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Where CSP beats fossil energy: agricultural desalination

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SkyFuel and WaterFX have just brought a six-month solar desalination pilot to a successful completion in California's Panoche Water District. Here's why thermal desalination of agricultural land could be a game-changer for the CSP industry.

By Susan Kraemer [2]

With California in a drought of epic proportions, a very timely solar desalination pilot has just completed its test period. For the last six months, heavily polluted drainage water has been stripped off the selenium and other toxic minerals that accumulate in agricultural land, and re-used in one of California's driest counties.

The pilot demonstrates the Aqua4 from WaterFX, a solar still, using Concentrated Solar Power (CSP) to supply steam to a multi-effect distillation process. A single 480-kW trough collector from SkyFuel, 115 metres long by 6 metres wide, supplied the steam for the pilot.

Now WaterFX has begun to put together the commercial-sized system that will desalinate 45 gallons a minute, or 2 million gallons a day, running the full distillation system, by the end of 2014.

The full size version consists of the distillation system, and two of the modular CSP solar thermal collection units with an output of 480kW each, along with thermal storage for 24-hour/day steam production.

Custom thermal-storage design

Although no storage was used in the Phase I pilot, WaterFX founder and chairman Aaron Mandell, an engineer by background, says that for Phase II, the company will build a storage unit that they designed in-house.

This thermal storage, designed for temperatures between 165C and 235C, utilises a specially formulated thermal concrete with embedded heat exchanger tubes, and is highly modular for easy and cost-effective shipping and assembly.

The trough system is supplied by Colorado-based manufacturer SkyFuel, which works closely with NREL, and is the recipient of many innovation awards.

Skyfuel designs and makes parabolic trough collectors suitable for delivering heat or steam for electricity production or for industrial, mining, and manufacturing processes, as well as waste-water treatment and desalination at any scale, using their flexible highly reflective ReflecTech mirrors, along with a tracking system.

A supplier relationship

The two companies were brought together by ATSI, a general EPC firm - with SkyFuel being among the bidders from an assortment of solar technologies vying to be the solar equipment supplier.

Mandell says that they didn't know SkyFuel before, but "when we went out to bid, SkyFuel came out the best in performance."

The collaboration is an exciting strategic alignment, according to SkyFuel Business Development Manager Bill Hargett. In addition to buying the solar field from SkyFuel, WaterFX separately outsourced boilers, expansion tanks, nitrogen tanks, piping and pumps, gages, and housing units.

While SkyFuel is not in a partnership arrangement with WFX, they do see their future in this sort of industrial steam application, although to date, their SkyTrough has been used to make electricity.

"Trough technology is better suited to hybrid projects, for which power tower CSP typically cannot be scaled down," Hargett points out.

An economical technology

Skyfuel says their system costs about 20 percent less than large-scale CSP projects; in part because there is no need for an onsite building to house manufacturing, and there is no need for any specialised equipment in the small, straightforward project.

In heat-only applications such as thermal desalination, the SkyTrough is used only to heat water for steam, so, like GlassPoint; using trough technology only to heat steam for Enhanced Oil Recovery (EOR), money is saved by not needing the power block for producing electricity, according to SkyFuel Marketing Director, Alison Mason.

But the real savings come from their innovative solar field technology.

Their patented trough system, made in their Colorado factory, comprises the SkyTrough, a parabolic trough solar concentrator; the OnSun, an integrated tracking, control, and drive system that focuses the concentrator onto the thermal receiver; and their flexible ReflecTech mirror film, which has a layer of pure silver that provides high specular reflectance.

Because this mirror is simply one monolithic sheet rather than the typical faceted series of glass mirrors, there is an optical efficiency gain. To reduce construction costs, this mirror film is made

flexible, and simply slid into place creating the parabolic shape.

“The film actually is laminated onto an aluminium backing about 1 mm thick. Once we finish the lamination and forming the edges, the mirror panel is a big semi-rigid sheet, 5 ft. wide by 22 ft. long,” Mason explains.

“It slides into and is gripped by the collector’s precision rib tracks with what’s called a button hook holding it into the parabolic shape. Even in high winds it can’t distort.”

A valuable desalination byproduct

Thermal desalination is an ideal application for CSP; using steam to evaporate out the waste.

“The steam that we use to feed into our multi-effect distillation system is identical to the steam that you’d feed to a conventional power plant,” says Mandell.

Thermal desalination lends itself better to recovery of the waste than reverse osmosis; which discharges a much wetter waste stream. By contrast, thermal desalination leaves only about 7 gallons of brine per 100 gallons of treated water.

The residue is a highly concentrated semi-solid with minerals and metals that can readily be precipitated out for recycling.

“We end up with a solid byproduct that looks a lot like salt, and from there we can actually separate and refine certain components that will have value,” says Mandell, who earlier in life founded Oasys Water, a provider of desalination and water-treatment technologies.

“We actually see the byproduct as being a revenue stream over time.” Among the saleable products are gypsum, used in construction, selenium, used in semiconductors, and boron, which also “sells for quite a bit of money.”

These recoverable minerals and elements could generate $2 million a day, according to WaterFX.

Solar desalinates at half the cost

As the equipment supplier; not the developer, SkyFuel is not as actively engaged in locating potential customers as is WaterFX, but they’d likely have no shortage of customers. Interest in solar for thermal desalination runs high in parched farming areas like California.

In commercial operation, each 6,500 sq. ft. SkyFuel unit, at slightly less than half a megawatt, provides enough steam to desalinate about 65,000 gallons per day. And as a modular trough system it can scale up.

Even buying the solar energy-generating equipment from a CSP manufacturer, WaterFX is able to sell to the water district at half the price of fossil-powered desalination.

“The Panoche plant's total operating cost will initially come in right around $450 per acre foot, and we can compare this to the Carlsbad desalination plant in San Diego which is being built

right now," Mandell points out.

"Their total operating cost is around $900 dollars per acre foot. It's a pretty significant operating cost reduction because of the cost of the energy required."

The market is enormous. Hundreds of thousands of acre feet of drainage water are generated in the Central Valley. "We are talking to a number of water districts, but also just large water users; agricultural businesses, large industrial companies that use water," he says.

Unlike California's highly developed and expensive coastline – where desalination of seawater using solar would be too costly because of the land use – inland there are millions of acres of land available that are either not being used or are even left fallow for lack of water.

As Mandell puts it: "When we talk to these water districts, land use is just not an issue."

To comment on this article, please write to the author Susan Kraemer [2].

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