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Steering sunbeams

Aug 7th 2009
From Economist.com

Solar power is becoming less of a luxury

JUST below your correspondent's hillside home in southern California, a house is being rebuilt with all the latest thinking in materials technology and construction codes. Much has changed in the eight years since your correspondent did the same. Most strikingly, the house below has a gleaming white roof of fireproof chippings embedded in a mastic undercoating. With summer temperatures in the nineties (32ºC and up), these new reflective coatings are said to reduce air-conditioning bills by 20% or more. Not content with that, the owner has added a five-kilowatt bank of solar panels.

Eighteen months ago, your correspondent ran the numbers to see what it would cost to use photovoltaic solar panels to replace the 8,300 kilowatt-hours of electricity he buys annually from the grid. Economically, solar turned out to be a dud. The 6.4 kilowatts of capacity needed would have cost $48,000 for the panels alone—and half as much again by the time the mounting frames, switching modules, power controller, fault protector, DC-to-AC inverter, service panel and installation charges had been included.

Admittedly, there would have been $14,000 worth of government grants to soften the blow. But even then, repayment of the loan (or the opportunity cost of paying cash) would have worked out at more than $600 a month over ten years—all to save a paltry $75 a month in electricity charges. With his conscience still twinging, your correspondent decided to buy a couple of tons of carbon offsets for a total of $70 a year and have done with it.

Now he's not so sure. The price of carbon offsets has risen slightly, to around $50 a ton. So has the price of juice in his part of the country, to 12.2 cents per kilowatt-hour. And the borrowing costs of home-improvement loans have fallen, too. Moreover, two other factors have tipped the balance somewhat in solar's favour.

One is the amount of government rebate now available. Starting this year, homeowners who install solar panels qualify for a 30% tax credit on the cost after state and other incentives have been deducted. A second factor is the tumbling price of the solar panels themselves. Eighteen months ago, typical 200-watt modules cost around $1,500 apiece retail. Today, such panels can be bought for $600 or less. The recession, plus the enormous oversupply caused by the surge of new factories in China and elsewhere making photovoltaic panels, have created spectacular deals for consumers.

As a result, a 6.4-kilowatt system can now be installed for $45,000 before rebates. Qualifying for some $20,000 worth of grants and tax credits, the final cost of going solar would cost your correspondent no more than $25,000 today-say, $260 a month over ten years. Cheap as that sounds, it is still three times more than the $85 a month he pays these days for electricity from his utility company.

On the plus side, at least the cost of his solar energy (effectively, 38 cents a kilowatt-hour) would not change for ten years, while the cost of electricity from fossil fuels could rocket. Thereafter, his electricity cost would fall near to nothing. Does he expect the price of electricity from the grid to triple over the coming decade? No. Does he expect to be living in the same house (or living anywhere for that matter) in ten years' time? The statistics would suggest not. So, once again, the green solution comes down to spending $100 a year to buy a couple of tons of carbon offsets.

And yet, and yet... Your correspondent would dearly love to have a big block of cheap, renewable energy. But he wants it more in the winter than the summer; and he would prefer it as heat rather than electricity. That's because heating a 20,000-gallon outdoor pool using electricity—even at cheap overnight rates-is prohibitive. It

is bad enough with natural gas which, in southern California, is half the price of electricity.

Yes, he has looked at solar-thermal panels, but finds them hopelessly inefficient and far from cheap. Ideally, he would like a solar boiler that could heat the pool directly. But that would require an array of mirrors to concentrate the sun's rays on the boiler tubes.

The Indians have developed some of the most ingenious solar cookers around. The one your correspondent especially admires uses a large stationary bowl to concentrate the solar rays. It tracks the sun as it moves across the sky by steering the receiver at the focal point rather than the reflector itself. The receiver's little boiler gets up to 150ºC and produces copious quantities of steam for cooking purposes.

He also looks longingly at the clever boilers that sit on top of the "power towers" that are sprouting across California, Israel and Spain. The first such heliostat-a circular array of steerable mirrors focusing the sun's rays onto a receiver at the top of a central tower-to start selling power to the American public was officially switched on this past week.

While the sun is shining, the Sierra SunTower, developed by eSolar of Pasadena, California, generates enough electricity to power 4,000 homes in the Antelope Valley, north of Los Angeles. Two other Californian firms, BrightSource Energy of Oakland and SolarReserve of Santa Monica, are working to get their own power towers into commercial operation.

But there is a snag with using concentrators like the Sierra SunTower to generate electricity for the grid. They don't work when it's cloudy or dark. That means adding costly backup heaters that burn natural gas to keep the boiler's steam at the temperature needed to drive the turbines. The obvious answer is to use a working fluid that, unlike water, can maintain its heat on cloudy days and through the night.

That is what SolarReserve has done with the molten-salt technology it has licensed from Rocketdyne, a company based in Los Angeles that has been building rocket engines since the dawn of the space age. The boiler on top of a SolarReserve molten-salt tower is effectively a rocket engine turned upside down (with the gubbins at the top of the structure, rather than the bottom) and inside out (with the cooling tubes running up the interior, rather than the outside).

Apart from being able to store heat for long periods, the advantage of using salt (actually a fertiliser brew of sodium nitrate and potassium nitrate) is that it melts at 200ºC and remains a liquid throughout its working cycle. Unlike a water-powered thermal generator, which has to cope with all the intricacies of phase changes from liquid to steam and back to liquid again, a molten-salt system needs no gas heaters for backup, no heavy pipework for containing the high-pressure steam, can adjust its output to match the utility company's hourly needs, and store internally enough heat to work around the clock, seven days a week.

That's just what your correspondent needs for his backyard. Unfortunately, existing molten-salt generators cost $600m and encircle a couple of square miles of desert. Your correspondent cherishes the thought that one day, may be, some enterprising Indian engineer will make a garden version. Hopefully, during the next ten years.