



High Grove Solar

Preliminary Environmental Information Report

Appendix 7.1 Climate Change – Supporting Evidence

April 2025

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1 Introduction

1.1 Assessment of effects

1.1.1 Greenhouse gas emissions

Construction

- 1.1.1.1 The effect of the Proposed Development on the global climate is the release of greenhouse gas emissions over the 30-month (2.5 years) construction period from the associated activities required to build the Proposed Development.
- 1.1.1.2 The embodied carbon associated with the Proposed Development will form the largest proportion of whole life cycle emissions and, as noted in IEMA GHG guidance [1], all emissions of carbon contribute to climate change. When considering construction emissions, the key test is whether the emissions expended will go on to facilitate the Science Based Targets Initiative [2] of *“aligning project emissions with a science-based 1.5C compatible trajectory and achieving net zero by 2050”*.
- 1.1.1.3 The construction phase spans the project lifecycle modules A1 through to A5. This includes the embodied carbon contained within the materials and components that form the solar PV modules, from extraction of the raw material [A1] through to manufacturing of the end products [A2-A3], as well as transportation of materials to the draft Order Limits [A4] and the construction and installation process [A5].
- 1.1.1.4 Table 1-1 summarises all the potential impacts of the Proposed Development during the construction stage.

Table 1-1 *Potential impacts of the Proposed Development during the construction stage*

Activity	Emission source and Impact
Raw material extraction	The embodied GHG emissions from fossil fuel energy are used to extract and manufacture materials and components off-site.
Manufacturing of the materials and components	
Transportation of the materials to the manufacturing centre and construction site.	Emissions from diesel, petrol, or other fuels are used in construction vehicles to transport materials and components.
Construction activities to build Proposed Development.	Emissions from construction compounds used on the site due to energy consumption, such as electricity and other fuels from plant, vehicles, and generators.
Use of construction infrastructure, including construction worker welfare facilities, a site office, wheel wash area, plant and machinery storage, waste storage areas	Emissions from energy consumption such as gas and electricity in temporary built infrastructure.
Disposal and treatment of construction waste	Emissions from diesel or other fuel use in HGV or other vehicles to transport waste to appropriate waste centre.
Land use change	Release of emissions as a result of soil disruption
Water use and treatment	Emissions from the provision of clean water on the site and energy use for wastewater treatment.
Use of construction machinery and equipment	Emissions from energy consumption such as electricity, diesel, and other fuels for machinery and equipment.
Site workers and managers travel to and from the site.	Emissions from fuel use in vehicles by construction workers

Context for construction emissions

- 1.1.1.5 Embodied carbon emissions of a solar farm and battery storage development are emissions arising from upstream processes that include:
- Raw material extraction
 - Materials production
 - Module manufacture
 - System/plant component manufacture
 - Installation and plant construction
- 1.1.1.6 The embodied carbon of solar PV modules, batteries and infrastructure can vary considerably as it is dependent on various factors, such as country of manufacture type of PV technologies (e.g. monocrystalline silicon, polycrystalline silicon, and thin film), and source of energy to extract and produce the materials.
- 1.1.1.7 Prior to 2020, the figure of 2,560kgCO₂/kWp was commonly referenced as the assumed embodied carbon of a monocrystalline photovoltaic (mPV) system. The more recent research published by Etude in 2021 [3], based on the work by Louwen et al. (2016) [4] and Pehl et al. (2017) [5], found that embodied carbon of solar was much less at around 615 kgCO₂e/kWp of installed capacity.
- 1.1.1.8 Kilowatt peak (kWp) is a unit of measurement that represents the maximum power output of a PV system under standardised test conditions.
- 1.1.1.9 Etude's (2021) research [3] indicates that the reduction in embodied carbon is:
- "...mainly driven by improvements in manufacturing process and the ongoing global decarbonisation of electricity, based on academic papers and sustainability reporting by manufacturers. Looking forward to 2040, research projects a drop to 325kgCO₂/kWp and by 2050 additional research projects just 205kgCO₂/kWp, a 92% reduction compared to currently assumed values."
- 1.1.1.10 As efficiencies in the production of solar PV modules are beginning to be realised, it is possible for the embodied carbon impacts to be further reduced. Etude (2021) [3] propose that 20-34gCO₂/kWh is a reasonable range for embodied carbon within solar PV modules at this time. The United Nations (UN) states under European Union (EU) conditions, solar PV technologies show lifecycle GHG emissions of about 37gCO₂e/kWh for ground and roof-mounted systems.
- 1.1.1.11 Although based on real life averages, attempting to forecast embodied carbon as a function of total energy generated means that figures are completely dependent on the lifetime of the solar farm, with the longer the solar farm lifetime, the higher the predicted embodied carbon. This cannot be correct as it would suggest a more long-lived solar farm has higher levels of embodied carbon. Since an estimated 99% of the embodied emissions for solar PV relate to the manufacturing process, the project lifetime is largely an independent variable. For this reason, the 615kg/kWp embodied carbon figure is used in this assessment to present a 'worst-case' scenario of impacts associated with the Proposed Development across all relevant project lifecycles.

- 1.1.1.12 As stated in the 2022 IEMA guidance “GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit; as such any GHG emissions or reductions from a project will be considered to be significant” . It is, therefore, determined that all unmitigated construction emissions are individually adverse and Significant.

Operational

- 1.1.1.13 Once operational, solar farms convert sunlight into electricity (direct current) through the use of PV cells, which are converted to alternating current and exported to the national grid.
- 1.1.1.14 As the fuel source is sunlight, there are no greenhouse gas emissions associated with the operation of the Proposed Development, except those from operations and maintenance vehicles associated with cleaning, repairing and maintaining the panels, electrical infrastructure and wider site, and other onsite grid connected electrical equipment such as security cameras and Supervisory Control and Data Acquisition (SCADA) equipment.
- 1.1.1.15 The reduction in the release of long-term (over 40 years) GHG emissions into the atmosphere because of the operation of the Proposed Development will have long-term, positive effects on the global climate.
- 1.1.1.16 A summary of the potential operational impacts and emission sources is shown in Table 1-2.

Table 1-2 Summary of the potential operational impacts and emission sources

Activity	Emission source and Impact
Maintenance of the solar PV modules.	Release of greenhouse gas emissions from energy consumption, material use, and waste generation as a result of ongoing site maintenance on a regular basis. Emissions via this source are expected to be negligible so they were not assessed.
Travel to the draft Order Limits for maintenance purposes.	Release of emissions from vehicles used to travel to the draft Order Limits for maintenance operations. Emissions via this source are expected to be negligible so they were not assessed as part of the assessment.
Component replacement	The model includes for one wholesale replacements of the original BESS which have a nominal lifespan of 20 years. Transformers assumed to have 20-year life with one replacement. Solar PV modules and inverters will only be replaced if there is a fault.
Generation of renewable electricity.	Offset the use of fossil fuels and reduce the carbon intensity of the National Grid, lowering emissions at the national level.

- 1.1.1.17 The operational phase spans the project lifecycle modules B1 (Use) through to B7 (operational water use) and includes the operational energy use [B6].
- 1.1.1.18 The 'In Use' lifecycle stage for solar PV modules will result in an emissions reduction when compared with alternative technologies (e.g., CCGT) that deliver an equivalent amount of energy (see residual effects Table 7-10).
- 1.1.1.19 As noted in the previous section, the embodied emissions from the BESS increase the overall emissions from the Proposed Development. However, within the context of operational emissions, it will also allow the Proposed Development as a whole to reduce the use of assets such as open cycle gas turbines, which have significantly higher carbon emissions, from being deployed and used, which release exceptional amounts of emissions, and which are generally deployed when the grid is under highest stress.
- 1.1.1.20 The operational element of the Proposed Development will, therefore, have a positive impact on climate change with no further mitigation measures required.
- 1.1.1.21 However, the IEMA definition of a beneficial impact [6] is where "the project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact." Across its lifetime, the Proposed Development will lead to the avoidance of a considerable amount of carbon emissions by avoiding the use of otherwise carbon intensive generation, and therefore, it is appropriate to assess it as having a beneficial effect.

Context for operational emissions

- 1.1.1.22 In relation to the operational water use [lifecycle module B7], there are currently few studies that have investigated the water use of solar PV electricity, which may be due to the low water demand of PV systems during operation. A recent study by the International Energy Agency (IEA) [7] assessed the water consumption and water withdrawal of electricity generated by PV systems by considering all life cycle stages for the manufacture of monocrystalline silicon (mono-Si) and cadmium telluride (CdTe) PV modules, and by taking account of country-level regional differences in water availability.
- 1.1.1.23 This research found that: "...The water consumption of electricity generated by mono-Si and CdTe PV systems amounts to 1.5 and 0.25 L/kWh, respectively. ...The electricity demand in the production of mono-Si and CdTe PV modules is an important driver of the total water stress impact. ...The water stress impact of process or cooling water used directly in the manufacture of PV modules amounts to 16 % for the mono-Si and 3 % for the CdTe technology, whereas the input materials contribute 2 % and 20 % to the water stress impact, respectively. Water consumption during operation of the European rooftop mono-Si and CdTe PV systems is negligible (<1 %)."

1.2 Relative emissions

1.2.1 Baseline A

- 1.2.1.1 When the Proposed Development is compared against the existing baseline (Baseline A), which is assumed to be zero, the result is a single number expressed in CO₂e. This gives rise to a relatively large number that, in isolation, is hard to contextualise when considering effects on the climate and does not take into account the fact that we need new sources of energy development.
- 1.2.1.2 The Baseline A scenario does not acknowledge the displacement of fossil fuels that the Proposed Development is expected to bring about. It is, therefore, limited in its ability to accurately reflect the reality of emission reductions associated with deploying renewables.
- 1.2.1.3 The baseline scenario shows zero operational emissions from the Proposed Development, but the total amount of absolute emissions from the embodied carbon during manufacturing and construction would result in the emission of 1,535,085 tCO₂e over the fixed layouts lifecycle (1,439,230 tCO₂e for the tracking panels), which would suggest an overall adverse impact that would be significant. However, this approach is clearly deficient in its presentation of the overall circumstances. It is, therefore, preferable to assess the Proposed Development against the future sectoral baseline (Baseline B) which results in a more balanced assessment.

1.2.2 Baseline B

- 1.2.2.1 In this instance, it is more appropriate to consider the relative emissions of solar PV compared to natural gas generation. This is because the solar PV generation is intended to be a replacement for natural gas generation.
- 1.2.2.2 Taking the natural gas scenario, the relative emissions are negative, therefore, showing a net reduction in whole lifecycle carbon emissions when comparing the two scenarios. This has been determined to have a beneficial impact on climate change.

References

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RWE Renewables UK Swindon Limited

Windmill Hill Business Park
SN5 6PB Swindon
United Kingdom