In Talk Of Solar Desalination, There's a Salty Elephant in the Room

Chris Clarke, KCET (Los Angeles television), 1-29-14

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As California anxiously awaits the rains that we hope will blunt the worst drought in the state's recorded history, people are again looking to a water source that's been discussed for decades: the Pacific Ocean. But turning seawater into something we can drink and irrigate crops with takes a lot of energy.

Unsurprisingly, some are suggesting that we turn to free energy from the sun to desalinate seawater. It makes sense on the face of it: all the naturally occurring freshwater on the planet has been desalinated by solar energy, as water vapor evaporates from the ocean and falls as salt-free rain.

With the drought declaration driving attention to California's water woes, people are asking whether we can use renewable energy to de-salt seawater on purpose. And we probably can, but there's a pesky problem that few seem to be discussing.

This article published Tuesday in the U.K.'s green-leaning paper The Guardian is a good example of the play renewable-powered desalination is getting as a potential approach to solving California's drought. But if you take a look at the piece, you may notice a glaring omission.

That omission: what do we do with the stuff we remove from the water?

Desalination is nothing new in California: we've been using various kinds of technologies to freshen up seawater for domestic and industrial use for decades. The amount of energy required, though, makes desalination an expensive proposition. In 1992, after a drought that threatened the city's water supply, Santa Barbara completed a plant capable of purifying 2.8 million gallons a day, the state's largest such plant. The plant was functional and actually produced a little bit of potable water in a demonstration run.

And then that drought ended, and it was no longer cost-effective to spend the energy and money to refine seawater for municipal use. The Santa Barbara desal plant is now essentially decommissioned.

A much larger desalination plant now under construction near Carlsbad on the San Diego coast is expected to start supplying 50 million gallons a day of (relatively expensive) water in 2016. That plant will purify water using reverse osmosis technology, in which seawater under pressure passes through a membrane that's permeable to water, but not to most dissolved solids.

That takes a lot of energy, and between the high energy consumption and the costs of amortizing plant construction, water from the Carlsbad plant is expected to cost as much as $2,000 per acre-foot, perhaps even more. (That's three or four times what many urban water users pay in their retail water bills.)

It makes sense, if we're examining desalination as a way to mitigate the drought's effects on California, to try to use renewable energy like solar power to cut down on long-term energy costs. Hence the attention paid to stories like those in The Guardian.

On paper, the idea seems reasonable. Whether you use PV to power a reverse osmosis filtration setup, or take the simpler approach of using the sun's hear to distill fresh water from seawater, you're cutting down the long-term energy costs of the process. And that's likely to make desalination competitive much sooner, as this drought (as will likely happen) intensifies and repeats in our warming world.

So it's not surprising that writer Oliver Balch's piece this week in The Guardian is getting some sympathetic exposure in social media. Focusing on the issue of brackish irrigation water in the Central Valley, Balch touts the WaterFX company's Aqua4 concentrating solar thermal desalination equipment as a potential way of reclaiming that water, making it usable for crop irrigation and freeing up the water that would otherwise be used for other purposes.

And Balch never once mentions the elephant in the room: the endless supply of toxic waste "brine" that desalination produces by definition.

Agricultural waste water in the Central Valley contains salts that had leached from the soil by irrigation water -- sodium chloride (table salt), gypsum, and other common compounds that are environmentally toxic in high concentrations. It's also got the selenium compounds that occur naturally in the soil of the Westlands area, which famously caused wildlife deaths and deformities in the Kesterson National Wildlife Refuge in the 1980s. It's got agricultural chemicals in it from fertilizers to insecticides and herbicides. It's got motor oil, antifreeze, and random non-point-source pollutants that filter out of the air.

And when you remove all that stuff from the water in order to reuse the water, you have to do something with it. But Balch doesn't mention that end of the process.

WaterFX does mention the issue on their website, saying, "The remaining brine is concentrated into solid byproducts for resale."

What those products are, they don't say. In the best of cases that would vary with the project. It's hard to imagine a buyer that would have a use for the various and sundry dissolved chemicals in your typical Fresno County wastewater drain in solid form. Using solidified brine as a filler in construction material is one possibility you often hear mentioned, but the notion of recycling a brine that's legally considered toxic waste into a community's buildings and roadways raises certain inevitable Environmental Justice concerns.

Which means that the safest assumption is that waste brine and solids from a central Valley desalination plant would go to the most convenient landfill or (ideally) a hazardous waste facility. And that poses an ironic problem: even the best-designed landfills and hazmat dumps eventually leak, putting that stuff right back into the groundwater.

For desalination plants treating seawater, the problem of brine disposal is potentially even greater. One 1985 study of the contaminated ag waste water in the Central Valley's heavily polluted San Luis Drain showed the water contained 9.2 grams of total dissolved solids per liter of water. Clean seawater from the Pacific Ocean has around 38 grams of dissolved solids per liter.

That might not seem like a huge problem: after all, people will shell out between five and ten bucks a pound for sea salt, which is just seawater with the water removed. But it adds up. If the Carlsbad plant puts out 50 million gallons of freshwater a day as advertised, that means (at 38 grams per liter, converted from the metric) it's removing 417,270 pounds of salt and other solids a day from that water.

And unless the people of San Diego start eating a pound of sea salt for every three gallons of freshwater they drink, bathe in, or water their gardens with, that means a surplus of removed solids piling up at the desal plant.

Along the coast, disposal of desalination waste usually involves pumping concentrated brine back into the ocean, under the assumption that the Pacific will dilute it. And it will, eventually, but that may take some time. Waste brine is heavier than seawater. It will thus tend to flow to the ocean floor, where currents are weaker and the brine will get diluted less quickly. If the brine flows into a hollow in the seabed, it may form a long-term pool of highly concentrated saltwater.

Though marine organisms are adapted to seawater, there are limits to the amount of salinity they can tolerate. Too much salt can kill marine life, especially for organisms that can't just swim away.

This may not be an entirely bad thing in all circumstances: there's some evidence that sea urchins are less tolerant of increased salinity than are other organisms found in kelp forests, including the kelps themselves. It's possible that extremely cautious application of waste desal brine might offer a tool in controlling the sea urchin population explosions currently ravaging the state's kelp beds.

There's also the possibility that if waste brine and sea salts become abundant enough, their price will necessarily drop and industry will develop ways to take advantage of that inexpensive abundance. Some desalination technologies are plagued by accumulations of "scale," a gypsum precipitate that coats equipment and necessitates cleaning. But gypsum itself, a compound of calcium and sulfur, is a very useful substance. It has applications ranging from organic gardening to construction to tofu-making. It's not out of the question that some bright equipment designer could find a way to turn the gypsum precipitation bug into a feature by making it easier to refine the gypsum from seawater.

Seawater also contains significant amounts of magnesium and potassium salts, both incredibly useful in industry. The oceans dissolve a huge amount of atmospheric carbon dioxide, some of which chemical and biological processes convert into bicarbonate ions: about 1.4 parts per thousand in typical sea water. Conceivably, bicarbonate salts extracted from the seawater could be sequestered so that the carbon doesn't re-enter the atmosphere anytime soon. Removing them would make room for the ocean to absorb more Co_2. If a plant the size of the Carlsbad desal plant was run entirely on non-carbon energy, that would come to something roughly like 2,200 tons of CO_2 removed from the atmosphere in a year of operation: a very small amount in the scheme of things, but it certainly wouldn't hurt.

In other words, to aim directly at the inevitable pun, the problem of what to do with the waste brine from desalination isn't insoluble. But it's still a big problem. And we can't have a real discussion of the costs and benefits of desalination as a tool for living with California's drought unless we face the issue head-on.

We certainly can't have that discussion if we fail to address it altogether. Even if we fuel the whole thing with solar energy.