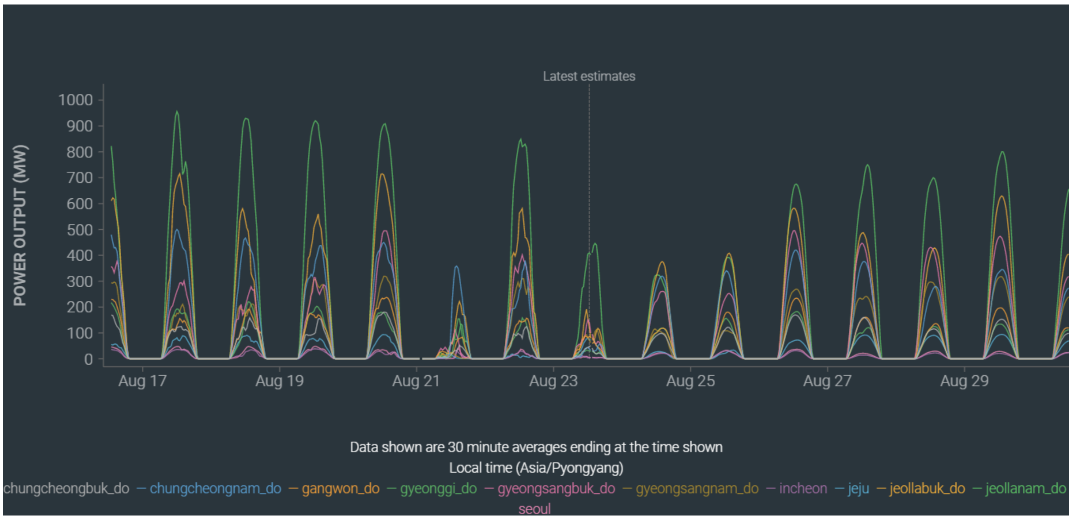
Grid Aggregations

Product guide and specifications

Last updated: 18th May, 2022



Solcast Grid Aggregations for regions of South Korea, as seen in the Solcast API Toolkit web portal.

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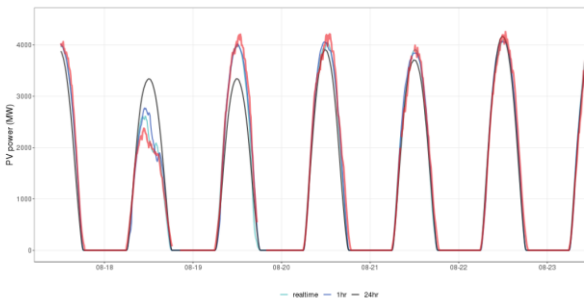
1. SUMMARY AND USE CASES

Solcast's Grid Aggregations estimate the aggregate power output from hundreds of thousands of distributed PV systems. Real-time satellite imagery, multiple weather models, and PV modelling are combined with information about the spatial distribution and installed capacities of PV on the network. Estimates are delivered in both total power (MW), and capacity factor (% of total installed capacity).

Power output from all constituent PV systems is grouped (aggregated) according to a given market, load zone or other geographic region, or according to physical or virtual power asset (e.g. whole transmission or distribution network, region, substation, feeder etc.).

Solcast provides operational Grid Aggregations data to TSOs and Utilities globally, including AEMO NEM, AEMO WEM, Taipower, Duke Energy, Korea Electric Power Corporation, Power and Water Corporation, SnowyHydro, Ausnet, Alinta Energy, Energy Australia, and others.

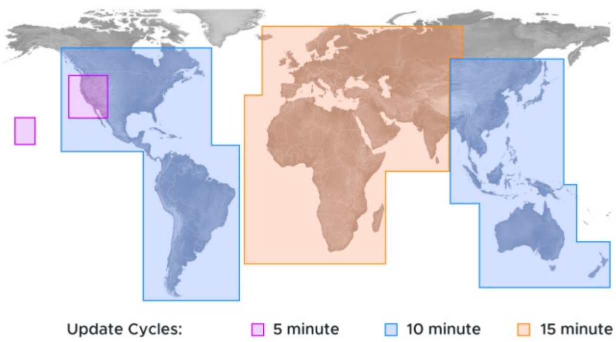
Installed capacity information is updated periodically using customer or market data to ensure changing geographical distribution of PV is captured. Between updates, capacity is incremented daily based on historic trends. Custom aggregations of any size can be set-up based on installed capacity data by sites, districts, or shapefiles.



Comparison by Taipower of their inverter-based estimated actual Taiwan-total solar (red) compared to Solcast Grid Aggregation (estimated actuals in light blue, 1-hr ahead forecasts in dark blue, day-ahead forecasts in black), 18-23 August 2021.

2. DATA PRODUCT SPECIFICATIONS

Attribute	Value
Product purpose	Estimating the aggregate power output from a set/fleet of PV systems (e.g. all systems in a given region, or a set of systems connected to a physical or virtual power asset), without the need for any live power measurements
Common customer use cases	• Manage reserves and avoid outages • Improve load/demand forecasts • Manage solar-related network congestion and voltage changes • Trade wholesale power • Manage VPPs and microgrids
Parameters	**Forecast (0 to + 14 days)** • PV Power output (AC) (MW) (10th, 50th, & 90th percentile) • PV Power output (AC) (%) (10th, 50th, & 90th percentile) **Estimated Actuals (-7 days to 0) and History (January 2007 to Present)** • PV Power output (AC) (MW) • PV Power output (AC) (%)
Coverage	All continents, excluding polar regions
Time resolution	5, 10, 15 or 30 minutes (period means, labelled with period-end time)
Spatial resolution	1-2km



Update frequency for Grid Aggregations, which is every time Solcast gets new imager data from each of five geostationary satellites.

3. DATA ACCESS

3.1. Solcast API Toolkit

The Solcast API Toolkit is a website for registered users to explore and download data, to assist software developers to build their API integrations, and for subscription management. In the toolkit, engineers will typically download data via CSV files to compare to measurements, and review their product access. Software developers will typically build up API calls using the web interface, and access API documentation.

3.2. Solcast API

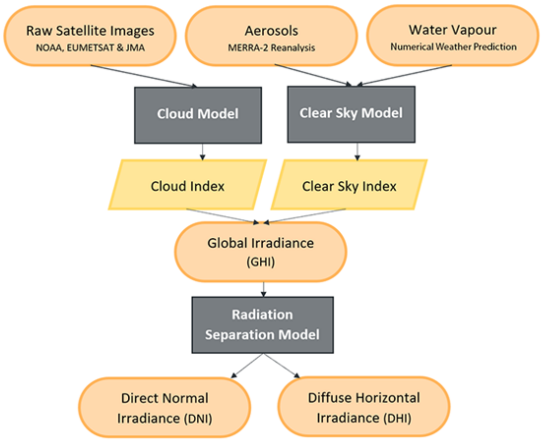
Users integrate programmatically with the Solcast API, to allow their systems to automatically retrieve the latest data from Solcast on their desired schedule. Some integrations with the Solcast API have been completed by software developers in less than one hour. Useful tools for scoping or building integrations include the Solcast API Toolkit, API documentation, and the Solcast Github. A range of authentication options are suported.

4. INPUTS AND ALGORITHMS

4.1. Satellite cloud and irradiance measurement

The Solcast method for estimating solar irradiance from geostationary weather satellites consists of three major steps.

1. Cloud index: The detection of the presence of cloud cover and the characterisation of that cloud cover in terms of its impact on global solar irradiance to create a cloud index. This step includes satellite quality control, handling of snow and water-glint, and also forward projection of cloud index for four hours ahead (nowcasting).
2. Clear-sky model: Modelling the available solar irradiance under clear skies, including treatment of aerosols (dust, salt, smoke, etc.) and water content to create a clear-sky index
3. Radiation modelling: Algorithmic estimates of the Global solar irradiance (GHI), and its separation into direct (DNI) and diffuse (DHI) components.



Schematic diagram of Solcast's satellite-based solar irradiance estimation

Solcast's satellite irradiance measurements have been validated against surface irradiance measurements at a wide range of locations globally, by Solcast and by various researchers. More details on validation and accuracy can be found here: https://solcast.com/historical-and-tmy/validation-and-accuracy/

For behind-the-meter (BTM) PV modelling, transposition to plane of array from diffuse and direct components follows the transposition model from Reindl et al.. (1990) "Diffuse fraction correlations." Solar energy 45(1).

4.2. PV installations and clusters

In the Solcast Grid Aggregations system, PV installations are modelled as a set of clusters. Each cluster is positioned in its town or suburb centre point based on gazetteer location data, this location is associated with the 1-2km resolution grid on which Solcast satellite irradiance measurements operate. The Solcast Rooftop PV model (described in the following section) is run at each cluster, producing a power output estimate. Grid Aggregation data from Solcast is simply the sum of the modelled output (in MW) across all clusters in the aggregation (in the case of the power parameter). For the percentage (%) parameter, across the aggregation (e.g. region) the sum of clusters are normalised by the sum of installed capacity.

Installed capacity information is updated periodically using customer or market data to ensure changing geographical distribution of PV is captured. Between updates, capacity is incremented daily based on historic trends. Custom aggregations of any size can be set-up based on installed capacity data by sites, districts, or shapefiles. Two illustrative examples are given here, for the United Kingdom (UK) and eastern Australia.

In the UK, Grid Aggregations are defined for each of 380 Grid Supply Points (GSPs), plus a system total (sum of all GSPs). Shapefiles for each GSP region's boundary area from National Grid were processed by Solcast. Installed PV capacity totals behind each GSP from Sheffield University PVLive are processed semi-annually, with extrapolative installations increases between updates. Post code level installation data is not available, so the capacity is uniformly spread amongst the towns and suburbs of the GSP. A cluster exists for each town/suburb.

In eastern Australia, Grid Aggregations are defined at state/region level of the National Electricity Market (NEM). Installed capacity data at postcode level (for approx. 2,000 postcodes) is taken semi-annually in CSV format from the Clean Energy Regulator (CER), for Small Generation Units (SGU), which are those under 100kW. This capacity data is incremented forwards at its recent rate of increase to correct for a reporting lag. Larger PV systems over 100kW are added at postcode level, based on data from the Australian Photovoltaic Institute (APVI), and registered generators are excluded. Postcode installed capacity is then uniformly spread amongst the towns and suburbs of the postcode (typical postcodes contain 1 to 5 towns/suburbs). A cluster is defined for each town/suburb. Extrapolative installations increases are applied between updates at a uniform rate nationally. In Australia, the installed capacity data is module (DC), however the Solcast Rooftop PV model loss factors (see below section) have been calibrated to inverter output (AC) data from many thousands of systems.

4.3. Solcast Rooftop PV model

The Solcast Rooftop PV model is designed to estimate production from a fleet of PV systems where system specifications, shading and other losses are poorly known at individual system level, and where system output measurement data is incomplete and/or not available in real time. The model can also be used to estimate system geometry and losses from measurement data. The original version of the model is described in Killinger et al., 2016 *("Projection of power generation between differently-oriented PV systems." Solar Energy 136: 153-165.)*. During 2016 to 2019 the model was refined at the Australian National University in a $2.6M ARENA industry research project, and thereafter was licenced to Solcast. The model is now in operational use globally by a range of TSOs, Utilities and load forecasters in Australia, Taiwan, Korea, US, UK and Germany. Each deployment of the model has included local calibration and validation in concert with users.

The model is empirical, consisting of a fitted quadratic function of the plane-of-array irradiance and air temperature (and their interactions), and the loss factor. The quadratic coefficients and the loss factor are fitted to measured inverter output (AC) data from a range of PV systems targeted at performance for specific countries.

For Grid Aggregations, the model is run at each town/suburb cluster, using Solcast's irradiance (transposed to plane of array) and air temperature data as the fully dynamic inputs. Static model inputs include module tilt, module azimuth, and a nondimensional bulk loss factor which accounts for shading, degradation, and other losses. These static inputs were first determined for Australia during the 2016 to 2019 ARENA project. The optimal azimuths and tilts for Australia were determined using a combination of inverter output data and Lidar studies from the project. Azimuths and tilts for other countries were developed outside the project, particularly for higher latitudes. The loss factors were first estimated using inverter output (AC) data from the project, focussed on Australia, and have since been reviewed and calibrated based on data from Australia and other countries.

The model output is in terms of inverter output (AC) power. In some countries, including Australia, installed capacity is available in terms of module (DC) capacity. In such cases, the model loss factors are calibrated using inverter output (AC) power measurements. This approach does not invalidate the shape of model's power curves so long as very high inverter loading ratios (ILRs) (e.g. >1.25) are not so dominant amongst the fleet so as to overwhelm shading, soiling and other loss factors that drive the shape of the power curve.