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Is Solar-Powered Desalination Answer to Water Independence for California?

From Isle of Man to Saudi Arabia, renewable desalination is gaining interest around the world as solution to water scarcity and food crisis

A flock of starlings takes flight in a field north of Bakersfield in California's San Joaquin Valley. Photograph: Eric Rorer/Getty Images/Aurora Creative

Thousands of acres on the west side of California's San Joaquin Valley lie fallow. In official speak, the former agricultural land has been "retired". Water supplies have always been a problem for this drought-prone region. Yet what's pushed the area over the brink is salinity.

The problem is in large part caused by farm irrigation, which picks up the salt that naturally occurs in the rocks and soils of the Central Valley and transfers it through drainage. Compounding the problem is the tidally influenced water that is pumped into the area from the Sacramento-San Joaquin Delta. A study by the University of California estimates that, left to continue, the Central Valley could be facing reparation costs of up to $1.5bn by 2030 and the loss of up to 64,000 jobs as agricultural production slides.

A California-based startup thinks it might have the answer. WaterFX's solution comes in the unlikely shape of a vast bank of parabolic mirrors and an advanced "multi-effect" evaporating unit. The Aqua4 system offers a renewable method of desalinating briny water, which, if its developers prove right, could put California "on a path to water independence".

How does it work? Unlike conventional desalination, which uses a high-pressure reverse osmosis system that forces salt and other solids through a membrane, WaterFX cleans water through use of a 400-kilowatt solar "trough" – hence the mirrors. This concentrated solar still collects the sun's energy, which heats a pipe containing natural oil, providing heat for the subsequent distillation process.

"We wanted it to be highly modular and highly scalable so the same system is usable for very small applications all the way up to very large scale," says Aaron Mandell, founder and chairman of WaterFX, which is piloting the idea in the Californian water district of Panoche.

The potential of renewable desalination is exciting interest in other corners of the globe. For example, Sundrop Farms, which is based in the Isle of Man, has installed a desalination plant near Port Augusta, South Australia. Located 100 metres from the shore, the solar-powered plant treats salt water pumped directly from the sea. As well as returning freshwater, the plant uses hot water generated during the desalination process to heat nearby greenhouses.

Interest is also on the rise in the Middle East and North Africa, which currently suffers a gap in water demand of about 42 cubic kilometres per year – a figure that could increase nearly fivefold between now and 2050, according to a recent World Bank report (PDF). Experimentation in renewable desalination is already under way in Qatar, where Norway's Sahara Forest Project has

embarked on a pilot scheme. Saudi Arabia, meanwhile, has plans to build a solar-powered plant in the Al-Khafji governorate, with talk of more besides.

From a sustainability perspective, the upside of the technology is huge. The US federal government is currently pumping in about seven million-acre feet of water into California's Central Valley every year. Replacing a "meaningful percentage" of that figure – say, 20%-30% – would be enough to have a dramatic impact on securing water security for the area, says WaterFX's Mandell.

The implications for sustainable agriculture are also vast. After a successful proof of concept stage, Sundrop is now building a 20-acre greenhouse, which promises to produce 2.8m kg of tomatoes and 1.2m kg of pepper a year. As well as making desert land productive, Sundrop maintains that its approach reduces pesticide use, cuts food miles and results in better tasting produce.

The arguments from a climate-change perspective appear especially attractive. Saudi Arabia's 30 or so desalination plants, for instance, currently use about 300,000 barrels of crude oil equivalent a day. The trend in other Gulf countries, as well as in Algeria and Libya, is similar. "The status quo is not sustainable," concludes the World Bank, which describes the elimination of fossil fuel use in desalination as "critical".

As with all new technologies, the key consideration is whether the idea is scalable. The first question is whether the science actually works. The initial pilots look promising. WaterFX's test facility, which started operations six months ago, is successfully producing up to 14,000 gallons of fresh water a day. Plans are now under way to expand the demonstration project, which will push up its capacity to 65,000 gallons a day over the same 6,500 sq ft area.

A big stumbling block is cost. Solar-powered desalination currently averages about $1.52-$2.05 per cubic metre of water produced, depending on technology, energy costs and location, according to the World Bank. Conventionally, alternatives typically cost half that or less. The cubic-metre costs of desalinised water in Israel's traditional Hadera and (newer) Sorek plants, for example, are $0.65 and $0.52 respectively.

Mandell insists that the technology promises to become more price-competitive as production increases. "If 70% of your cost is fuel production for traditional desalination and you want to scale up, the cost goes up significantly, unlike solar desalination," he says. That logic is truer still if oil and gas prices increase in the future. Advances in concentrated solar power will drive efficiency savings, too.

Either way, don't expect renewable desalination or its supporters to go into retirement any time soon.

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Guardian Professional, Tuesday 28 January 2014 12.35 EST