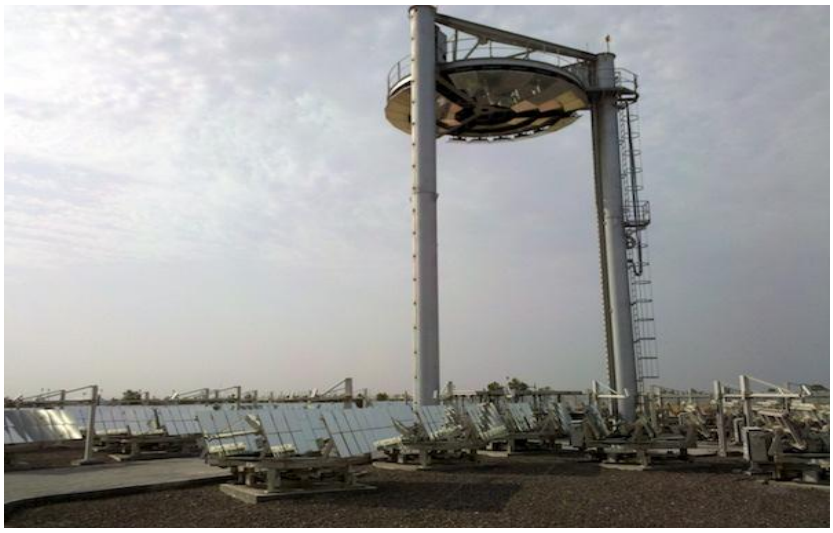
CAN SOLAR ENERGY LOWER THE COST OF CARBON CAPTURE?



Researchers at the Masdar Institute in Abu Dhabi chart a promising course toward cheaper carbon capture

Looming above a test plot full of mirrors like some kind of *Transformer*-inspired arachnid, the tower at the center of Masdar City's concentrating solar power plant is almost menacing at first glimpse.

Although still only one year into the R&D phase, the 100 kW Beam-Down Solar Thermal Concentrator at Masdar City, the emerging renewable energy research hub located 15 miles from downtown Abu Dhabi, has the potential to generate 75-85 megawatt-hours of renewable energy annually.

But as Masdar City Director Alan Frost tells a small group of journalists as we approach the plant on a recent January afternoon, "the Beam Down project is a different kind of concentrating solar plant."

Whereas most concentrating solar power (CSP) plants employing tower technology gather sunlight aimed at them from the mirror arrays below, the CSP tower at Masdar City goes one step further and directs the solar rays back downward and onto a receiver at the base of the tower, thereby eliminating the need for energy to pump the fluid up the tower.

Masdar City's Frost says the pilot project is "quite experimental," but he is also quick to point out that it is "the kind of thing we should certainly do."

The Beam Down at Masdar City is only a pilot project, but Dr. Matteo Chiesa, the head of the Laboratory of Energy and Nano Sciences (LENS) at the Masdar Institute of Science and Technology, says that substantially greater efficiencies could be found if the project was scaled up.

"The possibility of employing a multi-towers concept we have proposed (due to the fact of a simpler tower structure) can provide a way to optimize the overall energy outcome of the solar field," Chiesa said in an email.

By directing certain heliostats to different towers during the day, says Chiesa, "We have shown that one can reduce the energy losses due to cosine effect."

Solar-assisted carbon capture

But an even more important discovery made by Dr. Chiesa and his team of graduate students, though "not directly and exclusively related to the beam down," is the viability of a hybrid carbon capture process that uses solar thermal energy to assist the capture of carbon dioxide from power plant flue gases.

"Solvent-based Post-combustion Carbon Capture (PCC) is one of the promising technologies for reducing CO2 emissions from existing fossil-fuel power plants due to ease of retrofitting," writes one of Dr. Chiesa's students, Masdar Institute's Marwan Mokhtar, the lead author in a forthcoming paper published in the journal *Applied Energy* (available online Sept., 2011).

While experts agree that the most promising PCC processes in development around the world use absorption (pdf), these technologies are still incredibly expensive because of the energy intensive CO2 separation process.

According to the research team at Masdar, however, solvent regeneration requires thermal energy of lower quality, which can be provided cost-effectively by a solar thermal plant, leaving the higher quality for use in electricity generation at the plant.

To test their hypothesis, Mokhtar, et al modeled the performance of the process on a 300MWe pulverized coal power plant in New South Wales, Australia, using actual weather and wholesale electricity price data from the area.

The New South Wales location was chosen because sunny regions with long summers, substantial air-conditioning demand and a reliance on coal-fired power plants would be the most promising candidates for the implementation of this solar-assisted carbon capture technology. Given those conditions, the results of the test were favorable.

"It is shown that the proposed technology can be economically viable for solar collector costs of US$100/m2 at current retail electricity prices and optimal Solar load-Fraction of 22%," the authors write (Solar load-Fraction is the portion of solvent regeneration energy provided by solar energy).

Furthermore, the authors write, reducing the need for heat energy during the daytime coincides with peaks in wholesale electricity prices "thus increasing the revenue stream for a solar-assisted PCC plant."

And though a solar-assisted PCC plant has yet to be built, the economics are likely to become even more favorable as electricity prices continue to climb and solar collector prices decrease.

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