Solar PV
Feasibility Study

Evergreen Barn, Bowbridge Lane,
Prestbury, GL52 3BJ

Thursday, October , 2023

LZC Consultants

Issue Register

Revision Number	Comments	Created By	Checked By	Approved By	Date
1	Draft issue to Client for comment	MH	BC	MH	05/10/2023
3	Final document issued to client	MH	BC	MH	05/10/2023

Notes;
1 – Initial draft issued to client for comment
2 – Draft issue with client's comments
3 – Final document issued to Client

Alterations

Disclaimer

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Our standard Terms and Conditions apply in all cases and we dispense any responsibility to the client and its partners in relation to any matters outside of the agreed contract.

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Executive Summary

This statement has been prepared to support the application for the conversion of an existing detached barn into a 4 bedroom, 2 storey dwelling at Evergreen, Bridgwater Lane, Prestbury, GL52 3BJ

This feasibility study aims to identify the options available for the chosen technology and convey the benefits of such technology on both the proposed project and environment.

In this instance, the chosen technology is Solar Photovoltaic panels (Solar PV) and the study had chosen two system designs to review;

1. A 10kWp Solar PV system using 25 400w panels in the an optimised layout fits on the roof without impeding future maintenance of both the system and skylights.

2. A 4kWp Solar PV system using 10 400w panels in a standard single row layout.

Neither system has been calculated with the benefits of battery storage therefore all calculations are based on self consumption as generation occurs.

1. Introduction

Low Zero Carbon Consultants has produced this Solar PV Feasibility Study to support the application for the conversion of a detached barn into a 4 bedroom, 2 storey dwelling at Evergreen, Bowbridge Lane, Prestbury, GL52 3BJ. The purpose of this study is to explore the viable options for the adoption of Solar PV within the project.

2. The Development

2.1. Existing Site

The site is located on Bridgewater Lane as indicated below.

Figure 1 - Google Earth image of Freshwater Lane

2.2. Proposed Development

The proposed development is for the conversion of the existing barn to a 4 bed 2 storey dwelling.

Figure 2 - Proposed Development Render

Figure 3 - Proposed Development Landscape and Roof Plan

3. Feasibility Review

An initial high level review was conducted understanding and identifying the positives (Pros) and the negatives (Cons) of the technology shown below with specific comments related to the site.

Technology	Pros	Cons	Comments	Technically Feasible
Photovoltaics	High carbon emissions offset Relatively maintenance free and low cost installation Expected panel life in excess of 25 years Multiple mounting and orientation options available Can be combined with a battery storage system to fully utilise free electricity generation	Shading impacts generation of the system Inverter lifespan only expected to be 10 years	High proportion of available roof space Will provide a considerable amount of regulated energy along withthe unregulated energy demands of the proposed development	Yes

Table 6: LZC Feasibility Review

3.1. Proposed Options

The study has analysed two options for the client to consider, a maximised roof availability option providing the greatest generation and a more standard 'domestic' sized system for cost and infrastructure consideration.

Both system options share common components in terms of panels and mounting systems, however they differ based on size of appropriate inverter and quantities of materials.

3.2.2. Option 1 – 10 kWp PV System

The system comprises 25 *HIB* Longi HiMo5 400W All Black Mono solar panels to collect sunlight and turn it into DC electricity. The panels will be connected to 1 Growatt MOD 8000 TL3-X 3ph inverter, which converts the DC electricity into mains (AC) electricity. The image below shows and overlay of how the panels will fit onto the available roof space based on the architects site plan drawing 2311 P003.

Figure 4 – PV Option 1 roof overlay

The roof diagram below shows how the 25 panels will be arranged on the roof. Consideration has been given to provide future safe access to both the panels and skylights for maintenance.

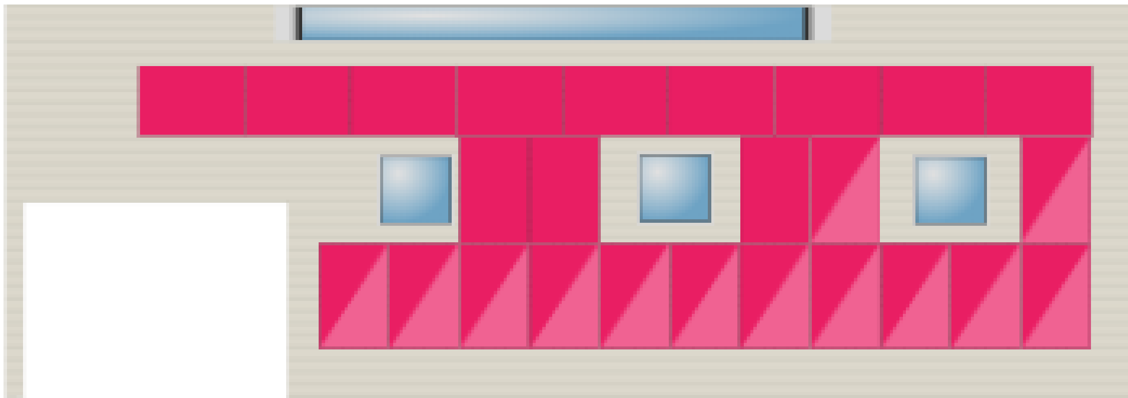


Figure 5 – PV Option 1 roof diagram

As shown above the diagram highlights two strings, one 12 panels and one 13 panels all connected to the single inverter. Both strings need to have their own sunpath calculations produced for the purpose of identifying shading impacts. However as there are no obstructions that could cause shading of the panels both sunpath diagrams below reflect this.

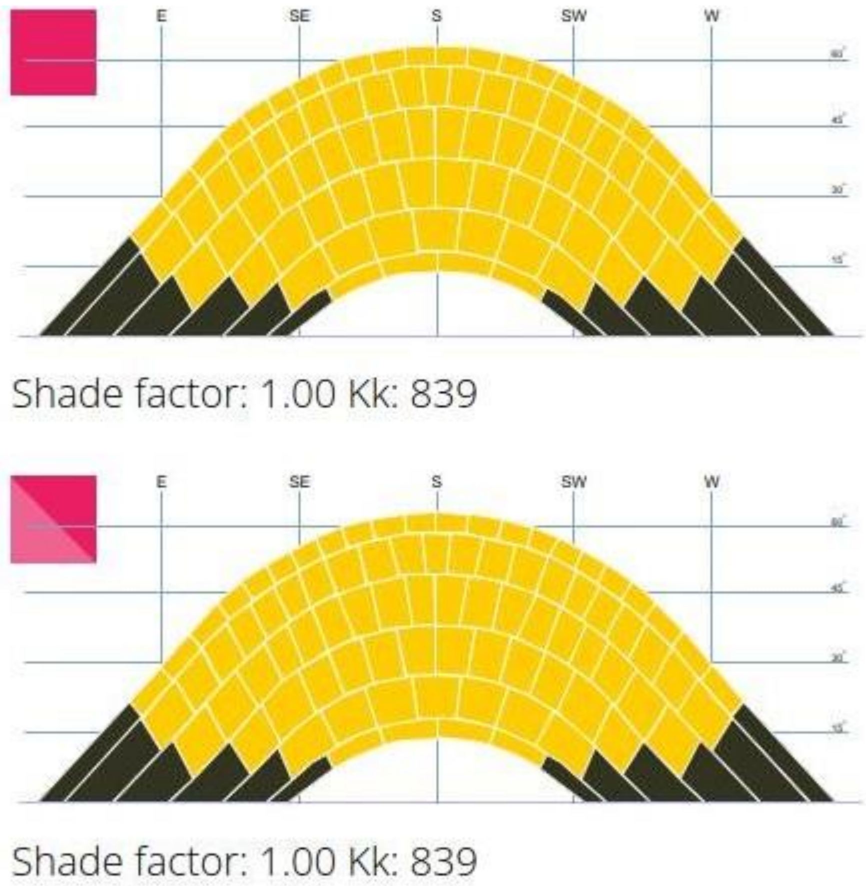


Figure 6 – PV Option 1 sunpath diagrams

This system is expected to generate 7,670 kWh of electricity per year. Considering the proposals do not include battery storage a conservative estimate of 1,510 kWh has been assumed to be consumed on site with the remaining 6,161 kWh being exported to the grid. If we assume a 4 bedroom house like the one proposed consumes 3,900 kWh of electricity per year then based on the above on site usage assumption the property would only have to import 2,402 kWh from the grid.

The graph below highlights the expected on site consumption (Blue) vs import requirements (Red) of the property across the year.

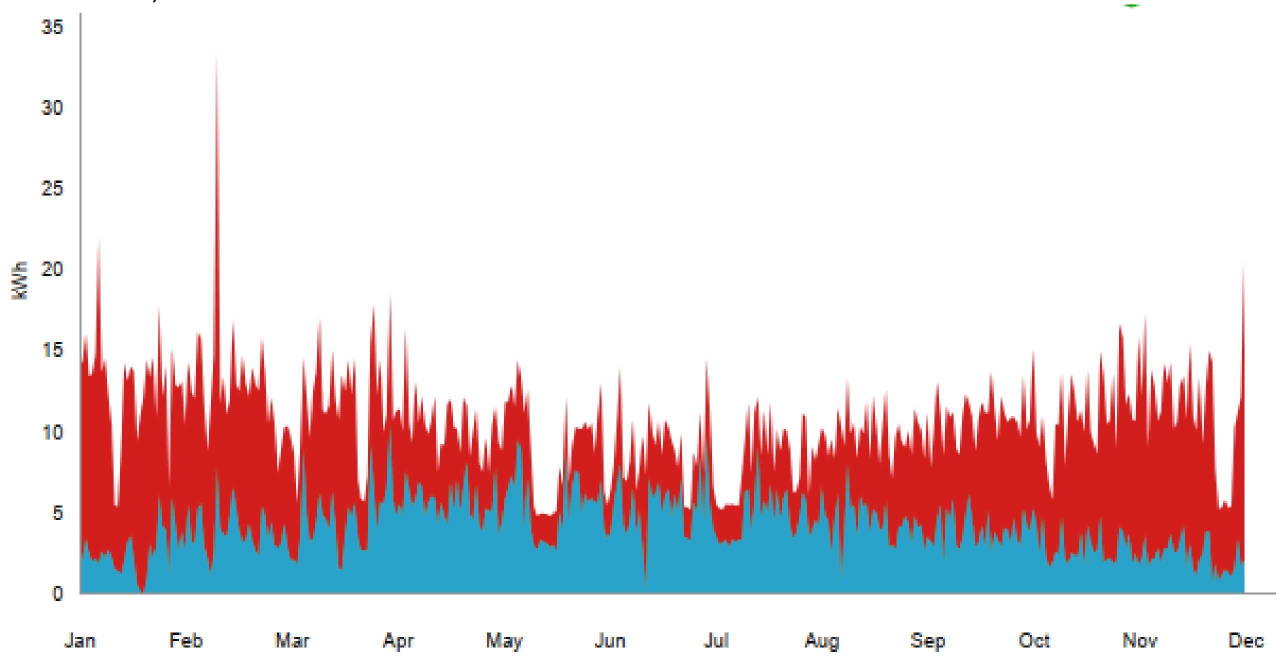


Figure 7 – PV Option 1 on site consumption and import

3.2.2. Option 2 – 4 kWp PV System

The system comprises 10 *HIB* Longi HiMo5 400W All Black Mono solar panels to collect sunlight and turn it into DC electricity. The panels will be connected to 1 SolaX X1-3.6T 1ph (inc WiFi dongle) inverter, which converts the DC electricity into mains (AC) electricity. The image below shows and overlay of how the panels will fit onto the available roof space based on the architects site plan drawing 2311 P003.

Figure 8 – PV Option 2 roof overlay

The roof diagram below shows how the 10 panels will be arranged on the roof. Consideration has been given to provide future safe access to both the panels and skylights for maintenance.

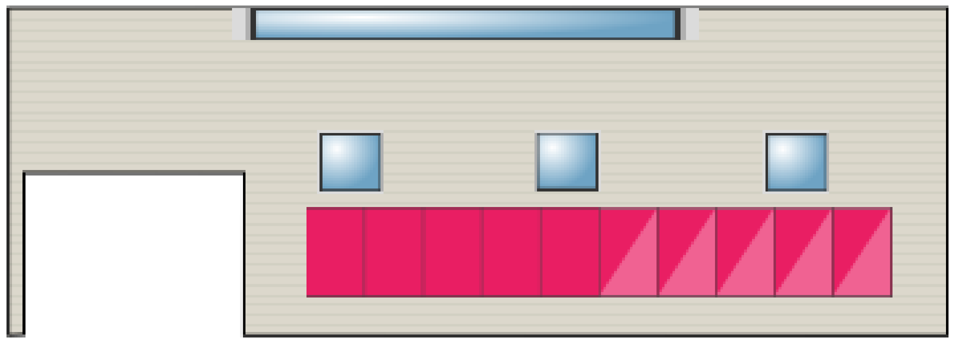


Figure 9– PV Option 2 roof diagram

As shown above the diagram highlights two strings, both at 5 panels each connected to the single inverter. Both strings need to have their own sunpath calculations produced for the purpose of identifying shading impacts. However as there are no obstructions that could cause shading of the panels both sunpath diagrams below reflect this.

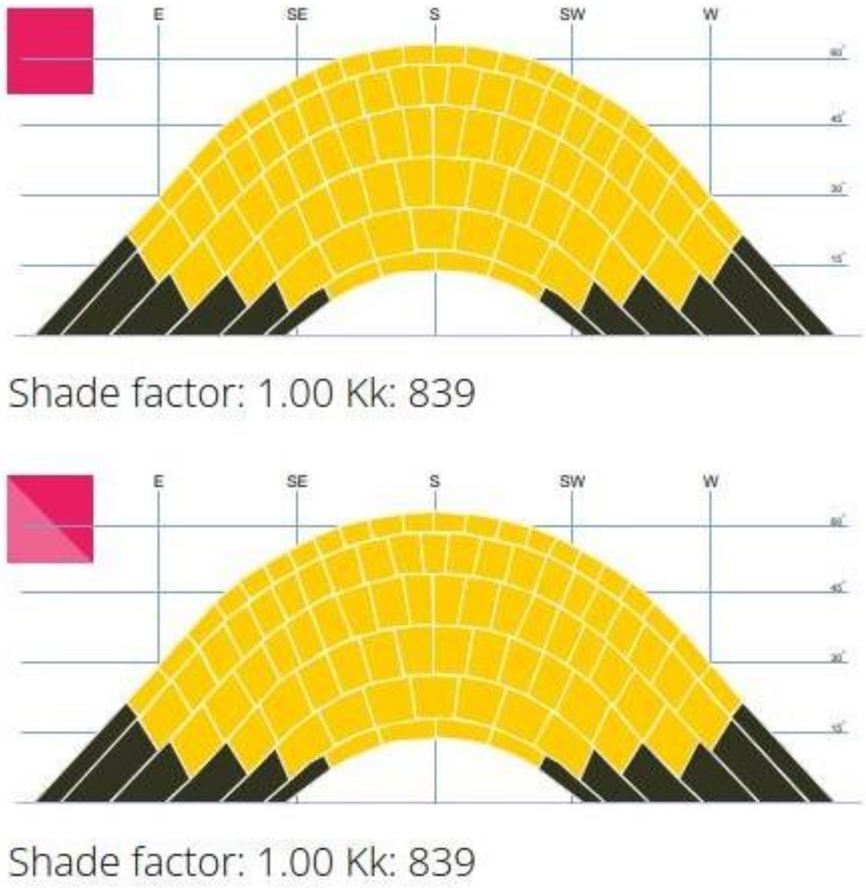


Figure 10 – PV Option 2 sunpath diagrams

This system is expected to generate 3,068 kWh of electricity per year. Considering the proposals do not include battery storage a conservative estimate of 1,179 kWh has been assumed to be consumed on site with the remaining 1,888 kWh being exported to the grid. If we assume a 4 bedroom house like the one proposed consumes 3,900 kWh of electricity per year then based on the above on site usage assumption the property would only have to import 2,733 kWh from the grid.

The graph below highlights the expected on site consumption (Blue) vs import requirements (Red) of the property across the year.

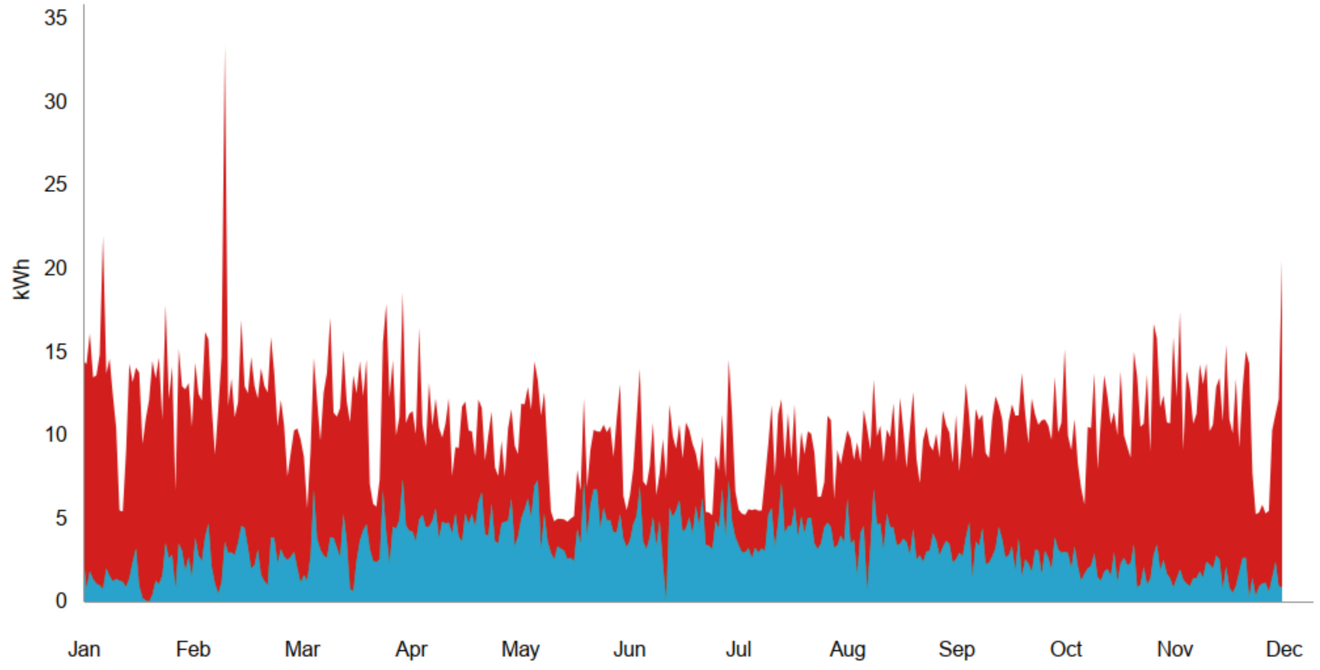


Figure 11 – PV Option 2 on site consumption and import

4. Conclusion

In conclusion we believe Solar PV is a suitable technology for the proposed development and have provided two options for consideration. These options provide the client with examples of system performance at either end of the scale in terms of what is standard and what is possible when it comes to system size.

The above study has demonstrated the ability to accommodate each system on the available roof space whilst maintaining adequate space for future maintenance and without compromising available light through the skylights. The study has also show the expected generation figures of each system and show a comparative benefit based on a dwelling of similar size.

Topics not covered in this study are the additional benefits battery storage can provide specially to the larger system in terms of maximising on site energy consumption. Additionally the financial benefits of applying for the Smart Export Guarantee were not covered in this study and will be left to the client to decide if they wish to register with a provider for this.

Additional supporting evidence from reputable sources is provide in the appendices to support our calculations and verify our predicted generation outputs.

Appendix A

EU PV Performance Calculation

Performance of grid-connected PV

PVGIS-5 estimates of solar electricity generation:

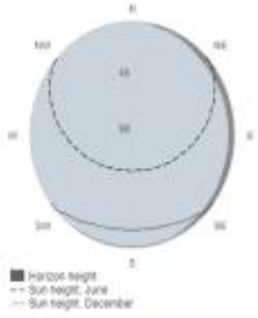
Provided inputs:

Latitude/Longitude:	51.917,-2.049
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed:	10 kWp
System loss:	14 %

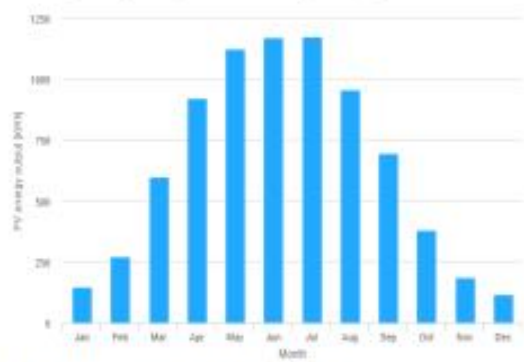
Simulation outputs

Slope angle:	20 °
Azimuth angle:	104 °
Yearly PV energy production:	7761.29 kWh
Yearly in-plane irradiation:	981.05 kWh/m²
Year-to-year variability:	256.92 kWh
Changes in output due to:	
Angle of incidence:	-4.67 %
Spectral effects:	1.5 %
Temperature and low irradiance:	-4.93 %
Total loss:	-20.89 %

Outline of horizon at chosen location:



Monthly energy output from fix-angle PV system:



Monthly in-plane irradiation for fixed-angle:

Monthly PV energy and solar irradiation

Month	E_m	H(i)_m	SD_m
January	146.9	20.6	12.7
February	274.5	35.3	38.7
March	601.3	73.6	75.0
April	923.7	113.4	117.1
May	1126.5	139.7	127.5
June	1172.6	147.3	132.5
July	1175.2	149.9	115.8
August	958.0	121.1	86.3
September	696.5	87.9	46.1
October	382.8	49.4	27.6
November	187.1	25.8	18.2
December	116.1	17.1	9.2

E_m: Average monthly electricity production from the defined system [kWh].

H(i)_m: Average monthly sum of global irradiation per square meter received by the modules of the given system [kWh/m²].

SD_m: Standard deviation of the monthly electricity production due to year-to-year variation [kWh].

Report generated on 2023/10/06

Performance of grid-connected PV

PVGIS-5 estimates of solar electricity generation:

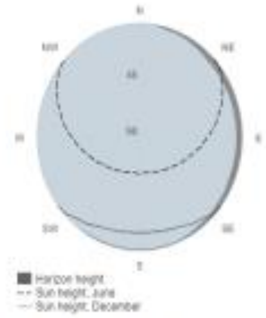
Provided inputs:

Latitude/Longitude:	51.917,-2.049
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed:	4 kWp
System loss:	14 %

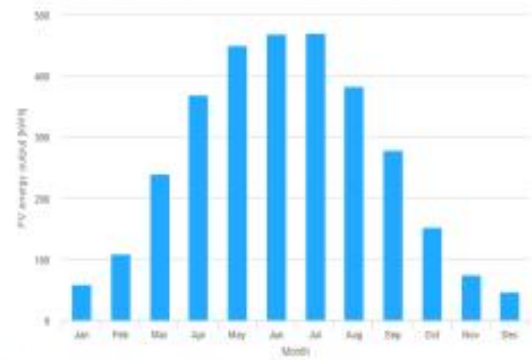
Simulation outputs

Slope angle:	20 °
Azimuth angle:	104 °
Yearly PV energy production:	3104.52 kWh
Yearly in-plane irradiation:	981.05 kWh/m²
Year-to-year variability:	102.77 kWh
Changes in output due to:	
Angle of incidence:	-4.67 %
Spectral effects:	1.5 %
Temperature and low irradiance:	-4.93 %
Total loss:	-20.89 %

Outline of horizon at chosen location:



Monthly energy output from fix-angle PV system:



Monthly in-plane irradiation for fixed-angle:

Monthly PV energy and solar irradiation

Month	E_m	H(i)_m	SD_m
January	58.8	20.6	5.1
February	109.8	35.3	15.5
March	240.5	73.6	30.0
April	369.5	113.4	46.9
May	450.6	139.7	51.0
June	469.0	147.3	53.0
July	470.1	149.9	46.3
August	383.2	121.1	34.5
September	278.6	87.9	18.5
October	153.1	49.4	11.1
November	74.8	25.8	7.3
December	46.5	17.1	3.7

E_m: Average monthly electricity production from the defined system [kWh].

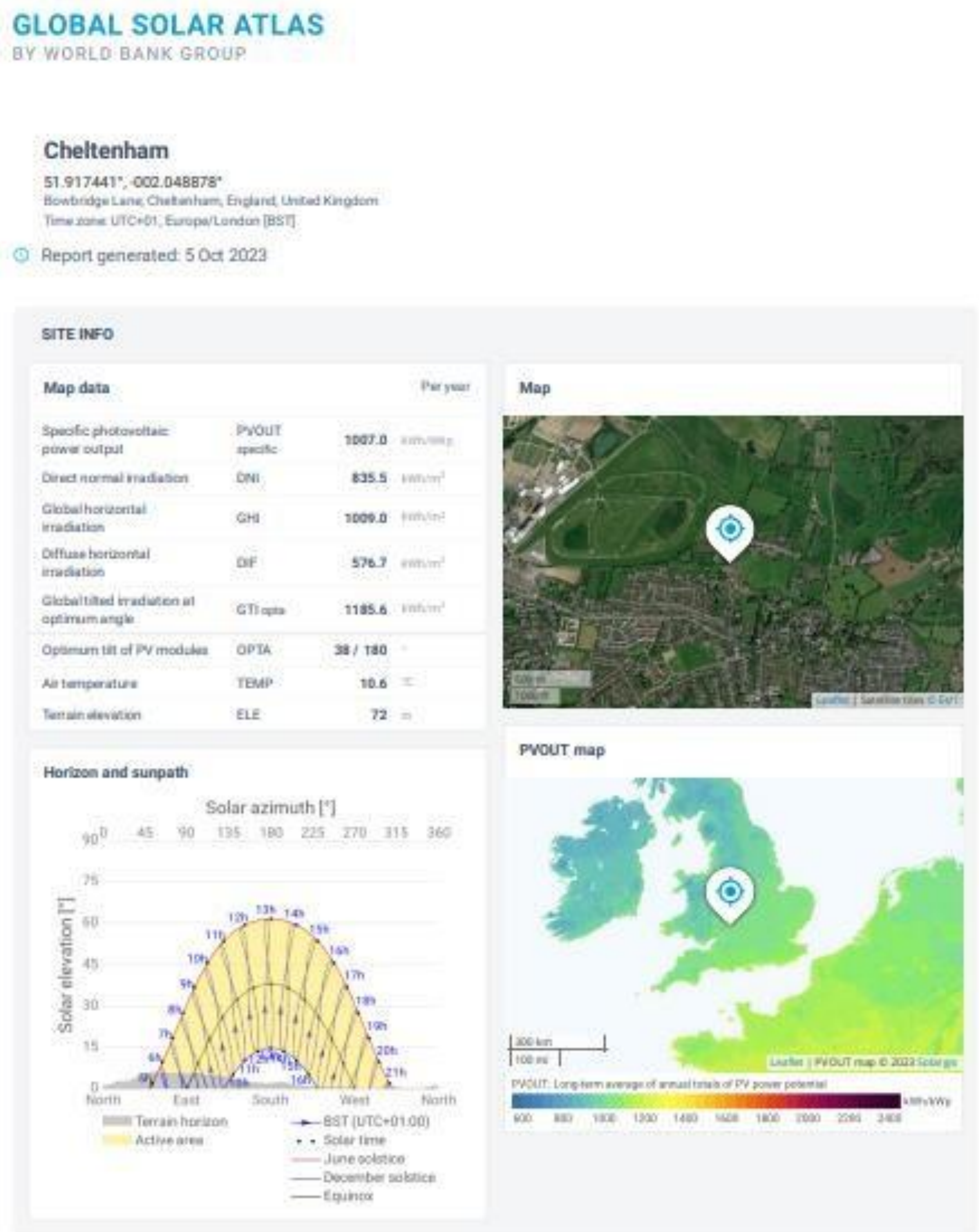
H(i)_m: Average monthly sum of global irradiation per square meter received by the modules of the given system [kWh/m²].

SD_m: Standard deviation of the monthly electricity production due to year-to-year variation [kWh].

Report generated on 2023/10/06

Appendix B

Global Solar Atlas Site Report



GLOBAL SOLAR ATLAS
BY WORLD BANK GROUP

Cheltenham

51.917441°, -002.048878°
Bowbridge Lane, Cheltenham, England, United Kingdom
Time zone: UTC+01, Europe/London [BST]

Report generated: 5 Oct 2023

SITE INFO

Map data — Per year

Specific photovoltaic power output	PVOUT specific	1007.0	kWh/kWp
Direct normal irradiation	DNI	835.5	kWh/m²
Global horizontal irradiation	GHI	1009.0	kWh/m²
Diffuse horizontal irradiation	DIF	576.7	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	1185.6	kWh/m²
Optimum tilt of PV modules	OPTA	38 / 180	°
Air temperature	TEMP	10.6	°C
Terrain elevation	ELE	72	m

GLOBAL SOLAR ATLAS
BY WORLD BANK GROUP

PV ELECTRICITY AND SOLAR RADIATION

Annual averages
Direct normal irradiation

860.2
kWh/m² per year