From:	Paul Miskelly
To:	IPCN Enquiries Mailbox
Subject:	Middlebrook Solar Farm plus BESS - Application ID: SSD-10455
Date:	Thursday, 26 September 2024 1:16:16 PM
Attachments:	Miskelly_Submission_to_the_IPCN_re_Middlebrook_Solar_Farm_Proposal.pdf

The Secretary,
Independent Planning Commission (of NSW)
Suite 15.02
Level 15
135 King Street
SYDNEY NSW 2000
Phone: 02 9383 2100
Email: ipcn@ipcn nsw.gov.au

Dear Madam/Sir,
Please find attached an initial submission in this matter.

Please forward to the Panel considering this matter.

I may add further material to this initial submission as further information comes to hand.

Yours sincerely,

Paul Miskelly

26 September 2024
The Secretary,
Independent Planning Commission (of NSW)
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Dear Madam/Sir,

Submission re the Middlebrook Solar Farm + BESS development
Application ID: SSD-10455

This submission is an objection to this proposal.

Executive Summary

The analysis presented here shows that the project as proposed fails to meet the proponent's own specification that: "*The Project would power the equivalent of about 153,000 NSW homes*.". Moreover, this analysis shows that the project, as proposed, fails to meet the specification by a very large margin.

On this outcome alone, the project as proposed should be rejected.

An outline of the analysis conducted, and the resulting conclusions, are presented as part of this Submission.

As an extension to the analysis, also considered is a parameter sensitivity analysis on the BESS storage size. That is, the outcome of a choice of larger values for the BESS storage are discussed, and a conclusion drawn as to why a solar generator of an installed capacity as specified by the proponent can never meet the demand of 153,000 average 2-person NSW households.

Also addressed are:

- the likely consequences for grid stability and reliability should this proposal be approved, and others that are similar in concept;
- the real environmental impacts of this proposal;
- the total lack of any serious attempt by the proponent to address the recycling and/or proper disposal of the enormous quantities of waste in the form of end-of-life solar cells and end-of-life BESS battery components that would be generated should this proposal proceed.

Should the Middlebrook Solar Farm plus BESS project be approved, then, as a minimum, as a result of the findings of this analysis, the following conditions should apply.

1. The proponent be required to put in place a practical, fully implementable, plan for the recycling and waste disposal of both end-of-life solar panels and end-of-life BESS battery components, this plan to be implemented entirely at the expense of the proponent, with any CO_2 emissions resulting from the energy costs resulting from the recycling and waste disposal to be debited against any CO_2 emissions reductions claimed by the proponent as resulting from the operation of the facility;

2. As the BESS as specified is unable to supply the stated demand for the entire duration of each and every night, and at other times when the solar generator is unable to supply the required amounts of energy, resulting in the need for external backup generation to make up the deficit, any CO_2 emissions resulting from the operation of such backup generation should properly be debited against any supposed reductions in CO_2 emissions claimed by the proponent.

Introduction

According to information at the proponent's website: https://middlebrooksolarfarm.com.au/,

"*The key features of the Proposal include the following:*

- *up to 320 MWac [sic] solar PV farm;*
- *solar panel arrays installed on single-axis tracking technologies;*
- *PV inverter collection boxes;*
- *onsite medium voltage cabling and electrical connections;*
- *a 330 kV onsite collector substation and switching station;*
- *onsite energy storage facility (up to 300MW/780MWh); and*
- *associated project infrastructure*.

The proponent's Environmental Impact Statement (EIS) is available at:
https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-10455%2120230703T010707.476%20GMT

I note that on page 17 of the proponent's there is the statement:
"*The Project would power the equivalent of about 153,000 NSW homes*."
This exact set of words appears 8 times in the EIS document.
At no point in the document is there any evidence provided as to how the proponent arrives at this figure of "*about 153,000 homes*".

Being a professional electrical engineer, I thought to assess the veracity of the statement that this development "*would power the equivalent of about 153,000 NSW homes*".

I have used *italics* above to indicate where I have quoted the proponent's statements.

As a professional engineer, should such as this proposal come before me for assessment, I believe that I would be required to conduct a thoroughgoing analysis of the claims of that proposal, within the area of my expertise, to the best of my ability, and, as with any other proposal that might be brought before me, that I am required to report my findings to the relevant authorities.
This response on my part as a professional engineer is as required by the Engineers Code of Conduct, see:
https://www.engineersaustralia.org.au/sites/default/files/2022-08/code-ethics-guidelines-professional-conduct-2022.pdf

It remains to test the proponent's claim.

Analysis

The starting point for any such analysis is the obtaining of reliable data as to the average household consumption of electricity in regional NSW.

In searching for official data on household electricity and gas consumption, I found the publication by the Australian Energy Regulator (AER) entitled:
"*Residential Energy Consumption Benchmarks*", published on 9 Deccember 2020,
and available at:
https://www.aer.gov.au/system/files/Residential%20energy%20consumption%20benchmarks%20-%209%20December%202020_0.pdf

I have chosen data from that very comprehensive document for what its authors refer to as Climate Zone 4. See Table 15 on page 34. According to the preamble in section 4.2.3 Climate Zone 4:

"*The sample includes 198 households in Climate Zone 4. The majority of these (127 households) are in New South Wales, with 53 in Victoria and 18 in South Australia. Climate Zone 4 covers a wide and sparsely populated region across north west Victoria and New South Wales and northern South Australia.*"

I have chosen the Climate Zone 4 data as being representative of the household consumption patterns in the region of Eastern Australia in which the particular proposed project is to be sited. From that same Table 16, I have chosen the data as representative of households in NSW, that is, covering the wider region within which the proposed project is to be situated, and which therefore it is most likely to supply. Climate Zone 4 Table 15 data for NSW is reproduced below:

Table 15: Climate Zone 4: Electricity consumption benchmarks by household size (kWh)

State / Territory	Household size	Summer	Autumn	Winter	Spring
NSW	1	957	909	1,153	871
NSW	2	1,492	1,393	1,870	1,406
NSW	3	2,401	2,202	2,658	2,034
NSW	4	2,401	2,202	2,658	2,034
NSW	5+	2,401	2,202	2,658	2,034

The document summarises electricity consumption patterns in Climate Zone 4 as follows:

"Climate Zone 4 is characterised by hot dry summers and cool winters. Overall, electricity consumption is highest in winter, followed by summer and autumn, with consumption the lowest in spring. Climate Zone 4 has high electricity requirements, with the average consumption across all seasons the second highest of all climate zones."

For my analysis, I have chosen the line in the above table for a household of 2 persons. This choice provides a sensible minimum demand requirement on the proposed solar generator plus BESS development.

Initially, I had thought that a fairly complex iterative calculation would be required to determine whether or not the proposed development would be able to supply the supposed load of 153,000 Zone 4 homes. However, it then became clear that a somewhat simpler, 2-step, approach might be taken. This 2-step approach results directly from the 2-part configuration of the proposed development itself.

The stand-out characteristic of any solar generator is that it produces no electricity – none, zilch – all night, every night, 24/7, 365 days of the year.
This fact cannot be emphasised too strongly. The implications for any generation system based entirely on the collection and conversion of solar energy to electricity and then conection to the grid, are profound.

Couple this fact with the absolute requirement for normal grid operation: electricity supply must match electricity demand instantaneously, that is, in common parlance, second-by-second, 24/7, 365 days of the year. This means that the grid does NOT operate in the way that a lending institution does. Power may NOT be borrowed at one time and paid back on another occasion. This iron law of physics, this engineering reality of the grid, is a fact often overlooked by such as government Planning authorities. What is relevant about this fact in the case of a solar generator ist, even though a solar generator may provide large amounts of electricity to the grid during the middle of the day, the supply cannot be "banked" as a credit against the fact that the same generator cannot supply anything at all to meet the demand at night. The only way any excess that it might provide during the day is that any such excess would have to be stored, for example in a battery such as a BESS, then supplied from the latter to the grid at night.

Clearly then, to address electricity demand at night, some other form of generation, or supply from storage such as a battery, MUST be substituted for the complete lack of any solar-supplied generation during the night-time hours.

Therefore, when the solar generator is not supplying electricity, all night, every night, the BESS, if this is the chosen form of storage, can be the only source of supply from the solar generator / BESS pair in this proposed development at this time. This fact may simplify the calculation somewhat.

The first step then is to determine whether or not the BESS is of sufficient capacity to supply the stated demand, (that of 153,000 NSW homes), on each night, throughout the night.

The second step, which needs to be addressed only if the BESS is in fact of sufficient capacity to supply, in full, the demand of 153,000 average NSW homes through the night, would be to apply what is an iterative technique through a number of years of real-time operational data of an existing solar farm of the same design as that proposed, the data scaled accordingly to match the installed capacity of that proposed as the Middlebrook Solar Farm. If the BESS fails the first step, pursuing the second step is not required.

To address the first step, from the above reproduced Table 15, I thought to take a 4-part approach. First, I chose the 2-person household as likely to be the most common, smallest household in the 153,000 households sample. Then, choose the lowest consumption figure for a 2-person household among the seasons, then move progressively through the larger values, checking whether or not the BESS capacity is sufficient for each.

For a 2-person household, from the above table, the lowest value is that for Autumn. This is a figure of 1393 kWh. Note that this figure is the consumption of an average 2-person household during the entire period of the Autumn season, that is, a period of some 92 days. (March has 31 days, April has 30 days, May has 31 days, giving a total of 92 days for that season.)

The BESS is quoted as having a storage capacity of 780 MWh.
Presuming that the BESS is fully charged before each evening's requirement begins, the question then is whether 780 MWh of storage is sufficient to power 153,000 homes until the following morning.
To answer this question, there are some conversions required.

As stated above the AER consumption figures are for the entirety of the particular season. There are 92 days in Autumn. I also have to convert kWh to MWh.
For the 12-hour period of the night 6 PM until 6 AM, (there is some variation in the night-time length during the 3- month period, but conveniently, Autumn straddles the equinox so that a 12-hour average is acceptable), the required energy to power 153,000 2-person average NSW homes on a night during Autumn is a straightforward calculation.
The average daily consumption is 1393 kWh divided by 92 days = 15.14 kWh
For a 12-hour night-time period, divide this value by 2 = 7.57 kWh
To convert this value to MWh, divide by 1000 (1 MWh = 1000kWh) = 0.00757 MWh
Then, for 153,000 average 2-person NSW homes in Zone 4, multiply by 153,000.
The result is 1158 MWh. This is the requirement to power 153,000 average 2-person NSW homes on a night of 12 hours duration during Autumn.

At the other end of the seasonal scale, the calculation for a 2-person household for Winter, (there being 92 days during the Winter period), using the value from the above table of 1870 kWh, the result is: 1555 MWh.
(This result is slightly low as I have presumed here that a winter's night is also of 12 hours duration. In fact, winter nights are somewhat longer than 12 hours.)

For Spring, a period of 91 days, using the value of 1406 kWh, the result is 1182 MWh
For Summer, a period of 90 days (non-leap year), using the value of 1492 kWh, the result is 1273 MWh.

These results may be summarised in a table

Season	Required night-time storage for 153,000 2-person homes (MWh)
Spring	1182
Summer	1492
Autumn	1158
Winter	1555

All of these values are much, much larger than 780 MWh, the stated storage of the proposed BESS. Clearly, during all seasons the BESS, and hence the solar generator plus BESS, fails the proponent's own specification, and fails it by a very wide margin.

Also clearly, by examining Table 15 above, should the 153,000 homes contain a significant number of 3-person and/or 4-person homes, the very significantly higher demand for the latter homes merely exacerbates the failure of the proposal to meet the claimed 153,000 home powered.

There is another item that must also be factored in, an item which further significantly reduces the likely number of homes that might be powered: this is the result of the necessary compensation required to minimise the effect of the depth of recycling on battery lifetime. For the calculations above, I have assumed that the BESS is an ideal battery: that is, an ideal battery can be charged to 100 percent of its stated capacity and that it can be fully discharged to zero capacity before being recharged. Treating real batteries in this way very considerably shortens their operational lifetimes. According to Post (2022), Tesla recomments that to ensure the longest operational working life of a Li-ion battery, it is best to ensure that it is never charged to more than 80 percent of its capacity, and that it is never discharged to less than 20 percent of its total capacity. These limits result in an effective operational capacity of 780 MWh times (0.8 – 0.2), or 780 times 0.6 = 468 MWh.

Clearly, a “real” BESS of 780 MWh is even less able to provide sufficient energy through the entirely of a single night to power 153,000 average 2-person homes.

The other limit that any such BESS is required to address is the impact of each and every cloudy day. On a cloudy day, the adjacent solar farm cannot recharge the BESS, thus completely compromising the supply for the following night.

Clearly this proposal fails the proponent’s specification at all times through the calendar year.

Therefore, clearly, the proposal fails in the proponent’s stated objective of assisting the New South Wales government in achieving its goal of NetZero.

This failure has very significant implications for the proposal.
Quite clearly, the storage capacity of the BESS needs to be doubled, at the very least, merely to address the overnight storage requirement.
That requirement, however, is merely the beginning. As stated above, the BESS also has to provide storage capacity in the several-days-overcast event.

Clearly, a mere doubling of its capacity will not even begin to address this reqirement.

With these considerations in mind, it is clear that the capacity of the BESS needs to be increased by at least an order of magnitude.

Thus, the required BESS will occupy an area some 10 times the size of that presently proposed. This represents a massive increase in the already large environmental impact of the proposal.

Impacts on grid operational stability and reliability

As the grid must be in balance second-by-second, any failure to meet demand by any one generator, or source of supply such as BESS storage, must be met instantaneously by some other generator. If supply form such a dispatchable generator is not instantly available, then the inevitable consequence is either immediate large-scale load-shedding to reduce demand, resulting in widespread blackouts or possibly even grid collapse. Should governments come to rely on a network of such generators and close down fossil-fuelled generation then a regime of frequent, unpredictable, widespread power shortages, and, as stated, even grid collapse, would be an inevitable result.

BESS Properties

A Battery Energy Storage System, BESS, or Grid-scale Battery, is nothing more than a large collection of rechargeable batteries, using, at present, Li-Ion technology of some description. There are a number of properties which they share with any rechargeable battery.

A battery, whether rechargeable or otherwise is NOT a generator, and certainly not a generator of renewable energy. A recargeable battery is merely a device which is able to convert electrical energy into chemical energy for local storage then, when required, to convert that stored chemical energy back into electrical energy
The energy supplied for recharging such a battery might come from any electricity source: the latter may be a wind generator, a solar generator, a hydro generator, or a fossil-fuel generator. The source of the electrical energy is irrelevant as far as thd battery is concerned: its task is to convert the supplied electrical energy into chemical energy and to release it subsequently, on demand, at a later time.

A storage device, such as a BESS, or a backup generator, is required on a grid that uses solar or wind generation, because each of these two sources of generation has the characteristic that its output is both highly variable and intermittent. Either fast-acting generation, and/or BESS, is an absolute requirement to make up for these profound deficiencies, intermittency and variability, of these forms of so-called “renewable” generation.

Conversely, on a grid that uses forms of electricity generation that are fully dispatchable, sources such as coal-fired, gas-fired, hydro, and/or nuclear generation, have no need for any BESS.

When using solar and/or wind generation, a BESS, or backup by fully dispatchable generation, is, in effect, an essential “band-aid” that is required to make these forms of generation a viable means to replace fully dispatchable generation plant.

Any required BESS, or backup fossil-fuelled generation, takes no part in the actual conversion of so-called “renewable” energy to electricity. Each performs the same role – that of filling in the gaps whenever the so-called “renewable” generation is unavailable. Therefore the BESS should be treated in the same way as any backup fossil-fuelled generation: a full accounting of any CO2 emissions generated during the operation of the BESS, or, of much more concern, a full accounting of the CO2 emissions resulting form the burning of fossil fuels in the mining, milling, refining, manufacture, and the recycling of BESS units at end-of-life.

Given the sheer scale of the BESS inventory required to support renewable generation, the CO2 emissions resulting from the full life cycle of these BESS units may not be ignored.

To my knowledge, government planners simply have no knowledge, no understanding, of these issues. They have the naive belief that BESS units, as with solar and wind generators, simply “pop into existence” as required.

Use of an iterative procedure in the analysis

In the case of this proposal, the BESS was found to be incapable of supplying the proponent’s claimed demand, (153,000 average NSW homes). Should the night time demand condition have been met, the next question that would have been required to be addressed would have been whether or not the solar generator plus BESS combination would have been able to address the 153,000 homes demand in the longer term.

In the event, this was not required. However, having taken the step to conduct a sensitivity analysis on the effect of varying the capacity of the BESS, this analysis itself required the use of the iterative procedure that would have been required in the more detailed analysis. It may be useful, therefore, to discuss the details of this iterative procedure that would be required by the complete analysis should the BESS battery have been found to be of sufficient capacity to provide for this claimed demand at night.

The analysis uses a method implemented by Fekete et al (1). Menton (3), in a recent article, discusses this scholarly paper by Fekete and colleagues (*ibid*), and also a blog post article by Fekete(2).

Essentially, the Fekete *et al (ibid.)* methodology is applied here in the following way:

- At the first, or earliest, timepoint in the series of interest, sum the renewables' subtotals (MW), subtract the corresponding demand (MW), the result is the deficit/surplus value at that timepoint.

- Convert this deficit/surplus value to MWh, noting that the time period is 5 minutes, and store it as the accumulated deficit/surplus.
- Repeat at the next timepoint, but for this, and successive timepoints, add the surplus/deficit from each previous timepoint. (Where it is understood that to "add" is an algebraic addition: a deficit carries a minus sign, so, "adding" a deficit value is essentially subtracting it).
- Continue in this fashion, recording the deficit/surplus value at each timepoint, and accumulating a total deficit/surplus value across the entire time span of the operational data.

This process, as Menton (3) observes, is very similar to the procedures used in normal financial profit and loss accounting. It is important to mention “deficits” because, at present, given that the renewables capacity on the Eastern Australian grid is still far short of being able to supply the present demand requirement, running this accumulation process with the current values of the renewables’ subtotals quickly results in a very large, negative value, that is, a large deficit, and hence a failure to supply sufficient generation to meet demand.

To implement the Fekete (1) methodology for an individual generator, I chose to use the seasonal average consumption of a representative household of 2 persons, (that is, using the data as already described above), in conjunction with 5-minute AEMO SCADA data for a representative generator at a similar location and latitude in New South Wales, scaled to match the specifications of the Middlebrook solar farm as proposed here.

As the representative generator, I have chosen that known to the AEMO as the “Nevertire Solar Farm”, with the AEMO’s identifier, or Dispatchable Unit ID (DUID), of “NEVERSF1”. I have chosen this generator as it is located geographically relatively close to the site chosen for the proposed Middlebrook generator, and, importantly, at a similar latitude. This “NEVERSF1” unit is listed by the AEMO as having an installed capacity of 132 MW. It is a simple matter to scale the output of this generator to be representative of the proposed Middlebrook generator. All I need to do is to multiply each of its 5-minute data points by the ratio of the respective installed capacities, that is, 320 MW / 132 MW.

Findings from the use of the iterative procedure

The file used in the analysis contains the AEMO 5-minute SCADA data for the Nevertire Solar Farm generator.
The start date-time is 12:05 AM on 1 June 2022.
The end date-time is 23:55 PM on 1 August 2024.

Using the proponent’s specified storage value for the BESS – 780 MWh

The BESS storage fall to less than 20% of the battery storage – the minimum allowed by Tesla for continued long-life operation of their BESS battery units (Post(4)) at 03:40 AM on 01 June 2022. That is, it fails to supply the demand within 4 hours of the commencement of the simulation.

Using a value of 10 times the proponent’s specified storage value, that is a value of 7400 MWh

The BESS storage falls to less than 20% of the specified battery storage at
08:00 PM on 02 June 2022, that is, part way into the second evening of the simulation.

Using a value of 100 times the proponent’s specified storage value, that is, a value of 78000 MWh

The BESS storage falls to less than 20% of the specified battery storage at
05:55 AM on 21 June 2022, that is, less than 21 days after the commencement of the simulation.

This preliminary analysis while not exhaustive tends to suggest that, given the failure after just a comparatively few days, of the proposed generator when coupled to an improbably large BESS storage value, it is very likely that, in fact, the solar generator itself is also not of sufficient output to meet the stated demand of 153,000 homes.

Therefore, on the basis that neither the BESS storage, nor the generator’s long-term performance is able to meet the proponent’s stated demand specification, the proposal should be rejected.

Conclusion

The following conclusions are an outcome of the analysis described in this submission.
That is, they ar based on a careful analysis performed by a professional electrical engineer (myself), acting within his area of expertise.

The proponent’s claim that 153,000 average NSW households would be served by the proposed Middlebrook solar energy generator + BESS facility is best described as being a wild exaggeration.

To come anywhere near achieving the stated figure, the BESS capacity would need to be increased by a factor of at least 5, and very likely very much more.

Also, in order to adequately serve both the number of households and provide the necessary BESS recharge, the solar generator will very likely also need to be very much larger.

Implementing these requirements would massively increase the environmental impacts, and result, similarly, in a massive increase in the quantity of materials required to be properly recycled and/or properly disposed of to waste, matters that are simply not properly addressed in the proposal.

The proposal should therefore be rejected.

Declaration and Disclaimer

I have made no donations to any political Party either in relation to this present matter or any other matter.
I am not in receipt of any payment from any person for the preparation and presentation of this submission.
I am not employed by, nor am I in receipt of any income, nor have I any shares in, any company or organisation that is involved in the manufacture or supply of any energy technology.

Paul Miskelly BE MEngSc (both degrees in Elctrical Engineering) UNSW
E: [redacted]

References

1.Fekete B M, Bacsko M, Zhang J and Chen M 2023 *Storage requirements to mitigate intermittent renewable energy sources: analysis for the US Northeast.* Front. Environ. Sci., 11, September 2023, 1076830. Available at: https://www.frontiersin.org/articles/10.3389/fenvs.2023.1076830/full .

2. Fekete B M 2023 *Net-Zero Targets: Sustainable Future or CO2 Obsession Driven Dead-end?* Available at: https://judithcurry.com/2023/11/14/net-zero-targets-sustainable-future-or-co2-obsession-driven-dead-end/ .

3. Menton F 2023 *Another Critical Thinker Reaches The Obvious Conclusion: Intermittent Renwables Can't Work On Their Own.* Available at: https://www.manhattancontrarian.com/blog/2023-12-3-another-critical-thinker-reaches-the-obvious-conclusion-intermittent-renewables-cant-work-on-their-own.

4. Post W 2022 *BATTERY SYSTEM CAPITAL COSTS, OPERATING COSTS, ENERGY LOSSES, AND AGING*. Available at: https://www.windtaskforce.org/profiles/blogs/battery-system-capital-costs-losses-and-aging