# Light Valley Solar

## Environmental Statement Volume 3

# Appendix 9.1: Greenhouse Gas Emissions Assessment

## Document Reference: EN0110012/APP/LVS/06.03.09.01

February 2026

Planning Inspectorate Reference: EN0110012
APFP Regulation 5(2)(a)

Light Valley Solar

**Infrastructure Planning**

**Planning Act 2008**

**The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**

# Light Valley Solar

# DCO Submission

---

## Appendix 9.1: GHG Emissions Assessment

---

| | |
|---|---|
| **Regulation Reference** | APFP Regulation 5(2)(a) |
| **Planning Inspectorate Case Reference** | EN0110012 |
| **Application Document Reference** | EN0110012/APP/LVS/06.03.09.01 |
| **Author** | Light Valley Solar Limited |

| Version | Date | Status of Version |
|---|---|---|
| 1.0 | February 2026 | DCO Submission |
| | | |
| | | |
| | | |

# Contents



## List of tables

# 1 Introduction

1.1.1 This appendix provides the assumptions and limitations associated with the Proposed Development Greenhouse Gas (GHG) emissions assessment. This appendix should be read in conjunction with Chapter 9: Greenhouse Gas Emissions (ES Volume 1) [**EN0110012/APP/LVS/06.01.09**].

1.1.2 The GHG emissions assessment is based on the description of the Proposed Development provided within Chapter 2: The Proposed Development (ES Volume 1) [**EN0110012/APP/LVS/06.01.02**].

1.1.3 Table 1-1 provides a summary of the lifecycle stages included and excluded within the Proposed Development assessment.

**Table 1-1 GHG emission assessment Proposed Development lifecycle stage inclusions and exclusions**

| Lifecycle ref | Lifecycle stage | Assessment inclusion / exclusion | Description, including justification where excluded |
|---|---|---|---|
| A0 | Pre-construction | Excluded | GHG emissions from preliminary studies and works are largely office-based and are assumed to be insignificant. |
| A1-3 | Product Stage | Included | Embodied GHG emissions associated with the required raw materials, e.g. Solar PV panels, steel for structures, concrete for foundations, for construction of the Proposed Development. |
| A4 | Transport stage | Included | GHG emissions from fuel consumption of vehicles used for transportation of materials to Site. |
| A5 | Construction process stage | Included | GHG emissions associated with energy, fuel and water usage on-site, and waste from the construction phase. |
| B1 | Non-energy-related impacts | Excluded | GHG emissions associated with accidental release of refrigerants with GWP from equipment such as cooling systems. GHG emissions from non-energy-related impacts are not expected to be significant. |
| B2-4 | Maintenance, repair and replacement | Included | GHG emissions associated with:<br>transport to site to carry out inspections and maintenance (including replacement);<br>transport to site to carry out repairs and embodied emissions associated with the required materials; and<br>Scheduled and ad hoc replacement of components such as PV panels, batteries |

| Lifecycle ref | Lifecycle stage | Assessment inclusion / exclusion | Description, including justification where excluded |
|---|---|---|---|
| | | | and substation equipment over the lifespan of the Proposed Development. Embodied GHG emissions associated with materials used for repair and replacement of elements (this includes replacement of most elements of the Proposed Development at least once across its lifetime). |
| B5 | Refurbishment[1] | Excluded | It is assumed there is no planned refurbishment within the operational lifespan of the Proposed Development. |
| B6 & B7 | Operational energy and water consumption | Excluded | Water will be used to clean the panels throughout operation, however water and energy impact assumed to be minimal and not significant. |
| B8 | Other operational emissions and user activities | Excluded | It is assumed no chemical, process or user emissions; assumed negligible impact and not significant. |

1.1.4 In addition to the lifecycle stages in Table 1-1, benefits and loads beyond the system boundary[2] of the Proposed Development are also included within the assessment as follows:

1) GHG emissions associated with land use change; and
2) The "avoided" GHG emissions associated with the renewable energy generation, further details are provided in Section 3.4.

1.1.5 The assessment has been undertaken following the Rochdale Envelope approach to consider worst case assumptions for the Proposed Development design. The worst case for GHG emissions assumes the largest scale of development and any assumptions are made to avoid under-estimation of quantities and associated emissions. At time of assessment, the detailed design information for the Proposed Development is not available.

1.1.6 Following the RICS guidance (Ref 7), the carbon impacts reported must reflect the accuracy of the calculation. Therefore, calculations and totals within this assessment are reported to three significant figures.

[1] As defined by RICS (2023) guidance, refurbishment is "a planned alteration or improvement to the physical characteristics and/or performance of the built asset" and "would typically involve a predetermined change that will occur during the service life of the project."
[2] As defined by RICS (2023) guidance, the system boundary "defines the unit processes to be included in the assessment model". For the Proposed Development, the system boundary is defined as the Study Area, which for the GHG emissions assessment is defined as the emissions with occur within the Order Limits and transportation of materials to the Proposed Development.

# 2 Construction assessment

2.1.1 Indicative parameters on material quantities used for key elements of the construction of the Proposed Development were provided by the 'Applicant), and where necessary assumptions were made to assess a likely worst case of material quantities for the Proposed Development. These quantities are subject to change during further development of the design however the maximum (or minimum) parameters assessed in the ES are set out the Works Plans [**EN0110012/APP/LVS/02.03**] and the Design Principles and Parameters [**EN0110012/APP/LVS/05.05.01**] documents.

2.1.2 Typical carbon factors for materials were obtained from the Inventory of Carbon and Energy (ICE) database (Ref 1) which provides estimates of the cradle-to-factory gate carbon factors[3] for a range of typical construction materials. In some cases, it has been necessary to draw on benchmark information and make conservative assumptions to provide a reasonable worst-case scenario for the particular item or factor to allow for a precautionary approach to assessment.

## 2.2 Construction phase: materials

2.2.1 Construction materials and associated emission factors for the Proposed Development infrastructure are presented in Table 2-1.

**Table 2-1 Construction materials and carbon factors for the materials used for the Proposed Development**

| Material type | Material use | Carbon emissions factor | Carbon factor source |
|---|---|---|---|
| PV panel (Silicon, Glass and Electrogalvanized steel included below) | PV Panels | 74.9 $kgCO_2e$/panel | Calculated based on material properties of a bifacial monocrystalline panel |
| Silicon | PV Panels | 6.30 $kgCO_2e$/kg | Greenhouse Gas Emissions from Silicon Production - Development of Carbon Footprint with Changing Energy Systems (Ref 2) |
| Glass | PV Panels | 1.43 $kgCO_2e$/kg | ICE V4, Glass, General |
| Electrogalvanized steel | PV Panels | 2.71 $kgCO_2e$/kg | ICE V4, Steel, electrogalvanized steel. |
| Steel, electrogalvanized steel | PV Panel supports | 2.71 $kgCO_2e$/kg | ICE V4, Steel, electrogalvanized steel. |

[3] An assessment of a partial product life cycle from resource extraction (cradle) to the factory gate (before it is transported to the consumer).

| Material type | Material use | Carbon emissions factor | Carbon factor source |
|---|---|---|---|
| Steel, Plate | Battery energy storage system (BESS) Containers, Substation buildings | 2.38 $kgCO_2e/kg$ | ICE V4, Plate Steel |
| Concrete | PV footings, Conversion unit bases, BESS and substation foundations | 0.10 $kgCO_2e/kg$ | ICE V4, Concrete, General |
| Rebar | BESS and substation foundations | 1.72 $kgCO_2e/kg$ | ICE Version 4, Steel, Rebar |
| Aggregate | Substation enclosures | 0.00747 $kgCO_2e/kg$ | ICE Version 4, Aggregate and Sand, Aggregate, UK general |
| Batteries | BESS | 100 $kgCO_2e$/ kwh | Following consultation with LeClanché, a supplier of batteries used in similar developments, a value of 100 $kgCO_2e$ per kwh was provided as a realistic worst case for the purposes of this assessment. |
| 275 kV Transformers | Transformers | 794 $tCO_2e$/transformer | Hegedic et al (2016) (Ref 3). |
| Integrated conversion units | Integrated conversion units | 23.4 $tCO_2e$/unit | A combined factor from: Lifecycle assessment for Sunny Central 4600 UP central inverter (Ref 4); and EPD for Toshiba Aluminum wound, Mineral oil filled Transformer (Ref 5) |
| High Voltage underground cables | Underground cables for energy transmission | 227 $kgCO_2e/m$ | EPD for High-voltage underground cable (Ref 6) |
| Fencing | Steel/wire/chain fence (including posts) | 0.001 $tCO_2e/m$ | ICE V4, Steel/wire/chain fence (including posts) |

## 2.3 Construction phase materials transportation

2.3.1 Transport types and distances from the Royal Institution of Chartered Surveyors (RICS) guidance (Ref 7) were used to calculate the sea and road transport GHG emissions for the materials associated with the Proposed Development, with the exception of elements that are expected to be sourced from China. Elements such as the PV Panels and batteries are assumed to be sourced from China and in this instance a bespoke distance has been provided of 22,000 km from Shanghai to Dover and 1000 km over land as a worst case. For other elements, steel will be sourced nationally, cables nationally, and concrete and aggregates will be locally manufactured. The emission factors used for material transport are shown in Table 2-2.

**Table 2-2 Construction material carbon factors for transport to the Proposed Development**

| Sourcing location | Distance (km) | Transport type | Carbon factor ($kgCO_2e$/ tonne.km) | Carbon factor source |
|---|---|---|---|---|
| China | 22,000 | Sea: Average Container Ship | 0.0162 | Department for Energy Security & Net Zero (DESNZ): Greenhouse gas reporting: conversion factors 2025 |
| | 1000 | Road: HGV Average Laden | 0.102 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| European manufactured[4] | 1,500 | Sea: Average Container Ship | 0.0162 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| | 100 | Road: HGV Average Laden | 0.102 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| Nationally manufactured[4] | 120 | Road: HGV Average Laden | 0.102 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| Locally manufactured[4] | 50 | Road: HGV Average Laden | 0.102 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| Locally manufactured – mixed concrete[4] | 20 | Road: HGV Average Laden | 0.102 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |

## 2.4 Construction and installation process

2.4.1 In line with similar projects and assumed construction activities, the assessment has calculated emissions related to fuel and water consumption over a 3-year construction period for the Proposed Development. The emission factors used for material transport are shown in Table 2-3.

[4] Values taken from RICS guidance on material transport distances

**Table 2-3 Construction and installation process emission factors**

| Activity | Carbon factor ($kgCO_2e/L$) | Carbon factor source |
|---|---|---|
| Fuel consumption - plant | 2.51 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| Fuel consumption - generators | 2.51 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |
| Water consumption | 0.15 | DESNZ: Greenhouse gas reporting: conversion factors 2025 |

## 2.5 Construction worker transport

2.5.1 The GHG emissions from worker transport are negligible in the context of the other construction emissions and therefore have been excluded from this assessment.

# 3 Operational assessment

3.1.1 The assessment of the Proposed Development operational emissions is based on the description of the Proposed Development information provided in Chapter 2: The Proposed Development (ES Volume 1) [**EN0110012/APP/LVS/06.01.02**].

3.1.2 As outlined in Chapter 2: The Proposed Development (ES Volume 1) [**EN0110012/APP/LVS/06.01.02**], the PV panels are expected to be replaced once (and further replacement will be required on an ad hoc basis, assumed to be 10% of the originally installed PV modules), transformers are expected to be replaced once and the batteries of the BESS are to be replaced up to five times over the design life of the Proposed Development. This replacement is responsible for the majority of emissions associated with the operational phase of the Proposed Development. Otherwise, due to the nature of the Proposed Development, remaining operational phase GHG emissions are expected to be minimal, arising from maintenance activities.

## 3.2 Operation and maintenance

3.2.1 During operation it is assumed that there will be maintenance requirements such as annual inspections. The GHG emissions associated with these maintenance activities (module B2 in the modular approach) have been included as a 1% allowance of Embodied Carbon (modules A1-5) calculated emissions, as per the RICS guidance (Ref 7).

3.2.2 An allowance for the assumed repairs during the life span of Proposed Development assets have been included as 25% of the maintenance (module B2) emissions as per the RICS guidance (Ref 7).

## 3.3 Replacement

3.3.1 Over the 60-year design life of the Proposed Development, all PV panels will be replaced once, while replacement of defective and broken PV panels will occur on an ad hoc basis. As a conservative estimate, this assessment assumes an additional 20% ad hoc replacement rate for the 60-year period.

3.3.2 As a conservative estimate, the BESS cells are expected to be replaced five times over the 60-year design life of the Proposed Development.

3.3.3 The replacement calculations assume that the GHG emissions associated with the production of these assets remain the same as during construction, however, it is likely that due to grid decarbonisation and improvements in manufacturing efficiency that the GHG emissions associated with this replacement may be lower.

## 3.4 Benefits arising from the Proposed Development

3.4.1 The purpose of the Proposed Development is to generate large amounts of renewable energy. For this assessment the capacity of the Proposed Development is assumed to be 662 MW, based the Indicative Site Layout [DOC REF].

3.4.2 When estimating the displaced energy generation and resultant emissions avoided by the generation of renewable electricity, the following elements associated with the Proposed Development should be considered:

1) Whole life GHG emissions of the Proposed Development;
2) Anticipated energy generation of the Proposed Development;
3) Operational lifetime of the Proposed Development; and
4) Consideration of the carbon intensity of energy generation displaced by the Proposed Development.

3.4.3 The Applicant has provided an estimate of 620,000 MWh generation in the first year of operation.

3.4.4 The GHG assessment assumes efficiency loss of the PV panels over time based on an initial 2% degradation in the first year and 0.45% for every additional year for a lifespan of 40 years. As this assessment assumes that the panels will be replaced at 40 years[5] (as a reasonable basis of assessment), the generation total resets to 620,000 MWh in year 41 and follows the same degradation in efficiency over the remaining 20 years of the Proposed Development's 60-year operational life. This assumes no advancement in PV technology and yield at the time of replacement.

3.4.5 As a result, lifetime generation for the Proposed Development is assumed to be approximately 33,100 GWh, an average of 568 GWh per year.

[5] Given the level of detail currently available at time of assessment, it is assumed that all PV panels will be replaced in one go. However it is understood that the reality of replacement for a scheme the size of the Proposed Development will be over a period of time.

**Table 3-1 Proposed Development capacity and generation assumptions**

| Element | Quantity and Units | Source |
|---|---|---|
| Capacity | 662 MW | Design team |
| Generation in first year | 620,000 MWh | Design team |
| Proposed Development operational phase | 60 years | Design team |
| Average generation per year over design life of the Proposed Development[6] | 568 GWh | Calculated |
| Total generation over the design life of the Proposed Development | 34,100 GWh | Calculated |
| GHG emissions intensity of energy generation in 2030 of UK grid (first year of operation) | 85.0 $tCO_2e/GWh$ | Generation Based Long-run Marginal Electricity emissions factors to 2100 (Ref 8) |
| Emissions of the UK grid for the equivalent generation over the total design life of the Proposed Development (using the above 2030 intensity) | 2,900,000 $tCO_2e$ | Calculated |
| Total emissions of the Proposed Developments life | 1,860,000 $tCO_2e$ | Calculated |

3.4.6 The carbon benefits that accrue from the generation of renewable electricity are challenging to quantify. The UK grid is set to decarbonise over time, and as average grid intensity decreases then the marginal carbon benefit of each unit of renewable energy similarly decreases. A simple arithmetic evaluation of carbon benefits, therefore, shows decreasing benefit each year over time – although that benefit is wholly reliant on projects such as the Proposed Development coming on-line to support that decarbonisation trend. Accurately estimating the benefit of solar generated renewables, relative to the wider grid intensity of electricity, is also challenging given the uncertainty in the rate at which the grid will decarbonise (and that in practice the carbon benefit of renewables fluctuates considerably day-to-day depending on levels of generation from other sources). This contextualisation exercise has taken the approach of fixing the carbon benefit per unit of exported electricity at the level expected in the first year of operation (2030). Whilst this provides an optimistic approach to estimating whole-life carbon benefits from the Proposed Development it also reflects that projects such as the Proposed Development are integral to delivering a decarbonised electricity grid. This numerical analysis supports the contextualisation exercise in the following paragraphs, but given uncertainties in future grid decarbonisation, should not be seen in isolation.

3.4.7 Using the elements within Table 3-1, along with the whole life carbon results for the Proposed Development, the total benefits beyond the boundary and

[6] This average generation accounts for the degradation and replacement of solar panels over the life of the Proposed Development.

calculated avoided emissions per year are 47,800 tonnes of carbon dioxide equivalent ($tCO_2e$) for the Proposed Development's 60-year operational phase, totalling 2,9000,000 $tCO_2e$. As the emitted GHG emissions over the course of the Proposed Development's life is estimated to be approximately 1,860,000 $tCO_2e$, this results in a total net saving of 1,040,000 $tCO_2e$ over 60 years.

3.4.8 In addition to the generation of electricity, it is noted that the inclusion of the BESS provides the potential for grid balancing by allowing storage of electricity during periods of low demand but while PV generation is high. This helps reduce wider reliance on fossil-fuel electricity generation elsewhere. While the impact of this grid balancing has not been quantified as part of this assessment, it is expected to have a positive impact in emission terms during the Proposed Development's operational phase.

3.4.9 The carbon generation methodology set out above is limited in that it only compares electricity generated by the Proposed Development to the equivalent electricity available via the national grid (at the carbon intensity of the opening year of the Proposed Development). By doing so it does not take full account of the carbon benefits that accrue from the provision of renewable energy as part of an increased and extensive electricity supply system that offers a diversity of generation sources, with the carbon and resilience benefits that these offer. In practice, low carbon electricity will not only contribute to a decarbonised grid but will also, secondarily, support the electrification of activities that currently rely on fossil fuel use (such as heating homes and fuelling cars). The limited comparison of generated electricity against equivalent grid intensity (as set out above) ignores the fact that a national process of electrification seeks to displace fossil fuel use. In practice, the energy use from transport, heating and industrial processes that the Proposed Development (and other) renewable energy projects displace may well be significantly more carbon intense than the national grid at that point in time, in which case the benefit of the Proposed Development will be greater.

# 4 Decommissioning

4.1.1 The decommissioning scenario for the Proposed Development is based on the assumed deconstruction, transport of waste, waste processing and disposal of waste. This scenario provides an allowance for the GHG emissions at the end of the study period of the assessment.

4.1.2 The GHG emissions associated with the deconstruction of the Proposed Development are assumed to be 50% of the GHG emissions calculated at construction (A5). This assumes that the recovery of the majority of materials is prioritised and promoted, as per the RICS guidance (Ref 7) and that the carbon intensity of deconstruction activities will have reduced significantly in the 60 years after construction, due to improvements in fuel efficiency, transition to alternative fuels, and improvements in best practices.

4.1.3 The transport of deconstructed materials and waste at end of life has been assumed to be 50% less than the emissions as those calculated for the transport of construction materials.

4.1.4 The GHG emissions for the end-of-life waste processing and disposal of materials have been calculated using default waste processing rates per material type within the RICS guidance (Ref 7) and DESNZ (Ref 9) GHG emission conversion factors per material type and waste route.

# 5 Land use GHG emissions and sequestered carbon assessment

5.1.1 Habitat areas were provided for the Order Limits as outlined in Chapter 6: Biodiversity (ES Volume 1) [**EN0110012/APP/LVS/06.01.06**]. The carbon sequestration factors used in the quantification of land use are based upon the Natural England (Ref 10) paper and their supporting assumptions and limitations. Table 5-1 sets out the habitat type and carbon factors used to determine the carbon sequestration potential estimates.

**Table 5-1 Carbon flux factors used to quantify the carbon sequestration potential for habitat types within the Study Area**

| Natural England habitat type | Carbon flux factors[7] | Unit |
|---|---|---|
| Arable / cultivated land | + 0.29 | $tCO_2e/ha/yr$ |
| Mixed native broadleaved woodland (30 years) | -14.5 | $tCO_2e/ha/yr$ |
| Neutral grassland | 0 | $tCO_2e/ha/yr$ |
| Upland & Lowland Heathland | 0.05 | $tCO_2e/ha/yr$ |
| Hard standing / developed land | 0 | $tCO_2e/ha/yr$ |

5.1.2 The following assumptions and limitations apply to considerations of carbon in habitats:

1) Carbon sequestration potential of the current land use of the Order Limits has been calculated using the habitat areas, as outlined in Chapter 6: Biodiversity (ES Volume 1) [**EN0110012/APP/LVS/06.01.06**].

2) The carbon values used assume a 30-year-old age profile, meaning that the presence of habitats older than 30-years old may result in an underestimation of the carbon stock.

3) Proposed Development habitat types have been mapped to the habitat types for which carbon sequestration potential is available in the Natural England source papers. Mapping has been carried out based on professional judgment, following a qualitative review of similarity from the

[7] Carbon flux factors represent the GHG emissions associated with a given habitat. A positive carbon flux factor (e.g. Arable land: +0.29 $tCO_2e/ha/yr$) represents a habitat type that emits greenhouse gases. Meanwhile a habitat with a negative carbon flux factor (e.g. Hedgerows: -1.99 $tCO_2e/ha/yr$) sequester greenhouse gases.

available information on habitat types and an assessment of the closest match.

# References

Ref 1 Circular Ecology, "Embodied Carbon - The ICE Database v4.0," 2025. [Online]. Available at: [redacted]

Ref 2 Sævarsdottir, Gudrun and Kvande, Halvor and Magnusson, Thordur, "Greenhouse Gas Emissions from Silicon Production - Development of Carbon Footprint with Changing Energy Systems," 2021. [Online]. Available at: [redacted]

Ref 3 Hegedic, M., Opetuk, T., Dukic, G. and Draskovic, H., "Life Cycle Assessment of Power Transformer – Case Study", 2016. [Online]. Available at: [redacted]

Ref 4 SMA, "Sunny Central 4600 UP Life cycle assessment", 2025 [Online]. Available at: [redacted]

Ref 5 Toshiba, "Aluminum wound, Mineral oil filled Transformer – 8574C]", 2023 [Online]. Available at: [redacted]

Ref 6 Brugg Cables, "Environmental Product Declaration," 2025. [Online]. Available at: [redacted]

Ref 7 RICS, "Whole life carbon assessment for the built environment," 2023. [Online]. Available at: [redacted]

Ref 8 Department for Energy Security and Net Zero, "Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal'," 2023. [Online]. Available at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

Ref 9 Department of Energy Security and Net Zero and Department of Environment Food and Rural Affairs, "UK Government GHG Conversion Factors for Company Reporting," 2025. [Online]. Available at: https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

Ref 10 Natural England, "Carbon Storage and Sequestration by Habitat 2021 (NERR094)," 2021. [Online]. Available at: [redacted]

Light Valley
Solar

W: Lightvalleysolar.co.uk
E: info@lightvalleysolar.co.uk