Overview of Solargis API

The aim of Solargis API is to provide programmatic access to Solargis database and services for computers over the web. API is a “user interface” for developers. Developers can automate getting Solargis products by using standard internet protocols (FTP, HTTP) and integrate data values into their processing chain (for evaluation, monitoring, forecasting, validation, calibration etc.).

<table>
<thead>
<tr>
<th>Solargis API</th>
<th>Available data (PV, solar, meteorological)</th>
<th>Technical features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>historical</td>
<td>operational</td>
</tr>
<tr>
<td>FTP data delivery</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>DataDelivery Web Service</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>pvPlanner Web Service</td>
<td>NO</td>
<td>NO</td>
</tr>
</tbody>
</table>

Solargis API consists of three endpoints with slightly different features:

- **FTP data delivery** - The service can deliver regularly updated Solargis data to remote FTP directories. This service provides the most comprehensive set of input parameters. Request processing is asynchronous (client registers a CSV request, server handles the request later, client then checks for the response CSV files). Request processing can be scheduled regularly (e.g. once per 12 hours, day, month) or occasionally. Both request and response are CSV delimited text files allowing multiple locations in one file. For pricing and setting up FTP user account, please contact us.

- **DataDelivery Web Service (WS)** - service for Solargis time series data in synchronous mode (client waits for server to deliver response). Both request and response are XML documents. the WS request parameters (represented as XML elements and attributes) are formally described by XML Schema Definition documents (XSD). By using the schema, request or response can be verified programmatically. For this service we provide two endpoints, standard SOAP or light REST-like access. Look for more technical information here. Authentication and billing is based on API key registered with the user. Please contact us to discuss details and we will prepare a quotation.
pvPlanner Web Service - service provides monthly long-term averaged data (including 1 yearly value) of PV, solar and meteorological data with global coverage. The service is targeted for site prospection and feasibility. The service represents the click on Calculate button in the interactive Solargis pvPlanner application. Request and response for the service is not described in this user guide. Technical information can be found here.

Description of data available through the WS and FTP data delivery

In case of solar and PV time series we use satellite data since available history up to present moment plus additional 4-5 hours ahead (in the regions where real time & nowcasting model is available). Satellite data includes historical (archived) data, operational data, real-time and nowcasting data. Historical data spans up to the last completed calendar month and can be considered as "definitive". Data in current calendar month up to DAY-1 is "operational" and will be re-analysed in the next month using final data inputs. Important to note is that differences introduced with every update is typically small. Data in current day are from "real-time" satellite model and will be updated when day is finished. Then, based on last satellite scenes we predict cloud motion in period in next 4-5 hours ("nowcasting"). The present moment and short period before is covered by the nowcasting model data as the last satellite scene is still in progress. This delay can take up to 30 minutes (depends on satellite scan frequency). Later on after nowcasting, we use post-processed outputs from Numerical Weather Prediction models (NWP). Satellite based data is seamlessly integrated with NWP forecasting data within one response. In case of locations where real-time & nowcasting data is not available, NWP data is used for the whole current day. Also, not every location is supplied by ECMWF IFS data. In such case NOAA GFS data is used for all forecasted values. Meteorological data (TEMP, WS, AP, RH...) is comprised of NWP modeled data.

Schema below shows how data sources are integrated on example of the the WS response having 9 days of data (generated at 12:00 of a given day).

Satellite based PV and solar data

Spatial coverage of data available through API (valid for Dec 2017). Click image to enlarge:
Orange regions on the map are accessible via API and data is updated everyday (DAY-1 is available). In the subset of these regions, the real-time/nowcasting data is available (DAY+0). Main data parameters include GHI, DNI, DIF, GTI, PVOUT.

<table>
<thead>
<tr>
<th>satellite region</th>
<th>data since</th>
<th>local DAY-1 available at</th>
<th>real-time/nowcasting</th>
<th>original satellite scan frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOES-E</td>
<td>1999-01-01</td>
<td>10:00 UTC (USA), 13:00 UTC (whole region)</td>
<td>planned</td>
<td>30 minutes</td>
</tr>
<tr>
<td>MFG/MSG PRIME</td>
<td>2005-01-01</td>
<td>03:45 UTC</td>
<td>15-min resolution, update frequency 30min, 0-5 hours ahead</td>
<td>15 minutes</td>
</tr>
<tr>
<td>MTSAT/HIMAWARI</td>
<td>2006-07-01</td>
<td>22:40 UTC</td>
<td>10-min resolution, update frequency 30min, 0-5 hours ahead</td>
<td>30 min. (10 min. since Jan 2016 onwards)</td>
</tr>
<tr>
<td>MFG/MSG IODC</td>
<td>1999-01-01</td>
<td>22:40 UTC</td>
<td>15-min resolution, update frequency 30min, 0-5 hours ahead</td>
<td>30 min. (15 min. since Feb 2017 onwards)</td>
</tr>
<tr>
<td>GOES-W</td>
<td>1999-01-01</td>
<td>13:00 UTC (Hawaii)</td>
<td>planned</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

Daily update of the data re-calculates data for two days backwards (DAY-1 and DAY-2). Monthly update (on 3rd day of month) re-calculates the whole previous month as soon as it’s completed. The purpose of these updates is described in this article. We gradually expands spatial coverage of satellite data accessible via API. To access operational and historical data in the grey areas on the map, please use Solargis climData online shop.

Note: the data from orange zones in the map is also available by using interactive application pvSpot (daily operational data) and is accessible within minutes after purchase via climData online shop (historical archived data).

**Meteorological data from re-analysed numerical weather models**

Main data parameters include air temperature (TEMP), wind speed (WS), wind direction (WD), relative humidity (RH). Meteorological data comes from post-processed numerical weather models and is available globally. The DAY-1 and DAY-2 values are taken from NWP models - NOAA GFS (resp. ECMWF IFS) data source (forecasted values). The preliminary meteorological data from GFS model is later updated with data from the NOAA CFS v2 data source (re-analysed archive data). Meteorological data for period DAY-3 (and older) can be considered as definitive.

**PV, solar and meteorological data from Numerical Weather Prediction (NWP) models**

Solargis forecast is based on post-processing of outputs from NWP models. The forecast time series include the following data parameters:

- Global horizontal irradiance, GHI [W/m²] - from NWP
- Global tilted irradiance, GTI [W/m²] - calculated parameter
- Air temperature at 2 m, TEMP [°C] - from NWP
- PV electricity output, PVOUT [kWh] - calculated parameter
- Wind speed at 10 m, WS [m/s] - from NWP
- Wind direction at 10m, WD [°] - from NWP
- Relative humidity, RH [%] - from NWP
- Atmospheric pressure, AP [hPa] - from NWP
- Precipitable water, PWAT [kg/m²] - from NWP

Map of NWP forecast coverage:
• violet regions: high resolution, higher reliability forecast data is available in the orange regions marked on the map. Upon request, we can start this kind of forecasting service for any other area. Source: IFS model from ECMWF, UK. Frequency of the update is once in 12 hours, forecasting today + 3 days ahead (4 days in total). The rest of days (up to 7 days ahead) is covered by GFS model. The light violet regions are latest additions.

• the rest of the map in white color: lower resolution forecast data is available globally. Source: GFS model from NOAA, USA is available globally with forecasting up to 7 days ahead (today + 7 days = 8 days in total). Frequency of the update is once in 12 hours.

Find more information about forecast here.

Request Parameters

Most comprehensive set of parameters comes with FTP data delivery. Subset of the parameters is exposed via Web Services. Following list of parameters is created with regards to FTP data delivery (CSV request). The last column shows the parameter availability in the WS. The standard XPath notation is used to describe parameter location within XML request. More information about XML schema used in the WS can be found here.

Location and Solar Resource Related Parameters

<table>
<thead>
<tr>
<th>Parameter name in FTP data delivery</th>
<th>Required</th>
<th>Value type</th>
<th>Value unit</th>
<th>Default value</th>
<th>Value Range</th>
<th>Description</th>
<th>WS request equivalent (XPath)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lat</td>
<td>Yes</td>
<td>float</td>
<td>degree</td>
<td>-90, 90</td>
<td>-90, 90</td>
<td>Latitude</td>
<td>dataDeliveryRequest/site/@lat</td>
</tr>
<tr>
<td>lng</td>
<td>Yes</td>
<td>float</td>
<td>degree</td>
<td>-180, 180</td>
<td>-180, 180</td>
<td>Longitude</td>
<td>dataDeliveryRequest/site/@lat</td>
</tr>
<tr>
<td>alt</td>
<td>Yes</td>
<td>float</td>
<td>meters</td>
<td>-500, 8848</td>
<td>-500, 8848</td>
<td>Altitude relative to sea level</td>
<td>dataDeliveryRequest/site/terrain/@elevation</td>
</tr>
<tr>
<td>groundAlbedo</td>
<td>No</td>
<td>float</td>
<td>-</td>
<td>0.12</td>
<td>0, 1</td>
<td>Estimated annual value of reflection coefficient expressing amount of ground-reflected radiation, value ranges from zero (no reflection, black surface) to 1 (perfect reflection)</td>
<td>dataDeliveryRequest/site/groundAlbedo/reflectivity/@value</td>
</tr>
<tr>
<td>geometry</td>
<td>No</td>
<td>string</td>
<td>-</td>
<td>FixedOneAngle</td>
<td>-</td>
<td>Type of surface absorbing solar energy. It can be fixed or sun-tracking. It is assumed this typically is a PV module</td>
<td>dataDeliveryRequest/site/geometry/@type</td>
</tr>
</tbody>
</table>
PV System Related Parameters

PV required parameters are required in case of PV output data is requested. For requesting solar radiation or meteorological data alone, PV parameters are not needed at all.

<table>
<thead>
<tr>
<th>Parameter name in FTP data delivery</th>
<th>Required</th>
<th>Value type</th>
<th>Value unit</th>
<th>Default value</th>
<th>Value Range</th>
<th>Description</th>
<th>WS request equivalent (XPath)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pvInstalledPower</td>
<td>Yes</td>
<td>float</td>
<td>kWp</td>
<td>positive floats</td>
<td></td>
<td>Total installed power of the PV system in kilowatts-peak (kWp). The total PV system rating consists of a summation of the panel ratings measured in STC.</td>
<td>dataDeliveryRequest/site/system/@installedPower</td>
</tr>
<tr>
<td>dateStartup</td>
<td>No</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>String formatted as &quot;yyy-mm-dd&quot; (example 2015-01-01). Start up date of PV system (resp. unpacking of modules). This parameter is used for calculation of degradation (or aging) of modules. If omitted, degradation is not taken into account.</td>
<td>dataDeliveryRequest/site/system/@dateStartup</td>
</tr>
<tr>
<td>pvInstallationType</td>
<td>Yes</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>This property of the PV system helps to estimate how modules are ventilated. For sloped roof with PV modules on rails tilted at the same angle as the roof choose 'ROOF_MOUNTED' value. For PV modules incorporated into building facade choose 'BUILDING_INTEGRATED' value. This</td>
<td>dataDeliveryRequest/site/system/@installationType</td>
</tr>
</tbody>
</table>
option is considered as the worst ventilated. As the best ventilated option is considered free standing installation. This typically means stand-alone installation on tilted racks anchored into the ground. Also choose this option if a PV system is installed on a flat roof (similar to stand-alone installation). The string value is in this case "FREE_STANDING".

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required</th>
<th>Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pvTrackerRotMin</td>
<td>No</td>
<td>string</td>
<td>-180,180</td>
<td>Parameter is a pair of limiting rotation angles for OneAxisVertical, OneAxisInclined, OneAxisHorizontalNS and TwoAxisAstronomical (its vertical axis) mounting geometries. If the tracker is purely theoretical (no limits) the default value of &quot;-180,180&quot; is used.</td>
</tr>
<tr>
<td>pvTrackerRot2Min</td>
<td>No</td>
<td>string</td>
<td>-90,90</td>
<td>Parameter is a pair of limiting tilt angles for TwoAxisAstronomical (its horizontal axis) and OneAxisHorizontalEW trackers. Because of technical realizations of variable tilt often a linear actuator is used. Inclination angle seldom varies beyond 0 to 90, more often, it has smaller range e.g. &quot;10,80&quot;. If the tracker is purely theoretical (no limits) the default value of &quot;-90 to 90&quot; should be used. Selecting tilt limits of &quot;45,45&quot; turns TwoAxisAstronomical tracker to the OneAxisVertical tracker tilted to 45 degree.</td>
</tr>
<tr>
<td>pvTrackerBackTrack</td>
<td>No</td>
<td>string</td>
<td>FALSE</td>
<td>Default value &quot;FALSE&quot; corresponds to a standalone tracker without neighbors (best possible) moving within specified rotation limits (pvTrackerRotMin or pvTrackerRot2Min), implemented for all trackers.</td>
</tr>
<tr>
<td>pvFieldSelfShading</td>
<td>No</td>
<td>string</td>
<td>FALSE</td>
<td>The parameter affects FixedOneAngle geometry, then OneAxisHorizontalNS and OneAxisInclined type of trackers with</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Default</td>
<td>Unit</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>---------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>pvTrackerBackTrack</strong></td>
<td>k=FALSE. When pvTrackerBackTrack k=TRUE, the parameter does not make sense as self-shading is avoided. No other options are implemented. It is used to determine the impact of self (inter-row) shading on PV power production. When set to TRUE, the effect of self-shading is taken into account in calculation, otherwise the geometry is assumed without neighbors (best possible).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>pvFieldColumnSpacingRelative</strong></td>
<td>No floating parameter has effect only in case of tracking system when pvTrackerBackTrack k is TRUE. It specifies the ratio between distance between the equivalent table legs and table width. Affected are trackers TwoAxisAstronomical, OneAxisVertical, OneAxisInclined, OneAxisHorizontalNS.</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>pvFieldRowSpacingRelative</strong></td>
<td>No floating parameter has effect only when pvTrackerBackTrack k is True. It specifies the ratio between distance between the equivalent table legs and table width. Affected are FixedOneAngle systems and TwoAxisAstronomical tracker. According to image below, pvFieldRowSpacingRelative = x3 / x2.</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>pvFieldTerrainSlope</strong></td>
<td>No floating parameter has effect only when calculating self-shading effect of PV system with FixedOneAngle.</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of pvTrackerBackTrack](image-url)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required</th>
<th>Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pvFieldTerrainAzimuth</td>
<td>No</td>
<td>float</td>
<td>degree</td>
<td>180, 0, 360</td>
</tr>
<tr>
<td>pvFieldTopologyType</td>
<td>No</td>
<td>string</td>
<td></td>
<td>UNPROPORTIONAL for all other module technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROPORTIONAL for CSI, ASI, CDTE, CIS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This parameter estimates a loss of PV system output when modules are self-shaded. The effect depends on wiring interconnection within a module.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shading influence ranges from 0% (no influence) to 100% (full influence) and is mapped to categories:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• PROPORTIONAL _L = 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• UNPROPORTIONAL _1 = 40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• UNPROPORTIONAL _2 = 60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• UNPROPORTIONAL _3 = 80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>When parameter is missing at all, the self-shading influence is estimated to 5%.</td>
</tr>
<tr>
<td>pvModuleTechnology</td>
<td>Yes</td>
<td>string</td>
<td></td>
<td>CSI, ASI, CDTE, CIS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Enumerated codes for materials used in PV modules. Use 'CSI' for crystalline silicon, 'ASI' for amorphous silicon, 'CDTE' for cadmium telluride, 'CIS' for copper indium selenide.</td>
</tr>
<tr>
<td>pvModuleDegradation</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>0.5, 0, 100</td>
</tr>
<tr>
<td>pvModuleDegradationFirstYear</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>0.8, 0, 100</td>
</tr>
<tr>
<td>pvModuleSurfaceReflectance</td>
<td>No</td>
<td>float</td>
<td></td>
<td>0.16, 0, 1</td>
</tr>
</tbody>
</table>


reflectivity of PV module surface. This parameter includes not only optical properties of covering glass, but also glass coating and dirt. Typical values for commercially available PV modules are 0.16 - 0.17 for clean surfaces, 0.20 for moderate dirty and 0.27 for dirty surface.

**pvModuleTempNOCT**
- **Type**: float
- **Unit**: degree Celsius
- **Description**: Normal operating cell temperature. Float value of the temperature in degrees Celsius of a free standing PV module exposed to irradiance of 800 W/m² and ambient air temperature of 20°C and wind speed is 1 m/s. The value is given by manufacturer and only for ventilated free standing PV system.

**pvModuleTempCoefPmax**
- **Type**: float
- **Unit**: percent per degree Celsius
- **Description**: Negative percent float value representing the change in PV panel output power for temperatures other than 25°C (decrease of output power with raising temperature). This property is given at STC by manufacturer.

**pvInverterEffConstant**
- **Type**: float
- **Unit**: percent
- **Value**: 97.5
- **Range**: 0, 100
- **Description**: Value of inverter’s efficiency known as Euro or CEC (California Energy Commission) efficiency. This value is a calculated weighted efficiency given by manufacturer. It gives a simplified picture about an inverter, in fact non-linear performance. Valid range of this value is practically 70%-100%. For better results, it is recommended to provide inverter efficiency curve (by using parameter `@dataPairs`).

**pvInverterEffCurveDataPairs**
- **Type**: string
- **Unit**: kW/percent pairs
- **Description**: Efficiency of inverter is of non-linear nature, so it can be described as simplified curve defined as list of data points. Data point on the curve is defined by coordinates, where the x coordinate is absolute float value of input power in kilowatts (kW) and y coordinate is percent float value of the corresponding inverter’s efficiency (%). This parameter is used to set inverter efficiency curve graphically.
parameter accepts string value of this pattern: "x1:y1 x2:y2 x3:y3 xn:yn". A dot should be used as decimal separator, white space as a point delimiter and colon as x:y delimiter. We assume the last point determines the maximum input power of the inverter (with corresponding efficiency).

Example efficiency curve of an inverter with the maximum input power of 3 kW is "0.85 0.95 1.0 0.85 1.0 0.95 2 0.95 3.0 0.95". It is assumed, that one efficiency curve is valid for all inverters of the PV system (their powers are summed).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required</th>
<th>Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pvInverterLimitationACPower</td>
<td>No</td>
<td>float</td>
<td>kW</td>
<td>Maximum AC power when inverter limits (clips) AC output. Clipping refers to the situation where the AC power output of an inverter is limited due to the peak rating of the inverter (the parameter value in kW), even though additional power may still be available from the solar modules. If you have power factor (PF) and AC limit in kVA available, use this formula: PF * AC_limit_kVA = kW, which is the value of this parameter.</td>
</tr>
<tr>
<td>pvLossesDCOther</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>5.4</td>
</tr>
<tr>
<td>pvLossesDCMismatch</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>1.0</td>
</tr>
<tr>
<td>pvLossesDCCables</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>2.0</td>
</tr>
<tr>
<td>pvLossesDCPollutionSnowMonth</td>
<td>No</td>
<td>string</td>
<td>formatted list of float percent</td>
<td>Distribution of the pvLossesDCPollutionSnow value into 12 average months. Example: &quot;5,0,2,0,2,0,2,0,0,0,0,0&quot;</td>
</tr>
<tr>
<td>Parameter name</td>
<td>Required</td>
<td>Value type</td>
<td>Value unit</td>
<td>Default value</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>----------</td>
<td>------------</td>
<td>------------</td>
<td>---------------</td>
</tr>
<tr>
<td>pvLossesDCPollutionSnow</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>2.5</td>
</tr>
<tr>
<td>pvLossesAC</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>1.5</td>
</tr>
<tr>
<td>pvLossesACCable</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>0.5</td>
</tr>
<tr>
<td>pvLossesACTransformer</td>
<td>No</td>
<td>float</td>
<td>percent</td>
<td>1.0</td>
</tr>
<tr>
<td>pvInverterLimitationACPowers</td>
<td>No</td>
<td>float</td>
<td>kW</td>
<td></td>
</tr>
</tbody>
</table>

**Parameters Controlling Request Processing**

<table>
<thead>
<tr>
<th>Parameter name in FTP data delivery</th>
<th>Required</th>
<th>Value type</th>
<th>Value unit</th>
<th>Default value</th>
<th>Value Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>siteId</td>
<td>Yes</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>Unique identification of one request (one row in CSV request), example: &quot;DETRKIT_roof_1&quot;</td>
</tr>
<tr>
<td>fromDate</td>
<td>No</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>String formatted as &quot;yyyyymmdd&quot; (example &quot;20150101&quot;).</td>
</tr>
<tr>
<td>toDate</td>
<td>No</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>String formatted as &quot;yyyyymmdd&quot; (example &quot;20150101&quot;).</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Type</td>
<td>Example</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>forecastFromDay</td>
<td>Yes (if forecast is needed)</td>
<td>integer</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For forecast request only. In case of FTP data delivery, forecast processing is indicated by file name of the CSV request file. Then this parameter is taken into account. 0=DAY+0, 1=DAY+1, etc.</td>
<td></td>
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</tr>
<tr>
<td>forecastToDay</td>
<td>Yes (if forecast is needed)</td>
<td>integer</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For forecast request only. In case of FTP data delivery, forecast processing is indicated by file name of the CSV request file. Then this parameter is taken into account. 1=DAY+1, 2=DAY+2, etc. up to 10.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>summarization</td>
<td>Yes</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>This parameter defines time resolution of output data. Original satellite and meteorological data are in various time steps (e.g. MSG satellite: 15 min, GOES-EAST satellite: 30 min, GFS weather model: 3 hour). When finer summarization is requested, the data will be interpolated into desired time step. In other words, you can request time resolution of 10 minutes even if the original dataset is not available in such resolution. The &quot;monthly-longterm&quot; summarization means 12 long-term monthly averaged entries + 1 annual entry in the response.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>processingKeys</td>
<td>Yes</td>
<td>string</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>The white-space-separated list of variable codes which will be included in the response (example: &quot;GHI DIF TEMP WS WD&quot;): GHI: Global horizontal radiation, (W/m² for instantaneous values, Wh/m² for hourly values, kWh/m² for daily, monthly and yearly values); DNI: Direct normal radiation, (W/m² for instantaneous values, Wh/m² for hourly values, kWh/m² for daily, monthly and yearly values);</td>
<td></td>
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</tr>
</tbody>
</table>
- **DIF**: Diffuse horizontal radiation, (W/m\(^2\) for instantaneous values, Wh/m\(^2\) for hourly values, kWh/m\(^2\) for daily, monthly and yearly values).
- **GTI**: Global tilted radiation, (W/m\(^2\) for instantaneous values, Wh/m\(^2\) for hourly values, kWh/m\(^2\) for daily, monthly and yearly values).
- Consider setting up the "geometry", "azimuth" and "tilt" parameters, otherwise default will be horizontal surface.
- **SE**: Sun altitude (elevation) angle (degrees).
- **SA**: Sun azimuth angle (degrees).
- **TEMP**: Air temperature at 2 m (degrees Celsius).
- **AP**: Atmospheric pressure (hPa).
- **RH**: Relative humidity (%).
- **WS**: Wind speed at 10 m (m/s).
- **WD**: Wind direction (degrees), true north-based azimuth. Do not request this variable in time steps above "hourly".
- **PVOUT**: Output from PV system (kW for instantaneous, otherwise kWh). Consider setting up "geometry" and related parameters and required PV-related parameters.

| timeZone | No | int | 0 (=UTC+0) -12, 12 | Signed integer. Time zone with hourly precision. Value defines the time zone of output data and it is used for all summarizations. For daily and monthly summation, the time zone it is activated automatically in the background. This is important for summarization of whole days, otherwise daily summary in UTC+0 would for Japan or Hawaii end up in putting together dataDeliveryRequestProcessing/timeZone, timeZone must be in format '+' GMT+hh'' or '-' GMT-hh'
data from two different local days. For hourly and shorter time steps, time zone must be specified, otherwise UTC+0 is used. All the satellite model results are calculated and internally stored in UTC-0. Therefore depending on the requested time zone value, the data reader automatically extends period from which data are read to acquire completed local day. For example, one whole day D (0-24h) in the time zone of UTC-5 will be read from UTC database as D (5-24 hours) and D+1 (0-5 hours).

timeStampType No string CENTER

The parameter can be used in hourly or even in sub-hourly time steps when averaging of more values occurred within time interval. Example: let's say the value is the result of averaging of more occurrences within hourly interval from 15:00 to 16:00. If the value of the parameter is "CENTER", the value is time-stamped at 15:30, in case of "END" at 16:00 and finally "START" at 15:00.

satelliteTimeStamp No string TRUE

This parameter is used to preserve time stamp of satellite data acquisition. The data for given position are recorded by satellite in exact moment given by scanning speed of the instrument. For example MSG data scan starts nearby south pole at time T and data for Europe are recorded with 10-13 minutes delay from nominal (start) scan time. To present the original satellite information and avoid degradation of the information content by temporal interpolation it is good to preserve local time stamp of satellite data acquisition.

terrainShading No string FALSE

Apply or not terrain (or horizon) shading (whether default SRTM
Note, there are no "fromDate" and "toDate" parameters. Date period is resolved according to contract and managed by the automated process.

Request Examples

FTP data delivery

Data request CSV file must have header with parameter names on a first row. Below header, there can be unlimited number of rows with parameter values (site requests). Order of parameters is optional.

Regular data request example for monitoring

Note, there are no "fromDate" and "toDate" parameters. Date period is resolved according to contract and managed by the automated process.
On-time data request example

Parameters “fromDate” and “toDate” are required in this case. Such request is processed only once. Note, only radiation and temperature is requested in this case, so no PV system settings are needed.

Forecast data request example

Note the usage of “forecastFromDay” and “forecastToDay” parameters. Typically data will processed each 12 hours forecasting period since today (forecastFromDay=0) up to 7 days ahead (forecastToDay=7).

Minimalist PV data request example for monitoring

Note, degradation is not considered (missing “dateStartup” parameter). This request will be processed each day according to schedule for any given satellite as soon as local day is finished. The DAY-1 is delivered.

Minimalist solar radiation data request example for monitoring

This request will be processed each day according to schedule for any given satellite as soon as local day is finished. The DAY-1 is delivered.
Web Services

There is no regularly processed request in case of this standard synchronous web service. Instead, the client will post the request and wait for the response. For technicalities visit this link. Developer can test various requests directly from web browser by using e.g. REST Client for Firefox. From within REST Client set HTTP Method to "POST", endpoint URL to: https://solargis.info/ws/rest/databedelivery/request?key=demo and also set header "Content-Type: application/xml". Then post the examples below in the body of the request and explore responses. Note, there is a limit of max. 31 days within requested date period. Typically, developer will create client code to post requests and handle responses. This client code can be created based on XSD schema documents by multiple libraries (JAXB for Java, PyXB for Python etc.)

Example of fixed mounted PV system

```xml
<ws:dataDeliveryRequest dateFrom="2018-02-11" dateTo="2018-02-11"
xmlns="http://geomodel.eu/schema/data/request"
xlns:ws="http://geomodel.eu/schema/ws/data"
xlns:geo="http://geomodel.eu/schema/common/geo"
xlns:pv="http://geomodel.eu/schema/common/pv"
xlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <site id="demo" lat="48.61259" lng="20.827079">
    <geo:terrain elevation="246" azimuth="180" tilt="2"/>
    <!-- azimuth and tilt of terrain affects PVOUT if selfShading attribute of system is true -->
    <pv:geometry xsi:type="pv:GeometryFixedOneAngle" tilt="25" azimuth="180"/>
    <pv:system installedPower="1" installationType="FREE_STANDING" selfShading="true">
      <pv:module type="CSI"></pv:module>
      <pv:inverter></pv:inverter>
      <pv:losses></pv:losses>
      <pv:topology xsi:type="pv:TopologyRow" relativeSpacing="2.5" type="UNPROPORTIONAL2"/>
    </pv:system>
  </site>
  <processing key="GTI TEMP PVOUT" summarization="HOURLY" terrainShading="true">
    <timeZone>GMT+01</timeZone>
    <timestampType>CENTER</timestampType>
  </processing>
</ws:dataDeliveryRequest>
```

Example of tracking PV system with one horizontal axis in north-south direction

```xml
<ws:dataDeliveryRequest dateFrom="2018-02-11" dateTo="2018-02-11"
xmlns="http://geomodel.eu/schema/data/request"
xlns:ws="http://geomodel.eu/schema/ws/data"
xlns:geo="http://geomodel.eu/schema/common/geo"
xlns:pv="http://geomodel.eu/schema/common/pv"
xlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <site id="demo" lat="48.61259" lng="20.827079">
    <geo:terrain elevation="246" azimuth="180" tilt="1"/>
    <!-- azimuth and tilt of terrain has no effect to PVOUT in case of tracking -->
  </site>
</ws:dataDeliveryRequest>
```
Example of tracking PV system with one inclined axis in north-south direction
Example of tracking PV system with one vertical axis

```xml
<ws:dataDeliveryRequest dateFrom="2018-02-11" dateTo="2018-02-11"
 xmlns="http://geomodel.eu/schema/data/request"
 xmlns:ws="http://geomodel.eu/schema/ws/data"
 xmlns:geo="http://geomodel.eu/schema/common/geo"
 xmlns:pv="http://geomodel.eu/schema/common/pv"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <site id="demo" lat="48.61259" lng="20.827079">
    <geo:terrain elevation="246" azimuth="180" tilt="1"/>
    <pv:geometry xsi:type="pv:GeometryOneAxisVertical" tilt="25"
     rotationLimitEast="-180" rotationLimitWest="180" backTracking="true"/>
    <pv:system installedPower="1" installationType="FREE_STANDING"
     selfShading="false"/>
    <pv:module type="CSI"></pv:module>
    <pv:inverter></pv:inverter>
    <pv:losses></pv:losses>
    <pv:topology xsi:type="pv:TopologyColumn" relativeSpacing="2.5"
     type="UNPROPORTIONAL2"/>
  </site>
</ws:dataDeliveryRequest>
```

Example of tracking PV system with two axis

```xml
<ws:dataDeliveryRequest dateFrom="2018-02-11" dateTo="2018-02-11"
 xmlns="http://geomodel.eu/schema/data/request">
</ws:dataDeliveryRequest>
```
Setting "dateFrom" and "dateTo" is required in all cases. User can control time zone for output data in two ways. Either by using "timeZone" element or by the "dateFrom" and "dateTo" attributes of "dataDeliveryRequest" element. The "timeZone" element takes precedence over "dateFrom" and "dateTo" attributes. There is no difference between historical an forecast data in case of XML request. Note, there are no "forecastFromDay" and "forecastToDay" parameters as with FTP data delivery. Instead, user can explicitly set the date period needed to be forecast-ed (max. 10 days ahead).

The examples above do not show all PV system related parameters, just required ones. For all the rest, the API has default values (see table of PV parameters). Example of more advanced setting of PV system is shown below:

```xml
<site id="demo" lat="48.61259" lng="20.827079">
  <geo:terrain elevation="246" azimuth="180" tilt="1"/>
  <pv:geometry xsi:type="pv:GeometryTwoAxisAstronomical"
    rotationLimitEast="-180" rotationLimitWest="180"
    tiltLimitMin="10" tiltLimitMax="60"
    backTracking="true"/>
  <pv:system installedPower="1" installationType="FREE_STANDING"
    selfShading="false">
    <pv:module type="CSI"></pv:module>
    <pv:inverter></pv:inverter>
    <pv:losses></pv:losses>
    <pv:topology xsi:type="pv:TopologyColumn" relativeSpacing="1.5"
      type="UNPROPORTIONAL2"/>
  </pv:system>
</site>

<processing key="GTI PVOUT" summarization="DAILY" terrainShading="true">
  <timeZone>GMT+01</timeZone>
  <timestampType>CENTER</timestampType>
</processing>
</ws:dataDeliveryRequest>
```
Response Examples

FTP data delivery response

Responses from this service are standard Solargis CSV format files with header, metadata and data sections. Files are suitable for automated processing. Examples of CSV response files:

- hourly time-series: Solargis_TS_hourly_sample.csv,
- monthly time-series: Solargis_TS_monthly_sample.csv,
- monthly long-term averages: SolarGIS_LTA_monthly_sample.csv

WS XML response example

Content of metadata element matches the same metadata used with Solargis CSV format file.

```xml
<?xml version="1.0"?>
    <site id="demo" lat="48.61259" lng="20.827079">
    <metadata>#15 MINUTE VALUES OF SOLAR RADIATION AND METEOROLOGICAL PARAMETERS AND PV OUTPUT
    #
    #Issued: 2017-09-03 12:40
    #
    #Latitude: 48.612590
    #Longitude: 20.827079
    #Elevation: 7.0 m a.s.l.
    #http://solargis.info/imaps/#t1=Google:satellite&loc=48.612590,20.827079&amp;z=14
    #
    #Output from the climate database Solargis v2.1.13
    #
    #Solar radiation data
    #Description: data calculated from Meteosat MSG satellite data ((c) 2017 EUMETSAT) and from atmospheric data ((c) 2017 ECMWF and NOAA) by Solargis method
    #Summarization type: instantaneous
```
# Meteorological data
Description: spatially disaggregated from CFSR, CFSv2 and GFS ((c) 2017 NOAA) by Solargis method
# Summarization type: interpolated to 15 min
# Summarization period: 28/04/2014 - 28/04/2014
# Spatial resolution: temperature 1 km, other meteorological parameters 33 km to 55 km

# Service provider: Solargis s.r.o., M. Marecka 3, Bratislava, Slovakia
# Company ID: 45 354 766, VAT Number: SK2022962766
# Registration: Business register, District Court Bratislava I, Section Sro, File 62765/B
# http://solargis.com, contact@solargis.com

# Disclaimer:
Considering the nature of climate fluctuations, interannual and long-term changes, as well as the uncertainty of measurements and calculations, Solargis s.r.o. cannot take full guarantee of the accuracy of estimates. The maximum possible has been done for the assessment of climate conditions based on the best available data, software and knowledge. Solargis s.r.o. shall not be liable for any direct, incidental, consequential, indirect or punitive damages arising or alleged to have arisen out of use of the provided data. Solargis is a trade mark of Solargis s.r.o.

# Copyright (c) 2017 Solargis s.r.o.

# Columns:
# Date - Date of measurement, format DD.MM.YYYY
# Time - Time of measurement, time reference UTC+2, time step 15 min, time format HH:MM
# GHI - Global horizontal irradiance [W/m²], no data value -9
# GTI - Global tilted irradiance [W/m²] (fixed inclination: 25 deg. azimuth: 180 deg.), no data value -9
# TEMP - Air temperature at 2 m [°C]
# WS - Wind speed at 10 m [m/s]
# WD - Wind direction [deg.]
# AP - Atmospheric pressure [hPa]
# RH - Relative humidity [%]
# PVOUT - PV output [kW]

# Data:
Date;Time;GHI;GTI;TEMP;WS;WD;AP;RH;PVOUT</metadata>
<columns>GHI GTI TEMP WS WD AP RH PVOUT</columns>
....
<row dateTime="2014-04-28T05:11:00.000+02:00" values="0.0 0.0 10.2 1.9 10.0 1005.4 81.2 0.0"/>
<row dateTime="2014-04-28T05:26:00.000+02:00" values="5.0 5.0 10.4 1.9 10.0 1005.4 80.3 0.0"/>
<row dateTime="2014-04-28T05:41:00.000+02:00" values="12.0 11.0 10.6 1.9 10.0 1005.3 79.5 2.85"/>
<row dateTime="2014-04-28T05:56:00.000+02:00" values="25.0 25.0 10.9 2.2 10.0 1005.3 78.7 11.936"/>
<row dateTime="2014-04-28T06:11:00.000+02:00" values="38.0 37.0 11.2 2.2 10.0 1005.2 77.9 21.25"/>
<row dateTime="2014-04-28T06:26:00.000+02:00" values="102.0 70.0 11.9 2.2 10.0 1005.3 79.5 2.85"/>
<row dateTime="2014-04-28T06:41:00.000+02:00" values="144.0 112.0 12.7 2.2 10.0 1005.0 75.0 68.925"/>
<row dateTime="2014-04-28T06:56:00.000+02:00" values="183.0 156.0 13.4 2.1 9.0 1004.9 73.5 106.197"/>
<row dateTime="2014-04-28T07:11:00.000+02:00" values="223.0 202.0 14.2 2.1 9.0 1004.8 72.1 150.239"/>
<row dateTime="2014-04-28T07:26:00.000+02:00" values="265.0 252.0 14.8 2.1 9.0 1004.7 71.2 197.703"/>
<row dateTime="2014-04-28T07:41:00.000+02:00" values="308.0 304.0 15.3 2.1 9.0 1004.7 70.3 248.14"/>
<row dateTime="2014-04-28T07:56:00.000+02:00" values="354.0 359.0 15.8 1.7 8.0 1004.6 69.4 301.096"/>
<row dateTime="2014-04-28T08:11:00.000+02:00" values="403.0 420.0 16.4 1.7 8.0 1004.6 68.4 357.374"/>
<row dateTime="2014-04-28T08:26:00.000+02:00" values="450.0 479.0 16.9 1.7 8.0 1004.7 66.0 411.019"/>
<row dateTime="2014-04-28T08:41:00.000+02:00" values="497.0 544.0 17.5 1.7 8.0 1004.8 63.5 468.12"/>
<row dateTime="2014-04-28T08:56:00.000+02:00" values="539.0 599.0 18.0 1.8 26.0 1004.8 61.0 515.073"/>
...
<row dateTime="2014-04-28T23:41:00.000+02:00" values="0.0 0.0 14.1 2.9 353.0 1004.8 93.3 0.0"/>
<row dateTime="2014-04-28T23:56:00.000+02:00" values="0.0 0.0 14.0 2.8 354.0 1004.8 93.3 0.0"/>
</site>
</dataDeliveryResponse>