TACKLING CLIMATE CHANGE:

Concentrating Solar to the Rescue

Why a nearly forgotten solar technology is emerging as a promising weapon in the war on climate change.

By CHUCK KUTSCHER

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The opinions expressed here are solely those of the author.

What comes to mind when you think of solar electricity? If you're like most people, you think of photovoltaic (PV) modules. But another type of solar technology generates electricity in a way that is much like conventional power plants: concentrating solar power, or CSP. As longtime solar advocate Fred Morse puts it (in a takeoff on the old pork industry ads), CSP is "the other white meat."

CSP is simple enough. Mirrors concentrate solar energy, producing the high temperatures needed to efficiently run a thermodynamic heat engine. Because diffuse sunlight can't be focused, CSP plants work best where skies are very clear, like the southwestern United States. A study done for the Western Governors' Association looked at the Southwest and filtered out land that was already utilized or environmentally sensitive, had a ground slope greater than 1 percent and had anything less than the best solar resource (6.75 kilowatt-hour per square meter per day of direct radiation). They concluded that the remaining land could provide six times the current U.S. electric capacity.

CSP isn't new. In the 1980s, the Israeli company Luz constructed nine plants for a total of 354 megawatts (MW) of CSP in the Mojave Desert, and these plants are still operating successfully. They employ tracking parabolic trough reflectors to focus sunlight onto evacuated tube receivers, through which a high-temperature heat-transfer fluid is pumped. The fluid transfers its heat to a boiler, and the steam spins a turbine-generator.

After the last Luz plant was built in 1991, Luz went out of business. The loss of financial incentives, low natural gas prices and utility deregulation all conspired to kill the industry. But in the last three years, CSP has experienced a rebirth. Higher natural gas prices and a 30 percent federal investment tax credit, recently extended for eight years, have made CSP attractive again. Renewable portfolio standards in 28 states have put pressure on utilities to produce or buy electricity from renewable energy. And utilities understand big steam-generating power plants.

In 2006, Solargenix (now Acciona, acciona.es) installed America's first new parabolic trough power plant in 15 years. Although only 1 MW in size, the Saguaro plant outside Tucson provided the field experience needed to build the 64-MW Nevada Solar One plant outside Las Vegas only a year later. The Saguaro plant also gave Arizona Public Service (APS) experience integrating CSP into their grid. When APS decided recently to order a new power plant to service Phoenix's growing population, they compared wind turbines, photovoltaics and CSP to a new combined-cycle natural gas plant. They chose CSP because it offers one key advantage: storage. CSP plants generate heat, and storing heat is cheaper and more efficient than storing electricity.

The 250-MW (net) Solana plant being built by Abengoa (abengoa.com) for APS will incorporate six hours of thermal storage. A parabolic trough collector field will be oversized so that, when the sun is shining, it will not only generate electricity to send out to the grid but will also heat tanks of molten salt. After the sun sets, the heat from the molten salt will be transferred to the same fluid that goes through the collectors, which can then continue to boil water for the steam turbines. Thus the utility can meet high demand through the evening hours when people get home from work. Solana is expected to create 1,500 construction jobs and 85 permanent jobs.

While the Solana plant will employ six hours of storage, and new plants in Spain are using seven hours, analysts at the National Renewable Energy Laboratory (NREL) are looking into 12 hours or more of storage, allowing CSP to compete in the base load power market, now dominated by coal, the worst carbon emitter. Of course, carbon price legislation will be needed to allow CSP to compete economically against coal.

It is estimated that electricity from Solana will cost about 14 – 15 cents per kilowatt-hour, after the tax credit, compared to about 12 cents per kilowatt-hour for a new combined-cycle plant. But the solar plant will eliminate the risk associated with potential future price hikes in natural gas. While further cost reductions are needed, CSP technology is improving. The newest receiver tubes being tested at NREL lose significantly less heat than those at Nevada Solar One. New polymer reflector materials have the potential to replace heavy glass mirrors, thus reducing the overall collector cost. One need only look

at the marked improvements that Acciona made in going from the 1-MW Saguaro plant to the 64-MW Nevada Solar One plant to realize that deployment and scale-up greatly stimulate technical improvement and cost reduction.

Parabolic trough collectors are the most mature CSP technology but not the only one. Linear fresnel collectors use segmented mirrors with lower optical efficiency but potentially lower cost. Power towers use a field of mirrors, or heliostats, to focus sunlight onto a central tower. This avoids moving heat-transfer fluid around a large field and can achieve higher temperatures. It could potentially generate electricity at a lower cost. The dish-Stirling system uses a parabolic dish to focus sunlight onto a Stirling engine, generating electricity right at the focal point of the dish. This can achieve impressive solar-to-electric conversion efficiencies, but it does not easily lend itself to thermal storage, and long-term engine reliability still needs to be demonstrated.

While it is expected that, in the near term, CSP will provide electricity to cities like Phoenix and Las Vegas, some visionaries look forward to a day when we can power civilization from far-away deserts. One study has examined the use of high-voltage DC transmission lines to transport electricity from CSP plants in North Africa to the major cities of Western Europe. Here in the United States, while the sun is still shining in the West, Eastern utilities could use CSP electricity transmitted across the country to meet evening loads.

There are currently plans to install more than 7,000 MW of various types of CSP worldwide, with 4,500 MW in the United States alone. Undoubtedly, the credit crunch will slow deployment in the near term. And concerns raised by some environmentalists regarding use of the desert will need to be addressed. But as we get serious about fighting climate change and creating jobs, CSP offers a means to get a large amount of carbon-free power on the grid in a fast and utility-friendly way.

ACCIONA ENERGY

Acciona's 64-MW Nevada Solar One plant, located outside Las Vegas, was dedicated in 2007.