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## Does Car-Mounted Solar Make Sense?

Researchers consider plug-in hybrids charged by stationary solar arrays a better bet.

By Peter Fairley

Last week, the Japanese newspaper *Nikkei* produced a buzz by reporting that a redesigned Toyota Prius, to be released next year, will come equipped with solar panels. Toyota spokespeople will neither confirm nor deny the report, but several companies already offer solar roof kits for the Prius, and researchers at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), in Golden, CO, have been testing one on a Prius modified to plug into the electrical grid. Their conclusion: for the time being, plug-in hybrids charged from stationary solar arrays are a more efficient and cheaper option.

The idea of car-mounted solar cells is not new: in the early 1990s, Mazda offered its 929 luxury sedan with optional solar cells in the glass sunroof to drive fans that removed hot air from the car. But most onboard solar systems to date have cost several thousand dollars while generating less than 100 watts of energy, improving a vehicle's fuel efficiency by just a few percent. "I think it's more a marketing gimmick," says Andrew Frank, a plug-in hybrid pioneer at the University of California, Davis, and chief technology officer for UC-Davis hybrid-vehicle spinoff [Efficient Drivetrains](#). "It takes kilowatts to really drive the car."

The limited surface area of the car roof is one constraint on the panels' power production. Another is that they can't be tilted perpendicular to the sun for optimal energy capture, unlike most photovoltaics on buildings or in solar farms, which either track the sun or are installed with a fixed southward tilt.

The NREL researchers tested the extent of these limitations by equipping the [plug-in Prius they built earlier this year](#) with the most powerful rooftop solar panel on the market. Assembled by [Solar Electrical Vehicles](#), based in Westlake Village, CA, the panel completely covers the Prius roof, wiring together 146 four-inch-square crystalline-silicon cells capable of generating a total of 215 watts. However, NREL senior engineer Tony Markel says that his group's tests suggest that the output will

max out at closer to 165 watts under normal use.

That's a meager improvement compared with the boost that the plug-in Prius gets from its extra lithium-ion battery. Markel says that the six kilowatt-hours of electricity available from the fully charged battery enable NREL's Prius to get about 100 miles per gallon in the first 50 miles of driving--more than double the fuel efficiency of a standard Prius. Put another way, the overnight charging should take the car about 50 miles in light-duty driving. Markel says that NREL has yet to quantify the solar panel's additional impact, but that the five hours of good sunlight the car sees on an average day would give it an electrical output of at most 0.825 kilowatt-hours. The system would probably boost the plug-in's fuel efficiency for the first 50 miles from 100 to 105 miles per gallon, he says.

Even that limited improvement comes at considerable cost. Solar Electrical Vehicles sells its panels for \$3,500, whereas NREL could have beefed up its lithium battery to draw another kilowatt-hour from the grid for just \$1,000.

Markel notes, however, that Solar Electrical is producing at very low volumes--just two to three systems per day, according to company president Greg Johanson. Economies of scale could sharply lower the system's price. Markel says that optimizing the electronic interface between the solar panel and the hybrid batteries could also boost performance. "The electronics are going to be key," he says. "I know their systems are not designed specifically for the application, so they probably are not the most efficient approach."

The other rooftop solar panel on the market, from Solar Electrical competitor [Solatec](#), operates exactly as *Nikkei* said that Toyota's would: rather than charging the hybrid-system battery, it charges the lead-acid auxiliary battery that drives the Prius's air conditioner, radio, and other peripherals. Solatec's current system provides just 24 watts and costs \$1,650 uninstalled--less than half as much as Solar Electrical's. The lower price and output are both a by-product of the less-powerful thin-film solar cells that the system employs.

Unsatisfied with the visual appeal of the flexible amorphous-silicon panels that the company has been using since 2005, Solatec president Howard Fuller says that the company is now testing a prototype for its next-generation product using printed cells from plastic-photovoltaics developer [Konarka Technologies](#). "Konarka puts out a gorgeous panel," gushes Fuller. "It looks like a couple of racing stripes up there on the roof."

Experts such as Frank and Markel say that building large, stationary solar installations to generate the power to charge electric vehicles will be more cost effective than installing solar onboard. "We want to see sunshine drive the entire society, including our transportation," says Frank. That, he says, will require megawatts of energy. "The ultimate would be to have all shopping centers and industrial parking lots with solar arrays on top. It gives you a little shade and at the same time is charging your car."

Frank says that, even if onboard solar is a marketing gimmick, it could advance the electrification of transportation by advertising the possibility of replacing gasoline with renewable energy. "Whether it's perception or real doesn't matter," he says, "because it creates public awareness."

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## **Upcoming Events**

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MIT Campus, Cambridge, MA

Tuesday, September 23, 2008 - Thursday, September 25, 2008

<http://www.technologyreview.com/emtech/08/>

### **[Nano-Net 2008](#)**

Boston, MA

Monday, September 15, 2008 - Thursday, September 18, 2008

<http://www.nanonets.org>

### **[MIT Professional Institute](#)**

Cambridge, MA

Monday, June 09, 2008 - Monday, August 04, 2008

[http://web.mit.edu/mitpep/pi/courses\\_topic.html?c1=banner&source=pi+TRevents](http://web.mit.edu/mitpep/pi/courses_topic.html?c1=banner&source=pi+TRevents)

### **[2008 Golden Jubilee Conference](#)**

New York City, New York

Friday, July 18, 2008 - Sunday, July 20, 2008

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