Improved forecasting of sunlight could help increase solar energy generation

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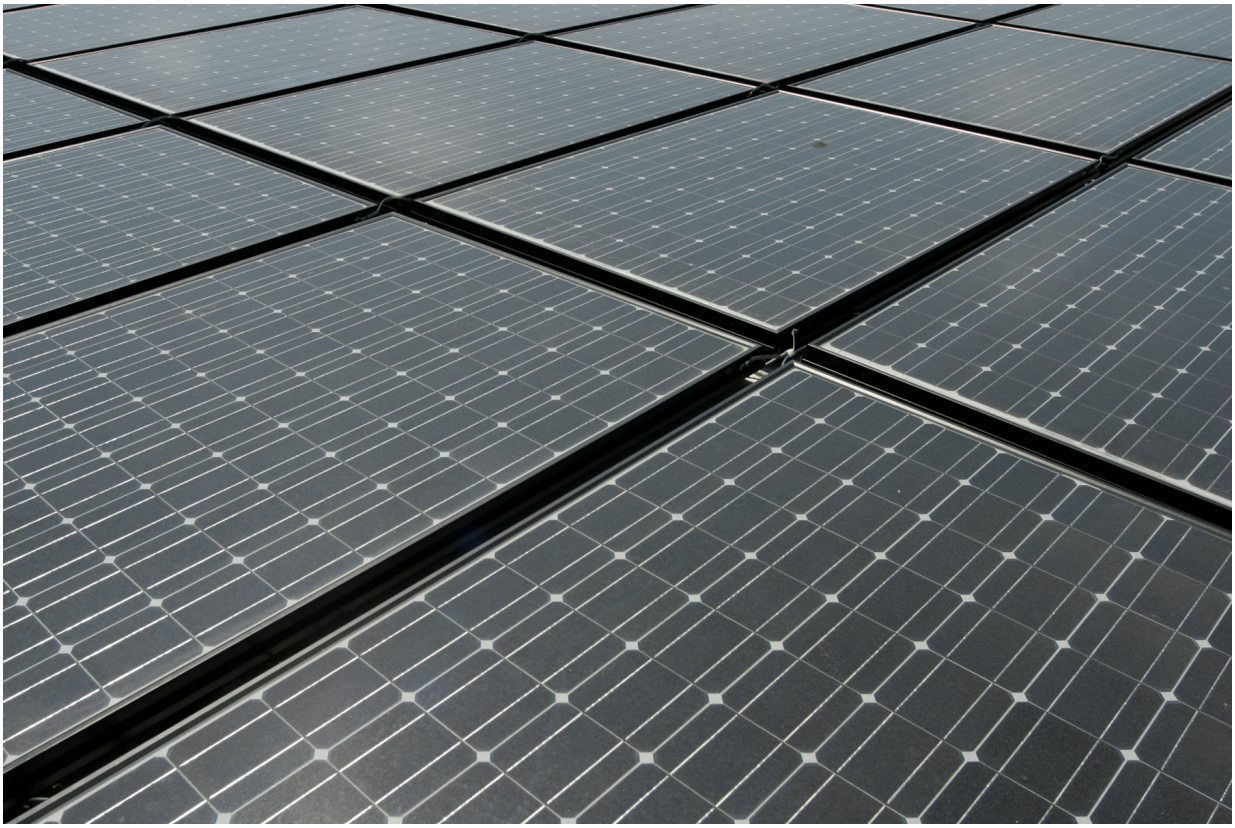

The Sun is becoming an increasingly important source of clean electricity. Accurate sunlight forecasts being developed by A*STAR researchers could greatly improve the performance of solar energy

plants, making it a viable alternative to carbon-based sources of power.

A photovoltaic power plant can cover up to 50 square kilometers of the Earth's surface and can generate up to a billion Watts of electricity. This capacity depends on the amount of sunlight at that location, so the ability to predict solar irradiance is crucial for knowing how much power the plant will contribute to the grid on any particular day.

"Forecasting is a key step in integrating renewable energy into the electricity grid," says Dazhi Yang from A*STAR's Singapore Institute of Manufacturing Technology (SIMTech). "It is an emerging subject that requires a wide spectrum of cross-disciplinary knowledge, such as statistics, data science, or machine learning."

Yang, together with Hao Quan from the A*STAR Experimental Power Grid Centre and colleagues from the University of Tennessee at Chattanooga and the National University of Singapore, has developed a numerical approach to weather prediction that efficiently combines multiple datasets to improve the accuracy of solar irradiation forecasts.

Hourly changes in the atmosphere, annual changes in the distance between Earth and the Sun, or 10-yearly changes in the Sun's internal cycles can all alter the amount of sunlight that reaches the Earth's surface. These changes occur on very different time scales, and so conventional forecasting methods model variability at different timescales separately, which makes computer processing easier. However, these methods rely on a simple addition of forecasts, with no weighting that makes more use of better forecast sub-series. Moreover, the forecasts they generate are only accurate on the timescale of the original series.

Yang and the team developed a framework that reconciles the different timescales by forming a temporal hierarchy that aggregates forecasts

obtained at different timescales, such as high-frequency, hourly data and low-frequency, daily data. "Temporal reconciliation is a type of ensemble forecasting model that forecasts the next day's solar generation many times, separately, using data of different temporal granularities, hourly, two-hourly, and daily," explains Yang. "These different forecasts are then combined optimally through statistical models to produce a final forecast."

The researchers tested their numerical weather prediction method using data from 318 photovoltaic power plant sites in California over a year. Their temporal reconciliation method was shown to significantly outperform other numerical day-ahead forecasts.

More information: Dazhi Yang et al. Reconciling solar forecasts: Temporal hierarchy, *Solar Energy* (2017). DOI: 10.1016/j.solener.2017.09.055

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