

# Researcher suggests storing solar energy underground for a cloudy day

November 24 2015, by Dan Stober

---



A new study shows that wind, water and solar generators can theoretically result in a reliable, affordable national grid when the generators are combined with inexpensive storage.

Over the last few years, Mark Jacobson, a Stanford professor of civil and environmental engineering, and his colleague, Mark Delucchi of the

University of California, Berkeley, have produced a series of plans, based on huge amounts of data churned through computer models, showing how each state in America could shift from fossil fuel to entirely renewable energy.

In a new study published today in *Proceedings of the National Academy of Sciences*, they use the data from those single-state calculations of the number of wind, water and solar generators potentially needed in each state to show that these installations can theoretically result in a reliable, affordable national grid when the generators are combined with inexpensive storage and "demand response" – a program in which utilities give customers incentives to control times of peak demand.

## **An underground effort**

The proposed system relies on the ability to store and retrieve heat, cold and [electricity](#) in order to meet demand at all times.

Summer heat gathered in rooftop solar collectors could be stored in soil or rocks and used for heating homes in winter. Excess or low-cost electricity could be used to make ice, which would be used for later cooling when the price of electricity is high.

Excess electricity could also be used to make more electricity, by supplementing the energy-producing mechanisms that drive concentrated [solar power plants](#) and pumped hydroelectric facilities. Utilities would also provide incentives to reduce energy use during times of peak demand.

In Jacobson's plan, hydrogen would also be used as a storage medium; during low-demand hours, excess electricity would be used to create hydrogen, which could be stored in fuel cells and used to power some vehicles.

Jacobson's new model foresees, and is dependent upon, an all-electric country, with virtually everything running 100 percent on electricity: cars, trains, buses, industry, heating and cooling, and with the electricity originating from wind, water and sunlight.

There would be no need for coal, [natural gas](#), biofuels, nuclear power or enormous battery farms for storing electricity. Such a world, which would be 100 percent clean by 2050, can result in a stable grid, he said.

Jacobson's previous studies have drawn wide attention, but critics have argued that a national electric grid without power plants powered by coal for background power and natural gas to fill in gaps of supply would not be reliable. The wind doesn't always blow and the sun doesn't always shine, and batteries for the grid are not yet affordable enough for storing and managing the nation's electricity.

"The utilities and others who are against renewables have always argued that the lights are going to go out, the grid is going to be unstable, and it will cost too much to keep a clean, [renewable-energy](#) grid stable and reliable," Jacobson said. "Skeptics have never studied a system of 100 percent clean, renewable energy for all purposes, and particularly one that combines low-cost storage with demand response and some hydrogen, as in this new paradigm."

Jacobson, who is also a senior fellow at the Stanford Woods Institute for the Environment and the Precourt Institute for Energy, briefed a congressional panel on his research on Nov. 19.

## **Restructuring the grid**

In his new study, Jacobson and his coauthors, including Bethany Frew, now at the National Renewable Energy Laboratory, and graduate student Mary Cameron, suggest that combining existing low-cost ways of storing

green energy and using that stored energy to smooth out the uneven demand for electricity, heat and cold simultaneously over the course of a minute, day, week or year could solve that problem.

All raw energy for this system would come from wind, water and sunshine – no natural gas, biofuels, coal or nuclear power. The resulting drop in [air pollution](#) would save tens of thousands of lives each year, the researchers say. Sixty thousand to 65,000 people die prematurely in America annually as a result of air pollution.

As a demonstration of some of these technologies, Jacobson points to the Drake Landing Solar Community in Canada, near Calgary. The 52 homes there are heated in winter with solar energy captured and stored underground during the summer. Water warmed to 175 degrees Fahrenheit by the sun is kept in insulated tubing buried under 120 feet of rocks, earth and insulation. The stored warmth is enough to heat the homes in the community through winter, Jacobson said.

An all-electric nation could reap a number of benefits. While the cost of electricity per kilowatt hour in Jacobson's system might be about the same as electricity generated from fossil fuels, users would actually spend about 30 percent less due to the fact that fewer kilowatt hours are needed in the new system because the efficiencies of electric engines exceed those of combustion engines, Jacobson said.

And underground storage of energy is cheaper than batteries, he added. Some wind turbines now shut down when there is no immediate demand for their electricity, because the cost of storing it is too high. Using excess electricity to produce heat simultaneously with using solar collectors to produce heat increases the availability of stored energy.

Widespread use of underground energy storage and the other types of storage he proposes would cost much less than batteries, Jacobson says.

Storing electricity in batteries currently costs \$350/kilowatt hour, compared with a cost two orders of magnitude lower for storing heat in soil, he said. Similarly, storage in concentrated solar power, pumped hydroelectric power and existing hydroelectric reservoirs costs one-tenth of storage in batteries.

"You eliminate air pollution and global warming emissions, stabilize fuel costs, create over two million more jobs than are lost in the U.S., you reduce reliance on international trade of fuels, and you reduce the risk of power disruption, such as from terrorism or massive failure, because more energy is distributed over larger areas," Jacobson said. "Most energy would be local. You can eliminate a lot of fuel emissions, just because you won't have to transport oil in tankers across the ocean, you won't have to use trains of coal cars to ship the coal."

This methodology for keeping the grid stable, he said, should work in many places worldwide.

**More information:** Mark Z. Jacobson et al. Low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes, *Proceedings of the National Academy of Sciences* (2015). [DOI: 10.1073/pnas.1510028112](https://doi.org/10.1073/pnas.1510028112)

Provided by Stanford University

Citation: Researcher suggests storing solar energy underground for a cloudy day (2015, November 24) retrieved 29 April 2024 from <https://phys.org/news/2015-11-solar-energy-underground-cloudy-day.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.