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Note in response to Carbon Green Consulting Output Report (and comments made in CPRE Devon/public representations)

1.1. The following information is provided in response to the Carbon Green Consulting report which was appointed by Torridge District Council to comment on a planning application for the Proposed 42MW solar farm on lands circa 1.2km south-west of the village of Pyworthy, Devon (**Planning ref: 1/0249/2021/FULM**). Carbon Green Consulting were asked to *"determine whether the likely output will be the amount quoted within the application".*

1.2. The Carbon Green Consulting report notes:

"The evidence review in this document suggests that the Peak Capacity of the proposed scheme of 42MW is a fair reflection of the potential size of the scheme and a description of the peak installed capacity….considering the number of variables, all of which may intrinsically affect performance over the long term, a decline in performance of the proposed PV farm is inevitable and difficult to predict. This will negatively affect the overall energy output over its life time. This should be reflected in the Planning Statement.

It seems that the Planning Statement has overstated the carbon reduction over the lifetime of the proposal, as unrealistic carbon emissions statistics to demonstrate carbon savings have been used and degradation has not been considered."

1.3. As correctly noted by Carbon Green Consulting, there are a number of variables (solar resource available, type, size and efficiency of the PV panels, orientation and inclination of the panels, shading etc) which affect performance of a solar panel over the long term and a decline in performance over the project's lifetime is inevitable. However, although not specifically referred to in the Planning Statement submitted in March 2021, the calculation of carbon savings does include an allowance for degradation of panels (0.25% per year).

1.4. Although many research papers including *Photovoltaic Degradation Rates – An Analytical Review*[1] report that a consistent degradation rate for silicon technology is between 0.4 and 0.5% pear year, it should be noted that most of these papers are significantly outdated; the referenced paper having been published in 2012. Since then, there have been significant technological improvements including that Mono-crystalline modules - which have a much higher efficiency rate have replaced Poly-crystalline (or Multi-crystalline) modules – are now

[1] Photovoltaic Degradation Rates -- An Analytical Review: Preprint (nrel.gov)

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the industry standard. Mono-crystalline modules also have much higher efficiency rates than Poly-crystalline (typically in around 20-22% range compared to 13-17% for Poly-crystalline[2][3]).

1.5. Mono-crystalline PV panels have also benefited from technology improvements such as Passivated Emitter and Rear Cell (PERC) technology which increases efficiency[4] and Gallium doping treatment which reduces module performance degradation[5].

1.6. As a result of the above, a degradation rate of 0.25% was included within the assessment. This rate is verified and warrantied by a number of leading solar manufactures[6] including SunPower, REC and Panasonic.

1.7. In relation to carbon savings from the Proposed Development, the Carbon Green Consulting report notes:

"3.10 The first assumption in the PS of using BEIS's "all fossil fuels" emissions statistic of 446 tonnes of carbon dioxide per gigawatt hour (GWh), does give the worst case scenario comparator for calculating carbon savings.

3.11 Currently the percentage of fossil fuels used in the generation of Grid Electricity in the UK annually has reduced dramatically over recent years and accounts for 47.6% of UK electricity generation[2]. Therefore, carbon savings on the proposed scheme compared to the probable carbon emissions generated over Grid generated electricity have been overstated.

3.12 In calculating the carbon savings as in PS Table 2 (PS page 76) the "All fuels (including nuclear and renewable) Emissions per GWh of Electricity of 239GWh could be used."

1.8. In reference to paragraph 3.10, it is considered that using the "*coal*" emission statistic would give the worst-case scenario comparator for calculating carbon savings. Using the "*all fossil fuels*" emission statistic is current industry standard and is considered an accurate depiction of calculating CO_2 savings when introducing renewable energy schemes as the emphasis of introducing renewable technology is to **replace** fossil fuels and combat CO_2 levels and not to replace other renewables.

[2] https://www.jasolar.com.cn/html/en/2018/7.html
[3] https://www.jasolar.com.cn/html/en/en_pv/
[4] https://www.trinasolar.com/us/resources/blog/what-solar-perc-technology-and-why-you-need-know-about-it
[5] https://en.longi-solar.com/home/events/press_detail/id/228_Gallium-doped_monocrystalline_silicon_fully_solves_the_problem_of_a_PERC_module_s_LID.html
[6] Solar Panel Degradation: How Does it Impact Savings? | EnergySage

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1.9. The emphasis on this comes from International and National Energy Policy. For example, the Climate Change Act 2008 set in legislation the UK's approach to tackling and responding to climate change. It introduced the UK's long-term legally binding 2050 target to reduce greenhouse gas emissions by at least 80% relative to 1990 levels. In June 2019, the Government amended this headline target to a 100% reduction (compared to 1990 levels) by 2050 (otherwise known as net zero).

1.10. The calculation used in the submitted Planning Statement to scale up the estimated prevention of emissions in tonnes of CO_2 over the solar farm's lifetime was slightly overestimated as it used the 10-year yield of 41.723 GWh but did not account for degradation after the 10 years. When taking the 0.25% annual degradation into account, the CO_2 emissions saved over 40 years totals to 683,212 te, which is not a significant reduction from the 744,338 te referenced in the Planning Statement (c. 8%). In any event the savings are still substantial.

1.11. It should also be noted that the calculation used in the Planning Statement only accounted for mono-facial PV panels. The Derril Water Solar project however is proposing the use of bi-facial modules, which as the name suggests, have two sides of solar cells, enabling additional energy generation from the reflected and diffused light on the rear-side of the panels as opposed to mono-facial panels which have only one side of solar cells collecting light. The use of bi-facial panels means that there is potential to produce more electricity in less space. Bi-facial panels are said to have an efficiency of 27% which is circa 11-12% more efficient than traditional mono-facial panels according to a study by a solar panel manufacturer, LONGi Solar[7].

1.12. Having re-calculated the 40-year output for bi-facial PV panels and using a degradation rate of 0.25% (1680.05 GWh), the tonnes of CO_2 saved over the lifetime of the project is estimated to be 749,300 te. The proposal will therefore actually contribute more than originally outlined towards meeting the Central Governments challenging target of net-zero carbon emissions by 2050, and in particular Torridge District Council's current and future policy objectives as stipulated within the current Local Development Plan; North Devon and Torridge Local Plan 2011 – 2031, adopted in October 2018.

1.13. The Carbon Green Consulting report also refers to long term load factors for solar PV in the UK from 2015-2019 and 2010-2019 as well as making reference to a nearby solar project with a load factor of 8%. This project, Pitworthy Solar Farm, was built in 2014 and since then there have been significant technology improvements which mean the performance of a project

[7] Bifacial Plus Tracking Boosts Solar Energy Yield by 27 Percent | Greentech Media

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built in 2014 would not be comparable with one built today. It should be noted that there were limited solar projects constructed since circa 2015 due to the cut in subsidies (Feed in Tariffs (FiTs) and Renewable Obligation (RO) certificates) and therefore the panels used for the bases of this load assessment are significantly less efficient than those presently available. It is noted that just 10 years ago, there were only 20 gigawatts of installed solar capacity globally but by the end of 2019, the world's installed solar power had jumped to about 600 gigawatts[8].

1.14. There are significant increases in output and efficiency yearly in solar panels; today's average commercial solar panel converts 17-19% of the light energy hitting it to electricity, up from 12% just 10 years ago[9]. Furthermore, it is expected that panels will be even more efficient at the time of construction of the solar farm, if consented (earliest construction is late 2022).

1.15. As mentioned previously, mono-crystalline modules have higher efficiency rates and have benefitted from various technology improvements such as PERC technology and Gallium doping treatment. This high efficiency rate means they produce more power per square meter, and are therefore very space-efficient. The use of bi-facial panels at the Proposed Derril Water Solar farm again means that there is potential to produce more electricity in less space. This is demonstrated in the fact that the Pitworthy Solar project has an output of 0.15MW per acre (16MW output over 109 acres), while the Proposed Derril Water Solar project has an output of 0.25MW per acre (42MW output over 166 acres).

1.16. Mono-crystalline also perform better than similarly rated polycrystalline solar panels at low-light conditions, which is ideal for use in the UK. Since these panels perform better, they are projected to have a longer lifespan. Most Mono-crystalline panels include an up to 30-year performance warranty and often last substantially longer than that.

1.17. It is also worth noting a recent study published in Nature Energy by Dr Gunnar Luderer which identified that *'building solar creates an insignificant carbon footprint compared with savings from avoiding fossil fuels'*.[10] The study measures the full lifecycle greenhouse gas emissions of a range of sources of electricity out to 2050. The footprint of solar comes in at 6gCO2e/kWh. In contrast, coal CCS (109g), gas CCS (78g), hydro (97g) and bioenergy (98g) have relatively high emissions, compared to a global average target for a 2C world of 15gCO2e/kWh in 2050.

[8] A breakthrough approaches for solar power - BBC News
[9] A breakthrough approaches for solar power - BBC News
[10] https://www.carbonbrief.org/solar-wind-nuclear-amazingly-low-carbon-footprints

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1.18. The Carbon Green Consulting report notes that:

"3.5 From the available evidence, the number of panels proposed of 75,920 set out in PS Paragraph 1.32, does approximately equate to the planned Installed capacity of the proposed solar farm, assuming and dependent on the utilisation of high efficiency panels. These have not been specified."

1.19. As per above, the panels were not specified in the Planning Statement submitted in March 2021 as this selection is yet to be made. It would be premature to specify a panel at this stage with panel efficiencies constantly increasing. It is worth noting that the values included within the Planning Statement and this response are approximate and therefore, the total installed capacity and resulting energy yield, houses supplied and carbon savings will ultimately depend on the final technology selection and detailed design of the solar farm. It is considered that values stated are reasonable estimates based on standard panels available at this time (circa 530 Watt).

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