New model better predicts solar cell output power in all weather

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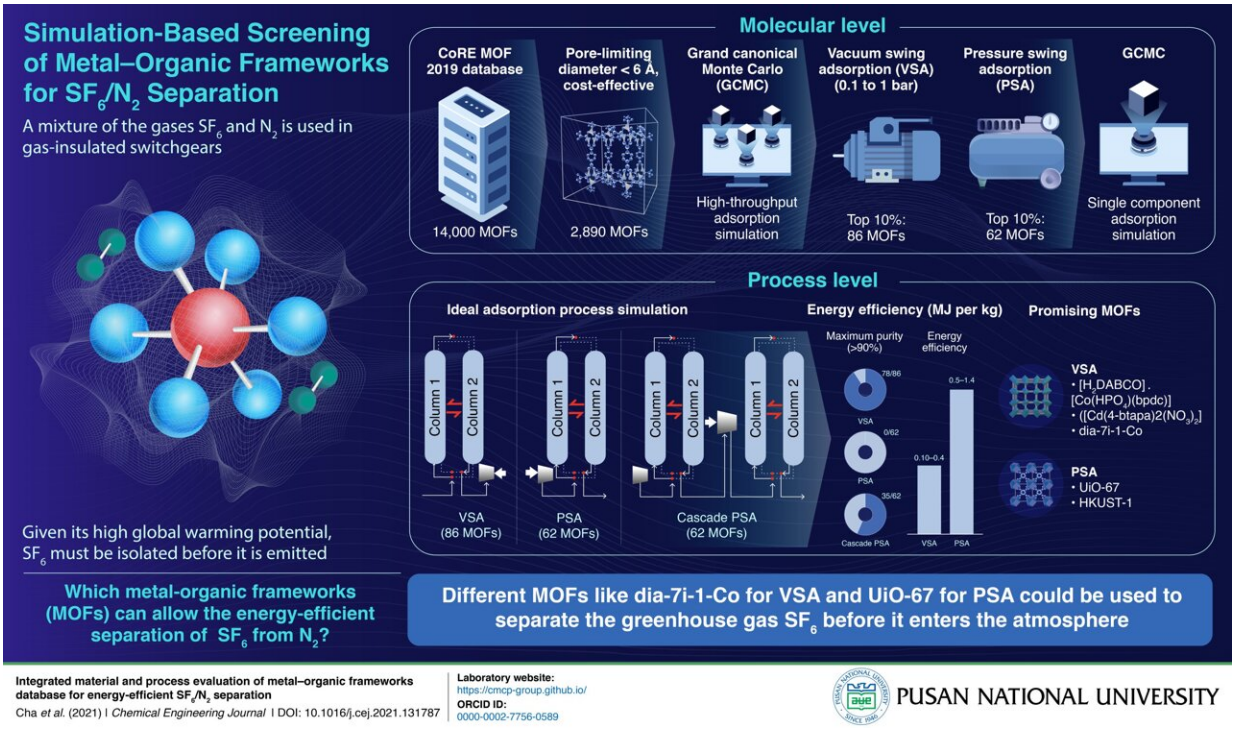

Accurately predicting the output power of solar cells over time is essential for long-term planning and energy management, and mathematical models have to consider multiple external and internal variables. Credit: Sebastian Ganso on Pixabay

The world is in dire need of a large-scale transition away from fossil fuels and towards sustainable energy sources to prevent an environmental

crisis. Thanks to recent advances in various scientific and engineering disciplines, solar cells have become a rising star in the field of renewable energy, reaching operational costs and performance close to those of the conventional electric grid.

However, in spite of the remarkable strides made in photovoltaics (PV) technology, the performance of the solar cell itself is only one part of the equation. For solar power projects to be funded and rolled out, decisionmakers need to know ahead of time how much energy the installed PV systems will provide, both for technical and administrative reasons. Of course, since solar cells are devices that harvest solar radiation, their solar-to-electricity conversion performance is tied to a variety of external factors, such as cloudiness, temperature, and humidity. So, forecasting how much power a PV system will output over a given amount of time is not a straightforward task.

But in a recent study published in *Solar Energy*, a team of researchers led by Professor Shyam Singh Chandel from the Centre of Excellence in Energy Science and Technology at Shoolini University, India, in collaboration with the Centre for Energy and Environmental Engineering, National Institute of Technology, Hamirpur, Himachal Pradesh, India, developed an innovative model for predicting the output of solar cells, which is much more accurate than existing models, and can help policymakers make that next giant leap in solar power installations!

Their approach is based on the well-established single-diode model, which offers sufficient accuracy without requiring too much computational complexity. The developed model can take into account three, four, or five different solar cell parameters depending on the level of precision needed. Most importantly, it considers the degradation of the solar cell components over time—something which previous models did not factor in.

To test the accuracy of their model under real conditions, the researchers first determined the values of the model parameters in a controlled experimental setup using a Class-A Sun Simulator over a test PV module. Once the parameters were determined and the predictions made, they studied a solar PV module and then 1 kWp PV system installed on the rooftop of the Centre for Energy and Environmental Engineering at the National Institute of Technology, Hamirpur. From there, the researchers gathered data to validate the predictions of their model.

The results are promising, as the predictions of the proposed model are more accurate than those of previous ones. Additionally, the researchers noted the number of solar parameters to include in the model so as to produce the best predictions with varied temperature and solar radiation intensities (in other words, with the time of day, season, and weather conditions). These insights will be helpful in future studies on solar energy, as Prof. Chandel explains that their "model could be useful for developing PV power forecasting software capable of predicting daily, monthly, and yearly solar power generation, which is a crucial parameter for calculating the electricity supply and demand distribution, as well as for marketing PV systems."

According to the researchers, their work could ultimately help improve the efficiency of solar cells and PV technology in large solar power plants, which are being installed both worldwide and locally under India's National Solar Mission. "Being able to predict the output power of different PV technologies will help interested parties decide for the best option available in the market for a particular location," explains Prof. Chandel, "Based on the foreseen energy generation and the selected technology, one can estimate the total expenditure and payback period for a given project."

More information: Prashant Malik et al, A power prediction model

and its validation for a roof top photovoltaic power plant considering module degradation, *Solar Energy* (2021). DOI: 10.1016/j.solener.2021.06.015

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