Researchers use artificial neural networks to accurately predict short-term solar irradiance

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Researchers from Universidad Politécnica de Madrid and Nicaraguan Institute of Territorial Studies have developed a technique to make accurate predictions of short-term global solar irradiance (GSI) using artificial neural networks (ANN).

The study introduces a new methodology based on observations made in parallel by neighboring sensors and values for multiple variables (temperature, humidity, pressure, wind and other estimates). Experiments were carried out using artificial neural networks with different architectures and parameters in order to determine which of these generated the best predictions for the various time frames studied.

Results allowed researchers to develop models that predict short-term GSI with error rates less than 20 percent. This could be useful for companies that manage both photovoltaic solar energy plants and solar thermal plants to estimate the production capacity of their installations.

A big challenge of modern society is the efficient use of natural resources and environmental impact minimization due to the increased demand and consumption of energy. Thus, renewable energy, especially solar energy, has become a long-term solution with greater potential less impact.

In particular, photovoltaic solar energy can be connected to transport and distribution networks, but it requires that supply and demand for energy are adequately managed. Therefore, the prediction of GSI within a few

hours and with a minimal error rate is required to estimate the expected energy production.

Various methods are used to estimate global solar irradiance including numerical predictions based on locations and time complemented with diverse correction models, methods based on satellite images that record the cloudiness and estimate the losses in the ideal model. Other models are based on time series or artificial intelligence. Each method has advantages and disadvantages. For instance, the satellite-based prediction has proved to be universal since it provides estimations for large geographical areas. However, it depends upon the availability of such images for certain regions of the planet and the pre-processing of the images, among other things.

In the case of predictions based on numerical methods, the dynamics of the atmosphere are estimated in a realistic way through the assimilation of data. However, they guarantee the general stability of the forecast on local meteorological events. So far, the methods based on artificial intelligence only use the endogenous input variables associated with the site of the prediction.

The study carried out by UPM and INETER researchers focused on the hypothesis that it was possible to improve the short-term forecast of global solar irradiance through the generation of models based on artificial neural networks using up to 900 inputs that show the evolution of variables in a nearby spatial–temporal context.

The research results show the capacity of the developed models based on artificial neural networks to identify both linear and non-linear relationships among the variables. The authors write, "This has allowed us to predict the short-term global solar irradiance with a significant forecast skill and normalized root mean square error less than 20 percent compared to the rest of models based on artificial neural networks.

Additionally, the developed methods have allowed us to identify a relationship among the predictions via a sliding window of time of one to three hours and four to six hours regarding the reference distance of 55 km. This can lead to a research line to use diverse reference distances for different prediction slider windows."

These results have applications for companies that manage both photovoltaic solar energy plants and solar thermal plants to estimate the production capacity of their installations as current legislation requires, and the operators of national electrical systems. Both fields can use these methods to achieve their goals more efficiently, maximize return on investment and adjust the curve of demand and supply.

More information: Federico-Vladimir Gutierrez-Corea et al. Forecasting short-term solar irradiance based on artificial neural networks and data from neighboring meteorological stations, *Solar Energy* (2016). DOI: 10.1016/j.solener.2016.04.020

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