DESALINATION

Can desalination aspire to having a global impact?

One should take a moment to reflect on how scarce freshwater really is on planet Earth; all the freshwater in lakes, dams, aquifers and rivers make up less than one percent of our planetary water. Hence the urgency with which this precious, life-sustaining resource is being managed around the world, is completely understandable. So writes Dawid Bosman of the Trans-Caledon Tunnel Authority.

But as this miniscule slice of the water pie chart comes under greater pressure from the Anthropocene, as urbanisation, population growth and climate change take its toll on our freshwater security, it surely begs the question: "What about the abundant 97% of planetary water that is saline, found in the sea and salty lakes and aquifers? Could that not be accessed?" And yes, quite simply, the technology exists, it is quite mature, and it is already being done on a vast scale in a select few markets, mainly in the Middle East.

As it stands now, desalination adds about 24 billion cubic metres per year to the global water supply and serves about 300 million people. This contribution grows at a compound annual growth rate of about 7.9%, according to Global Water Intelligence (GWI).

Projecting this growth rate forward to 2030, desalination should be adding about 3.6 billion cubic in new supply each year by the end of the decade; equivalent to 4.5 times the yield of phase one of the Lesotho Highlands Water Project in new supply, each year.

Simultaneously, the globe's freshwater supply is increasingly constrained. This is not unexpected; in 2009, the ***2030 Water Resources Group*** projected in their seminal report ***Charting Our Water Future*** that a 24% global water deficit would arise by 2030, if water productivity and augmentation continued to follow historical trends. The message was clear: Business as usual in the consumption and supply of freshwater would not be sufficient to avert the deficit. This was an urgent call on the global water sector and major water-consuming industries to accelerate the adoption of water-saving technologies in mining, agriculture and manufacturing. Many of these options appeared viable. There was less enthusiasm for water augmentation, due to fewer workable options and a steep marginal cost curve, culminating in seawater desalination, the most expensive option at a prohibitive $0.80 per kilolitre, and back then entirely reliant on fossil-based energy.

Today, fourteen years later, the world is not on track to resolve the anticipated deficit by 2030. If anything, the realisation has taken root that the global water challenge encompasses much more than mere supply and demand; the UN 2023 Water Conference highlighted the triple planetary crisis of climate, biodiversity and pollution. And yet, it is projected that by 2030, some 1.5 billion people would no longer be able to rely on traditional sources of freshwater, largely because of climate change and urbanisation.

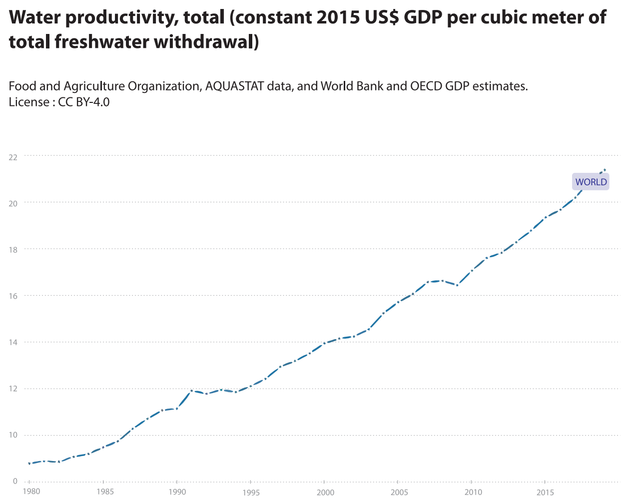


Figure 1: Global water productivity index (1980-2019). (World Bank, 2023)

Looking to the World Bank's tracking of the water productivity index, as shown in Figure 1, there has been no significant accelerated rate of improvement in the quantum of water we require per unit of economic value creation in the decade since 2009. It would seem that demand management and conservation are not progressing fast enough, and the world is not on track to close the water deficit anticipated by the 2030 Water Resources Group.

Whilst recognising that climate change, in particular, has proliferated the water-related challenges into many areas, a key question remains unanswered: How do we bring new water into the global water supply system?

The *Future of Desalination International Conference (FDIC),* held in Riyadh in September last year, may have provided a glimpse on at least a part of the answer. I was fortunate to be there, serving as a panellist in the finance and policy stream. The high-profile event was co-sponsored by the UK-based GWI and the Saudi Saline Water Conversion Corporation, the world's largest owner of desalination capacity, producing nearly 7 million cubic metres per day.

The aim of the conference was to explore if the global seawater desalination industry would be capable of a significant, breakout expansion, to jump from serving 300 million people to serving 1.5 billion people, amounting to a five-fold growth in a mere eight years. As the industry is now, GWI assessed, it is simply too complicated, expensive and risky to grow this rapidly. But, perhaps at FDIC we could explore how to transcend this.

It was clear at the outset that the technology domain of desalination did not present the fertile ground for dramatic growth; most technologies in seawater reverse osmosis (SWRO) are already quite mature, and the outlook for advances and innovation is limited to mostly incremental improvements in energy efficiency, recovery rate and mineral harvesting. While this may yield some cost savings, the incremental technology advances in SWRO could not unlock a market of 1.5 billion people.

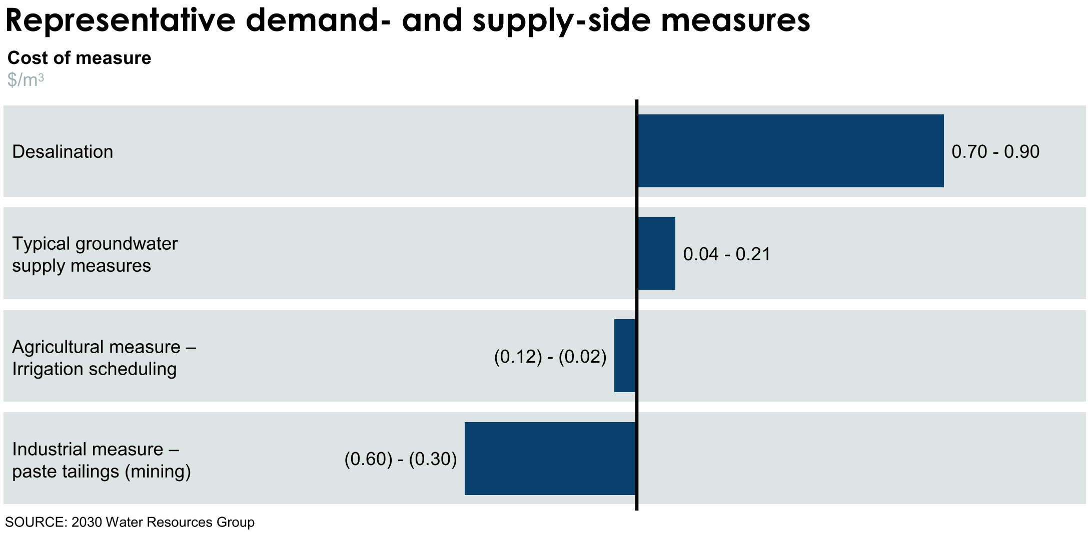
Much more scope for improvement was deemed to exist in the finance and policy domain, where significant hurdles continue to impede the path to low-priced, simple and dependable desalination. A key obstacle is the general lack of well-informed and consistent government policies pertaining to the implementation and operation of desalination; this is especially so in the emerging desalination markets, beyond the Gulf nations and Middle East. And as we know, policy uncertainty tends to inhibit investment.

There are a number of strategies which most governments do not know how to craft and execute, such as the integration of desalination into an existing water resources portfolio, especially when demand for additional supply is seasonal or drought related, or how to make the trade-offs between marine impact and costs, or how to integrate desalination into a renewable energy strategy. Furthermore, there is only sparse knowledge on how to manage the financing risks, which can add to the financial outlay, and often, an absence of the necessary conditions for a successful desalination implementation, such as low non-revenue water and cost recovery tariffs. These are not easy challenges to overcome, and the organisers of FDIC felt that the conference would make a substantial start to having the conversations that would eventually provide some answers.

The conversations did not disappoint, and some powerful insights emerged.

Seawater desalination is still perceived as expensive, even though the benchmark price has dropped significantly over the past decade, and especially since around 2019, mainly as a result of the combined effect of cheap renewable energy, transparent procurement and contracting methods, and the shift towards very large-scale projects. All-inclusive prices around the $0.40/m^3 mark have frequently been seen in the mature Gulf Cooperation Council (GCC) and Middle East markets, provided that it is produced at large scale, around 500 megalitre per day, and using reverse osmosis (RO) technology powered by renewable energy.

However, if the benchmark could be lowered to $0.20/m^3, in all markets, desalination would become a viable source of water for agriculture as well. This would be a significant breakthrough, as desalted seawater then becomes a transformational force



Representative demand- and supply-side measures.

in solving climate change; deserts could be greened, and vast amounts of CO_2 could be captured into the newly formed biomass. In this way, desalination could become part of the solution to climate change, instead of a contributor to the problem. But how could $0.20/m³ desalination be achieved?

A first step would be integrating desalination with renewable energy, to bring the energy cost element down to $0.02 per kWh. This is not unreachable, as solar photo-voltaic projects in the Middle East / North Africa region have already yielded feed-in tariffs of around $0.01 per kWh. However, so far, desalination developers are mostly denied that pricing, and are compelled to pay a much higher fee for grid electricity, upon the reasoning that all off-takers need to pay for the grid, and solar energy does not work at night. However, demand peaks and troughs are a challenge to power grid operators, and desalination plants can run very well at night, when there is often a demand trough, so there is room for finding mutually beneficial solutions, on a case-by-case basis.

The proposed way forward is to introduce the concept of 'energy freedom' in the procurement process, whereby independent water producer (IWP) bidders can negotiate menus of peak and off-peak prices with energy suppliers, or even build their own captive power plants, if necessary. In South Africa, the easing of regulations in 2021 which previously restricted private power generation, now allows uncapped embedded power generation, and in this manner a local pathway for such solutions is already visible.

A second factor towards the goal of $0.20/m³ is to scale up the plant capacity. One reason why the price of desalination has fallen in recent years is because of scale. Ten years ago, a 100 Ml/day plant was considered big, and the rule of thumb was that engineering, procurement and construction (EPC) costs should be around $1,000 per each cubic metre per day capacity. Today, 1 000 Ml/day facilities are built at a price closer to $650 per cubic metre per day capacity. The assessment from the technical stream at FDIC was that to reach $0.20/kl desalination, the specific EPC cost needs to come down to $450, which will require building at a scale of about 2 000 Ml/day.

When building at such a massive scale, an optimised plant configuration will be essential. What comes to mind are the innovative, easy-to-maintain vertical installation of pressure vessels of the Soreq desalination plant, the energy-flexible pressure centre design of IDE Technologies, the high recovery designs that allow reduced water handling throughout the plant, and prudence in the setting of operating specification of the plant. But even more innovation will be required; one such example may be Veolia Sidem's 'Barrel', a massive pressure vessel containing hundreds of RO elements, yielding benefits of cost, spacial efficiency, and ease of maintenance.

One caveat of massively scaling up plant capacities, is that seawater abstraction and brine dispersal will require much more attention, to minimise the impact on the marine environment. On the one hand, there are fine examples of well-designed marine works and diligent monitoring of brine dispersal during operation; the Kwinana desalination plant in Perth, Western Australia comes to mind. But it is important to feed such good practice into a prudent permitting process for new developments. An example not to follow would be the stalled development in Huntington Beach, California, where poorly advised activism and overly onerous regulation has incurred more than $100 million in legal costs, without any soil being turned or a single drop of water produced. One solution may be to establish a credible industry certification relating specifically to the marine interface, containing clear parameters for design and permissible impacts, to introduce a standard guidance for local regulators to follow, and to simplify the environmental approval process, especially in jurisdictions where desalination is new.

In conclusion, the matter of water security is becoming increasingly complex, moving well beyond the conventional supply-demand calculus. But there is some relief in the knowledge that humanity has mastered the technology of drawing freshwater from the infinite oceans, that it can be done cleanly and cost-effectively, and is vastly scalable. If the step-change in scale could be achieved, and the sea becomes the water resource for billions of people, we may well have gained a most powerful adaptation response to climate change.