Solargis Evaluate Technical Note

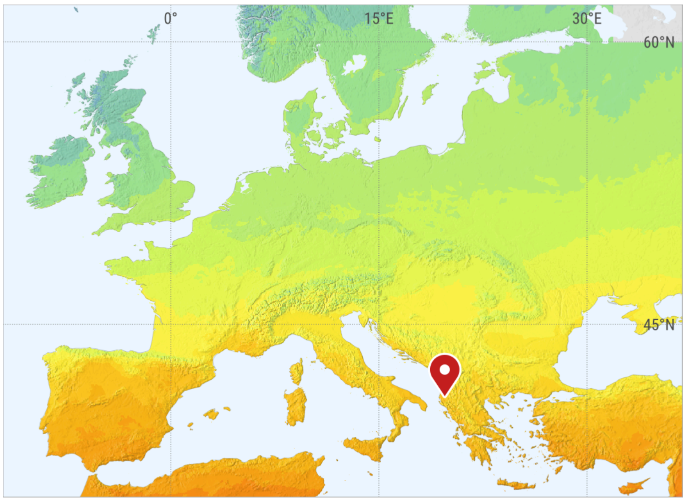
Review of Photovoltaic Energy Project

Mallakastër, Fier, ALB

PV system

PROJECT LOCATION

Mallakastër, Albania



REPORT ID

6CXJOT54KD

REPORT GENERATED

24 September 2025

DATA

TMY P50

01/1994 to 12/2024

SOURCE OF DATA

Solargis v2025.09.19-2.2.65

CUSTOMER

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SERVICE PROVIDER

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1 Summary

This technical note provides a brief evaluation of the solar power production potential of a photovoltaic (PV) project. It also examines solar resource, climate, and environmental factors that influence the operation and performance efficiency of the power plant. The power production is calculated by the Solargis PV simulator using high-resolution Typical meteorological Year (TMY) data. The Solargis TMY data represents a historical period from 1 January 1994 to 31 December 2024 and it is calculated by models using satellite, atmospheric, meteorological, and environmental inputs.

1.1 Solar resource

Global horizontal irradiation (GHI) and Direct normal irradiation (DNI) describe the primary solar resource for calculating Global tilted irradiation (GTI, plane-of-array irradiation) received by PV modules. The long-term average yearly value is often referred to as P50, which represents 50% probability of exceedance. Considering the long-term average to be equal to P50 (median) is a simplification, assuming normal distribution of annual values of solar resource, but it is widely accepted in the industry.

Table 1.1 summarizes the long-term average values (represented by a P50 value) of solar resource parameters. The values are shown with and without shading by the terrain horizon. Solar resource with terrain shading is considered in the PV energy simulation across the entire report. The values without shading are shown only for a reference as they are often used as an input to other PV simulation software.

Table 1.1 Solar resource: Long-term yearly values at P50, calculated from Solargis TMY data

	Acronym	Unit	Terrain shading considered	Terrain shading not considered
Global horizontal irradiation	GHI	[kWh/m²]	1,631.3	1,640.5
Direct normal irradiation	DNI	[kWh/m²]	1,723.5	1,746.7
Global tilted irradiation	GTI	[kWh/m²]	2,133.6	-

Notes: For the sake of simplification, long-term average is considered as equal to P50

1.2 Climate and environment

Local climate and environment have an impact on the operation of the PV power plant and degradation of the long-term performance. Some factors have a direct impact on the quantity of electricity generated (air temperature, soiling, snow, ground surface albedo and precipitation) or they affect the operation (wind speed and humidity). Table 1.2 shows yearly average values of the meteorological and environmental parameters important for a PV project.

Table 1.2 Meteorological and environmental parameters: Yearly average values

	Acronym	Unit	Yearly average
Air temperature at 2 m	TEMP	[°C]	15.5
Wind speed at 10 m	WS	[m/s]	1.8
Wind gust at 10 m	WG	[-]	
Relative humidity at 2 m	RH	[-]	
Atmospheric pressure	AP	[-]	
Precipitation (rainfall)	PREC	[-]	
Ground surface albedo	ALB	[-]	0.15
Precipitable water	PWAT	[kg/m²]	17.7

1.3 Photovoltaic power generation

The electrical output from the photovoltaic power plant is calculated from a Typical meteorological year (TMY) data . Assuming global tilted irradiation and 100 % technical availability, PV power production is calculated. When considering the reduction of conversion efficiency of PV modules, the life time yearly PV power production is calculated as follows: 2.0 % performance reduction for the first year and 0.5 % for a period of 25 years. Table 1.4 shows the estimates of the long-term average values, or P50.

Table 1.3 Energy system properties

Nominal DC capacity	31,980 kWp
Nominal AC output power	27,000 kW

Table 1.4 Long-term average yearly values of PV power production

	PVOUT specific	PVOUT total	PR
	kWh/kWp	GWh	%
Total system performance considering technical availability and losses due to snow	1,436	45.93	69.2
Power generation in the first year	1,408	45.01	67.9
Yearly power generation, average over 25 years	1,326	42.41	63.9

Notes: For the sake of simplification, long-term average is considered as equal to P50

2 Project site

Site name	**Mallakastër, Fier, ALB**
Geographical coordinates	40.604252°, 019.756840°
Elevation above sea level	170m
Terrain slope inclination:	2°
Terrain azimuth:	quasi flat

Location on the map (Solargis Prospect):
https://apps.solargis.com/prospect/map?center=40.604252,19.756840,15&layer=mapbox-satellite&location=40.604252,19.756840

Details of this data and report can be accessed from Solargis Evaluate:
https://apps.solargis.com/evaluate

2.1 Geographical context

Figure 2.1 Detailed position of the project site

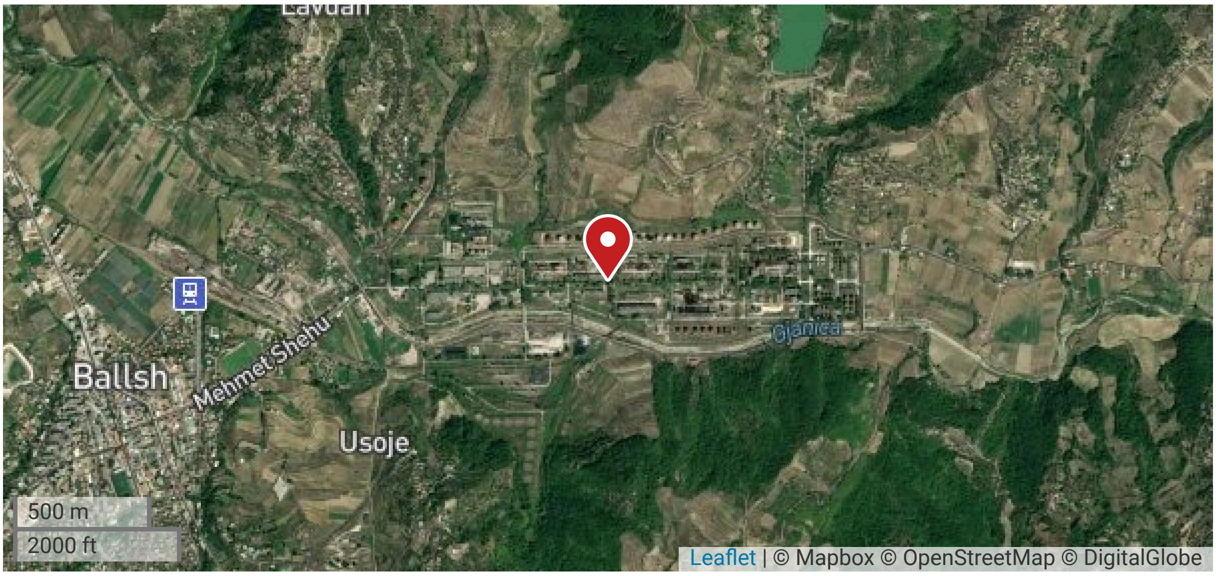
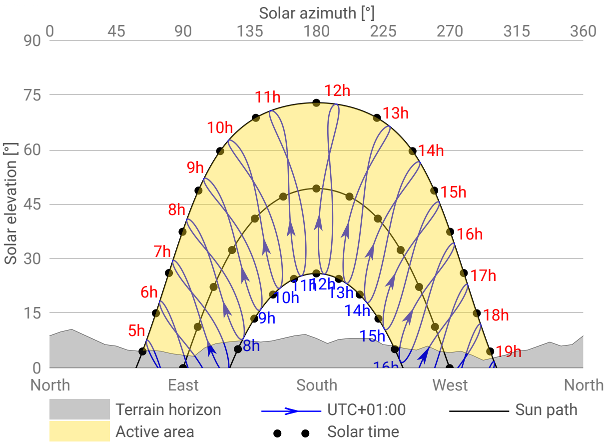


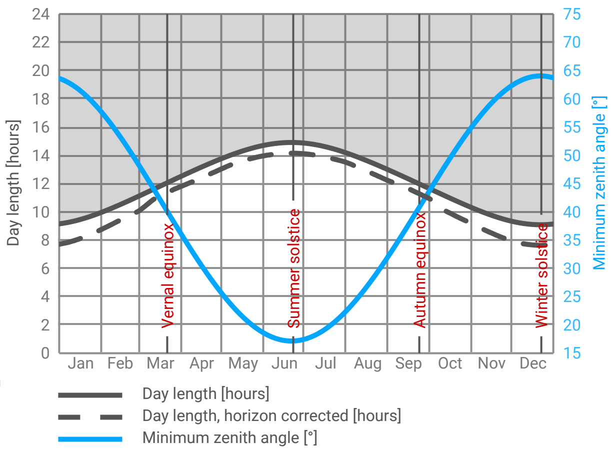
Figure 2.2 Position of the site in the context of a Global horizontal irradiation map

2.2 Terrain and astronomic conditions

Terrain properties (elevation, slope, azimuth, and horizon) are derived from the SRTM3 digital elevation model, unless customized.

Figure 2.3 Project horizon, sunpath, day length, and solar zenith angle





2.3 Configuration of photovoltaic power plant

Table 2.1 General

Nominal DC capacity	31,980 kWp
Nominal AC output power	27,000 kW
Grid power limitation	unlimited
Power factor (cos phi)	1
Segment count	5

Table 2.2 Buildable area 14

Mounting type	Ground segment, Fixed one angle, Azimuth (specific / effective) 180° / 180.78°, Tilt (specific / effective) 33.21° / 34.06°, Row spacing (relative • GCR • absolute) 1.5 • 67 % • 3.7 m
PV modules	JA Solar, JAM72D42-640/LB, 78% (bifacial), modules: 5454 pcs, installed DC capacity 3,491 kWp
Inverters	Inverter setup (E) - Power-One, ULTRA-750-TL-OUTD-4-US-690-x-y-z [690V], 36 unit(s), installed AC capacity 27,000 kW
LV/MV Transformers	Inverter transformer 690 / 22,000 V, Apparent rated power 3500 kVA, 1 unit(s), Inverter setup (E)

Table 2.3 Segment 1

Mounting type	Ground segment, Fixed one angle, Azimuth (specific / effective) 180° / 181.09°, Tilt (specific / effective) 33.21° / 33.9°, Row spacing (relative • GCR • absolute) 1.4 • 71 % • 3.45 m
PV modules	JA Solar, JAM72D42-640/LB, 78% (bifacial), modules: 12240 pcs, installed DC capacity 7,834 kWp
Inverters	Inverter setup (A) - Power-One, ULTRA-750-TL-OUTD-4-US-690-x-y-z [690V], 36 unit(s), installed AC capacity 27,000 kW
LV/MV Transformers	Inverter transformer 690 / 22,000 V, Apparent rated power 10000 kVA, 2 unit(s), Inverter setup (A)

Table 2.4 Segment 2

Mounting type	Ground segment, Fixed one angle, Azimuth (specific / effective) 180° / 181.37°, Tilt (specific / effective) 33.21° / 33.63°, Row spacing (relative • GCR • absolute) 1.5 • 67 % • 3.7 m
PV modules	JA Solar, JAM72D42-640/LB, 78% (bifacial), modules: 8352 pcs, installed DC capacity 5,345 kWp
Inverters	Inverter setup (B) - Power-One, ULTRA-750-TL-OUTD-4-US-690-x-y-z [690V], 36 unit(s), installed AC capacity 27,000 kW
LV/MV Transformers	Inverter transformer 690 / 22,000 V, Apparent rated power 6300 kVA, 1 unit(s), Inverter setup (B)

Table 2.5 Segment 3

Mounting type	Ground segment, Fixed one angle, Azimuth (specific / effective) 180° / 179.64°, Tilt (specific / effective) 33.21° / 36.2°, Row spacing (relative • GCR • absolute) 1.5 • 67 % • 3.7 m
PV modules	JA Solar, JAM72D42-640/LB, 78% (bifacial), modules: 16920 pcs, installed DC capacity 10,829 kWp
Inverters	Inverter setup (C) - Power-One, ULTRA-750-TL-OUTD-4-US-690-x-y-z [690V], 36 unit(s), installed AC capacity 27,000 kW
LV/MV Transformers	Inverter transformer 690 / 22,000 V, Apparent rated power 10000 kVA, 2 unit(s), Inverter setup (C)

Table 2.6 Segment 4

Mounting type	Ground segment, Fixed one angle, Azimuth (specific / effective) 180° / 181.73°, Tilt (specific / effective) 33.21° / 34.83°, Row spacing (relative • GCR • absolute) 1.5 • 67 % • 3.7 m
PV modules	JA Solar, JAM72D42-640/LB, 78% (bifacial), modules: 7002 pcs, installed DC capacity 4,481 kWp
Inverters	Inverter setup (D) - Power-One, ULTRA-750-TL-OUTD-4-US-690-x-y-z [690V], 36 unit(s), installed AC capacity 27,000 kW
LV/MV Transformers	Inverter transformer 690 / 22,000 V, Apparent rated power 4000 kVA, 1 unit(s), Inverter setup (D)

Annex 1 shows the full description of parameters used in the simulation

3 Data description

All calculations in this report are based on Typical meteorological year (TMY) data with 15-minute temporal resolution, derived from Solargis historical time series. The data reduction in the TMY data set is not possible without loss of information contained in the original multiyear time series. It does not include extreme values and ignores weather variability, thus representing local climate to a limited extent. Therefore, long-term monthly and yearly average values may not correspond to the values calculated from the full history of time series.

Statistics based on TMY offer only partial information on typical solar resource and climate, which is sufficient for a brief project evaluation in its early stage. A full history of time series data has to be considered for full evaluation of solar project. Higher accuracy estimates can be achieved by adapting the Solargis models to the project site, based on local measurements.

3.1 TMY data properties

Table 3.1 Global characteristics of solar resource parameters

Data originator	Solargis
Version	2.2.65 (19 September 2025)
Type of data	Typical meteorological year (TMY) for scenario P50
Geographical representation	Grid resolution depends on the input data and geographical site. Terrain and clouds: between ~2.5 km and 8 km, PWAT and aerosols: ~30 km to 125 km
Time resolution	15-minute
Data aggregation	Yearly, monthly and hourly averages
Period of time represented	1 Jan 1994 to 31 Dec 2024 (complete calendar years are used in this report)
Time zone	UTC+01
Method	Solargis solar models characterizing state of the atmosphere, cloud transmittance, and terrain conditions. Data from geostationary meteorological satellites Meteosat, GOES, Himawari, global meteorological data MACC-II, CAMS, MERRA-2, CFSR, GFS and digital terrain model SRTM3 are used as inputs.
Parameters	GHI, DNI, DIF, GTI , SUN_AZIMUTH, SUN_ELEVATION
Terrain shading	Terrain shading is considered in all calculations. Typically calculated from the SRTM3 data set. Depending on a specific data product/format the solar parameters may be provided with or without consideration of the terrain horizon shading.

Table 3.2 Global characteristics of meteorological and environmental parameters

Data originator	Solargis
Version	2.2.65 (19 September 2025)
Type of data	Typical meteorological year (TMY) for scenario P50
Geographical representation	Grid resolution depends on the input data and geographical site. TEMP and AP: ~1km, other parameters: between ~9 km and 25 km
Time resolution	15-minute (recalculated from hourly)
Data aggregation	Yearly, monthly and hourly averages
Period of time represented	1 Jan 1994 to 31 Dec 2024 (complete calendar years are used in this report)
Time zone	UTC+01
Method	Processing of ERA5, ERA5-Land and IFS global meteorological model outputs
Parameters	TEMP, RH, TD, WBT, WS, WD, WG, AP, PREC, SDWE, PWAT

Table 3.3 Ground surface albedo

Type of data	Long-term yearly and monthly averages
Geographical representation	Grid resolution ~1km
Time resolution	Long-term averages
Period of time represented	1 Jan 2006 to 31 Dec 2015
Time zone	N/A
Method	Processing based on the input data from MODIS database, global meteorological models, and Solargis time series
Parameters	ALB

3.2 Primary data parameters

The chapters below show summary of solar, climate and environmental parameters and the results of the PV simulation. All is based on the Solargis TMY and long-term average data sets, which are delivered together with this report. Table 3.4 provides an overview of parameters delivered and analyzed in this report.

The calculation of long-term statistics in this report is limited to complete calendar years represented by the TMY.

Table 3.4 Data parameters analyzed in this report

Parameter	Acronym	Monthly and yearly	Hourly	Uncertainty
Global horizontal irradiance	GHI	Yes	-	-
Direct normal irradiance	DNI	Yes	-	-
Diffuse horizontal irradiance	DIF	Yes	-	-
Global horizontal irradiance, no shading	GHI	Yes	-	-
Direct normal irradiance, no shading	DNI	Yes	-	-
Diffuse horizontal irradiance, no shading	DIF	Yes	-	-
Global tilted irradiance	GTI	Yes	-	-
Cloud identification quality flag	CI_FLAG	-	-	N/A
Sun elevation	SUN_ELEVATION	-	-	N/A
Sun azimuth	SUN_AZIMUTH	-	-	N/A
Air temperature at 2 meters	TEMP	Yes	-	-
Relative humidity at 2 meters	RH	Yes	-	-
Dew point temperature at 2 meters	TD	-	-	-
Wet bulb temperature at 2 meters	WBT	-	-	-
Wind speed at 10 meters	WS	Yes	-	-
Wind direction at 10 meters	WD	-	-	-
Wind gust at 10 meters	WG	-	-	-
Atmospheric pressure	AP	Yes	-	-
Precipitation rate/total	PREC	Yes	-	-
Precipitable water	PWAT	Yes	-	-
Snow depth water equivalent	SDWE	-	-	-
Snowfall rate water equivalent	SFWE	-	-	-

Table 3.5 Customized parameters

Parameter	Acronym	Monthly and yearly	Hourly	Uncertainty
Ground surface albedo	ALB	Yes	-	-

3.3 Simulation results

Table 3.6 Calculated PV power output

Parameter	Acronym	Monthly and yearly	Hourly	Uncertainty
PV electricity output specific	PVOUT specific	Yes	Yes	-
PV electricity output total	PVOUT total	Yes	Yes	-
Performance ratio	PR	Yes	-	-

4 Solar resource

This chapter shows solar energy potential of the site as calculated from the Solargis TMY data. It includes long-term monthly and yearly averages of Global horizontal irradiation (GHI) and Direct normal irradiation (DNI) that describe the key information about solar potential. GHI represents the total amount of direct and diffuse radiation (DIF) received on a horizontal surface. GHI is used for comparing solar energy potential of different sites, as it is independent of any choice of solar technology. Additionally, the chapter presents Diffuse to global (DIF/GHI or D2G) ratio and Global tilted irradiation (GTI). The DIF/GHI ratio indicates the proportion of DIF compared to GHI. GTI is the technology-specific energy that is converted into electricity in the PV array.

Solar resource parameters shown in this report consider solar radiation losses due to terrain shading calculated from SRTM3, if not changed by the user. The only exception is Table 4.2, which shows theoretical GHI and DIF values without consideration of horizon and terrain shading. While these values have no practical meaning, they are shown here for reference, as they are often used as an input into PV energy simulation software, which calculate the terrain shading internally.

GTI is calculated for the project system configuration defined in the Annex 1 of this report. All GTI values, incorporate shading effects caused by default terrain horizon of the project reference point or of the individual segments of the PV power plant. The default horizon could have been customized by Customer. For multi-segment PV systems, Solargis Evaluate calculates GTI as a weighted average of GTI values calculated for individual segments. The weight is represented by the surface area of solar cells installed in each segment. In the GTI hourly statistics, we omit nighttime values, concentrating solely on data recorded during daylight hours (i.e. with the Sun above horizon).

The GTI values in Table 4.1 include terrain horizon shading and summarize GTI input from both front and rear side of PV modules.

Figure 4.1 Global horizontal irradiation (GHI, left) and Direct normal irradiation (DNI, right): Long-term monthly averages

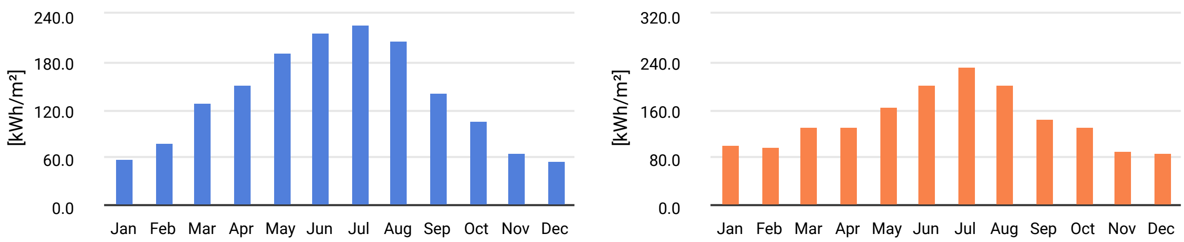


Figure 4.2 Ratio of diffuse to global horizontal irradiation (DIF/GHI, left) and Global tilted irradiation (GTI, right): Long-term monthly averages

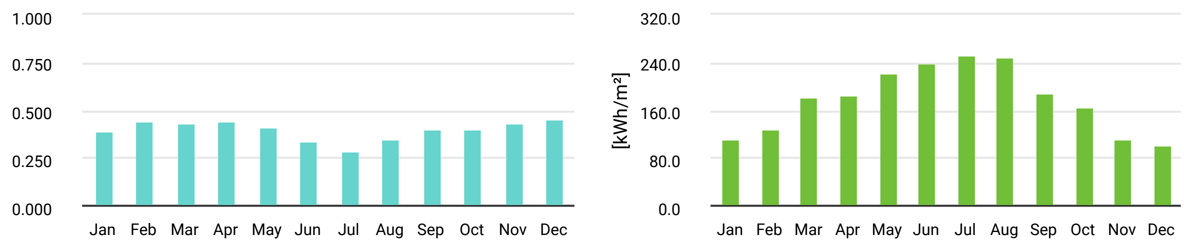


Table 4.1 Solar resource: Long-term monthly and yearly averages

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
GHI	kWh/m²	Sum	59.1	78.5	129.8	150.7	193.0	217.6	228.2	206.7	141.0	107.1	64.5	55.0	1,631.3
DNI	kWh/m²	Sum	100.4	98.8	131.7	132.4	165.6	202.8	233.5	201.9	146.4	130.5	92.6	87.0	1,723.5
DIF	kWh/m²	Sum	23.3	34.6	55.4	66.2	79.0	74.2	65.0	71.8	56.1	43.2	27.9	24.8	621.4
D2G		Average	0.394	0.440	0.427	0.439	0.409	0.341	0.285	0.347	0.398	0.403	0.433	0.450	0.381
GTI	kWh/m²	Sum	109.5	126.6	181.2	185.0	220.8	239.6	253.6	248.9	189.8	164.3	111.9	102.5	2,133.6

Table 4.2 Solar resource: Long-term monthly and yearly averages, terrain shading not considered

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
GHI	kWh/m²	Sum	60.1	79.3	130.6	151.3	193.7	218.2	228.9	207.3	141.7	107.9	65.4	56.1	1,640.5
DNI	kWh/m²	Sum	106.0	101.4	132.9	132.9	165.9	204.2	233.9	202.3	147.0	132.5	95.8	91.8	1,746.7
DIF	kWh/m²	Sum	24.1	35.6	56.8	67.6	80.7	76.1	66.9	73.6	57.6	44.5	28.9	25.7	638.1
D2G		Average	0.401	0.449	0.435	0.447	0.417	0.349	0.292	0.355	0.406	0.412	0.442	0.458	0.389

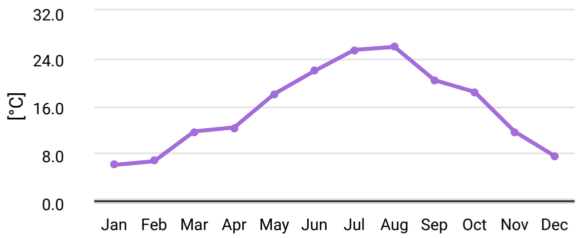
5 Climate

Meteorological parameters, representing the climate of the site, are used in evaluating the operation conditions of a PV project and for optimizing the PV design and energy production. Data is derived from meteorological models and processed by Solargis algorithms. Due to its spatial representation, the data represent the climate of a larger area that may exceed limits of the project. The meteorological parameters are derived from Solargis TMY.

Air temperature (TEMP) and relative humidity (RH) impact the efficiency and performance of solar panels. High temperature can reduce the efficiency of PV cells, while humidity can contribute to soiling and maintenance needs. Wind speed (WS) data helps in evaluating cooling effects on panels and the stability of PV trackers. Atmospheric pressure (AP) influences weather patterns and can affect both solar radiation and wind flow, thus impacting energy generation. Monthly precipitation (PREC) data informs about potential soiling and cleaning needs for PV modules, as heavy rain can clean panels while light rain can cause dust accumulation.

Figure 5.1, Figure 5.2, Figure 5.3 and Table 5.1 show monthly and yearly averages.

Figure 5.1 Air temperature at 2 m (TEMP, left) and Relative humidity at 2 m (RH, right): Monthly averages



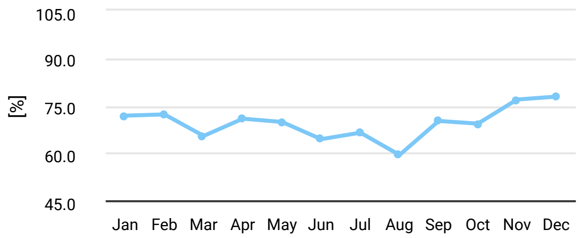
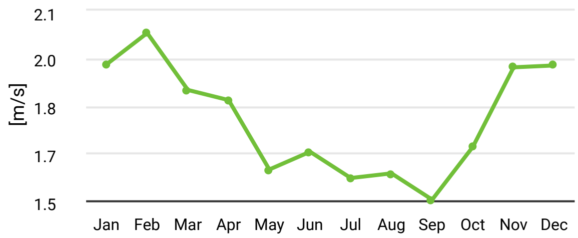


Figure 5.2 Wind speed at 10 m (WS, left) and Atmospheric pressure (AP, right): Monthly averages



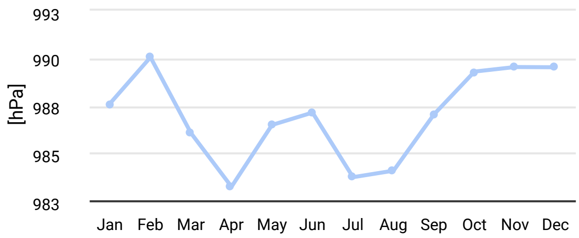


Figure 5.3 Monthly sums: Precipitation (rainfall, PREC)

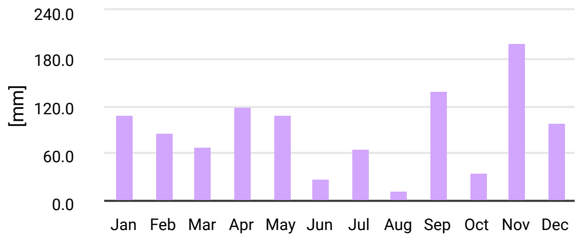


Table 5.1 Monthly and yearly statistics of selected meteorological parameters

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
TEMP	°C	Average	6.0	6.6	11.6	12.3	17.9	21.8	25.4	25.9	20.3	18.3	11.6	7.5	15.5
RH	%	Average	71.8	72.2	65.3	70.8	69.8	64.3	66.4	59.3	70.1	69.2	76.9	77.8	69.5
WS	m/s	Average	1.9	2.0	1.8	1.8	1.6	1.7	1.6	1.6	1.5	1.7	1.9	1.9	1.8
AP	hPa	Average	988	990	986	983	987	987	984	984	987	989	990	990	987
PREC	mm	Sum	108.9	86.9	67.3	118.7	109.5	27.4	66.6	13.3	138.5	35.8	199.0	98.1	1,070.0

6 Atmospheric and environmental conditions

Precipitable water (PWAT) refers to the total amount of water in a column from the Earth's surface to the top of the atmosphere, and this parameter is used to model the PV module spectral losses. Ground surface albedo (ALB) refers to the fraction of solar radiation that is reflected off the ground, and it is used in modeling energy output by bifacial PV modules.

Figure 6.1 Ground surface albedo (ALB, left) and Precipitable water (PWAT, right): Monthly averages

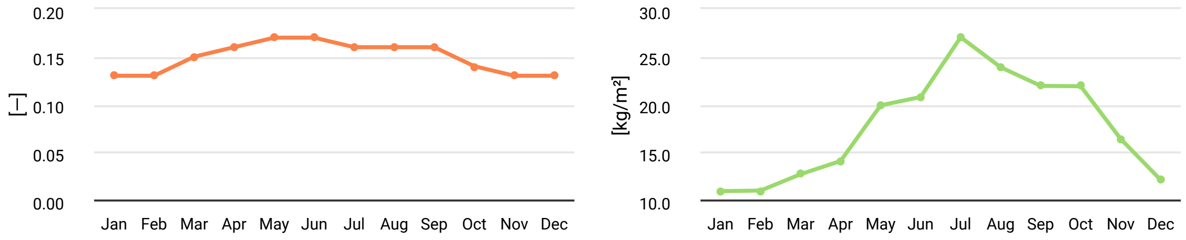


Table 6.1 Ground surface albedo (ALB) and Precipitable water (PWAT): Monthly and yearly averages

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
ALB	[-]	0.13	0.13	0.15	0.16	0.17	0.17	0.16	0.16	0.16	0.14	0.13	0.13	0.15
PWAT	[kg/m²]	10.9	10.9	12.7	14.0	19.9	20.8	27.0	23.9	21.9	21.9	16.4	12.0	17.7

7 Photovoltaic power generation

The conversion losses and the long-term average yearly and monthly electricity output from the photovoltaic power plant are calculated from the solar radiation, meteorological and environmental parameters included in the Solargis TMY. Monthly average values of GTI and PV system losses due to soiling and snow are estimated by user.

The GTI, PVOUT and PR results are calculated for the PV system configuration as fully described in the Annex 1 of this report.

In GTI values, we show the contribution of shading losses, caused by the default terrain horizon of the project reference point or of the individual segments of the PV power plant. The default horizon could have been customized by the customer. For PV systems with multi-segment, Solargis Evaluate calculates GTI as a weighted average of the GTI values calculated for individual segments. The weight is represented by the surface area of solar cells installed in each segment. In case of bifacial PV modules, the GTI values are shown separately for both the front and the rear side of the PV modules. These two GTI values, together with the consideration of the terrain horizon are shown as a summarized values in Table 4.1.

The results shown in this Chapter are based on the use of TMY and should be considered as preliminary, suitable for early-stage project evaluation. Full evaluation, with lower uncertainty of results, and considering interannual variability, can only be performed using Time series data.

7.1 PV system losses and performance ratio

Table 7.1 shows yearly breakdown of energy losses, providing an insight into the power plant performance. Degradation of conversion efficiency of PV modules is not considered here.

Figure 7.1 Summary of yearly losses at the level of a PV system

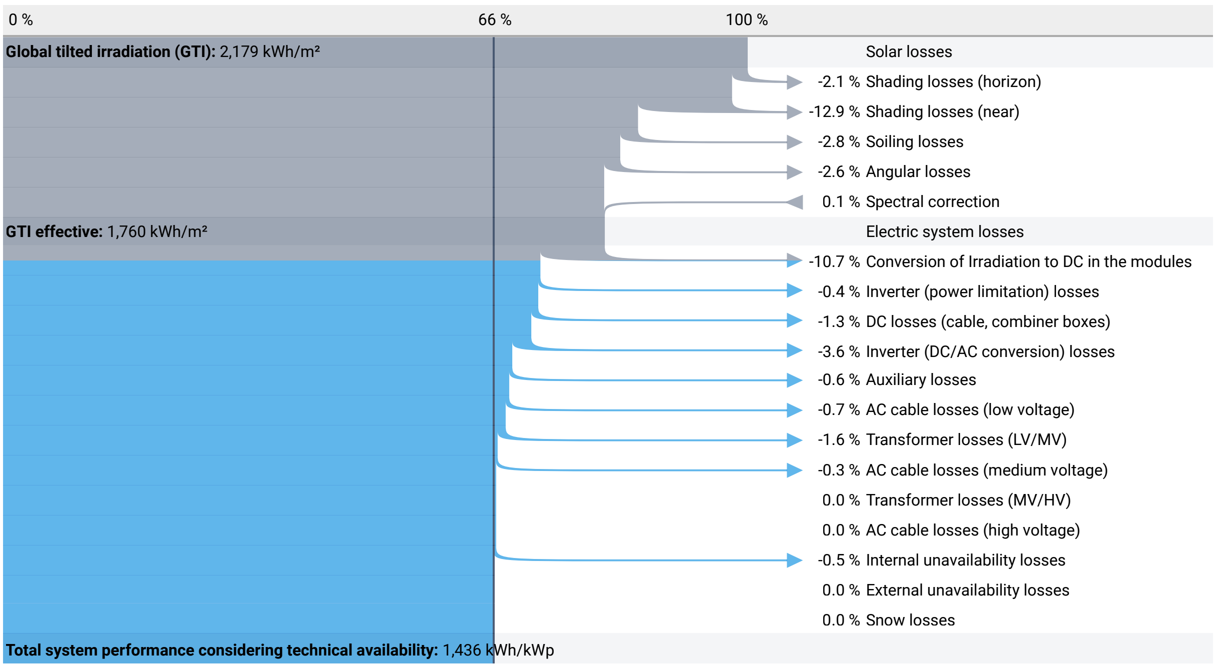


Table 7.1 Conversion stages, energy losses, and performance ratio at the level of the PV system.

Energy input	kWh/m²
Global horizontal irradiation	1,641
Global horizontal irradiation after shading	1,631

Optical losses	Energy output	Energy loss	Energy loss	Energy loss	Energy loss	Performance loss
			Partial	Relative to previous	Relative to input	Cumulative
	kWh/m²	kWh/m²	%	%	%	%
Front side						
Global tilted irradiation	1,898	–	100.0	–	–	100.0
Shading losses (horizon)	1,863	-36	98.1	-1.9	-1.9	98.1
Shading losses (near)	1,741	-122	93.4	-6.6	-8.3	91.7
Soiling losses	1,688	-52	97.0	-3.0	-11.1	88.9
Angular losses	1,654	-35	97.9	-2.1	-12.9	87.1
Spectral correction	1,654	1	100.1	0.1	-12.9	87.1
Rear side						
Global tilted irradiation	280	–	100.0	–	–	100.0
Shading losses (horizon)	271	-10	96.5	-3.5	-3.5	96.5
Shading losses (near)	117	-154	43.3	-56.7	-58.2	41.8
Soiling losses	117	-1	99.5	-0.5	-58.4	41.6
Angular losses	105	-11	90.3	-9.7	-62.4	37.6
Spectral correction	106	0	100.2	0.2	-62.4	37.6
GTI effective	1,760					80.8

Conversion losses	kWh/kWp	kWh/kWp	%	%	%	%
Conversion of Irradiation to DC in the modules	1,572	-188	89.3	-10.7	0.0	75.8

Electrical losses	PVOUT specific	Energy loss	Energy loss	Energy loss	Energy loss	Performance ratio
			Partial	Relative to previous	Relative to input	Cumulative
	kWh/kWp	kWh/kWp	%	%	%	%
Inverter (power limitation) losses	1,566	-6	99.6	-0.4	-0.3	75.5
DC losses (cable, combiner boxes)	1,547	-20	98.7	-1.3	-0.9	74.6
Inverter (DC/AC conversion) losses	1,491	-56	96.4	-3.6	-2.5	71.9
Auxiliary losses	1,481	-10	99.4	-0.6	-0.4	71.4
AC cable losses (low voltage)	1,472	-10	99.3	-0.7	-0.4	71.0
Transformer losses (LV/MV)	1,448	-23	98.4	-1.6	-1.1	69.8
AC cable losses (medium voltage)	1,443	-5	99.7	-0.3	-0.2	69.6
Transformer losses (MV/HV)	1,443	0	100.0	0.0	0.0	69.6
AC cable losses (high voltage)	1,443	0	100.0	0.0	0.0	69.6
Internal unavailability losses	1,436	-7	99.5	-0.5	-0.3	69.2
External unavailability losses	1,436	0	100.0	0.0	0.0	69.2
Snow losses	1,436	0	100.0	0.0	0.0	69.2
Total system performance considering technical availability and losses due to snow	1,436	-743	65.9	-34.1	-34.1	69.2

Capacity factor	%
Capacity factor considering technical availability and losses due to snow	16.4

In the results of PV power simulation, shown in Chapters below, the terrain shading of the individual segments and near shading by objects are considered.

7.2 Long-term average monthly and yearly PV power generation

Figure 7.2 Specific power generation and Performance ratio, with internal, external unavailability and snow lossess: Long-term monthly averages

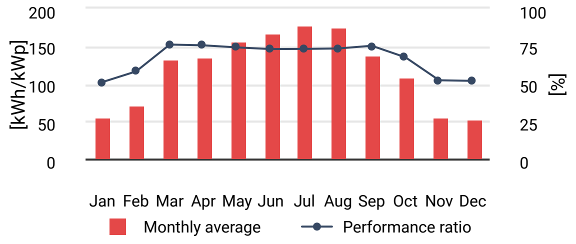


Table 7.2 Specific (PVOUT specific) and total power generation (PVOUT total) of PV system, with internal, external unavailability and snow lossess. Performance ratio (PR): Long-term average monthly and yearly values. Terrain shading is considered

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
PVOUT specific	kWh/kWp	Sum	54.9	72.1	134.3	135.3	157.9	168.7	179.1	177.2	138.7	108.5	57.3	52.2	1,436.2
PVOUT total	MWh	Sum	1,757	2,306	4,295	4,328	5,050	5,396	5,728	5,667	4,437	3,469	1,832	1,669	45,931
PR	%	Average	51.0	58.1	76.0	75.5	74.1	73.0	73.1	73.4	75.2	67.5	52.2	51.8	69.2

7.3 Long-term average hourly PV power generation

Figure 7.3 Specific power generation (PVOUT specific), without internal, external unavailability and snow losses: Long-term average hourly profiles [Wh/kWp]

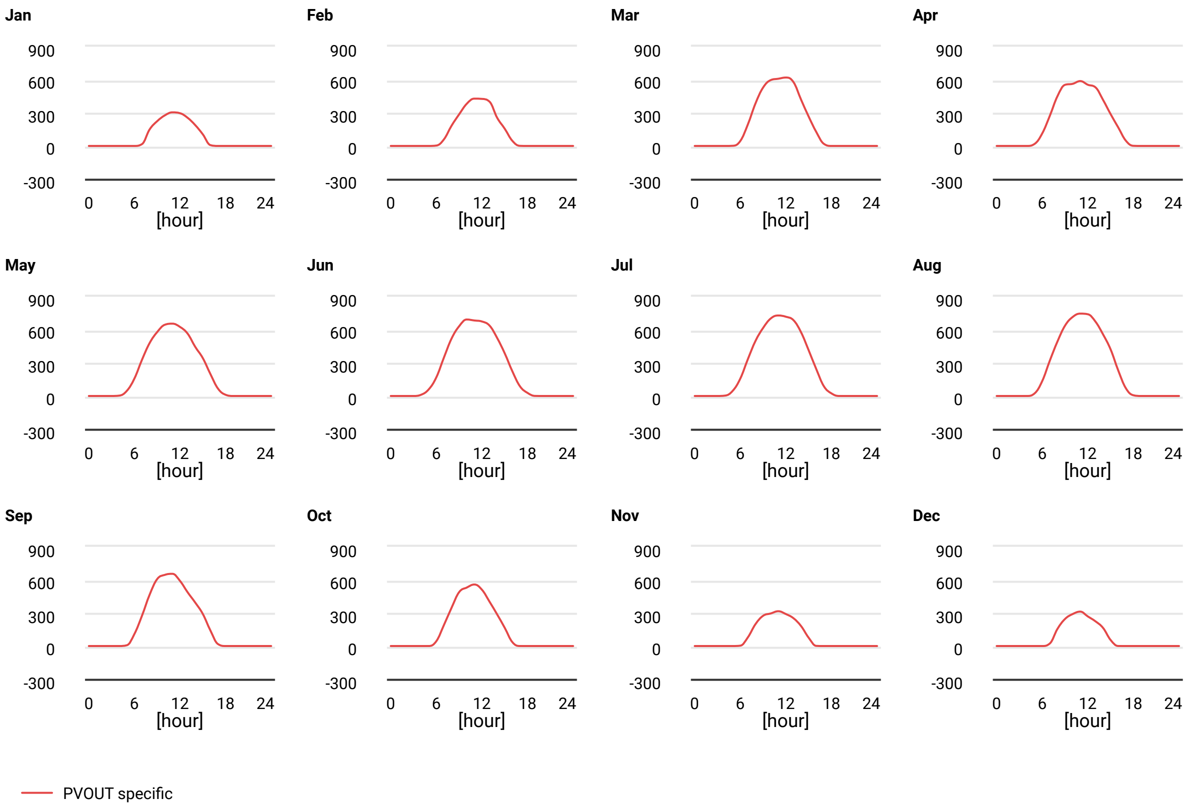


Table 7.3 Specific power generation (PVOUT specific), without internal, external unavailability and snow losses: Long-term hourly averages per month [Wh/kWp]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1	-	-	-	-	-	-	-	-	-	-	-	-
1 - 2	-	-	-	-	-	-	-	-	-	-	-	-
2 - 3	-	-	-	-	-	-	-	-	-	-	-	-
3 - 4	-	-	-	-	-	-	-	-	-	-	-	-
4 - 5	-	-	-	-	1	9	1	-	-	-	-	-
5 - 6	-	-	-	17	45	58	45	22	5	-	-	-
6 - 7	-	2	43	112	157	168	156	134	107	42	1	-
7 - 8	15	58	195	273	328	348	334	320	274	189	77	21
8 - 9	148	182	385	450	479	520	499	493	464	346	197	154
9 - 10	223	286	529	553	579	632	616	638	607	488	273	244
10 - 11	276	381	596	562	645	693	702	716	645	529	294	288
11 - 12	303	428	609	588	655	684	730	747	654	557	314	311
12 - 13	295	426	620	554	626	675	718	741	590	509	288	267
13 - 14	254	400	578	531	565	638	687	674	487	401	250	223
14 - 15	187	254	418	417	445	525	576	558	393	285	179	163
15 - 16	104	154	264	287	342	385	413	421	290	163	73	52
16 - 17	6	44	125	166	197	223	242	230	139	33	-	-
17 - 18	-	-	17	46	65	86	86	69	16	-	-	-
18 - 19	-	-	-	-	9	26	21	5	-	-	-	-
19 - 20	-	-	-	-	-	-	-	-	-	-	-	-
20 - 21	-	-	-	-	-	-	-	-	-	-	-	-
21 - 22	-	-	-	-	-	-	-	-	-	-	-	-
22 - 23	-	-	-	-	-	-	-	-	-	-	-	-
23 - 24	-	-	-	-	-	-	-	-	-	-	-	-
Sum	1,781	2,588	4,354	4,533	5,119	5,653	5,807	5,745	4,647	3,516	1,919	1,692

8 Photovoltaic power generation for next 25 years

To estimate power generation of the PV power plant for 25 years, degradation (aging) of nominal power (conversion efficiency) of PV modules must be considered. Not only are the modules subject to aging, but the overall performance of the power plant also depends on the performance degradation effects in cabling and inverters during the planned 25 years. Another source of uncertainty is the non-uniform degradation of individual modules, which results in higher mismatch losses. The calculation below is built on the results of Chapter 7.1, and it considers a simplified assumption of yearly linear degradation rate of 2.0 % in the first year and 0.5 % in the following years.

Figure 8.1 Specific PV power generation (PVOUT specific) [kWh/kWp] and Performance ratio (PR) [%] for next 25 years

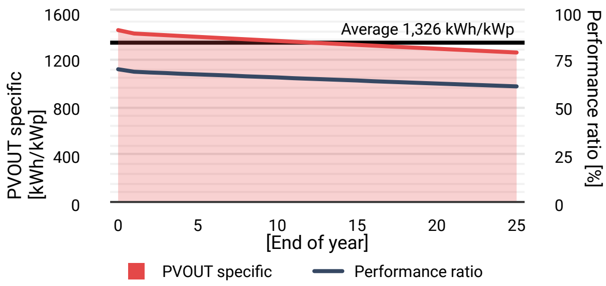


Table 8.1 Power generation over lifetime of PV power plant

End of year	Degradation rate	PVOUT specific	PVOUT total	PR
	%	kWh/kWp	GWh	%
0	-	1,436	45.93	69.2
1	2.0	1,408	45.01	67.9
2	0.5	1,401	44.79	67.5
3	0.5	1,394	44.56	67.2
4	0.5	1,387	44.34	66.8
5	0.5	1,380	44.12	66.5
6	0.5	1,373	43.90	66.2
7	0.5	1,366	43.68	65.9
8	0.5	1,359	43.46	65.5
9	0.5	1,352	43.24	65.2
10	0.5	1,345	43.03	64.9
11	0.5	1,339	42.81	64.5
12	0.5	1,332	42.60	64.2
13	0.5	1,325	42.39	63.9
14	0.5	1,319	42.17	63.6
15	0.5	1,312	41.96	63.3
16	0.5	1,306	41.75	62.9
17	0.5	1,299	41.54	62.6
18	0.5	1,293	41.34	62.3
19	0.5	1,286	41.13	62.0
20	0.5	1,280	40.92	61.7
21	0.5	1,273	40.72	61.4
22	0.5	1,267	40.52	61.1
23	0.5	1,261	40.31	60.8
24	0.5	1,254	40.11	60.5
25	0.5	1,248	39.91	60.2
Average	0.6	1,326	42.41	63.9
Cumulative	13.1	-	1,060.32	-

9 Acronyms

ALB	Ground surface albedo
AP	Atmospheric pressure
CFSR	National Centers for Environmental Prediction (NCEP) Climate Forecast System Reanalysis
D2G, DIF/GHI	Ratio of diffuse to global horizontal irradiation
DIF	Diffuse horizontal irradiation, if integrated solar energy is assumed. Diffuse horizontal irradiance, if solar power values are discussed
DNI	Direct normal irradiation, if integrated solar energy is assumed. Direct normal irradiance, if solar power values are discussed
ERA5, ERA5 Land	Climate reanalysis data, providing atmospheric, land-surface and sea-state parameters. Service operated by ECMWF
GFS	Global Forecast System. Service operated by NOAA
GHI	Global horizontal irradiation, if integrated solar energy is assumed. Global horizontal irradiance, if solar power values are discussed
GTI	Global tilted (global in-plane) irradiation, if integrated solar energy is assumed. Global tilted irradiance, if solar power values are discussed
LTA	Long-term average values
MACC-II/CAMS	Monitoring Atmospheric Composition and Climate - Interim Implementation of the Copernicus Atmosphere Monitoring Service operated by ECMWF
MERRA-2	Modern Era Reanalysis for Research and Applications operated by NASA
Meteosat	Meteosat satellites operated by EUMETSAT organization
MODIS	MODerate resolution Imaging Spectroradiometer operated by NASA
p01, p10, ... pxx	Calculated percentile values, pxx stands for the x-th percentile, p50 is median
PREC	Precipitation total
PVOUT Specific	AC energy delivered by a PV system and normalized to 1 kWp of installed capacity
PVOUT Total	AC energy delivered by the total installed capacity of a PV system
PWAT	Precipitable water. The total amount of vapor in a column of the atmosphere
RH	Relative humidity at 2 meters
SDWE	Snow depth water equivalent
SRTM3	Global digital elevation model prepared by the Shuttle Radar Topography Mission at the spatial resolution of 3 arc-second
SUN_AZIMUTH	Sun azimuth angle
SUN_ELEVATION	Sun elevation angle
TD	Dew point temperature at 2 meters
TEMP	Air temperature at 2 meters
WBT	Wet bulb temperature at 2 meters
WD	Wind direction at 10 meters
WG	Wind gust at 10 meters
WS	Wind speed at 10 meters

10 Glossary

P50 value	Best estimate or median value represents 50% probability of exceedance. For annual and monthly solar irradiation summaries it is close to average, since multiyear distribution of solar radiation is (in a simplified approach) considered to be a normal distribution.
Solar irradiance	Solar power (instantaneous energy) falling on a unit area per unit time [W/m²]. Terms solar resource or solar radiation are used when considering both irradiance and irradiation.
Solar irradiation	Amount of solar energy falling on a unit area over a stated time interval [Wh/m²].

11 References

11.1 Solargis methodology

[1] Solargis digital terrain models: https://kb.solargis.com/docs/geospatial-mapping-1

[2] Solargis solar, meteorological, and environmental database: methods, inputs, numerical models, validation, data parameters, and properties: https://kb.solargis.com/docs/solar-meteorological-and-environmental-data

[3] Validation of Solargis model parameters: https://kb.solargis.com/docs/accuracy-validation

[4] Geographical representation of Solargis model data: https://kb.solargis.com/docs/geospatial-mapping

[5] Calculation of Solargis TMY data: https://kb.solargis.com/docs/time-series-and-tmy-data

[6] Solargis PV simulation chain: https://kb.solargis.com/docs/pv-energy-yield-simulation#the-solargis-approach

[7] Solar resource uncertainty: https://kb.solargis.com/docs/uncertainty

[8] Solargis Analyst software: https://kb.solargis.com/docs/analyst

11.2 Data sources from third parties

CFSR	© 2025 National Oceanic and Atmospheric Administration (NOAA)
ERA5	© 2025 European Centre for Medium-range Weather Forecasts (ECMWF)
ERA5 Land	© 2025 European Centre for Medium-range Weather Forecasts (ECMWF)
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