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Making a Dent in the Water Crisis

Water

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Article by Jiajun Cen

Developing a centuries-old idea to provide clean drinking water

BEFORE you read this, I suggest you help yourself to a glass of water. That is, if you can. Today, 633m people won't have access to a safely-managed source of drinking water[1], and water stress exists in every continent.

You'd be forgiven for not realising the extent of the global drinking water crisis – I had little idea until my job forced me to pay attention. Growing up in the Netherlands, charities and news reports had kept me fairly well informed about regions suffering persistent droughts, but I hadn't spent much time thinking about the connections to the bigger picture. I was used to abundant rainfall (as any Dutch person will tell you), the tap water tasted fine, and I could always pick up bottled water when out and about. Today, however, I'm acutely aware of the real, and often hidden, challenges of accessing quality drinking water.

The challenge

Despite living on a ‘blue planet’, 98% of our water is found in oceans and seas, and over 67% of the freshwater available is trapped in ice shelves and glaciers[2]. Historically, we have been supporting humanity on less than 1% of available freshwater sources, and now, a confluence of factors including population growth, over-extraction, pollution, and climate change is rapidly diminishing them.

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This has manifested itself in some more high-profile cases - you are likely to have come across the ongoing crisis in Cape Town, where years of drought and underinvestment have limited residents to a strict daily water allowance. The world is watching their race against time to delay “Day Zero” when the city’s main water sources will be completely turned off. However, there are so many examples of water stress that remain under the radar.

Cape Town : Years of drought and underinvestment have limited residents to a strict daily water allowance

In Southern California for example, nearly 1m residents use supplies that don't meet federal standards, with arsenic contamination a key culprit[3]. In the South Pacific islands, rising sea levels are creating a new generation of environmental refugees, driven from their ancestral homelands as their aquifers become saline. In India, the so-called "Water Mafias" sabotage new methods for cleaning water for fear of losing their monopolies on supply. Even in Europe, the combination of London's Victorian piping systems and exponential demand threaten acute water shortages by 2025[4]. And globally, 266m potential work hours are lost every day to collecting water from wells and water trucks[5], a burden usually left to the females in a household.

Additionally, our environmental footprint for producing drinking water is staggering. The estimated direct carbon footprint of global desalination processes (ie turning saline/seawater into drinking water using fossil fuels) is roughly 120m t/y[6], and the process also releases toxic effluent back into the seas.

Much of the developing world relies on the water truck, and although the exact environmental cost is difficult to quantify due to its ad hoc and remote journeys, we know that these are often old and inefficient vehicles, travelling hundreds of miles a day.

Supply struggle: A daily water truck collection in India (Desolenator 2015)

We do know that 1m plastic bottles are bought around the world every minute and the number will jump by another 20% by 2021[7]. The quality of water in plastic bottles also remains debatable, given that plastic bottles can contaminate the water within them, and that a number of bottling companies have been found to be selling 'purer' water that is, in fact, barely different to tap water (as protests against Nestlé in California have demonstrated)[8].

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Step forward, Desolenator

Desolenator, a relatively new technology company, is one of those new, sustainable solutions, having designed an innovative, but simple technology (also called the Desolenator) that allows users to produce clean drinking water from any source, using only solar power. We hope that the technology, essentially a mobile distillation unit, will bring water independence to millions, once rolled out.

Our patented process operates in an integrated system, with the solar panel secured in place above a water reservoir. A typical solar panel is only ~15% efficient at turning solar irradiance into electricity, so the Desolenator also harvests the 'waste' heat to warm up the reservoir water to ~90°C. This hot water is then passed into a small vessel, where the electrical energy produced by the solar PV panel is used to flash evaporate the water. This produces water vapour which is condensed in the internal heat exchanger. The latent heat is retained within the device to assist in a continuous cycle of production throughout the day (*See Figure 1*).

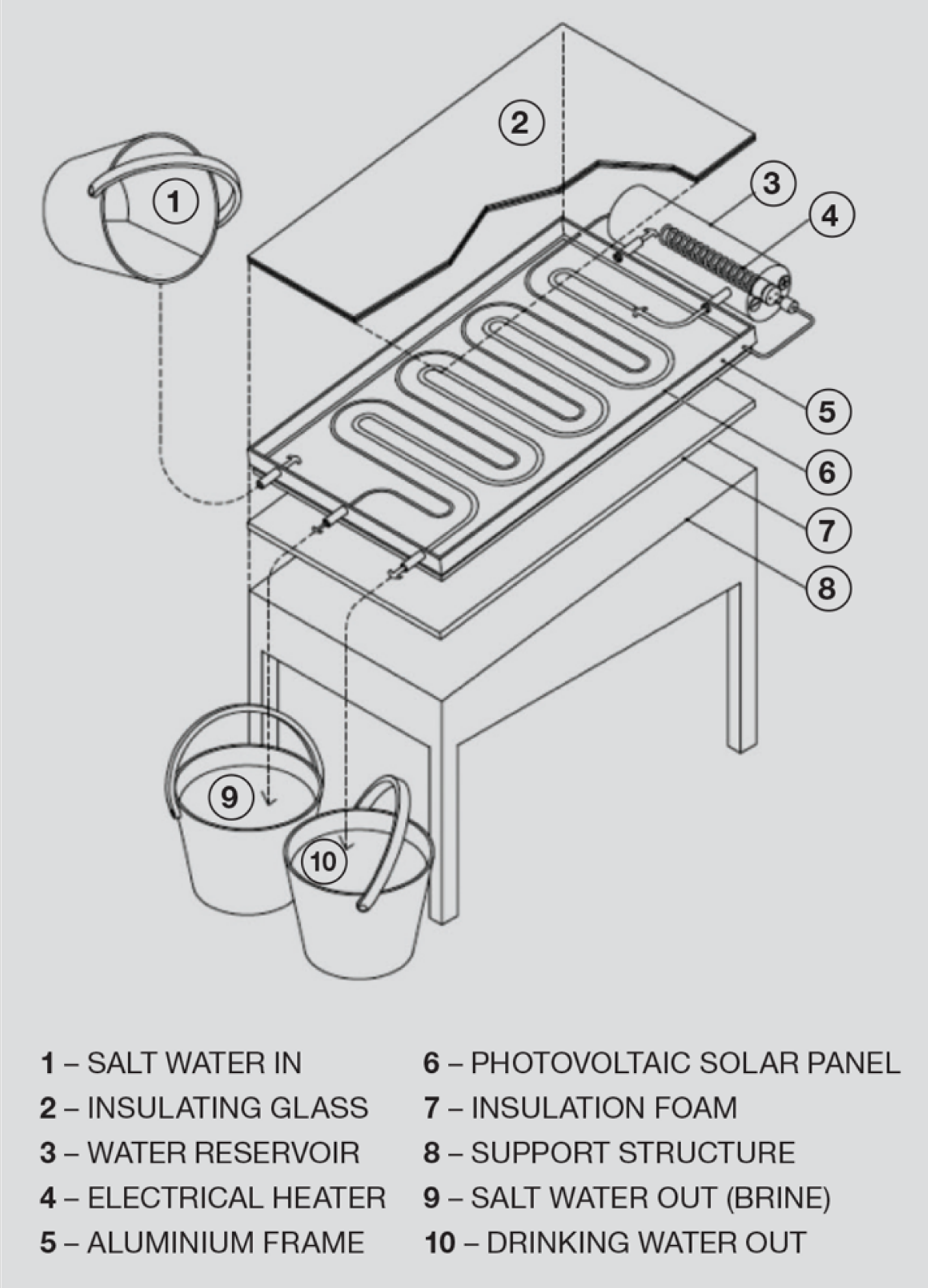


Figure 1: The Desolenator process schematic

We are building this function into portable, household, and community-sized units, the largest of which will produce ~10,000 L/d of water (*see Figure 2*).

We know that user experience is also key to encouraging a transition to sustainable technology, so we have added small innovations to help. For example, to ensure we can process multiple contaminated water sources over an extended period of time, we have added a self-cleaning mechanism to the system that uses the existing steam to remove any buildup of unwanted materials, on a daily basis.

Figure 2: Desolenator models will come in three sizes

Key technological challenges

This isn't the first product to combine two abundant resources - solar power and unpotable water - to create clean drinking water. Devices like solar stills have been in use since pre-Incan people inhabited the Andes, but their critical problem has always been yield.

Early on, Desolenator faced similar challenges to make a high-yielding distillation process, and the first prototype had yields of just 1–2 L. William Janssen, a mechanical engineer and Desolenator's inventor, knew that the key was in retaining heat in the device to maintain a continuous process throughout the day. Developing the unit in his living room over eight months, he has since stated that his "Eureka!" moment came when he integrated a heat exchanger into the device. His wife claims he fell off his chair in astonishment, realising that he had built a potentially life-changing product.

Early prototype, 2014: The goal of building this simple prototype was to study the effect of baffles to guide the water flow inside the water reservoir

Taking on the technical challenge

My dream of becoming an engineer began at an early age. I enjoy tackling complex problems, and doing engineering work came naturally to me. I studied chemical engineering at Delft University of Technology, and graduated with a Master's in 2012. At that time, renewable energy technologies were increasingly gaining profile and I foresaw the need for a sustainable energy storage method. Early on I saw potential in energy storage using salinity gradients (eg table salt concentration differences in water streams), and co-founded a company that develops this into a sustainable battery. Developments were slow and impeded by limited funding, so in the meantime I decided to do a PhD at Imperial College London. Thanks to the flexibility of my supervisors, I was able to work as an engineering consultant alongside my research.

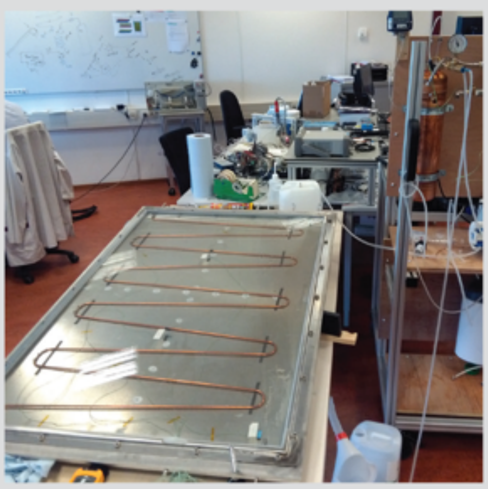
Field trials: A User experience study in Kerala in 2015

> In just over three years we have taken the technology from Janssen's proof-of-concept to three products set for launch in 2018/2019 and filed two additional patents

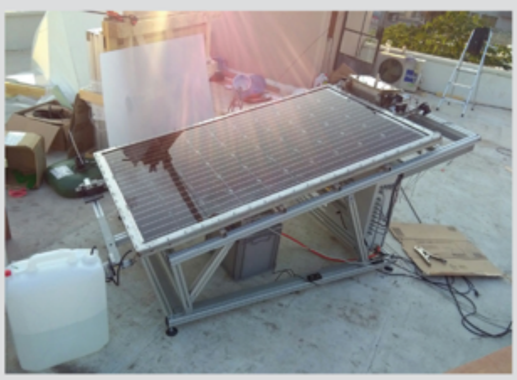
In late 2014, after he had built the first prototype, Janssen came to Imperial looking for a consultant to help perform a thermodynamic and computational fluid dynamic analysis, to optimise his technology. I was truly intrigued by the simplicity of the idea and believed that it could have a tremendous impact worldwide. Without hesitation, I took on the technical challenge. After just a month working with Janssen and his co-founder Alexei Levene, I was also totally committed to the company's vision and became the technical lead.

In just over three years we have taken the technology from Janssen's proof-of-concept (TRL 2) to three products set for launch in 2018/2019 (of which two are at TRL 7), and have filed two additional patents.

Since then, we have been testing and improving our prototypes. Our current technological challenges lie in optimising the process, ensuring the longevity of the materials used, redesigning the aesthetics of the prototypes to make them into commercial units, and completing the various (unfailingly complicated) certification processes for each jurisdiction.



Lab test in the Netherlands
We optimised the length, aspect ratio and configuration of the heat exchangers inside the water reservoir.



Field test 1 in Limassol, Cyprus
This is the first fully assembled Desolenator. It consists of a solar panel with a water reservoir under it where the heat exchangers are located. The boiler is placed next to the solar panel, which has the control box underneath it.

Field test 2 in Dubai, UAE
We incorporated the learning from our first field test into this device. The purpose of this field test was to develop and optimise the control system.

Testing, testing: Lab and field tests will take proof of concept to products set for launch

Building a company

Alongside the technological challenges have been the inevitable highs and lows that come from building a company from the ground up. Highs have included growing our original trio into ten full-time employees spread across our offices in Europe and test sites in the Middle East. We have also expedited our development through accelerator programmes run by Climate-KIC, Singularity University in California, Unreasonable Impact in London, Dubai Futures in Abu Dhabi, and Booking.com and What Design Can Do in Amsterdam.

We have also won a number of awards, from Pitch@Palace, Shell Springboard, to two IChemE Global Awards (Water, and Outstanding Achievement in Chemical Engineering Award) and are gearing up to be a showcase technology at Expo 2020 in Dubai. This recognition has helped us to see the huge range of opportunities where our technology might be applicable, and form long-term partnerships that can accelerate our development.

The lows, however, have also been tough, including a fiercely long struggle to find investment. After multiple months spent wondering if this would be the last, we were delighted to secure seed investment in March 2017. We found a partner where ethos, strategic knowledge and aspirations aligned: our lead investor is at the heart of the world of industrial desalination but aspires to bring clean water to the poorest places.

Spreading the word: Cen explains Desolenator's technology in Dubai

What's next

2018 will be a year for building our portfolio of pilot projects and securing our first official sales. We kicked this off towards the end of 2017 with our first humanitarian project in Lake Turkana in Kenya, an incredibly remote area an 11-hour drive north of Nairobi. Known as "The Cradle of Mankind" (the site of the oldest found *Homo Sapien* fossils), today the water sources in the Turkana

Basin are extremely alkaline, and excess fluoride means average life expectancy is just 47 years of age, and bone and teeth deformities hinder everyday activities.

Working with local partners, and funded through grants, this year we are dispatching units to the local maternity clinic and schools to provide clean water and educational initiatives. The potential wider impacts will be transformational – as healthier children can improve their school attendance, women will have a reduced time burden for water provision, and there will be reduced tensions between nomadic groups competing for clean water.

We are also working with a luxury hotel in South-East Asia to reduce the number of plastic water bottles it uses; in India as part of a micro-entrepreneurship scheme; and hosting conversations with corporates about making their factory processes more environmentally friendly.

Our aim is to implement pilot projects across a multitude of industries, building partnerships that set a new standard for sustainable water production. Next year, the focus will be on launch planning for consumer markets, building up our operational capacity for distribution to disparate regions, and optimising the technology for economies of scale. We are also hugely excited about our products becoming ready for the home, and for corporate use.

Fightback: Desolenator could help eliminate bone deformities caused by excess fluoride in water

The bigger picture

I am relentlessly driven by the thought of getting our technology out to the people who really need it, and the knowledge that clean drinking water is fundamental to solving the other issues that humanity faces. I challenge you to think about how we can even begin to meet the Sustainable Development Goals such as eliminating poverty (SDG1), building sustainable cities (SDG11) or ensuring peace (SDG16) if we haven't sorted out water first.

The sustainable and reliable production of clean water will be hard. Yet I am confident that humans have the power to achieve it. At Desolenator we will make a small dent, providing water independence through our solar-powered technology, and raising the profile of the water crisis in public consciousness. However we can't do this alone. If you are an investor or potential partner, get in touch with us at info@desolenator.com.

And in the meantime, keep hydrated.

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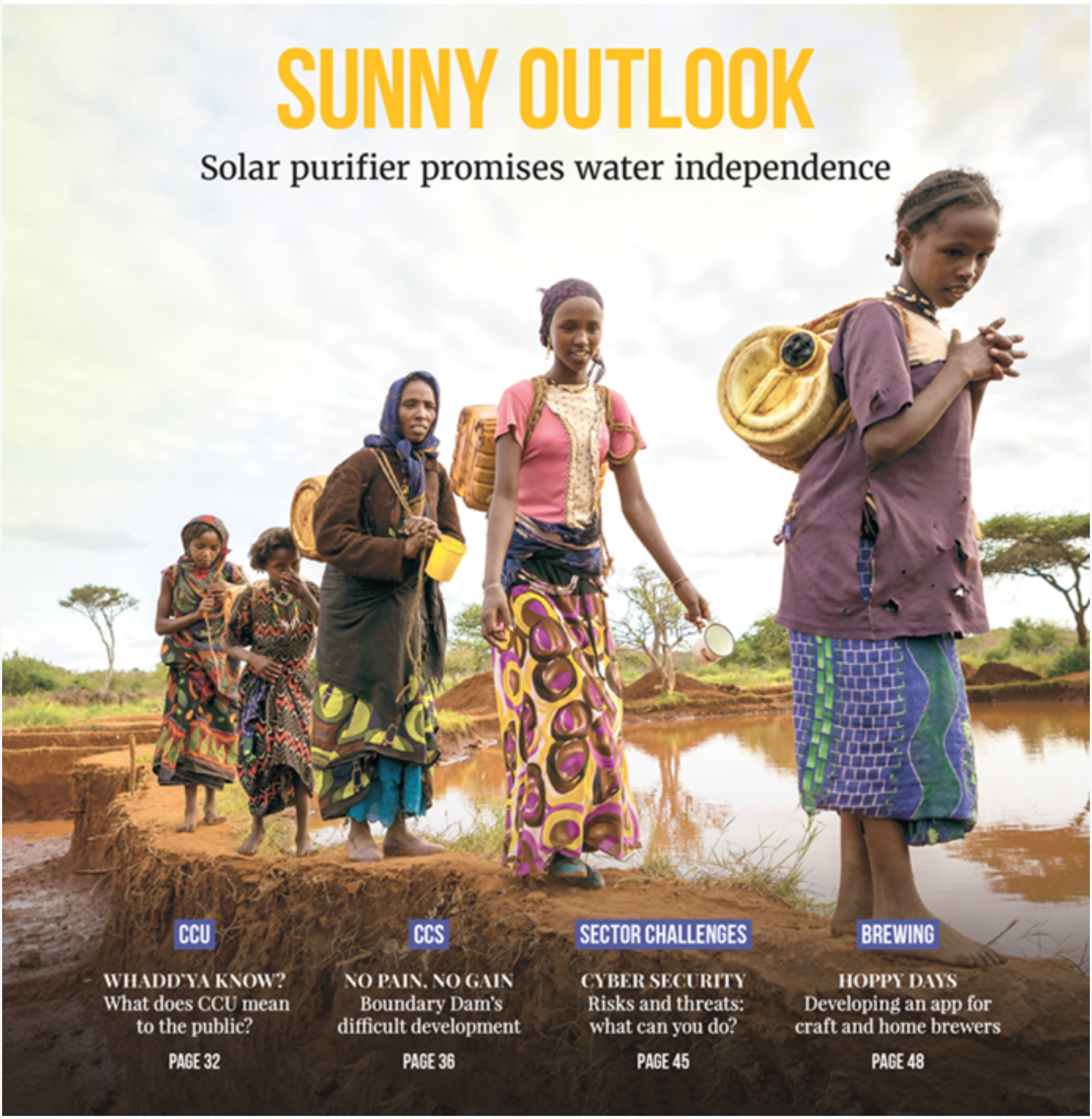

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