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Water and Industrial Development
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Desalination in South Africa: Panacea or peril for industrial development?

Muhammed Patel, Trade & Industrial Policy Strategies (TIPS)

Outline

1. World trends
2. South Africa's experience
3. Manufacturing
4. Policy Implications

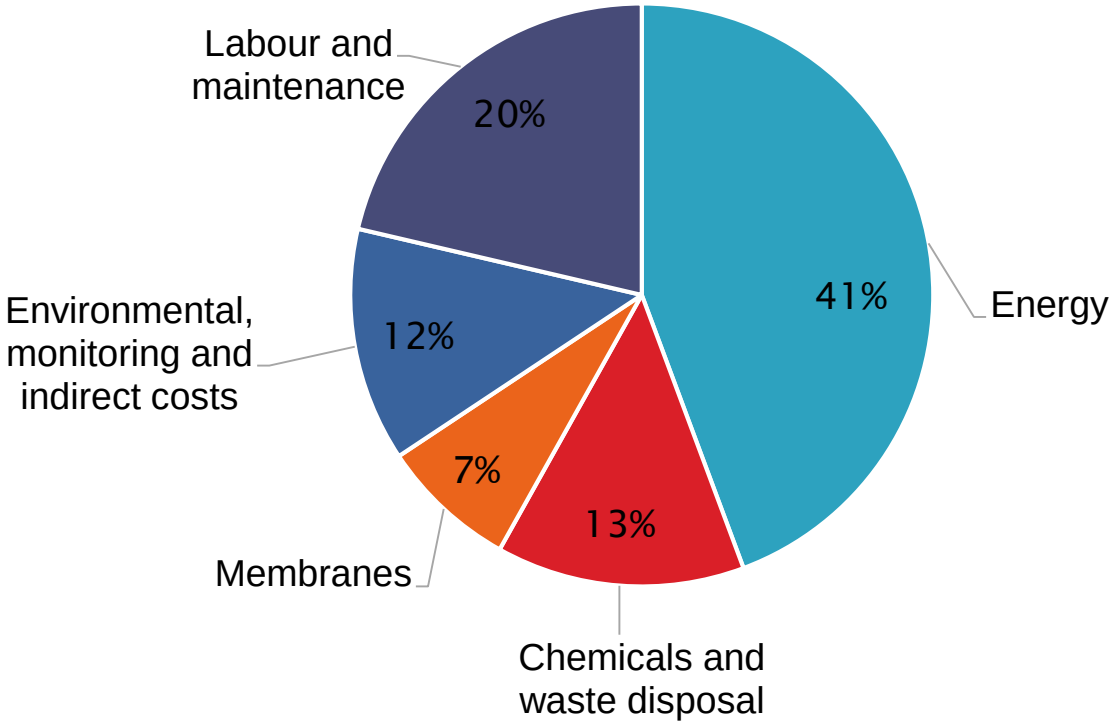
World trends

Overview

- Over the past 30 years, desalination technology has evolved as a viable, albeit costly means of producing water, opening up non-traditional sources of water like brackish water and seawater.
- Desalination via reverse osmosis (RO) is the prevalent membrane separation process internationally.
- An RO desalination plant is built on four integral systems: pre-treatment, high-pressure pumps, membrane systems, and post-treatment.

Cost drivers & trends

Primary cost drivers of RO desalination OPEX

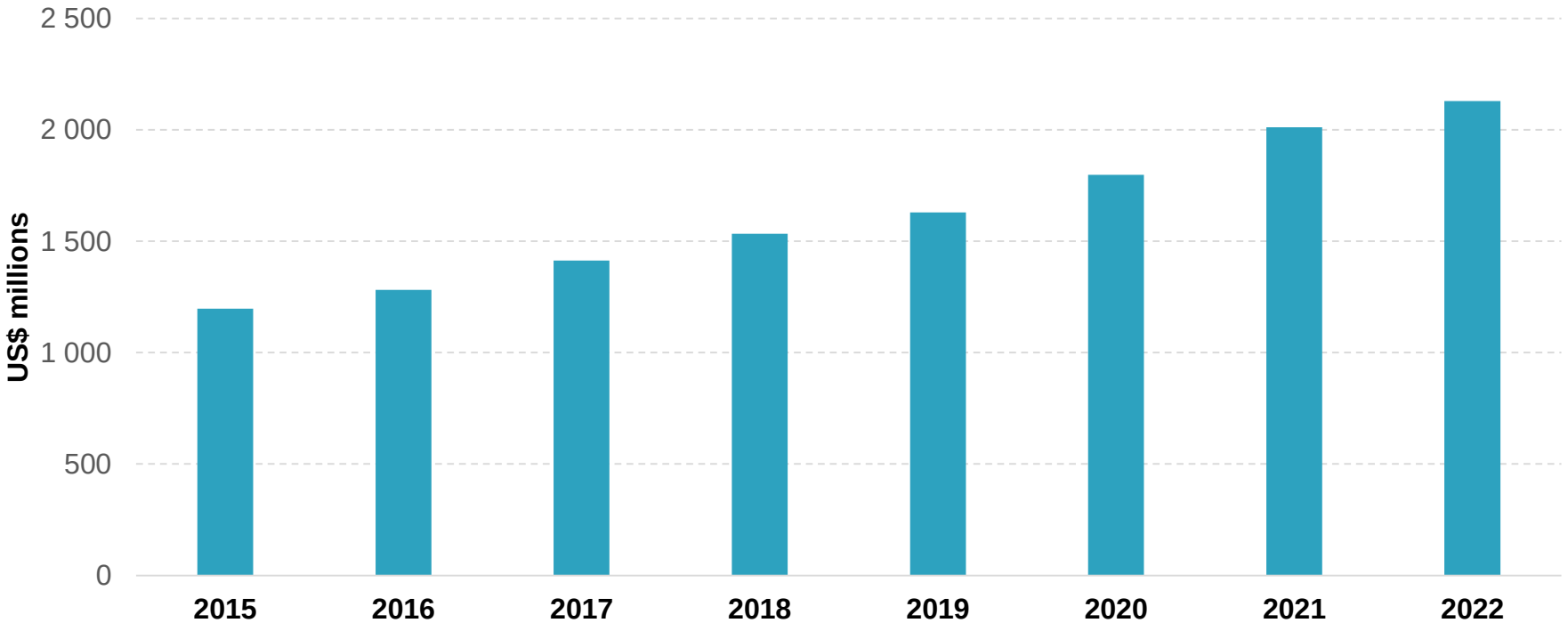


Source: Author's adaptation of CMI and Almar Water Solutions, 2016, p. 15; Advisian, n.d.; WRC, 2015a, p. 25

Desalination in perspective

- Desalination accounts for only 1% of the world expenditure,
- However the technology faces strong growth prospects over the near future.

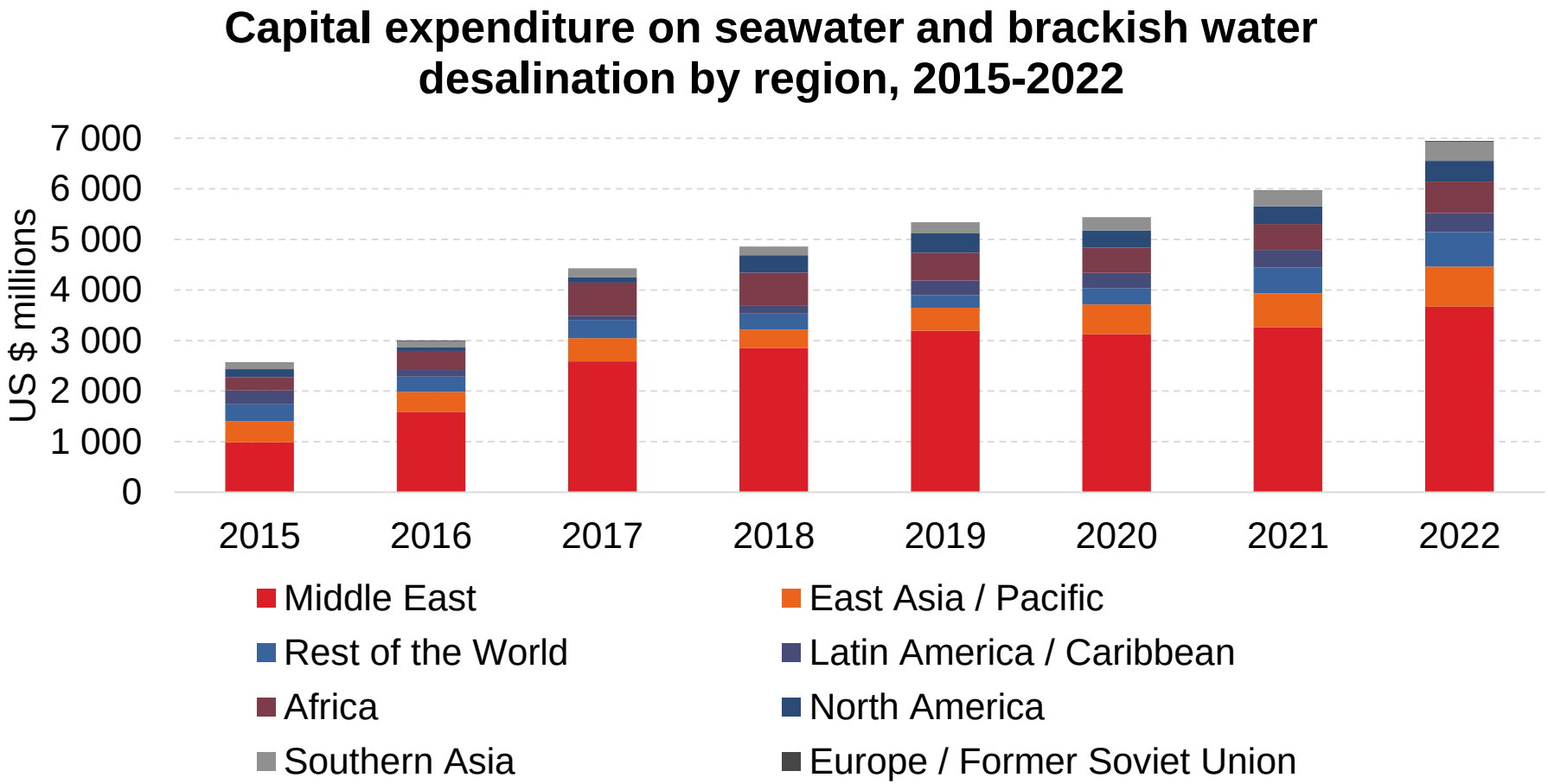
Global capital expenditure on desalination from 2015 to 2022 (in USD million)



Source: Author, based on data from GWI

Global expenditure

- Most new capacity is expected in the Middle East, however promising developments expected in Asia, US and Latin America.



Source: Author, based on data from GWI

South Africa's experience

Desalination so far

- Implementation of desalination in South Africa has been limited with a few small-scale desalination projects

Owner/Operator	Location	Detail
Veolia	Mossel Bay	15 ML/day plant – currently mothballed
Veolia	Knysna	2 ML/day seawater desalination plant
Veolia	Plettenberg Bay	2 ML/day seawater desalination plant
Cederberg Municipality	Cederberg	1.7 ML/day seawater desalination plant
Knysna Municipality/ Grahamtek	Sedgefield	1.5 ML/day plant
Veolia	Cannon Rocks & Boknes Communities	Plant produces 750 m^3 of water per day from groundwater

SA Dynamics

- The high energy costs associated with seawater desalination have served as a barrier to its implementation thus far.

- The largest desalination plant in the country, operated by Veolia, was mothballed due to the high cost of producing water. The cost of water was approximately double that of water sourced from a dam: **R16 per kilolitre for desalinated water as compared R9 per kiloliter (avg municipal price).**

- In WC, three seawater desalination plants, which cost R250 million each, were expected to be running by March 2018. These plants only went online in August 2018, after delays related to water quality amongst other reasons. These plants cost up to **R40 per kilolitre.**

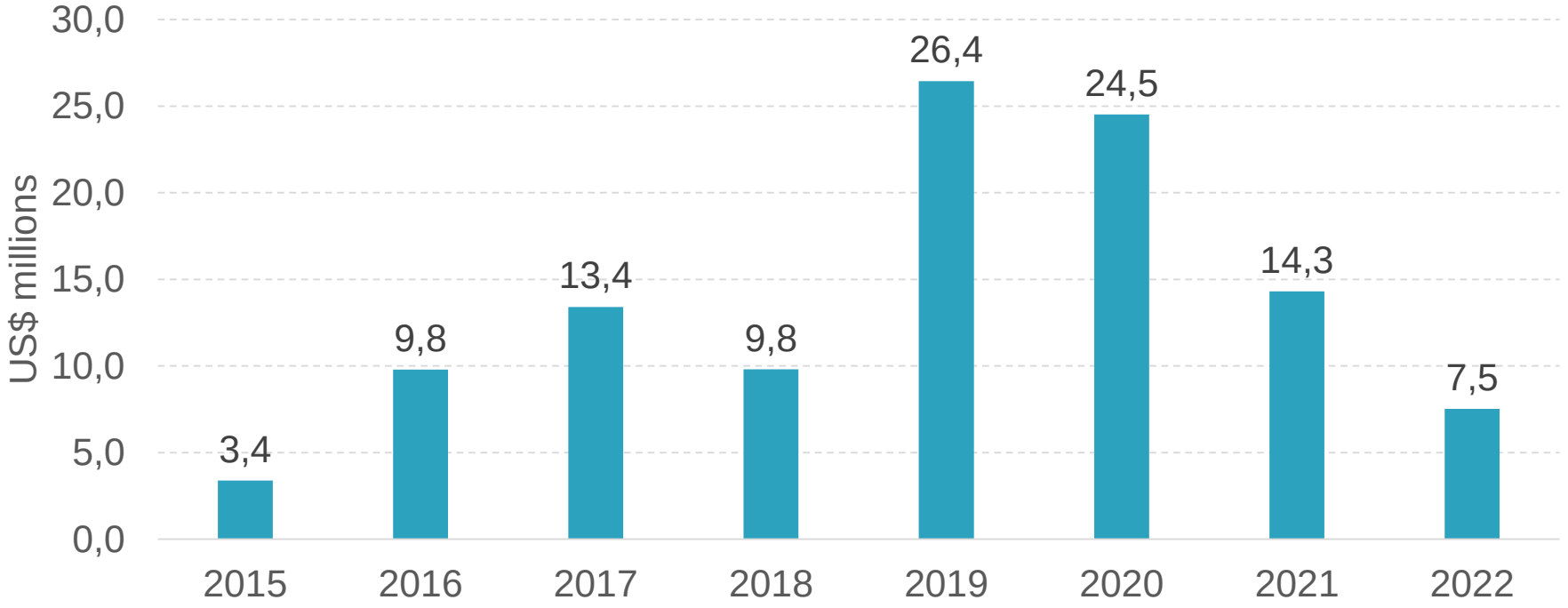
Industrial desalination

- Industrial desalination has seen more successes however.
- Anglo American supplies 30 million litres of potable water per day to Witbank community – approx. 12% of drinking water
- Glencore supplies 15 million litres per day to the 20% of the Hendrina's community
- Sasol Secunda also has desalination operations to purify AMD water from coal activities

SA Investments

- Desalination capital expenditure is less than 2% of expected total spending in the water sector.

Figure 3: Capital expenditure on desalination in South Africa, 2015-2022

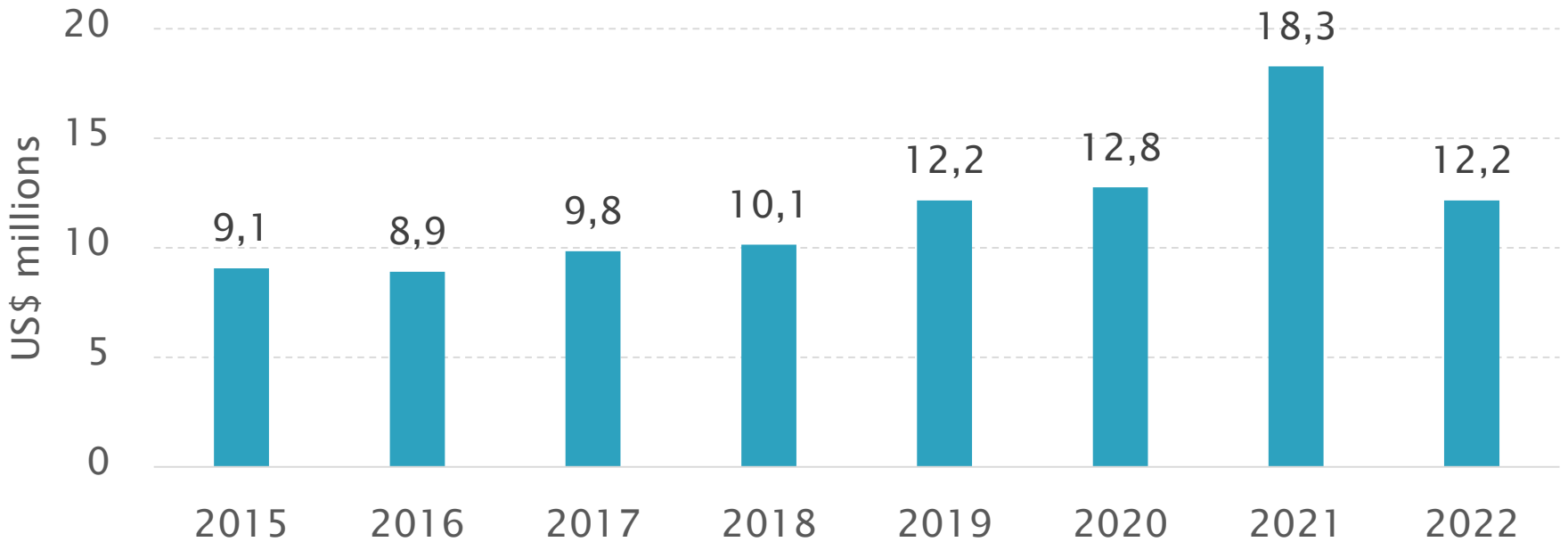


Source: Author, based on data from GWI

Membrane Trends

- Membranes are a crucial component of the RO system.

Figure 4: Capital and operational expenditure on desalination-related equipment, in South Africa from 2015 to 2022



Source: Author, based on data from GWI

SA Dynamics

- What began as ambitious plans for future desalination projects in South Africa have evolved into an environment with a high probability that many projects will not come to fruition.
- Umgeni Water desalination investments have been temporarily deferred projects due to rising electricity costs, in favour of investments in the Lower uMkhomazi bulk water supply scheme dam. This assumedly includes R1 billion to be spent on the Durban SWRO, the Umgeni Water East Coast Desalination project, and the Elysium SWRO.
- Cape Town has recently shifted its focus away from desalination to more cost-effective measures, with some desalination projects being halted due to other projects exceeding the budget.
- In all likelihood, desalination expenditure will be lower than expected, **indicative of a smaller potential local market.**

Manufacturing

Global suppliers

- Globally, large specialist multinational firms lead large-capacity desalination infrastructure projects.

Firm	Head Office	Notable projects
IDE Technologies	Israel	Sorek Plant (Israel), Santa Barbara Plant (USA), Carlsbad Plant (USA), Tianjin Plant (China)
Hutchison Water	Singapore	Sorek Desalination Plant (Israel)
Doosan	South Korea	Ras Al Khair Plant (Saudi Arabia), Shuaibah Plant (Saudi Arabia), Busan Gijang Plant (South Korea)
Fedco	USA	Jeddah III Plant (Saudi Arabia)
Veolia Group	France	Basra (Iraq), Jubail I and II Plants (Saudi Arabia), Sur Plant (Oman)
IVRCL	India	Minjur Plant (India)
Abengoa Water	Spain	Carboneras Plant (Spain), Chennai Plant (India), Ténès Plant (Algeria)

Local suppliers

- In SA, there are a handful of local providers, of which only a few are proven.

Firm	Products/Services	Notable desalination projects
Veolia	Designs, constructs, commissions and operates desalination plants through its association with the parent company, the Veolia Group in France.	Operates five desalination plants throughout the country including the large Mossel Bay plant.
Grahamtek	Designs, constructs, commissions and operates desalination plants in South Africa and abroad.	Operates the desalination plant in Knysna.
Proxa	Designs, develops, engineers and constructs reverse osmosis systems for a range of specifications.	Was awarded the tender for the supply, establishment, and operation of the CoCT, Strandfontein and Monwabisi desalination plants in the WC in a joint venture with Water Solutions.
Quality Filtration Systems (QFS)	Designs, develops, engineers and constructs RO systems in South Africa.	Was commissioned by CoCT to Design, Supply, Establish, Commission, Operate the V&A Waterfront sea water RO desalination plant.

Local suppliers

Firm	Products/Services	Notable desalination projects
Energy Partners Holdings	Energy Partners Holdings is a new entrant into the desalination space.	Was commissioned by the CoCT to supply, establish, and operate a Sea Water RO Plant in Harmony Park Strand.
Water Solutions	A partnership between WSSA and Sikhulakahle Water Services cc which supplies water services in South Africa.	Was awarded the tender for the supply, establishment, and operation of the CoCT, Strandfontein and Monwabisi desalination plants in the WC in a joint venture with Proxa.
Water Skills	Conception, equipment manufacturing, commissioning and operation of reverse osmosis products.	N/A
Aveng Water	Design, construction, and operation of desalination plants.	Designed, constructed, and operates the largest seawater desalination plant in southern Africa, the Erongo Desalination Plant in Namibia.
Water Purification Chemicals & Plant	Design, supply and installation of desalination plants.	N/A

Local suppliers – membranes

- Membrane manufacturers are limited to a small number of global firms.

Firm	Parent company	Location
Dow Filmtec	Dow Chemical	USA
Fluid Systems	Koch	USA
Hydranautics	Nitto Denko	USA and Japan
Toray	Toray	Japan
Osmonics	General Electric Power	USA
Rochem	PALL	Germany and USA
Toyobo	Toyobo	Japan
Vontron	South Huiton	China
Yarn-Home	Yarn-Home	China
Kent	Kent	US
LG Water Solutions	LG Chem	USA and South Korea
Membratek	Veolia Water Technologies South Africa / Veolia Group	South Africa
Memcon	Memcon	South Africa

Local suppliers – chemicals

- Local and international firms manufacture chemicals for water treatment and desalination in particular.

SA Firms	Global Firms
Protea Chemicals	Ecolab/Nalco
Veolia Water Technologies South Africa	GE Water
Water Purification Chemical & Plant cc Zetachem	Solenis
ECM Chemicals	BASF Water Solutions
Lonza Water Treatment	Kemira
Nanotech Water Solutions	SNF Floerger
Curechem	Dow
NCP Chlorchem	

R&D

- Local R&D generally carried out by water specialist companies, research organisations, and academia.

Firm/organisation	Notable research
WRC	WRC recently conducted an investigation into desalination in South Africa, exploring the background, current status, and costs of desalination plants in South Africa. More recently, the WRC looked at the factors impacting the choice of desalination locations in South Africa.
UCT	Project to increase the recovery yields from mine waste water using RO, which is less energy intensive than other separation mehtods.
Grahamtek	Project examining decreasing the energy use of RO desalination through waste-to-energy technology and off-grid desalination solutions. Also involved in developing barge-based mobile sea desalination plants for emergency disaster relief.

Policy Implications

Policy implications

- Desalination is not fit for **wide-scale** rollout in the country.
  - Technology is highly capital-intensive, requiring substantial investments to erect plants and large plants are required to make a difference.
  - Technology is associated with high operating costs.
  - These costs translate into a high water price – if users cannot afford to pay, plants lie dormant which is also a huge cost to the fiscus.
- Prudent to direct resources in addressing challenges which can be targeted with lower costs, such as *reducing water losses* in the system, *addressing maintenance of existing infrastructure*, and *demand management*.
- Further rollout should be examined very carefully.

Policy implications

- From an industrial development point of view, desalination appears to be falling out of favour by local public entities, and desalination is unlikely to be a substantial component of the water mix moving forward.

- The market for desalination services in SA is relatively small and not expected to grow substantially over the near future given the trends and investment environment.

- Local manufacturers of desalination technologies are export-oriented, servicing centres of demand such as the Middle East (e.g. Grahamtek)

Policy implications

- Given the local context, current support measures geared towards supporting these firms should be maintained, however it would be inappropriate to mobilise substantial funds and support to attempt to create a local desalination industry when there is a very limited local market.

- Licenses can be used to encourage industrial activities such as mining to utilise desalination in water treatment.

- Local industry support in international projects: where flexibility is allowed to project-implementing firms like Grahamtek to procure their own supply, incentives to support South African manufacturers of desalination-related equipment should be encouraged.

Policy implications

- Examples include subsidies or other support measures that make SA-produced products or services attractive, drawing in adjacent South African manufacturers into such foreign desalination markets.

- R&D funding should be maintained to seek technological advances and potential cost-savings.

- In the South African context, the setting of priority themes in desalination R&D can include energy efficiency, non-renewable energy use, and the use of affordable solutions, and funding can be directed towards these initiatives.

Trade & Industrial Policy Strategies

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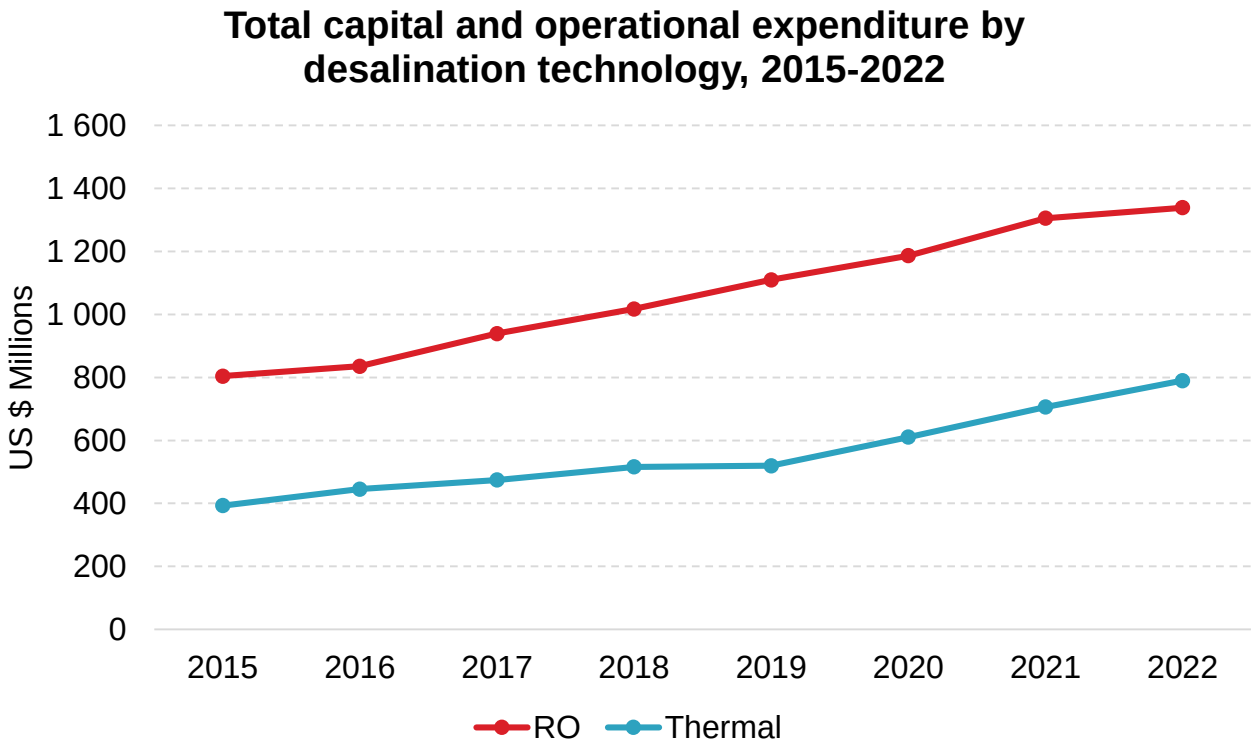
Muhammed Patel
Economist: Sustainable Growth
muhammed@tips.org.za

Backup slides

Global dynamics

- RO desalination dominates the market globally and this is reflected by the larger and rising capital expenditure on membrane-based desalination projects



Source: Author, based on data from GWI

Planned SA projects

Project name	Client	Expected cost	Project description
Amatola Water BWROs	Amatola Water	ZAR 60 million ($6.6 million)	Construction of three brackish water reverse osmosis (BWRO) plants as part of the Ndlambe Bulk Water Supply Scheme. The existing 750 m3/d BWRO plant at Cannon Rocks will be enlarged and upgraded to a new capacity of 6,000 – 6,500 m3/d, while a new 5 000 m3/d BWRO facility is planned for Port Alfred, and a new 7 000 m3/d BWRO facility at Dabi.
Saldanha Bay	West Coast District Municipality	ZAR 500 million ($46 million)	To construct a 25 500 m3/d desalination plant to supply 22 towns in the West Coast Region. The plant will be built in three phases of 8 500 m3/d each, depending on demand, although the supporting infrastructure, including as the intake and outfall, will be designed to handle the full capacity from the outset.
Durban SWRO	Umgeni Water	ZAR 5.1 billion ($382 million)	Up to two seawater reverse osmosis (SWRO) plants of 150 000 m3/d each to serve Durban and Pietermaritzburg. Two potential sites have been identified: one near the Lovu River on the south coast and another near the Mdloti River to the north of the city. Indications are that this investment will be deferred due to escalating electricity costs (IOL, 2017)
Cape Town SWRO	City of Cape Town	n/d	To construct a desalination plant with an initial capacity of 150 000 m3/d, expandable to 450,000 m3/d, to serve the municipality of Cape Town. The final capacity and technology still have to be determined, but it is likely to be an SWRO plant.
Zandkopsdrift rare earths project SWRO	Sedex Desalination	n/d	A new SWRO plant with a capacity of up to 8 million m3/year (22 000 m3/d) to supply process and potable water to the Zandkopsdrift rare earths project in the Northern Cape. The plant would employ DAF/DMF pre-treatment steps, and is scheduled to employ an open water intake incorporating coarse and fine screens.

Source: Author, based on data from GWI

Planned SA projects

Project name	Client	Expected cost	Project description
Kouga desalination plant	Kouga Local Municipality	n/d	The municipality of Kouga is investigating the possibility of building a desalination plant, and is looking to undertake a feasibility study as the first step. The study will compare the feasibility of a desalination plant to various alternatives, including a recycling plant which would treat sewage effluent to potable standards, and the development of a new wellfield to supplement existing groundwater resources.
Elysium SWRO	Umgeni Water	n/d	To build a 2 500 m3/d SWRO plant to provide potable water for pumping to the Elysium Reservoir south of Durban. The plant would be expandable to 10 000 m3/d in future.
Umgeni Water East Coast Desalination	Umgeni Water / eThekwini Municipality	n/d	To build two East Coast 150 000 m3/d seawater desalination plants. An official tender was issued on 25 June 2012 for the appointment of a professional service provider to undertake the environmental impact assessment study.
Lucky Star (St. Helena Bay) and Amawandle (Laaiplek) fish factories	Oceana Group	ZAR 22 million ($2.4 million)	Two canned pilchards and fishmeal processing plants are expected to have two desalination plants installed. Phase one of a R2 million desalination project is expected to be completed over the next few months at Amawandle, while phase one of a R20 million desalination plant is expected to be completed by the end of March at Lucky Star (Netwerk24, 2018).
Hessequa hybrid solar desalination plant	Municipality of Hessequa	ZAR 9 million ($0.9 million)	Co-funded by the Western Cape Government and the French Treasury, a hybrid solar-powered desalination plant will be commissioned by the end of October 2018. The plant is planned to produce 100 kilolitres of water per day powered by the solar energy only, to address the normal local water requirement. Outside of daylight hours, grid electricity can be used to produce up to 300 kilolitres of water per day (Engineering News, 2018b).

Source: Author, based on data from GWI

Business Model: Techno-economic

- Desalination is technically possible in South Africa – producing water at an affordable cost is the primary barrier to implementation and is contingent on a number of factors.
  - Geography: Seawater desalination appropriate only in coastal towns, and constructed in light industrial areas, ports, or harbours due to space requirements. Substantial civil works are required to connect plants to the existing distribution infrastructure.
  - High energy costs: Due to energy intensity, the cost of electricity inputs impacts on the costs and hence the viability of desalination projects. Also presents a conundrum as SA's electricity is primarily dependent on coal.
  - Climate uncertainty: Uncertainty around future rainfall risks viability of project (e.g. Mossel Bay)

Business Model: Techno-economic

- Environmental costs: location of desalination plants can have detrimental effects on the environment. This occurs at the intake of seawater point and the discharge of brine and chemicals at the end of the process.

- Techno-economic analysis of desalination points to substantial economic risks associated with desalination and limited techno-economic potential in South Africa.

Business Model: Funding

- The reality of the SA context is such that resources are constrained.
- Internationally many nations' water utilities face financial constraints and are shifting towards greater private sector participation.
- Involving the private sector in public projects can take on many forms, which involve a sharing of risks and rewards.
  - Performance/ Management Contracts
  - O&M Contracts/Affermage-type contracts
  - Concessions and canon contracts
  - Utility leases

Business Model: Funding

- A fully government-funded desalination strategy given budget constraints where the public sector builds, finances, maintains and operates desalination projects is highly improbable and likely inefficient due to the deep technical skills and knowledge that is present in the private sector.

- Entire private desalination projects absent of any public sector involvement places the management of the nations key resource and public good in the hands of the private sector, which is undesirable.

- A form of PPP arrangement as has already implemented is appropriate – risks and rewards shared between the public and private sector, and will have to be tailored to each project which will depend on the project size and cost, amongst other factors.

Business Model: Socio-political

- A there are a number of stakeholders which stand to be impacted by the rollout of desalination projects.
- Consumers and municipalities will eventually bear the burden of higher tariffs since desalination is a costly technology.
- A lack of proper long-term planning for projects can also lead to a lack of water as was in Cape Town. The knee-jerk reaction to the water crisis and a lack of proper planning resulted in the short-term disaster relief desalination plants being non-operational past their planned start date.
- Depending on the arrangement of projects, Treasury may face increased pressures to invest in the technology placing strain on the national coffers.

Business Model: Drivers and barriers

- Primary drivers:
  - Water supply
  - Socio-economic development
- Secondary drivers:
  - Water efficiency
  - Food security
- Primary barriers:
  - Water quality
  - Environmental sustainability
  - Fit-for-purpose
  - Ease of implementation
  - Cost savings
  - Energy security