APPENDIX 2.5
CARBON ASSESSMENT

Appendix 2.5
Alleston Solar Farm
Carbon Assessment

Document Control Sheet

Project Name: Alleston Solar Farm

Project Ref: 333100998

Report Title: Carbon Assessment
Doc Ref: 333100998/A5/Carbon Assessment

Date: October 2024

Revision	Date	Description	Prepared	Reviewed	Approved
00	May 2024	Carbon Assessment	NS	LW	LW
01	August 2024	Carbon Assessment	NS	MM	LW
02	September 2024	Carbon Assessment	NS/CD	LW	

Contents

Appendices

This page is intentionally blank

1 Introduction

1.1 Overview

1.1.1 This carbon assessment has been prepared by Stantec on behalf of Alleston Clean Energy Limited (the Applicant) in support of a Development of National Significance (DNS) application for a ground mounted photovoltaic (PV) solar farm together with associated equipment, infrastructure and ancillary works (the Development) on land at Alleston Farm, Lower Lamphey Road, Lamphey, Pembrokeshire (the Site, see Figure 1.1 of the ES) submitted to Planning and Environment Decisions Wales (PEDW). The Site extends to approximately 96 hectares (ha) and is located within the administrative boundary of Pembrokeshire County Council (PCC).

1.1.2 This report forms Appendix 2.5 of Chapter 2 EIA Methodology of the ES.

1.1.3 This carbon assessment includes an assessment of the greenhouse gas emissions (GHG) to be emitted by the traffic associated with the construction phase of the Development and commentary on the renewable energy to be generated.

1.2 The Development

1.2.1 A Development of National Significance (DNS) application is proposed for the construction, temporary operation, and decommissioning of approximately 30 MW solar farm and associated equipment such as inverters, transformer stations, substation, fencing, CCTV, weather monitoring stations and cabling. The solar farm will connect to the grid via a 132kV overhead wooden pole, located within the site. The solar farm development will have an operational lifespan of 40 years from the date of first export of electricity, after which it will be decommissioned.

1.2.2 The Site Layout Plan can be seen in ES Figure 3.3 and demonstrates one potential way the Development can be built out during the operational phase.

1.2.3 Full information on the Development is available from ES Chapter 3.

2 Methodology

2.1.1 'Climate' is generally understood to mean the weather conditions prevailing over a long period of time and climate change refers to changes in recorded long-term climate trends. As a topic for the assessment within EIA, climate change is relatively new. Guidance is evolving and there is no prescribed way in which climate change should be incorporated into an ES. However, some guidance has been prepared by the Institute of Environmental Management and Assessment ('IEMA'), discussed further below. It sets out the two main approaches that can be taken to determine a project's climate change impact. These involve identifying:

- The direct and indirect influence of the Development on climate change resulting from GHG emissions (climate change mitigation); and
- The vulnerability of the Development to climate change (climate change adaptation/ resilience).

2.1.2 This report will only assess emissions associated with climate change. An EIA Scoping Report submitted to PCC in November 2023 sought to scope out climate change from the EIA. The EIA Scoping Direction provided by Planning and Environment Decisions Wales (PEDW) stated *'PEDW agrees that climate change does not need to be covered in a standalone chapter, however, the ES should contain information adequate to enable the decision maker to judge the likely impact on carbon emissions should permission be granted.'*

2.1.3 This report therefore considers climate change mitigation as an appendix to Chapter 2 EIA Methodology of the ES.

2.2 Climate Change Mitigation

2.2.1 In February 2022, IEMA published guidance (the 'IEMA GHG Guidance')[i] to seek to assist practitioners with addressing GHG emissions assessment and mitigation in EIA. The guidance indicates that a 'good practice' approach is advocated where GHG emissions are always considered and reported but at varying degrees of detail depending on the project.

2.2.2 The guidance sets out that there are a number of different assessment methods available for measuring and quantifying the GHG emissions associated with the built environment, ranging from general guidance to form standards for the use of an EIA. The IEMA GHG Guidance recognises that *'qualitative assessments are acceptable, for example: where data is unavailable or where mitigation measures are agreed early on in the design phase with design and engineering teams'.*

2.2.3 The guidance outlines that an EIA must give proportionate consideration to whether and how the Development will contribute to the 2050 net zero target. Therefore, the crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions, but whether it contributes to reducing GHG emissions relative to a comparable baseline, consistent with a trajectory towards net zero by 2050. Notwithstanding, likely significant effects from the nature and magnitude of GHGs from the Development are still relevant for purposes of the EIA, under Schedule 4 of the EIA Regulations.

2.2.4 Although this report does not form part of the EIA process or assessment, the IEMA guidance summarised is still relevant for this carbon assessment outside of the EIA process and has therefore been utilised.

2.3 Assessing Construction Vehicle GHG Emissions

2.3.1 The climate change impact is assessed as the uplift in carbon emissions associated with the baseline construction vehicle movements of the Development. The study area for carbon emissions assessment is defined by the Site boundary and the transport network study area for the Transport Statement.

2.3.2 In terms of transport-related emissions, whilst forecasting can be carried out to project potential increases in traffic flows, and, by inference, the impact on CO_2 levels, the impact of technological changes is harder to infer. Hence, the assessment broadly assumes a conservative uptake of electric vehicles, other than assumptions which are inherent in the Emissions Factors Toolkit (EFT V12.0.1)[ii] utilised for the assessment.

Traffic Flow Data

2.3.3 In order to assess the effects of the Development during the construction period, the total peak construction traffic flows from Table 2 of the Transport Statement have been utilised. The peak construction traffic flows are based on the volume of heavy goods vehicles (HGVs), cars and light goods vehicles (LGVs) travelling through different road links on the affected road network defined in the Transport Statement. The assessment of construction vehicle GHG emissions arising from the Development is a reasonable 'worst-case' assessment, representing the peak period. On a typical day, traffic flows would be lower.

2.3.4 Transport distance is subject to the anticipated supply chain route of materials and staff traveling to the Site. In the absence of specific sourcing information, a transport distance of 80 km, taken from RICS guidance[iii] assuming the majority of staff and materials will travel regionally, has been applied to this assessment. It is acknowledged that certain materials will be supplied from further afield however, it is unknown what proportion of transport movements will be associated with this, either on the road network or by other modes such as shipping.

2.3.5 The road type utilised was in the EFT assessment was 'Rural– Not London' and the area was selected as 'Wales' to reflect the location of the Site.

2.3.6 The EFT assessment is shown in Appendix A.

2.4 Operational Emissions and Carbon Reductions

2.4.1 An assessment of likely carbon savings realised through the provision of renewable solar energy has been undertaken for the duration of the lifespan of the Development (modelled to be up to 40 years operating life). This assessment is based on the stated maximum export of renewable electricity (from the Development, which is outlined in Chapter 3 Site and Development Description of the ES.

2.4.2 The Carbon Factor (or Carbon Intensity) of the current electricity grid is derived from the Department for Energy Security and Net Zero ('DESNZ') conversion factors[iv]. The Carbon Factor is 0.20705 kg of CO_2e per kWh.

2.4.3 The efficiency of solar panels is measured by Load Factors. These are often affected by average daily sun hours, which can vary year on year. The assessment utilises the load factor taken from the Government Digest of United Kingdom Energy Statistics ('DUKES')[v]. This is a national figure and does not consider localised irradiation levels, nor site-specific attributes of the Site.

2.4.4 In order to calculate the carbon saving (t CO_2e/year) the MWh/Year is calculated by multiplying hours in a year (8,766) by the stated maximum output of the Development (30MW). This is then multiplied by Load Factor to give a MWh/Year / Load Factor value, which is then multiplied by the Carbon Factor outlined above. The calculation is as follows:

Annual Energy Output (MWh) = Installed Capacity (MW) x Load Factor x Total hours in a Year

Annual Carbon Reduction (tCO_2e) = Annual Energy Output (MWh) x Carbon Factor

2.4.5 Calculations for carbon savings from the Development are provided in Section 4 below. The full calculations are shown in Appendix B.

2.4.6 The methodology prescribed above is tried and tested and is applied across TCPA and DCO solar projects. It is noted that the actual observed carbon savings from the Development could be higher based on variables including AC/DC load factors, solar panel technology and site-specific attributes. The methodology applied within this carbon assessment is therefore considered to be a conservative approach.

2.5 Temporal Scope

2.5.1 The assessment assumes the Development to be constructed in the year of 2027 over a period of approximately 9 months (refer to Chapter 5 Construction Methodology and Phasing of the ES for information).

2.5.2 The data available to allow an assessment of GHG emissions from vehicle movements associated with the construction of the Development is limited to the modelling scenarios assessed in the Transport Statement.

2.5.3 The nature of effect in the assessment of climate change mitigation (GHG Emissions) is considered to be permanent as once GHG emissions are emitted into the atmosphere it is a reasonable assumption to make that they stay there.

2.6 Spatial Scope

2.6.1 The data available to allow an assessment of GHG emissions from vehicle movements associated with the construction of the Development is aligned with the study area of the Transport Statement. The study area involves six road links surrounding the Site which are shown in the Transport Statement submitted in support of the DNS application.

2.7 Assumptions and Limitations

2.7.1 This assessment is a simplified GHG assessment that focusses on construction vehicle GHG emissions, aligned with the study area of the Transport Statement, and GHG emission reductions from the operational phase of the Development. Other sources of emissions include embodied carbon associated with the production and manufacturing of purchased materials, construction transport associated with shipping purchased materials, fuel use for any onsite construction equipment, plant or generators, transport or purchased materials associated with maintenance during operation and emissions from the deconstruction stage. It is noted that upstream scope 3[1] emissions are likely to comprise the majority of the Developments emissions. The exact specification of the PV technology and sourcing location is unknown at this stage and given the variation in possible options for this, it has not been possible to obtain accurate information on which GHG calculations could be made. These emissions have therefore been scoped out of the assessment.

2.7.2 As the Development would generate minimal vehicle movements once operational, only a construction phase vehicular emissions assessment has been undertaken. An assessment of vehicular emissions during the decommissioning phase has also been scoped out on the basis that effects would be no greater than the construction phase and the decommissioning phase is too far in the future to be able to accurately predict traffic flows and emissions.

2.7.3 Road link speeds were not provided by the Transport Statement and therefore an average speed across the six road links has been derived using national speed limit guidance.

[1] The GHG Protocol classifies emissions into three scopes: Scope 1 (direct emissions from owned or controlled sources), Scope 2 (indirect emissions from the generation of purchased energy) and Scope 3 (all indirect emissions, not included in Scope 2, that occur in the value chain.

2.7.4 Transport distance is based on regional distances taken from RICS guidance. The assessment has not accounted for national or international transport movements that may occur as a result of sourcing some purchased materials due to limited available information.

3 Baseline Conditions

3.1.1 This chapter sets out the local GHG emissions (the baseline conditions) to provide context to the emissions calculated within this assessment.

3.1.2 DESNZ[vi] reports on energy and emissions projections by source, and reports on local and regional GHG emissions. This has allowed the collection of baseline data for the period 2005-2022 for PCC.

3.1.3 The historic GHG emissions from PCC are provided in Table 3.1 below. A breakdown of GHG emissions from the four main sources for PCC are provided form 2005-2022, utilising the most recent dataset.

3.1.4 Overall, carbon emissions have steadily declined in the period 2005 to 2022. There has been a downward trend in the contribution of each of the four main sources of emissions with commercial emissions seeing the greatest percentage decrease of approximately 89% over the 15-year period. Per capita emissions in PCC have decreased by approximately 45% from 2005-2021.

Table 3.1: GHG Emissions within PCC 2005-2022

Year	Industry Total (kt CO_2e)	Commercial Total (kt CO_2e)	Domestic Total (kt CO_2e)	Transport Total (kt CO_2e)	Grand Total* (kt CO_2e)	Population ('000s, mid-year estimate)	Per Capita Emissions (tCO_2e)
2005	318.4	186.2	373.6	238.6	2,156.1	117.2	18.4
2006	319.6	192.0	379.7	244.5	2,156.7	118.3	18.2
2007	321.0	200.1	351.8	247.4	2,116.3	119.6	17.7
2008	306.2	198.0	365.0	242.8	2,053.5	121.1	17.0
2009	325.9	214.8	339.9	236.1	2,050.2	121.6	16.9
2010	313.0	198.5	369.4	233.7	2,034.0	122.0	16.7
2011	300.5	197.5	313.1	227.8	1,900.6	122.6	15.5
2012	290.1	188.3	327.3	225.4	1,905.0	122.7	15.5
2013	280.6	178.7	321.0	226.9	1,860.2	122.6	15.2
2014	247.4	146.2	276.4	232.1	1,776.4	122.7	14.5
2015	218.3	129.8	264.6	235.4	1,722.2	122.5	14.1
2016	189.9	94.9	251.7	245.2	1,643.2	123.0	13.4
2017	180.8	59.4	237.7	243.7	1,615.2	123.5	13.1
2018	180.6	20.6	236.2	245.4	1,565.6	123.5	12.7
2019	197.4	21.4	226.7	245.0	1,559.6	123.6	12.6
2020	180.2	17.4	220.3	190.6	1,450.4	123.6	11.7
2021	171.6	21.6	225.7	204.3	1,488.6	123.7	12.0
2022	56.5	101.3	199.7	202.4	1,437.1	124.4	11.6

*includes sectors not shown in the table (Public Sector, Land Use and Land Use Change and Forestry, Agriculture and Waste Management)

4 Carbon Assessment

4.1 Construction Vehicle GHG Emissions

4.1.1 The increase in road traffic on the local road network attributable to the Development during the approximately 9 month construction phase is set out in Table 4.1 below.

Table 4.1: Construction Traffic Flows

Variable	2027 Peak Construction
24-hour Average Annual Daily Traffic (AADT) of the Proposed Development*	292
% HGV	65%
Link Length	80 km
Road Type	Wales, Rural – Not London
Average Vehicle Speed**	85.83 kph

* Trips are two way
**Estimate based on average national speed limits of road links identified. Average mph then transferred into kph

4.1.2 The Development will result in an increase in vehicle movements on the local road network. As shown in Table 4.1 above, the AADT traffic flow associated with the 2027 peak construction scenario is 292 vehicle trips per day.

4.1.3 In total, the peak construction traffic flows represent **3,916.77 tCO_2** of vehicular emissions. The timescales for emissions to occur are fixed to the construction period (approximately 9 months). Whilst the emission of GHGs will be on a temporary basis, once emitted to the atmosphere they are considered to reside there permanently.

4.2 Operational Carbon Reductions

4.2.1 When operational, the Development will generate electricity from solar radiation and export this to the National Grid. The Development will have a maximum export capacity of 30MW.

4.2.2 It should be noted that due to the continual evolution of solar PV panel technology, the panels installed as part of the Development at the point of construction, will have a higher power rating than panels currently available in the market. The National Grid is also decarbonising so the assessment presents a reasonable assessment of positive impact at this point in time based on the export capacity rather than an installed capacity.

4.2.3 The generation of electricity from the Development will displace energy generation from other conventional power sources, including fossil-fuel reliant sources. In 2023, the average emission of carbon dioxide equivalent was estimated as 0.207054kgCO_2e/kWh[vii]. Using a Load Factor of 10.2%, if these emissions were avoided as a result of the Development, then a saving of approximately **5,553.90 tCO_2e per year** would occur.

4.2.4 This is a total saving of **222,156 tCO_2e** over the Development's 40-year lifespan.

5 Conclusions

5.1.1 Construction of the Development is likely to result in GHG emissions from direct and indirect sources. This includes emissions from construction vehicles used during the phase. The assessment of GHG emissions from construction vehicle movements will be on a temporary basis. The GHG emissions associated with peak construction traffic flows, as outlined in paragraph 4.1.3 are small compared to the operational savings of the Development outlined in paragraph 4.2.3. It is anticipated that the 3,916.77 tCO_2 associated with construction vehicles will be paid back within approximately 9 months of the first year of operation.

5.1.2 The implementation of mitigation measures which will be within the detailed CTMP will reduce GHG emissions associated with construction vehicles. Such measures could include switching off idling engines, car sharing schemes and bus travel for construction workers.

5.1.3 During the operation of the Development, there will be a carbon saving resulting from the export of renewable energy to the grid, in lieu of the current energy mix, which include fossil fuels. This is anticipated to be a carbon saving of approximately 5,553.90 tCO_2e per year.

5.1.4 This is a total saving of 222,156 tCO_2e over the Development's lifespan of 40 years.

5.1.5 The Development will be associated with a reduction of GHG emissions through the generation of renewable energy, contributing to climate change mitigation. This reduction in GHG emissions is anticipated to outweigh the GHG emissions associated with the construction of the Development.

5.1.6 Therefore, in line with the IEMA GHG Guidance, it is a reasonable assumption that the Development will have a beneficial effect as the Development will displace GHG emissions associated with fossil fuel energy generation, whether directly or indirectly, compared to the without-project baseline.

5.1.7 The Development would therefore have a positive climate impact during operation.

Appendix A Emissions Factor Toolkit

Primary Inputs		Pollutants	Selected	Standard Outputs	Selected	Additonal Outputs	Selected	Advanced Options	Selected	Click the button to:
Area	Wales	NO_x		Air Quality Modelling (g/km/s)		Breakdown by Vehicle		Bespoke Base Fleets		Run EFT
Year	2027	PM_{10}		Emissions Rates (g/km)		Source Apportionment		Bespoke Euro Fleet		
Traffic Format	Basic Split	$PM_{2.5}$		Annual Link Emissions	Y	PM by Source		Fleet Projection Tool		Clear Input Data
All must be selected		CO_2	Y			Primary NO_2 Fraction				
						Export Outputs				

SourceID	Road Type	Traffic Flow	% HDV	Speed(kph)	No of Hours	Link Length (km)	% Gradient	Flow Direction	% Load
Alleston EFT	Rural (not London)	292	65	85.83	24	9.2			

Source Name	Pollutant Name	All Vehicles (Annual Emissions (kg/yr except CO2 tonnes/yr))	All LDVs (Annual Emissions (kg/yr except CO2 tonnes/yr))	All HDVs (Annual Emissions (kg/yr except CO2 tonnes/yr))
Alleston EFT	CO2	449.50141	51.24616	398.25525

All Sources	Total CO2 Emissions (tonnes/annum)	Direct CO2 Emissions from Tailpipe (tonnes/annum)	Indirect CO2e Emissions from Electric Charging (tonnes/annum)
	450.43	449.50	0.93

Source Name	Total CO2 Emissions (tonnes/annum)	Direct CO2 Emissions from Tailpipe (tonnes/annum)			Indirect CO2e Emissions from Electric Charging (tonnes/annum)				
		All Vehicles	All LDVs	All HDVs	All Vehicles	Electric Cars	Plugin Hybrid Cars	Electric Taxis	Electric LGVs
Alleston EFT	450.43	449.50	51.25	398.26	0.93	0.85	-	-	0.08

Appendix B Carbon Calculations

Alleston Solar Farm

Carbon Calculations

Document Control Sheet

Project Name: Alleston Solar Farm

Project Ref: 333100998

Report Title: Carbon Assessment – Carbon Calculations
Doc Ref: 333100998/A5/Carbon Assessment

Date: October 2024

Revision	Date	Description	Prepared	Reviewed	Approved
00	May 2024	Carbon Assessment – Carbon Calculations	NS	LW	
01	August 2024	Carbon Assessment – Carbon Calculations	NS	LW	
02	September 2024	Carbon Assessment – Carbon Calculations	NS/CD	LW	

1 Alleston Solar Farm Carbon Calculations

1.1 Overview

1.1.1 During the operation of the Development, there will be a carbon saving resulting from the export of renewable electricity to the grid, in lieu of the current energy mix, which include fossil fuels. This is anticipated to be a carbon saving of approximately 5,553.90 tCO_2e per year.

1.1.2 This is a total saving of 222,156 tCO_2e over the Development's lifespan of 40 years.

1.1.3 Therefore, in line with the IEMA GHG Guidance, it is a reasonable assumption that the Development will have a beneficial effect as the Development will displace GHG emissions associated with fossil fuel energy generation, whether directly or indirectly, compared to the without-project baseline.

1.1.4 The Development would therefore have a positive climate impact during operation.

Table 1:1 Supporting Calculations

Site	Figure	Calculation	Source
Solar Farm Capacity (MW)	30	N/A	
Site Specific (UK) Load Factor	10.2%	N/A	Assumes a capacity factor of 10.2% for average UK solar photovoltaic projects as per the 'Digest of UK Energy Statistics (DUKES) 2023: Chapter 6', published by the Department for Business, Energy & Industrial Strategy. See Table 6.3 "Load Factor". Updated 30 July 2024 **https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes**
Carbon Factor	0.20705 kg of CO_2e per kWh	N/A	The values are taken from the Department for Energy Security & Net Zero 'Greenhouse gas reporting: conversion factors 2023' spreadsheet. Updated 8 July 2024 **https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024**
Annual "units" /kWh generated	26,823,960 kWh	30,000 kW (30MW x 1,000) x 8766 (Number of hours in a year – 365.25 days (to account for leap years x 24 hours) x 0.102 (load factor of 10.2% / 100) =26,823,960 kWh	Assumes a capacity factor of 10.6% for average UK solar photovoltaic projects as per the 'Digest of UK Energy Statistics (DUKES) 2022: Chapter 5', published by the Department for Business, Energy & Industrial Strategy. See Table 6.3 "Load Factor". Updated 27 July 2023. **https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes**
Annual estimated CO_2 reduction	**5,553.90 tCO_2e**	26,823.960 (MWh/Yr / Load Factor) x 0.20705 (Carbon Factor in tCO_2e) =5,553.90	Based on a saving of 0.20705 kg of CO2e per kWh. The values are taken from the Department for Energy Security & Net Zero 'Greenhouse gas reporting: conversion factors 2024' spreadsheet. Updated 8 July 2024 **https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024**
40-year estimated CO_2 reduction	**222,156 tCO_2e**	5,553.90 x 40 = 222,156	

References

[i] IEMA (2022) Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available from: **https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance**

[ii] DEFRA, December 2023, Emissions Factors Toolkit v12.0 User Guide. Link: **https://laqm.defra.gov.uk/wp-content/uploads/2023/11/EFTv12.0-user-guide-v1.0.pdf**

[iii] RICS, 2023 Whole life carbon assessment for the built environment. Available from: **https://www.rics.org/content/dam/ricsglobal/documents/standards/Whole_life_carbon_assessment_PS_Sept23.pdf**

[iv] Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy (2024) Available from: **https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024**

[v] Department for Business, Energy & Industrial Strategy (2022) Available from: **https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes**

[vi] Department for Energy Security & Net Zero (2024). Available from: **UK local authority and regional greenhouse gas emissions statistics, 2005 to 2022 - GOV.UK (www.gov.uk)**

[vii] Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy (2023) Available from: **https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023**