

Solar & Photovoltaic products

For the single solar power plant IDEAM Srl provides on site forecasts of:



- **common meteorological fields** (e.g. temperature, humidity, precipitation, wind, pressure, ...)
- total **irradiance** values, if requested with detailed components:
 - direct and diffuse irradiance
 - near-infrared, visible and ultraviolet irradiance
 - incident radiation on a tilted solar panel
 - incident radiation on a tilted solar tracker

Characteristics of day ahead solar radiation forecast

- hourly or sub-hourly time steps
- from 24-48-72 hours ahead up to 2 weeks
- bi-daily updates (or more) with mobile or fixed temporal horizons
- confidence intervals such as 10 and 90 percentiles for irradiance and other fields

Specifically for solar irradiance, IDEAM Srl has developed a **proprietary algorithm** (MOSRH) that recalculates cloud cover and weighs appropriately the direct and diffuse components of radiation. The resulting forecasts have significantly smaller errors in situations with only partial cloud cover.

For grid operators and TSO's IDEAM Srl can integrate the meteorological day ahead forecast with **power production forecasts** for grid stability, risk analysis and decision making purposes. The fundamentals parameters included in the analysis are:

- estimated instantaneous power and energy production
- hourly energy production forecasts
- daily estimated energy production forecasts
- mean seasonal and annual production values of the solar field
- ramp rate

Statistical techniques and **Artificial Neural Networks** are used to improve the forecast accuracy. If radiation and power measurements from the plant are available, the correction algorithms can be trained using the site specific data, in order to offer the best forecast performance. Otherwise, algorithms are trained using satellite data and data from other sites, and so an improvement from the basic model forecast is possible in every location, even without site specific data.

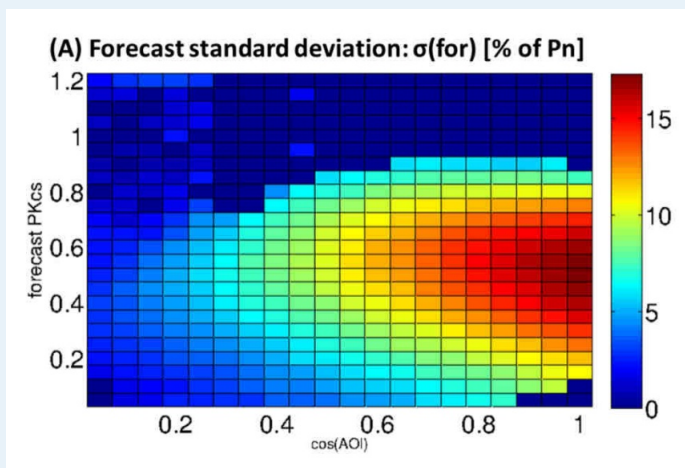
Other solar radiation related products

IDEAM Srl with its partners also provides **regional forecasts**. Specific innovative upscaling techniques have been developed providing detailed and accurate results with a sensible minimization of forecast errors on a regional scale.

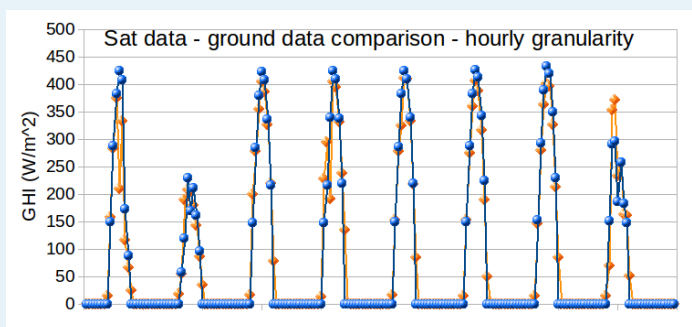
IDEAM Srl can also provide climatic estimates of solar radiation and power production for a single plant or on a regional scale through high resolution satellite data.

We also provide **intra-day** solar radiation and power production forecasts. IDEAM Srl and its partners make use of satellite data combined with Artificial Neural Networks and high resolution Numerical Weather Prediction models to produce detailed data beneficial to the trading energy market, for hedging purposes and for unit commitment.

Nearly real-time satellite data can also be provided to the plants which do not have an automated radiation measurement system. Plus, IDEAM Srl can also provide the check and the real-time monitoring of the expected energy (based on in-situ radiation measurements or satellite data) and the actually produced energy, in order to promptly identify a malfunction in the plant.



Predictability as a function of cloud cover and angle of incidence of solar radiation (predicted standard deviation of power production).



Comparison between ground based solar radiation measurement and satellite derived solar radiation

Greater details on our work can be found on peer reviewed journals and conference posters:

M. Pierro et al., **Multi-Model Ensemble for day ahead prediction of photovoltaic power generation**, Solar Energy, Volume 134, September 2016, Pages 132-146, ISSN 0038-092X, <http://dx.doi.org/10.1016/j.solener.2016.04.040>.
<http://www.sciencedirect.com/science/article/pii/S0038092X16300731>

M. Pierro et al., **Model output statistics cascade to improve day ahead solar irradiance forecast**, Solar Energy, Volume 117, July 2015, Pages 99-113, ISSN 0038-092X, <http://dx.doi.org/10.1016/j.solener.2015.04.033>.
<http://www.sciencedirect.com/science/article/pii/S0038092X15002212>

M. Pierro et al., **Deterministic and Stochastic Approaches for Day-Ahead Solar Power Forecasting**, Solar Energy Eng, Volume 139, November 2016, Paper No: SOL-16-1066; doi: 10.1115/1.4034823
<http://solarenergyengineering.asmedigitalcollection.asme.org/article.aspx?articleid=2565041>

A. Perotto et al., **Estimation and forecast of PV generation on a regional scale using satellite data and high resolution WRF output combined with machine learning techniques**, EMS 2016 Conference oral presentation, <http://meetingorganizer.copernicus.org/EMS2016/EMS2016-131.pdf>

E. Maggioni et al., **Use of post processing techniques and satellite irradiance data to forecast short wave radiation**, EMS 2016 Conference oral presentation, <http://meetingorganizer.copernicus.org/EMS2016/EMS2016-302.pdf>

E. Maggioni et al., **A combination of post-processing techniques and satellite irradiance data for solar short wave radiation forecast**, Poster presentation at ICEM 2017, http://www.wemcouncil.org/ICEMs/ICEM2017_PRES/ICEM2017_Poster_44_Maggioni.pdf

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