A tower of power

BY DANIEL SARAGA

Soaring 160 meters into the sky, Spain's new PS20 is a spectacular example of heat-driven solar energy production.

As every child knows, a simple magnifying glass placed in the way of the sun's rays can set a piece of paper on fire. So imagine more than 1,200 mirrors, each with a surface area of 120 square meters, aimed toward a heat collector at the summit of a 160-meter tower. Welcome to PS20, the second solar tower installed by the Spanish power company Abengoa Solar at Sanlúcar la Mayor, 25 km from Seville. It produces 20 MW, enough electricity to power 10,000 homes. Southern Spain is an ideal location for this technology, which requires long periods of intense sunlight.

"Prototypes of these towers exist in Israel and the U.S., but we are the only ones to use them commercially," explains Ana Díaz, coordinator of research at Abengoa Solar. The first tower, PS10, cost 35 million euros and took four and a half years to build. The installation is subsidized by the government, as is all energy from renewable sources in Spain.

KEEPING THE STEAM HOT

Thanks to the powerful mirrors, the steam heated in the collector reaches a temperature of 250°C. Then it's brought to the ground and injected into turbines that produce electric current. It can also be stored in reservoirs for nearly an hour, in case steam production outpaces turbine capacity.

"The higher the tower, the more energy the installation can produce."

The Spanish facility is also working to integrate heat storage techniques that use molten salt. "Once it has

In southern Spain, Abengoa Solar's PS10 tower concentrates the light reflected from 624 mirrors. The world's first commercial solar tower generates 11 MW

Thermal solar energy, a little-known technology with big potential

There are many ways to capture the sun's energy. Photosynthesis, the metabolic motor of the plant world, is the most powerful; it converts 100 trillion watts of solar power into chemical energy – five times the entire planet's electricity consumption.

The best-known man-made mechanism is the photovoltaic installation, with its solar panels that convert photons directly into electricity. There are also rooftop solar collectors that simply heat water and can be used as a supplemental heat source.

Thermal solar energy production (or "solar concentrators") uses the sun's heat to generate steam, which turns giant steam turbines and produces electricity. According to Abengoa, the electricity produced by solar concentration costs about 20 euro cents per kilowatt hour (compared with 35 euro cents for solar cells and 7 euro cents for fossil fuel power plants), but should fall and become competitive by 2017, with a price under 10 euro cents per KWh. The U.S. National Renewable Energy Laboratory predicts even lower prices: under 6 U.S. cents (or 4 euro cents) per KWh by 2020.

Because thermal solar electricity production plummets when the sky is cloud-covered, solar concentrators are targeted at sun-drenched regions. Photovoltaic technology, on the other hand, can still be used in cloudy conditions.

More modular and easier to install, photovoltaic installations are useful in countries like Switzerland. "Future energy production in Europe will be built in three major zones," says Püttgen. "Southern areas will invest in solar and northern areas in wind technology. In the middle, the Alpine countries will play the role of supply moderator; thanks to the flexibility offered by their hydroelectric dams, they can store energy at night and deliver it during the day."

DENIS DOYLE / GETTY IMAGES

of electricity.

Desertec, a huge geopolitical time bomb?

Solar concentrators are at the heart of Desertec, a gigantic project in the Sahara that was officially launched last summer. The consortium, which includes companies like ABB, Siemens, Abengoa and Deutsche Bank, plans to channel some 700,000 GWh of electricity produced at 20 to 40 sites in North Africa and the Middle East to Europe every year. That's one and a half times France's consumption. The electricity will travel over high-voltage direct-current power lines (HVDC) that allow transmission over long distances with an energy loss of less than 3% per 1,000 km.

"Technologically, the project is complicated but feasible," says Püttgen. "But from a geopolitical and ethical point of view, it's much more problematic. Between now and 2050, Africa's energy needs will multiply by a factor of 15. How can we justify putting these installations there if the continent can't benefit from them? Another question related to the raw materials used in energy production, such as oil and uranium, of which a large quantity comes from Africa. Today, they are converted in developed countries that have the necessary industries and the electricity. But if Africa starts to increase its electricity production, it would make more sense to convert those materials locally. The industries that process combustibles would have to move to Africa."

been heated to 280°C, salt can keep the steam hot for about eight hours," explains Díaz. This allows the turbines to continue to turn during the night.

"Storage is one of the biggest issues for alternative energies," explains Hans Björn Püttgen, director of EPFL's Energy Center. "In principle, renewables can reduce the use of fossil fuels, but the fact that they are not produced continuously poses a real problem, for example at night with solar energy or when the wind is not blowing with windmills. The issue of capacity is the clincher – in other words, it is still necessary to build nuclear or coal-fired power plants to guarantee that electricity is available during peak hours."

The higher the tower, the more mirrors can be aimed at its summit – and thus the more powerful the installation. This new technology has certain advantages over the parabolic mirrors that focus solar radiation on tubes placed in front of them, a technique from the 1980s that was never widely adopted. "Parabolic mirrors are a little less efficient because the temperatures reached are lower than in the towers," says Püttgen. "There can also be significant energy loss in the heating liquid, which has to circulate hundreds of meters alongside the mirrors, whereas with the tower the steam circulates over much smaller distances." Another advantage of the tower is that the mirrors are flat and thus easier to clean than the curved parabolic ones. A complex system of motors allows the flat mirrors to follow the sun's movement.

The Spanish company also has a 150-meter-long 50 MW parabolic mirror installation. With these two technologies, Abengoa hopes to increase Sanlúcar la Mayor's production to 300 MW by 2012. The company will also build a solar installation in Arizona that incorporates the molten salt heat storage technology. ■