Sun quenches thirst

Two thirds of our blue planet are covered by water. Yet there is still not enough clean drinking water to go around, especially in many poor countries. To help improve this situation in the future, scientists have developed a new method that uses solar energy to desalinate seawater.

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Theoretically, there is more than enough water on the Earth to meet everyone's needs. Yet only a small portion of it is actually fit for drinking; the remainder is either too salty or too polluted. In many parts of the world, clean drinking water is a precious commodity: people will walk miles to fetch what they need or pay large sums for it to be shipped and trucked to its destination. In the future, this situation looks set to get even worse: climate change is leading to droughts in many regions and causing deserts to grow. At the same time, steady increases in the global population require us to produce ever more food and to cultivate and irrigate ever more land. In dry, arid regions, rivers are running dry – making conflicts between neighboring countries inevitable. Experts are already warning of water wars and mass migrations when the poorest of the poor are forced to abandon their drought-desiccated homelands. In many places people have already been reduced to fighting for their very survival. "Contaminated water kills more people than AIDS, malaria and measles combined," said Bolivia's former UN ambassador Pablo Solón in a speech to the United Nations General Assembly last year. He added that most of the victims are children under five years old, noting that diarrhea is the second most common cause of death in this age group. The UN General Assembly passed a resolution in July 2010 affirming that everyone has the right to safe and clean drinking water. This right is an internationally recognized fundamental human right on a par with the right to food and the right to freedom from torture and racial discrimination.

Water shortages cost lives

But where will this clean water come from? New, deep wells only offer temporary respite in areas where rainfall is scarce, because groundwater reserves dwindle rapidly if they are not replenished. The only truly abundant source of water on the Earth is seawater. Desalination is perfectly feasible from

Many remote areas that lack clean water typically have abundant quantities of three things: sun, wind and sea. Construction of a solar-powered water desalination plant in Gran Canaria. © *Fraunhofer ISE*

a technical standpoint, but it requires copious amounts of energy, and most existing plants run on oil or natural gas.

"There are a number of tried-and-tested methods of converting seawater and brackish water into drinking water," explains Marcel Wieghaus from the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg. "The second most common method – after distillation or 'thermal desalination' – is reverse osmosis, where water is forced through a membrane to filter out the salt." Worldwide, some 50 million cubic meters of seawater per day are already desalinated using this method, and this figure is constantly rising: in four years' time, plant operators expect to be producing some 100 million cubic meters of desalinated water a day. Most of this water is used in agriculture, major conurbations and tourist resorts, where per capita consumption is especially high.

Ultimately, large-scale desalination is not sustainable because it consumes fossil fuels, but it is certainly cheap, with the biggest plants producing drinking water for 50 U.S. cents per cubic meter. "Industrial-scale desalination is an economically acceptable solution for cities and holiday destinations which have a network of pipes into which the desalinated water can be fed," says Wieghaus. Together with an international team of researchers, industry representatives and potential investors, he worked as an engineer on the EU project ProDes, which investigated the extent to which alternative energy could also potentially be used to desalinate seawater. The abbreviation ProDes stands for Promotion of Renewable Energy for Water Production through Desalination. The team of researchers spent two years comparing technologies, preparing market analyses, examining financing models and developing strategies to implement desalination plants powered by renewable energy sources.

Sustainability is feasible

Now their results are out, and the figures show that desalination plants can, in principle, be powered by alternative energy sources – though not at prices that can compete with water produced by industrial-scale desalination plants. Nevertheless, the ProDes researchers say that systems based on renewable energy have a good chance of succeeding in the market for a very simple reason: even though experience with seawater desalination has shown that the larger a plant's capacity, the cheaper it can produce water, the fact remains that many parts of the world, especially isolated regions, do not require water in industrial quantities. The challenge here is to supply water to farms and villages that are not connected to the power grid or the mains water supply. A system capable of producing between 100 and 1,000 liters of drinking water a day is often all that is required – and on this scale renewables-based systems are already capable of competing with conventional technologies: "For places such as villages or settlements in North Africa and the Middle East or on small islands, which are hundreds of miles from the nearest big town, seawater desalination plants powered by renewable energy are already an excellent choice," says Wieghaus.

Membrane technology: perfect for remote areas

The researcher and his team at the ISE have developed a 'solar thermal membrane distillation system' tailored to the concept of a decentralized water supply. The energy required for desalination is supplied by the sun, which heats the salty or brackish water in the collectors to 80 degrees. The hot water and steam are then guided into a module containing a hydrophobic membrane which is permeable to steam, but not to liquid water. The steam condenses on the other side of the membrane to produce clean water, which can be collected in a container. "Basically, the desalination process works in a similar way to the breathable membranes in outdoor clothing which keep rain out while allowing moist air to escape from the inside," explains Wieghaus, who teamed up with two of his colleagues from the ISE in 2009 to set up the spin-off company SolarSpring GmbH, which develops and markets the membrane distillation systems.

The technology claims to offer advantages over conventional methods of reverse osmosis. It is robust and less complex, and the fact that the membrane is hydrophobic means that water immediately drips off before any dirt can accumulate, so there is no need to pretreat the water. Industrial-scale plants that work on the principle of reverse osmosis have to perform membrane cleaning on a regular basis, while solar thermal membrane distillation systems require virtually no maintenance at all. The first successful prototypes are already up and running on Gran Canaria and Tenerife, in Italy, Tunisia, Mexico and Namibia.

And solar thermal membrane distillation is not the only technology capable of drawing on renewable energy. Studies carried out by the ProDes researchers have also shown that reverse osmosis can be powered by solar energy, wind energy or hydropower, so it is certainly feasible to achieve sustainability in theory. In practice, however, Wieghaus acknowledges that this comes at a price: "Environmentally-friendly desalination technologies are still the preserve of those who can afford them. The places that need them most, such as remote villages, generally don't have the necessary financial resources, so they are dependent on aid from governments and NGOs." The question of how long it will take for renewables-based water treatment to become properly established therefore depends on how seriously governments take the UN General Assembly's resolution and, crucially, on whether they are willing to stump up the cash to provide everyone with something to which they theoretically have a right – namely clean drinking water. ■