Mallard Pass

Solar Farm

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9.51 - Applicant's Response to MPAG's Deadline 8 Submissions on Carbon

Deadline 8a (1st November 2023)

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Introduction

This report responds to the four issues that MPAG raised in their Deadline 8 submission, relating to Climate Change.

They were:

- **Issue 1:** Without visibility of any calculations it is difficult to follow everything the Applicant has said in their D7 response.
- **Issue 2:** The figures the Applicant provides are not conservative just because they state 2 x 40 year cycles. We already know there are the initial carbon costs and the replacement carbon costs, so there are 2 cycles. Whether that is 2 x 30 years or 2 x 40 years or 2 x 50 years is irrelevant as the majority of the carbon cost stems from the construction and associated transport. MPAG believe this is just an easy way for the Applicant not to have to redo their calculations based on 60 years, and the choice they would have to make about when they replace the panels – at 30 years or 40 years. The excel tables should be supplied to show how they have arrived at their headline figures.
- **Issue 3:** IPCC's Technology-specific performance parameters Annex 111, table A.111.2 shows 3 ranges of lifecycle emissions from 18kgCO2eq/MWh (min) to 48kgCO2eq/MWh g (median) to 180kgCO2eq/MWh g (max). MPAG would contest the Applicant's starting point is wrong using the median value. Given the IPCC report was published in 2014 and data was taken earlier to inform the document, in 2010 China had a market share of 55% of the solar panel market. In 2021 that share had risen to 75%. Panels made in China use the dirtiest electricity via fossil fuel plants in the world and therefore the emissions of these panels should not be based on the median point of 48g CO2e/kWh. [MPAG reproduced IPCC table which shows 26/41/60 range for rooftop and 18/48/180 range for utility scale (gCO2e/kWh)]
- **Issue 4:** If the Applicant truly believes the panels manufactured in China only fall within the median value emissions, can they explain what scenario would sit at the higher or maximum end of the scale? MPAG's point, as outlined originally in our Written Representation is that the carbon cost is underestimated, and also takes no account of carbon costs due to grid balancing which is likely to be even higher with no battery storage.
 The Applicant provides the following response, with paragraph numbering in its response relating to the paragraph number above.

Response to Issues

Response to Issue 1:

- The Applicant has provided the calculations to Issue 1.

Response to Issue 2:

- The Applicant's oral representation at ISH4 **[REP7-036]** and its DL7 submission **[REP7-028]** both explain why assessing the total carbon cost as equivalent to that of two full 40-year lifetimes is conservative. In essence, this is because it covers two lifetimes of emissions associated with procurement, supply chain, construction, installation, operations, maintenance and decommissioning. These submissions also explain that if no benefit arising from the *replacement* of panels (i.e. no load factor uplift just continued degradation) is attributed to the project, the carbon benefit calculation for the 60-year scheme is also conservative.

- Therefore taking a conservative (lower than likely) benefit, and finding that it is significantly higher than a conservative (higher than likely) cost, can only be interpreted as a demonstrate of the significant benefits of the Proposed Development over its 60-year operational life. Clearly because of the conservative methodology used, the timing of the replacement of panels is not relevant to the calculation.

- **9.2.3** The Excel spreadsheet which contains the calculations from which the Applicant's DL7 response [Paras 1.1.37 – 1.1.54 of **REP7-038**] is appended at **Appendix A** to this response.

Response to Issue 3:

- The Applicant addressed this point in **REP3-029**, under the 'Issued Raised' relating to 'Issues around the Proposed Development not being able to achieve carbon neutrality due to the supply chain, manufacturing, materials, and shipping from China.' In this response the Applicant included examples of carbon cost calculations for other projects in the UK and elsewhere, to demonstrate that using the IPCC median value of 48gCO2eq/kWh is a conservative assessment.

  The Applicant revisited this issue in **REP7-038** (Para 1.1.45), and included further assessments for broadly comparable UK solar developments which corroborate the conclusions the Applicant has arrived at based on available data.

- In relation to the carbon intensity of electricity used to produce solar panels, MPAG state that "in 2010 China had a market share of 55% of the solar panel market. In 2021 that share had risen to 75%. Panels made in China use the dirtiest electricity via fossil fuel plants in the world and therefore the emissions of these panels should not be based on the median point of 48g CO2e/kWh" but MPAG do not offer any alternative suggestion or evidence to support their claim.

- The Applicant has therefore reviewed data to see if there is a question which needs to be answered, and finds that based on the evidence available, there is not.

- In 2010, the six countries with the largest share in solar panel manufacturing (accounting for 89% of production) were reported to be China, Taiwan, Japan, Germany, Malaysia, USA. The grid carbon intensities of these countries in 2010, was reported to range between 462 gCO2eq/kWh and 727 gCO2eq/kWh with a weighted average between the six countries, of 565 gCO2eq/kWh. Emissions from China were reported to be 651 gCO2eq/kWh – or 17% higher than the weighted average emissions.

- Clearly the scale of such a difference (17%, as calculated in paragraph 9.3.4) cannot account for the difference in the range of lifetime emissions published by the IPCC in the cited resource (375%).

- Secondly, MPAG state that "Panels made in China use the dirtiest electricity via fossil fuel plants in the world". While the geographic location of PV module manufacture can have a bearing on the embodied carbon of those panels due to differences in the carbon intensity of energy used in the process, the carbon impact of the electricity used in the PV manufacturing process is taken into account when producing an EPD ('Environmental

Product Declaration') to reflect the specific carbon intensity of the electricity used in manufacture, and will therefore will be assured as part of the commitment within the oCEMP to provide a statement that demonstrates that the lifecycle emissions of the Proposed Development will deliver a carbon benefit over the lifetime of the project. . As noted at the Hearings, the Applicant's choice of PV module is still to be made.

- To provide additional information in support of the Applicant's conclusions, it is known that many manufacturers of PV modules in China have installed large arrays of PV modules on their own facilities, helping to significantly reduce the carbon intensity of electricity consumed in the manufacturing process. It is also reported by Reuters that *"China had installed 365 GW of wind power capacity and 392 GW of solar capacity by the end of last year - about a third of the world's total. The country's installed [solar] capacity is expected to top 500 GW by the end of 2023"*.

- A literature review on the topic ('A comparative life cycle assessment of silicon PV modules: Impact of module design, manufacturing location and inventory' - ScienceDirect) suggests that due to the *"rapid reductions in energy and material consumption in the PV industry, and the significant increase in module efficiencies … studies based on these old inventories are likely to overestimate the environmental impact of PV systems"*.

Response to Issue 4:

- In answer to this point, the Applicant refers to the IPCC's Technology-specific performance parameters Annex III, table A.III.2 and directs the ExA to the min-median-max range for rooftop solar (26/41/60) in comparison to the range for utility scale (18/48/180) gCO2e/kWh.

- The Applicant observes the consistency between the min and median for rooftop and utility scale solar PV and notes that it is the max of the range alone which is not consistent between the technology types. The Applicant concludes that the max end of the range ***cannot*** be ascribed to the panels having been sourced from China for this 'max' data point, while different procurement routes for all other installations across rooftops and utility scale developments have kept lifetime emissions lower. If this was the case it would be mathematically inconsistent with MPAG's observation (with which the Applicant broadly concurs) that approximately half of all solar panels manufactured in 2010, were manufactured in China.

- The Applicant therefore will not definitively answer for the IPCC to explain *"what scenario would sit at the higher or maximum end of the scale"* but would observe that (a) the data presented in the IPCC table is 'max', not 'higher', and therefore may represent one project, (b) the median of the data is much closer to the min than the max, and is also close to the min, median and max of the rooftop solar range, therefore it is likely than a great number of developments provided as evidence to IPCC's analysis lay within a reasonable distance of the median, and (c) the max data point is not likely to be due to solar panel procurement but other reasons, potentially particular to the individual project referenced.

- For all of these reasons, and those included in **REP3-029** and **REP7-038**, the Applicant continues to put forward 48 gCO2e/kWh as a conservative assessment of lifetime emissions from a utility scale solar farm, and continues in its carbon benefit calculations to use that number conservatively.

Appendices

Appendix A GHG Calculations Breakdown

	40 years - assume one lifetime of costs, degradation through to 40 years			60 years - assume two full lifetime costs, but assign no benefit and continue degradation from 40 year scenario as a conservative worst			Commentary
	Capacity	350	MWp	Capacity	350	MWp	Installed capacity of panels
	Capacity factor	11.4%		Capacity factor	11.4%		Capacity factor including clipping (yr 1)
	Hours per year	8760		Hours per year	8760		
	Year 1 degradation	2%		Year 1 degradation	2%		
	Thereafter	0.45%	per year	Thereafter	0.45%	per year	
Carbon cost	Annual generation (cost)	349,524	**MWh**	Annual generation (cost)	349,524	**MWh**	Year 1 anticipated generation
	Lifetime generation (cost)	13,980,960	**MWh**	**Lifetime generation (cost)**	27,961,920	**MWh**	Anticipated lifetime generation (no degradation) as a conservative input into carbon cost calculation
	i.e. with no degradation	13,981	**Gwh**	*i.e. with no degradation*	27,962	**Gwh**	GWh = MWh / 1000
	Carbon intensity (IPCC)	48	**kg CO2e/MWh**	Carbon intensity (IPCC)	48	**kg CO2e/MWh**	From IPCC
	Lifetime emissions	671,086	**tonnes CO2e**	Lifetime emissions	1,342,172	**tonnes CO2e**	Row 12 x Row 15
Carbon Benefit	**Lifetime generation (benefit)**	12,564,816	**MWh**	**Lifetime generation (benefit)**	18,046,608	**MWh**	Anticipated lifetime generation after the effects of degradation to 40 or 60 years. Conservative assumption of no uplift benefit associated with replacement of panels.
	i.e. with degradation	12,565	**Gwh**	*i.e. with degradation*	18,047	**Gwh**	GWh = MWh / 1000
	Carbon intensity of grid (DUKES)	**182**	**kg CO2e/MWh**	**Carbon intensity of grid (DUKES)**	**182**	**kg CO2e/MWh**	From DUKES
	carbon benefit	2,286,797	**tonnes CO2e**	carbon benefit	3,284,483	**tonnes CO2e**	Row 19 x Row 21
Net Carbon Benefit	**Net Benefit**	**1,615,710**	**tonnes CO2e**	**Net Benefit**	**1,942,310**	**tonnes CO2e**	Row 22 - Row 16
Households		**GWh/Year**	**Households**		**GWh/Year**	**Households**	
	Lifetime Average	314,120	**83,543**	**Lifetime Average**	300,777	**79,994**	Equivalent to consumption of 'n' households at 3,760kWh/Yr/household (lifetime)
	Year 1 - Year 40 Average	314,120	**83,543**	**Year 1 - Year 40 Average**	314,120	**83,543**	Equivalent to consumption of 'n' households at 3,760kWh/Yr/household (Yrs 1-40)
	Year 41 - Year 60 Average	NA	**NA**	**Year 41 - Year 60 Average**	274,090	**72,896**	Equivalent to consumption of 'n' households at 3,760kWh/Yr/household (Yrs 41-60)
Degradation	**Year**	**Output**		**Year**	**Output**		**Degradation Calculations**
	1	342,533,520		1	342,533,520		Note: even these are conservative because the effects of reduced clipping as panels age has not been included in this analysis
	2	340,992,119		2	340,992,119		
	3	339,457,655		3	339,457,655		
	4	337,930,095		4	337,930,095		
	5	336,409,410		5	336,409,410		
	6	334,895,567		6	334,895,567		
	7	333,388,537		7	333,388,537		
	8	331,888,289		8	331,888,289		
	9	330,394,792		9	330,394,792		
	10	328,908,015		10	328,908,015		
	11	327,427,929		11	327,427,929		
	12	325,954,503		12	325,954,503		
	13	324,487,708		13	324,487,708		
	14	323,027,513		14	323,027,513		
	15	321,573,890		15	321,573,890		
	16	320,126,807		16	320,126,807		
	17	318,686,236		17	318,686,236		
	18	317,252,148		18	317,252,148		
	19	315,824,514		19	315,824,514		
	20	314,403,303		20	314,403,303		
	21	312,988,489		21	312,988,489		

22	311,580,040
23	310,177,930
24	308,782,129
25	307,392,610
26	306,009,343
27	304,632,301
28	303,261,456
29	301,896,779
30	300,538,244
31	299,185,822
32	297,839,485
33	296,499,208
34	295,164,961
35	293,836,719
36	292,514,454
37	291,198,139
38	289,887,747
39	288,583,252
40	287,284,628
41	-
42	-
43	-
44	-
45	-
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22	311,580,040
23	310,177,930
24	308,782,129
25	307,392,610
26	306,009,343
27	304,632,301
28	303,261,456
29	301,896,779
30	300,538,244
31	299,185,822
32	297,839,485
33	296,499,208
34	295,164,961
35	293,836,719
36	292,514,454
37	291,198,139
38	289,887,747
39	288,583,252
40	287,284,628
41	285,991,847
42	284,704,883
43	283,423,711
44	282,148,305
45	280,878,637
46	279,614,683
47	278,356,417
48	277,103,814
49	275,856,846
50	274,615,491
51	273,379,721
52	272,149,512
53	270,924,839
54	269,705,678
55	268,492,002
56	267,283,788
57	266,081,011
58	264,883,646
59	263,691,670
60	262,505,057