARS requires proponents to include a comparison with alternatives to their project but they do not do so. By omitting comparisons with rooftop solar, offshore wind turbines, HELE, CCGT and nuclear power plants they avoid a proper understanding of the options, particularly those that can produce electricity at least 90% of the time compared to the wind works estimated 30% a year.

This proposed project will do little to address the already compromised energy needs of NSW, let alone, Australia. In fact, it will make it worse as evidenced by overseas experiences in recent years and our own experiences in 2022 with soaring electricity prices, blackouts, energy rationing and business closures predicted for years to come.

Yours Faithfully
Save Our Surroundings (SOS)

## APPENDIX C: SOS email to DPE Planner for Hills of Gold

**Hills of Gold - SOS issues not addressed 07/03/2023**

Good day Tatsiana

Save Our Surroundings (SOS) have reviewed the Proponent's response to submissions. We see that the Proponent has ignored responding to our submission concerns. Only our name was listed as a submission in Appendix G – Submissions Register and did not even show that we objected. We attach our submission for your convenience.

Appendix G does not show SOS has raising any issues. We raised at least 11 categories of issues with the EIS, none of which were addressed by the Proponent's response. This is unacceptable and we request that you obtain full and complete responses to the issues we raised as an addendum to the Proponent's Response to Submissions.

In addition to raising issues under the Proponent's headings of Biodiversity, Justification, Visual, Noise, Socio-economic we raised issues that include Inconsistent Information, Cumulative Impacts, Financial Viability, Ownership Changes, Misleading Information and Inadequate Comparisons.

Amanda Antcliffe and Murray Curtis signed the declaration stating that *"The information contained in this EIS, to the best of our knowledge, contains all available information that is relevant to the environmental assessment of the development and the information provided is neither false or misleading."* It is our opinion that just the few examples we included in our submission do indicate that the information would mislead a reader, especially one who does not have a good understanding of the electricity system. Our submission included the following issues with the EIS:

1. **Biodiversity:** "environmentally damaging"; "68km2 appears an enormous waste of resources and destruction of bushland and agricultural land for such an intermittent, unreliable, weather impacted source of electricity generation"

2. **Justification:** "...is not fit for purpose"; "does the claim that the wind project is necessary to replace the output of Liddell power station when it closes completely in April 2023 stack up?"; "...avoid a proper understanding of the options, particularly those that can produce electricity at least 90% of the time compared to the wind works estimated 30% a year."; "This proposed project will do little to address the already compromised energy needs of NSW, let alone, Australia. In fact, it will make it worse as evidenced by overseas experiences in recent years and our own experiences in 2022 with soaring electricity prices, blackouts, energy rationing and business closures predicted for years to come."

3. **Visual:** "...scarring 24km of bushland mountain tops, "...further scars 23kms of transmission lines and associated infrastructure"

4. **Noise:** "audible noise ...; however infrasound ... can travel ..(up to 13km)"; "...may adversely affect the health of these people and animals"

5. **Socio-economic:** "electricity available on average 7 hours a day"; "28 operating jobs is a poor return for the communities around this project"; "the wind works operating staff of 28 is much lower than a base-load power station, which also provides such jobs for at least twice as long (> 50 years)"; the project will make our electricity system "...worse as evidenced by overseas experiences in recent years and our own experiences in 2022 with

soaring electricity prices, blackouts, energy rationing and business closures predicted for years to come."

6. **Inconsistent Information:** "inconsistency of information on the proponent's web-site and documentation,..."; ";... it can't be 65 or 70 6MW turbines and still have a capacity of 420MW"; "which is it, 1000GWh or 1100MWh annually"

7. **Cumulative Impacts:** "the cumulative impacts of this project, the Liverpool Ranges, Liverpool Plains and numerous CWO REZ projects that will result in years of disruption to their lives, damage to roads, loss of tourism, traffic delays, etc."

8. **Financial Viability: "**a project value of $750M, based on NREL modelling and other studies, indicates that about 75% ($563m) is for imported equipment; 12.5% capital cost ($94m) and 12.5% ($93m) for construction; not much Australian content in this project!" **"**is this current project owner for Hills of Gold Wind in it for the long haul of 25 years plus decommissioning/rehabilitation time or are they just a typical construction firm that builds and sells, like several other such projects?"

9. **Ownership Changes: "**Original EIS Nov 2018 by Wind Energy Partners ; Engie bought out Wind Energy Partners on 28/11/2020"; **"**is this current project owner for Hills of Gold Wind in it for the long haul of 25 years plus decommissioning/rehabilitation time or are they just a typical construction firm that builds and sells, like several other such projects?"

10. **Misleading Information:** "claims it will supply electricity to 185,000 homes"; "Claim the project output is needed to offset the closure of Liddell power station." "the capacity of the wind works is not equivalent to a similar base-load power plant e.g. the 420MW for the wind project equates to only about a 140MW base-load power station"; "The non-equivalence of capacity values results in misleading the general public and others, as does the omission of capacity factors."

11. **Inadequate Comparisons: "**the wind works capacity factor (29.9%) is vastly inferior to even a 50 years old based-load power station (54.4%); modern base-load power stations have capacity factors above 90%. [capacity factor is the ratio of actual or estimated output to the potential 24/7 output over a year based on the stated maximum capacity of the power plant]"; "The SEARS requires proponents to include a comparison with alternatives to their project but they do not do so."

Regards
Dennis Armstrong
For Save Our Surroundings (SOS)
Save Our Surroundings (SOS) is part of network of groups of like-minded concerned and impacted citizens that are directly affecte
of industrial scale weather-dependent "renewables" and their negative impacts on local and global environments and communiti
groups span multiple States and share and distribute information, research and experiences with each other and other parties.

## APPENDIX D: Planners reply to SOS email of 7/03/2023

Sent: Monday, 27 March 2023 4:53 PM

To: Dennis Armstrong

Subject: RE: Hills of Gold SSD-9679 - SOS issues not addressed by Proponent's Responses

Good afternoon Dennis,

Thank you for your email and a summary of outstanding concerns and apologies for the delayed response, I was out of the office last week.

The Department has now commenced its own detailed assessment of the proposed project in accordance with applicable NSW Government policies and guidelines. As part of our assessment we are also reaching out to the relevant State agencies that provide an expert advice on various aspects of the proposed development.

We are aware of your group's concerns and will consider them in our merit assessment of this development application.

In regard to your concerns about the EIS and Submissions Report containing false and misleading information, it is important to recognise that from a legal perspective, an error in the information contained in the reports is a different matter to providing 'false and misleading' information under the Environmental Planning and Assessment Act 1979.

For 'false and misleading' to be proved, it must first be shown that the person has 'knowingly' provided false and misleading information, and secondly, that the subject matter would materially affect the decision to be made in respect of the matter in question.

While the Department accepts there may have been errors or omissions in the applicant's reports, it does not necessarily constitute 'false or misleading' in its legal definition.

I hope this clarifies your query. However, if you have further questions or information that you would like to share with the Department, do not hesitate to contact me on the details below.

Kind regards,
Tatsiana Bandaruk
Principal Planning Officer
Energy Assessments | Department of Planning and Environment
T 02 8275 1349 | E tatsiana.bandaruk@planning.nsw.gov.au
4 Parramatta Square,12 Darcy Street, Parramatta, NSW 2150
www.dpie.nsw.gov.au

**APPENDIX E:** SOS response to Planner's email of Monday, 27 March 2023 4:53 PM

Sent: Tuesday, 28 March 2023 11:15 AM

Good day Tatsiana

We must express our concerns with the Department's response to our email of 7th March 2023.

Firstly, the Department usually requires of a Proponent:

"You are requested to prepare a written response to the issues raised in the submissions, including the full range of matters and recommendations raised in the agency advice by [date]. The written response must be in the form of a submissions report that has been prepared having regard to the State Significant Development Guidelines including Appendix C - Preparing a Submissions Report."

Clearly, the Hills of Gold Proponent did not respond in writing to all the issues raised, and in fact did not even acknowledge that SOS had raised any issues at all (Appendix G of their report). It nevertheless is a breach of all of s 4.15 of the EP&A Act. In our view the DPE should ask the Proponent to address each one of the issues and submit another Submissions Report. A Development Consent should not be issued until this is done.

SOS look forward to an updated Response to Submissions that covers all the concerns raised by SOS and amend Appendix G of the current submission. The Department's confirmation that the Hills of Gold Wind Works Proponent has been requested to submit another Submissions Report will be appreciated.

Secondly, the Department acknowledges that "there may have been errors or omissions in the applicant's reports." SOS pointed out just a few of such errors and omissions. So did other submissions. "Section 10.6(1) of that Act provides "A person must not provide information in connection with a planning matter that the person knows, or ought reasonably know, is false or misleading in a material particular" [Underlining added]. The Department's response to SOS did not include this requirement of the Act.

Finally, Based on the numerous comments by Councils, organisations and individuals made in submissions during the exhibition periods of many proposed projects and at other times, it appears that errors, omissions, misleading statements and unsubstantiated claims are a feature of all wind, solar, BESS, etc. proposals. What actions is the Department taking to address these wide-spread concerns, which appear to be a breach of the EP&A Act?

Regards
Dennis Armstrong
For Save Our Surroundings (SOS)

Save Our Surroundings (SOS) is part of network of groups of like-minded concerned and impacted citizens that are directly affected by the proliferation
of industrial scale weather-dependent "renewables" and their negative impacts on local and global environments and communities. The independently run
groups span multiple States and share and distribute information, research and experiences with each other and other parties.

**APPENDIX F:**

# Wind and Solar Works Resource Requirements are Unsustainable

## Summary

This paper by Save Our Surroundings (SOS)highlights the extent of resources required by various types of electricity generation. It considers the comparisons from the same stated nameplate capacity (e.g. 400MW) but more importantly from equivalent electricity generation over a 60 year time period, which is a much better assessment of resource requirements.

An overseas study by Sovacool (2010, 2020) of the tons of materials required, based on a capacity of one gigawatt (GWe), for installed industrial wind, solar and nuclear plants concluded that solar (169,363t) and wind (410,530t) required 0.78 and 1.89 times more materials respectively than does a nuclear plant (217,101t). Current proposed solar and wind works are more recent and much larger in Australia than in the Sovacool study.

SOS has assessed the tonnes of materials required based on actual results derived from Australian installed or proposed projects for rooftop solar, industrial solar and wind, High Efficiency Low Emissions (HELE) and Combined Cycle Gas Turbine with Carbon Capture and Storage (CCGT-CCS). The Nuclear plant figures are from the Sovacool study.

When compared to the same 400MW capacity HELE power plant, just the average materials requirements for installed industrial solar and industrial wind electricity generating works are 1.2 times and 2.8 times respectively more than for an installed HELE plant (refer to Table 1). However, capacities of solar and wind works are in no way equivalent to base-load power plants.

All generator types output a single product - alternating current electricity. SOS puts forward a superior method to just capacity comparison that is based on output equivalence over a given time-frame. While the methodology used grossly understates the materials required by industrial solar and wind works it still exposes a massive resources demand difference just for the basic components when compared to fully installed and operating HELE and Nuclear plants.

SOS chose to compare industrial solar and wind works with HELE and Nuclear works as the latter are being installed in increasing numbers globally and are 24/7 base-load electricity generation plants. When compared to the same electricity output over 60 years of an installed HELE plant, just the average materials requirements for industrial solar and wind electricity generating works (average) are 3.8 times and 7.8 times respectively more than for the same electricity output of a HELE plant (refer Table 2).

Stubbo Solar (NSW), Wind Works 1 (Bowmans Creek NSW) and Wind Works 2 (Winterbourne NSW), which only include the solar panels and steel supports for Stubbo, and Wind Turbines and the concrete bases for the wind works, provide an Australian context. The results for two wind works, based on information included in their Environmental Impact Statements (EIS,) are 5.0 and 8.1 times more tonnes of materials than for the same output of an old supercritical HELE (Kogan Creek, Qld). Stubbo Solar Works is 3.1 times more materials than for the HELE.

The very significant additional materials and land requirements of solar and wind technologies has very serious implications for the global and local environments. More mining of a wider variety of minerals, more toxic processing, more manufacturing, more sea and land transportation, more land clearing, more land withdrawn from original use, more construction, more impacts on wildlife, more waste disposal, and more frequent replacement are all leading to greater destruction of local

environments and more creation of greenhouse gases. In addition, energy security and national security are significantly diminished. This unsustainable!
The capacity equivalence (Ce) of solar and wind electricity generating works compared to a 400MW HELE is 56.6MW for solar and 53.5MW for wind. That is, to match the electricity output of a 400MW HELE plant at least seven or more 400MW wind and solar works have to be built as well their required high voltage, energy storage and other infrastructure. This unsustainable!

## 1. Comparisons based on Capacity

The 400MW Stubbo Solar Works currently under construction near Gulgong in the NSW Central West Orana Renewable Energy Zone (CWO REZ) was evaluated against actual and published figures for Industrial Solar (average), Rooftop Solar (actual in the CWO REZ), Wind Turbines (average), High Efficiency Low Emissions (HELE) coal fired plant (actual), Combined Cycle Gas Turbine with Carbon Capture and Storage (CCGT-CCS) plant (proposed) and, a nuclear power plant (average). The Stubbo solar works result aligned well with the industrial solar averages. The results are summarised in Table 1.

**Table 1: 400W capacity generators material requirements over 60 years**

| Generator Type | Land Req'ts Ha | Capacity Factor % | Output MWh/Year | Availability | Material Req't Tonnes# | Expected Life Years | Energy in/out Payback % | Materials Over 60 Years t |
|---|---|---|---|---|---|---|---|---|
| Stubbo Solar EIS^ | 1772 | 25.2 | 883,008 | Daylight Hrs | 73,400 | 30 | 60 | 146,800 |
| Industrial Solar (ave) | 1280 | 25.5 | 893,520 | Daylight Hrs | 61,457 | 25 | 60 | 184,371 |
| Rooftop Solar (CW) | 0 | 24.5 | 858,480 | Daylight Hrs | 13,550 | 25 | >60 | 40,650 |
| Wind Works (ave) | 10,160 | 30.1 | 1,054,704 | Wind dependent | 148,970 | 20 | 290 | 446,910 |
| Wind Works 1 EIS^^ | 12,734 | 34.2 | 1,176,471 | Wind dependent | 158,472 | 30 | NA | 316,944 |
| Wind Works 2 EIS^^^ | 19,905 | 35.0 | 1,226,190 | Wind dependent | 178,534 | 25 | NA | 535,602 |
| HELE (Qld) | 30 | 82.3 | 2,915,328 | 24hrs/7days | < 78780 | 50 | 3,000 | 157,560 |
| CCGT-CCS (NSW) | 146 | 90 | 3,153,600 | 24hrs/7days | < 78780 | 25 | 3,000 | 236,340 |
| Nuclear (average) | 169 | 91.3 | 3,199,152 | 24hrs/7days | 78,780 | 60 | 7,400 | 78,780 |

* Ratios were used to bring to all types to 400MW capacity level
* ^Stubbo NSW estimated by SOS: 16,000T (25kg x 800,000) solar panels, 53,400T steel (40kg/m x 5m lengths X 133,500 piles plus 133,500 cross members) but no allowance for concrete, inverters, wiring, etc.
* no BESS included
* Rooftop solar from CWO REZ resident
* ^^WW1 = Bowmans Creek NSW; 60WTG x 5.6MW (at 2232t total each turbine & 600m3 concrete base) =336MW; 71WTG = 398MW & 158,472 tonnes
* ^^^WW2 = Winterbourne NSW; 119WTG x 6MW (at 2665t total each turbine & 750m3 average concrete base) = 714MW; 67WTG = 402MW and 178,534 tonnes
* HELE = Kogan Creek Qld supercritical 750MW commissioned 2007; assumed weight as for nuclear plant
* CGCT-CCS = AGL proposed Newcastle NSW 250MW dual fuel; assumed weight as for nuclear plant
* Nuclear from Sovacool study 1000MW; design life of 60 years from UK Hinkley C project
* Average hectares for solar based on developers' published figures for Beryl, Gulgong, Stubbo and Wellington solar works
* Average hectares for wind based on developers' published figures for Coopers Gap, Bodangora, Hornsdale & Sovacool
* Materials averages from sciencedirect.com "global environmental change Vol 60 Article 102028 table 1"
* 30/6/20 M Shellenberger "Apocalypse Never" p192 for energy in/out payback

One of the major drawbacks of this analysis is that there is no consideration of the non-equivalence of Solar Works or Wind Works capacity compared with base-load power plants.
SOS has developed a basic indicative formula where Capacity equivalence Ce = generator type (capacity X capacity factor X claimed life)/ base-load (capacity factor X economic life). e.g. for a 400MW solar works generator Ce = (400 x 25% x 25 years)/ (90% x 50 years) = 55.6MWe or seven times less than the 400MW HELE plant. Solar Ce will be even lower if solar panel degradation, solar works likely economic life and intermittency were taken into account. But that is for Mathematicians to work out.

The Ce for a 400MW Wind Turbine electricity generation is Ce = (400 x 30.1% x 20 years)/(90% x 50 years) = 53.5MWe or greater than seven times less than the 400MW HELE plant. Wind Ce will be even lower if wind turbine degradation, wind works likely economic life and intermittency were taken into account. But that is for Mathematicians to work out.

An alternate view of resource demands of each electricity generation type is by equating total alternating current electricity produced over a period to the initial material resources required to create the power plant. The next section provides an analysis using the data in Table 1.

## 2. Comparisons based on equal output

The calculations presented here are indicative of the differences in material requirements. The differences are so significant that they do point to a real but often ignored issue about the sustainability of wind and solar works and the associated greenhouse emissions involved in their construction.

**Assumptions:**

- Only onshore works were considered.
- Maintenance materials used during the works or plant operation are not included.
- A new and similar replacement power plant is built and operating at the time that the previous generating plant is decommissioned.
- No land requirements are included in the calculations, which are in fact very substantial for wind and solar works (refer to Table 1).
- No indirect, but necessary, materials are included that are specifically needed to connect remote wind and solar works to the electricity grid, such as new transmission lines, sub-stations and road works.
- No indirect, but necessary, additional materials associated with works necessary to address the intermittency of wind and solar works electricity generation, e.g. BESS and pumped hydro, are included.
- No degradation of output over time has been included; however, for solar works it is 2% the first year and 0.5 - 0.8% per year over a life of up to 25 years; for wind turbines the efficiency decline varies widely from 0.17% to 1.6% yearly over a life of 15 - 20 years. Declining efficiency results in declining output, which will increase the material requirements per MWh of output.

- The tonnes of materials for HELE and CCGT plants were not available so SOS assumed a worse case by using the Nuclear (average) materials figures.

The exclusion of materials required for connection, backup, and maintenance, as well as ignoring falling output from efficiency degradation favours solar and wind works. That is, solar and wind works create the need for even more materials than base-load power plants to support their operation.

Table 2 summarises the weights of direct materials required for each electricity generation type.

**Table 2. Comparison of material needed based on output (adjusted to 400MW)**

| Electricity Generator type | Output MWh/year | Output Over 60 years MWh | Materials Over 60 years t | Material Tonnes/ MWh | Materials to Equal HELE output t | Materials to Equal Nuclear output t |
|---|---|---|---|---|---|---|
| Stubbo Solar EIS | 883,008 | 52,980,480 | 146,800 | 0.002771 | **484,673** | **531,859** |
| Industrial Solar (ave) | 893,520 | 53,611,200 | 184,371 | 0.003439 | **601,556** | **660,120** |
| Rooftop Solar (CW) | 858,480 | 51,508,800 | 40,650 | 0.000789 | **138,044** | **151,483** |
| Wind Works (average) | 1,054,704 | 63,282,240 | 446,910 | 0.007062 | **1,235,313** | **1,355,578** |
| Wind Works 1 EIS^ | 1,176,471 | 70,588,260 | 316,944 | 0.004490 | **785,396** | **861,859** |
| Wind Works 2 EIS^^ | 1,226,190 | 73,571,400 | 535,602 | 0.007280 | **1,273,421** | **1,397,395** |
| HELE (Qld) | 2,915,328 | 174,919,680 | 157,560 | 0.000901 | **157,560** | **172,899** |
| CCGT-CCS (NSW) | 3,153,600 | 189,216,000 | 236,340 | 0.001249 | **218,483** | **239,754** |
| Nuclear (average) | 3,199,152 | 191,949,120 | 78,780 | 0.000410 | **71,791** | **78,780** |

When compared to the same electricity output of a HELE plant, just the materials requirements for averaged solar and wind electricity generating works are 3.8 times (601556/157560) and 7.8 times (1235313/157560) respectively more than for the same electricity output of a HELE plant.

Stubbo Solar (NSW), Wind Works 1 (Bowmans Creek NSW) and Wind Works 2 (Winterbourne NSW), which only include the solar panels and steel supports for Stubbo, and Wind Turbines and the concrete bases for the wind works, provide an Australian context. The results for two wind works, based on information included in their Environmental Impact Statements (EIS,) are 5.0 and 8.1 times more tonnes of materials than for the same output of an old supercritical HELE (Kogan Creek, Qld). Stubbo Solar Works is 3.1 times more materials than for the HELE.

The massive amount of materials required for just a part of the solar and wind works indicates that total electricity grid costs must substantially increase from current levels which will result in ongoing increases in electricity costs to consumers. In addition, the upfront embedded greenhouse gases directly and indirectly created by solar and wind works should not be ignored.

## 3. Wind and solar only produce electricity less than 30% of the time.

Significant issues with both wind and solar generated power results for their dependency on the weather. Both wind and solar are dilute, inefficient and inconsistent forms of energy conversion. Being only able to initially produce electricity over a year on average 25 -30% of the time and often zero because of wind and irradiance (sunshine) droughts means that electricity must be provided from some other sources at these times.

Filling the up to 100% gap in electricity generation is very costly, so resulting in significant price rises as more wind and solar works are built and supported by evermore storage works (e.g. batteries and pumped hydro) and thousands of kilometres of new transmission lines.

A study has shown that a PV solar system only generates **1.6** times the energy that was used leading up to its commissioning. It therefore starts operation with a CO2e and energy deficit. Assuming a 25 year life then the system will only offset its energy deficit at the time of commissioning after 10 years of operation, i.e. at least **40%** of its life before contributing to any global reduction in CO2e. Batteries in a BESS need to be replaced more frequently (10 -14 years), so adding more CO2e to the atmosphere. If the components are manufactured in China the embedded greenhouse gases are very much greater. [ref: https://doi.org/10.1016/j.energy.2013.01.029]

For energy generation, wind is an ancient technology. Solar cells were invented in 1883 by C Fritz and the first commercially viable PV solar panel was developed by Bell Laboratories in 1954.

Both wind and solar are dilute, inefficient and inconsistent forms of energy conversion. The energy density (the amount of energy in mega-joules [Mj] released per kg) of different fuels in increasing order is wood (16Mj/kg), coal (24), oil (45), natural gas(55) and nuclear (3,900,000). The higher the energy density the lower the total demand on all resources and the higher the efficiency in producing electricity. A mega-joule is equivalent to 0.278KWh of electrical energy.
Logically, natural gas and zero emissions nuclear should be the preferred fuels at this time.
[ref: understandsolar.com "Who invented solar panels?"; energyeducation.ca/encyclopedia/energy_density]

A study of Germany's electricity generation found that over their operating life solar and wind have very low energy output compared to the energy used to make and install them. The energy generated by nuclear, hydro, wind and solar was, respectively, **75, 35, 3.9** and **1.6** times greater than the energy required to make them. Wind and solar provide a poor return on an energy in/energy out basis compared with other methods. More energy in means the more emissions created and embedded in the product, especially those sourced from China, which generates the most emissions globally. Up to 90% of Australia's solar panels, wind turbines and batteries are made in China.

Logically, nuclear energy should be preferred for electricity generation as it gives the best energy in/out result, causes fewer emissions in its creation and generates zero emissions during its operation. Also, the imbedded GHG in renewables must be taken into account.
[ref: 30/6/20 M Shellenberger "Apocalypse Never" p192]

Australia is the only country of the top 20 developed countries and the top 'developing' countries (China and India) that does not depend on zero-emissions nuclear power for part of their electricity generation. There are currently about 53 nuclear power reactors under construction, mainly in China, India, Russia and UAE. Australia is being left behind due to its illogical and damaging ban on nuclear energy.
[ref: World Nuclear Association "Plans for New Reactors Worldwide" September 2020]

## Conclusion

Even when only taking into account just the main materials required by industrial Solar Works (solar panels and supporting structures) and industrial Wind Works (turbines and concrete bases) it is apparent that they require many more tonnes of materials over a 60 years period than do a High Efficiency Low Emissions coal-fired power plant or nuclear plants of the same capacity. The implications of this considerable materials requirements difference are that:

- Solar works require at least **3.1 - 6.8** times more materials, just for some components, than does a fully installed operating HELE or nuclear plant.

- Wind works require at least **8.1 - 17.7** times more materials, just for some components, than does a fully installed operating HELE or nuclear power plant.

- All these extra materials only provide intermittent electricity generation less than 30% annually on average.

- All the extra materials (transmission, storage, etc) required to build a 100% solar and wind based electricity system must also be added to the tonnes of materials required to create solar and wind operating plants and to fill the 70% plus gap when solar and wind are unavailable.

- Such massive extra tonnes of materials demands of solar and wind electricity generation are not only substantially increase electricity system costs but are highly damaging to multiple environments and are unsustainable.

## APPENDIX G: Hills of Gold Wind Works Materials Requirements

From the Proponent's EIS, a manufacturer of 6MW wind turbines and the Bowmans Creek Wind Works EIS the base data used is:

1. Sixty-six 6MW wind turbines, which yield a nominal capacity of 396MW (HoG 18/11/2020 EIS page i) for comparison with other approximately 400MW capacity electricity generators (HELE & Nuclear)

2. Capacity factor of 29.9% derived from 420MW capacity (HoG EIS pi) and initial annual output of 1100GWh (HoG EIS p19), rounded up to 30% (no allowance for 31% efficiency decline over 25 years per Proponent's HoG 221204 case study) [CF = (1100GWh x 1000 x 100) / (420MW x 24 hours x 365 days) = 110000000/3679200 = 29.9%]

3. Life expectancy of 25 - 35 years (HoG EIS p61), mid-point of 30 years used, which is still highly optimistic

4. Weight of a 6MW Vestas V150-6.0MW wind turbine is 773 tonnes ('Materials Use in Vestas turbines' brochure at V150-6.0 MW™ (vestas.com))

5. Turbine reinforced concrete base volume 500 - 900m3 (HoG EIS p42), mid-point of 700m3 used by SOS

6. 2.5 tonnes per m3 of reinforced concrete base derived from Bowmans Creek Works (EIS page 228 and their table 4); volume of 600m3 weighs 1500 tonnes of concrete and reinforcing steel).

Using the foregoing data results in a total materials requirement for the Hills of Gold Wind works for **just the wind turbine and its reinforced concrete base** over two life-times (60 years) of 1,023,777 tonnes. This is already 5.9 times more than an operating HELE power plant and 13 times more than an operating nuclear plant.

**Table 3: HoG materials required to match the 60 years of HELE or Nuclear plant output**

| WTG Capacity MW | Capacity Factor % | Initial Output MWh per year | Materials Tonnes WTG & concrete base | Expected Life (yrs) | Materials required over 60 years (tonnes)# | Output over 60 years (MWh) | Tonnes of Materials used per MWh t/MWh | Materials used to match HELE o/p* (t) | Mat used to match Nuclear o/p* (t) |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 30 | 15,768 | 2523 | 30 | 5,046 | 946,080 | 0.0053336 | 932,949 | 1,023,777 |
| 396 | 30 | 1,040,688 | 166,518 | 30 | 333,036 | 62,441,280 | 0.0053336 | 932,949 | 1,023,777 |

^ main components only included: turbines and concrete bases

# 60 years total materials required for HELE power plant is 157,560, Nuclear is 78,780 tonnes

* 60 years electricity output from HELE 174,919,680MWh, Nuclear 191,949,120MWh

The HELE and Nuclear figures and methodology come from the "Wind and Solar Works Resource Requirements are Unsustainable" (Appendix F). The calculation figures in Table 4 above are shown below for a 396MW capacity comprising sixty-six 6MW Wind Turbine Generators (WTG).

## Calculations of HoG WTG to HELE and to Nuclear:

1. Output for sixty-six 6MW Wind Turbine Generators = 66 x 6MW capacity x 0.3 Capacity Factor x 24 hrs x 365 days = 1,040,688 MWh annually (initially)

2. Materials required for sixty-six 6MW WTG and concrete bases = 66 x [773t + (2.5t x 700m3)] = 166,518 tonnes

3. Materials required for sixty-six 6MW WTG and concrete bases over two 30 year life-times = 2 x 166,518 = 333,036t

4. Output produced over 60 years by sixty-six 6MW WTG = initial 1,040,688 MWh x 60 = 62,441,280 MWh

5. Tonnes of materials required per MWh for output of sixty-six 6 MW WTG = 166,518t / 62,441,280 MWh = 0.005333587 t/MWh

6. Tonnes of materials required to match a 400MW HELE plant output of 174,919,680 MWh over 60 years = 0.005333587 t/MWh x 174,919,680 MWh = 932,949 tonnes

7. Sixty-six 6MW WTG 60 years materials requirement compared to a HELE plant = 932,949t / 157,560t = 5.9 times greater

8. Tonnes of materials required to match an average 400MW nuclear plant output of 191,949,120 MWh over 60 years = 0.005333587 t/MWh x 191,949,120 MWh = 1,023,777 tonnes

9. One 6MW WTG 60 years materials requirement compared to a 400MW nuclear plant = 1,023,777t / 78,780t = 13 times greater.

**APPENDIX H:**

# Chinese Manufactured PV Solar Panels Increase GHG Emissions

or Will the embedded GHG emissions in Chinese manufactured solar panels ever be offset?

## Summary

Currently about 90% of all PV solar panels imported into Australia are manufactured in China. It is therefore relevant to understand how much carbon dioxide equivalents (CO2e) are embedded in Chinese made panels. Good data is available for PV solar panels manufactured in France but little data is available for panels made in China.

Save Our Surroundings (SOS) has developed a methodology that compares French made panels to Chinese made panels in terms of the time it takes to produce enough electricity to offset the embedded CO2e in each panel.

The payback period for offsetting embedded CO2e in PV solar panels made in France is 1.5 - 2.5 years. The payback period for offsetting embedded CO2e in PV solar panels made in China is 8.6 - 14.3 years. The range of the payback periods results from the latitude at which the panels are installed.

This significant difference in payback periods has substantial implications for the "clean" claims of proponents of industrial PV solar electricity generating works that install panels made in China.

The total embedded CO2e of industrial PV solar works is all up front, unlike fossil fuel CO2e emissions, which are released slowly over a 50 years or more life-time. Thus, from where PV solar panels are sourced is vital to achieving global CO2e reductions. Solar panels, and other components, sourced from China will increase global CO2 emissions. This is counter to the objectives of our Australian governments to reduce greenhouse gas emissions.

The evaluation of all industrial PV solar works proposals must include assessment of the likelihood that the project will actually substantially increase CO2e emissions that may never be offset over its operational life-time and upon decommissioning, disposal and land rehabilitation.

A moratorium must be called on installing anymore solar works projects in Australia until a thorough understanding of the true impact on global emissions from PV solar panels are known.

## Background

- There are many types of photovoltaic (PV) solar panels, all of which require substantial quantities of energy to produce, especially the silicon (Si) ingots from which silicon-wafers are made. [1]

- Si-wafer- based PV technology accounted for more than 95% of the total production in 2021. The share of mono-crystalline technology is about 84%, and growing, of total c-Si production. Multi-silicon PV panels accounted for 11% and thin film 5%. [2]

- Fifty percent of a silicon ingot is lost when being cut into wafers for mono-crystalline solar panels. This loss is excluded from embedded CO2e in solar panels. [1]

- The research that has been done suggests an Industrial PV solar electricity generating works takes ten years or more of electricity generation to offset its energy consumed in its construction, [p] but this was based on the use of mainly European or American manufactured panels [p] ???

- Recent research suggests even the standard greenhouse gas emissions (carbon dioxide equivalents or CO2e) figures for PV solar panels quoted by the IPCC and IEA are understated by a factor of at least three. [5]

- Europe (1%) and North America (3%) only manufactured about 4% of the world's PV solar panels in 2021. Asia is now increasingly the primary source of PV solar panels, with China providing at least 80% of all PV solar panels.[2]

- 90% or more of PV solar panels (industrial and rooftop) imported into Australia are manufactured in China. [6]

- French legislation requires solar panels manufactured in France to specify the carbon footprint (embedded carbon dioxide equivalents or CO2e)payback period of the solar panel. [7]

- Dualsun, a French company that manufacturers PV solar panels in France, has stated that its PV solar panels, excluding the aluminium frame, have a payback period of 1.5 - 2.5 years depending on whether it is installed in Spain or Northern Europe, which is "very good, among the best in the world" it says. [8]

- The latitude of Southern Spain (37) in the Northern hemisphere is similar to that in the Southern hemisphere of Victoria (-38) and South Australia (-35). Gulgong NSW (-32) in the Central West Renewable Energy Zone is a similar latitude to Dallas Texas (32).

- The aluminium frame of a Dualsun 2.1m by 1.1m, 26kg, ECS value 510kg CO2/KWc-e, FLASH 500W PERC monocrystalline PV solar panel weighs about 2 kilograms with an embedded CO2e emissions of 16.2kg, which brings the total CO2e embedded in the 500W framed panel to 271.2kg. [9]

- France's power generation mix in 2022 was 11% fossil fuel electricity production. [10]

- China's power generation mix in 2022 was 63% fossil fuel electricity production. [11]. By comparison, Australia's NEM grid was 66.6% fossil fuels generation at 30/06/23. [12]

- Little information exists on Chinese manufactured PV solar panels and their carbon footprint. [5]

- China is by far the biggest emitter of greenhouse gases and currently generates about 31% of human-induced emissions, which is growing each year. [14]

- The CO2e emissions embedded in Chinese manufactured PV solar panels is therefore of great importance to our understanding of the CO2e payback period and whether they aid or hinder Australia's target of net zero emissions by 2050.

- The claimed life of an industrial PV solar works is usually about 20 - 25 years with a US study arriving at 21 years average economic life for decommissioned solar works. [4]

- PV solar panels have efficiencies ranging from 6% to the mid 20s% ex factory. [1] However, this efficiency drops by 2% on installation and declines linearly from 98% to 84.5% over 25 years. This will increase the payback period to offset the embedded CO2 in the panel. [14]

- Apart from a PV solar panel's degradation with age it also drops about 0.5% in efficiency per degree as temperatures rise above 25 degrees Celsius. This will increase the payback period to offset the embedded CO2 in the panel. [1]

- Save Our Surroundings has developed a methodology as presented below to determine a payback period for PV solar panels manufactured in China by using a French made solar panel as the base case and then relating the relative fossil fuel power generation of France and China in full year 2022.

## The method

Inputs:

- Dualsun's payback periods of 1.5 - 2.5 years for a monochrystalline panel .[8]
- France's 11% power generation from fossil fuels in 2022. [10]
- China's 63% power generation from fossil fuels in 2022. [11]

Assumptions:

- The solar panel is of the same type and manufacturing process in both France and China.

- The energy input is the same with the only difference being the proportion of the energy generated from fossil fuels in each country.

- No aluminium frame is included.

- No loss of the 50% of a silicon ingot is attributed to a PV solar panel i.e. the embedded CO2e of the lost ingot material is not included in the CO2e footprint of a PV solar panel.

- The payback period only relates to the solar panel before framing, packing and shipping from the factory.

- No allowance for the 0.5 - 0.8% annual decline in efficiency of installed PV solar panels or the reduced output due to temperature, weather or fire damage, maintenance downtime, etc. which reduces electricity production over time. [p]

- No allowance for all the embedded CO2e in the other necessary components, infrastructure and services needed before commissioning of a PV solar works can occur.

- Little change is expected in the power generation mixes of France and China in the next decade or two. However, France has announced it will be building more nuclear power plants and China has indicated it will continue to rapidly increase adding coal-fired power plants. [p]

- No consideration of the non-equivalence of Solar Works capacity compared with base-load power plants. For example, a 200MW nameplate capacity Solar Works is equivalent to a 28MW base-load plant in terms of life-time electricity generation. SOS has developed a formula where Capacity equivalence Ce = solar works (capacity X capacity factor X claimed life)/ base-load (capacity factor X economic life). e.g. for a 200MW solar (or wind) works Ce = (200 x 25% x 25 years)/ (90% x 50 years) = 27.8MW. Ce will be even lower if solar panel degradation, solar works likely economic life and intermittency were taken into account.

Calculation of CO2e Payback of Chinese made solar panels:

- **Formula:** France's payback years multiplied by (China's fossil fuel percentage divided by France's fossil fuel percentage)
- **Ex-factory payback case 1.5 years:** 1.5 x (63%/11%) = 1.5 x 5.727 = **8.6 years**
- **Ex-factory payback case 2.5 years:** 2.5 x (63%/11%) = 2.5 x 5.727 = **14.3 years**
- **Ex-factory average payback case 2.0 years:** 2.0 x (63%/11%) = 2.0 x 5.727 = **11.6 years**

## Conclusion

- Just the PV solar panels made in China before leaving the factory have upfront embedded CO2e (carbon footprint or embedded greenhouse gas emissions) of between 8.6 years case and 14.3 years case, based on 2022 energy generation mixes of France and China. This is a significant result. In addition, very substantial embedded CO2e emissions will occur in up to commissioning a solar works project. Not just the PV solar panel payback but all the embedded CO2e in the rest of the project must be offset from the electricity generated by only the solar panels. This is unlikely to occur.

- The claimed life of an industrial PV solar works is about 20 - 25 years with a US study arriving at 21 years average economic life for decommissioned solar works. Therefore, it is unlikely when all embedded CO2e is fully accounted for at the time of commissioning of an industrial PV solar works can ever be offset, especially as Australia's fossil fuel electricity generating plant fleet output is falling. Lower fossil fuel output results in longer payback times for each

new solar and wind works project.

- The total embedded CO2e of industrial PV solar works is all up front, unlike fossil fuel CO2e emissions, which are released slowly over a 50 years or more life-time. Thus, from where PV solar panels are sourced is vital to achieving global CO2e reductions. Solar panels, and other components, sourced from China will increase global CO2 emissions. This is counter to the objectives of our Australian governments to reduce greenhouse emissions.

- The evaluation of all industrial PV solar works proposals must include assessment of the likelihood that the project will actually substantially increase CO2e emissions that may never be offset over its operational life-time and upon decommissioning, disposal and land rehabilitation.

- A moratorium must be called on installing anymore solar works projects in Australia until a thorough understanding of the true impact on global emissions from PV solar panels are known. Comparisons must be made against the modern alternatives of High efficiency Low Emissions (HELE), Combined Cycle Gas Turbine (CCGT) and nuclear power plants, including small nuclear reactors (SMR).