TACKLING THE ENERGY STORAGE PROBLEM FOR GRID-SCALE SOLAR POWER

Power from the electric grid that is generated by solar panels is already less expensive in many areas than that generated by fossil fuels. But as solar power facilities expand, the clean energy movement faces a difficult problem: while such facilities can generate more power than is needed in the middle of the day when the sun is shining, they can't power the electrical grid in the evening or overnight. Storing grid-scale power in batteries would be extremely expensive. But what if solar energy could be stored cheaply as heat, and the heat converted to electricity when needed? That potential was among the reasons why the U.S. Department of Energy's Office of Science funded an Energy Frontier Research Center (EFRC), the Solid-State Solar-Thermal Energy Conversion Center.

About the image: Solar power capacity is growing rapidly, and so are installations of solar photovoltaic panels such as the industrial-scale system shown here. Without some means of energy storage, however, solar cannot replace all of the fossil fueled power stations. *(Jenson / Shutterstock)*

The Center focused its research on improving novel thermo-photovoltaic cells that can convert heat radiation into electricity—much as a conventional solar cell converts solar radiation into electricity. Thermo-photovoltaic cells are similar to thin-film photovoltaic cells used to power satellites and drones, and in principle their efficiency can be higher than that of conventional power generation equipment such as coal- or gas-fired power plants. The researchers also developed a prototype device that could absorb and store the sun's heat and re-emit it as photons in a narrow band of wavelengths appropriate for thermo-photovoltaic cells—in effect, a thermo-photovoltaic converter that turns heat into electricity. That required precisely etching the surface of materials such as tungsten, working at extremely high temperatures. The resulting prototype converter attracted a lot of attention. Additional research focused on mating it with thermo-photovoltaic cells.

David Bierman was one of the graduate students working on the EFRC project at the Massachusetts Institute of Technology. He was inspired by the research, but he also wanted to do something more hands-on that could help mitigate climate change—such as develop a practical energy storage system. So he linked up with other like-minded young engineers, founded a company now called Antora Energy, and gained the support of Cyclotron Road, an incubator for technology-based enterprises. The company is now working with DOE's National Renewable Energy Laboratory (NREL) to commercialize a low-cost thermal energy storage system for grid-scale solar power.

In the years since the EFRC Center work began, however, the cost of solar cells has declined precipitously and their efficiency has improved. So capturing the sun's energy as heat turned out not to be as important as anticipated. The Antora team believes that it's more practical to just convert excess electricity from the grid into heat, then turn it back into electric power at night or as needed. In the storage system the company envisions, that excess electric power would be directed through blocks of carbon, heating them up to extremely high temperatures. Effective insulation traps the heat until it's needed. Then the radiation from the hot carbon blocks is directed to advanced thermo-photovoltaic cells that generate power for the grid. Antora's prototype systems are already as efficient as most conventional power generation processes (such as gas turbines), and the company believes it can reach 50 percent efficiency. Such an energy storage system could, in principle, operate at far lower costs—perhaps 30 times lower—than storing electrical power in conventional batteries.

Top: The Tarraleah Power Station is a pumped-storage hydroelectric power station in Tasmania, Australia. Pumped-hydro is one of the few current grid-scale means of storing electric power. *(Ikonya / Shutterstock)*

Bottom: Solar-powered charging station for electric cars that also shades the cars from the sun's heat. *(Jenson / Shutterstock)*

As renewable energy production—such as that from solar panels and wind turbines—expands, finding an effective grid-scale energy storage system becomes increasingly critical. Pumped-hydro storage—in which water is pumped uphill during the day and then flowed downhill through turbines to generate power at night—can't be built everywhere that solar power will be deployed. The storage system Antora hopes to create could be. And even though that system will differ from what the EFRC effort envisioned, Bierman credits the Center for the inspiration that led him to form the company.

Solid-State Solar-Thermal Energy Conversion Center (S^3TEC)
Winner — Technologies and Tools Award
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