POLICY BRIEF

March 2019
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

WATER RESEARCH COMMISSION

Planning for desalination – implementation of an integrated water-energy -climate nexus approach

In view of the water scarcity problem, the National Water Resources Strategy (2) and the draft National Water and Sanitation Masterplan emphasise the need for increased use of alternative water sources. Seawater desalination has been identified as one of the possible responses to meet the growing water demand.

The National Desalination Strategy highlights a number of key considerations for the successful implementation of desalination in South Africa. Among these, is the need for an integrated water and energy planning approach, and corresponding streamlined regulatory approval processes. A Water Research Commission project was initiated to establish an understanding of desalination within the water-energy nexus; clarify the role of desalination with or without drought; explore opportunities for achieving water-energy-climate balance in the context of desalination and identify any knowledge and policy gaps. Results from this study have shown that though a desalination strategy exists, implementation has been lagging as there is no coherence in the existing policies and legislation, and the current regulatory approvals are not adequate for promoting and enforcing an integrated approach for the implementation of desalination as envisaged. A techno-economic analysis of different desalination and energy options showed that co-locating desalination in proximity of power plants, use of less energy-intensive desalination processes, use of renewable energy options, and perhaps in combination with energy recovery and storage, offer the opportunity to lower the cost of water production by desalination.

Background

The increased frequency and intensity of drought, significantly attributable to climate change, is already causing acute water shortages in many parts of the world, including parts of South Africa. In general, four interrelated processes drive water stresses: population growth; economic growth; increased demand for food, feed and energy (of which biofuel is one source); and increased climate variability. In view of the projected water supply gap, the second edition of the National Water Resources Strategy emphasizes on the use of alternative water sources to meet demand. Among these, seawater desalination has been identified as one of the possible responses to meet the growing water demand. Desalination is a mature process comprising different technologies which have historically been favoured in different parts of the world. Desalination capacity is poised for substantial growth in the coming decades as countries explore alternative solutions to meet growing water demand. In a similar manner, the number desalination plants constructed and commissioned in South Africa since the 2009/10 spate of drought has increased significantly.

The National Desalination strategy

Apart from being a water scarce country, South Africa is not immune to the effects of climate change and variability, urbanisation, etc, on water resources. In view of this problem, the second edition of the National Water Resources Strategy (2013 version) emphasizes on the need for increased use of alternative water sources. Seawater desalination has been identified as one of the possible responses to meet the growing water demand and as strategy is in place to guide its implementation. The National Desalination strategy highlights a number of key strategic considerations for the successful implementation of desalination in South Africa. An understanding of the critical factors for success and guidelines for the implementation of desalination addressing planning aspects, financing options; selection of appropriate technology and equipment; operations and maintenance costs, as well other management, consumer, staffing and resources requirements have been identified as some of the prerequisites for desalination in South Africa. With regards to planning, the strategy emphasizes on the need for an integrated nexus approach considering water source, scale (demand), location, energy and environmental considerations, as well as the associated regulatory approvals.

Current practice in the implementation of desalination

Though desalination has been used in South Africa for decades now, its scale of application in the municipal sector has not matured well enough to the level observed in other similar water scarce countries. Though a number of reverse osmosis (RO) desalination plants have been commissioned to date, most of these are small-scale and have been constructed as emergency plants to alleviate water shortages due to droughts, as and when they are experienced. Planning and the regulatory approval procedures followed for implementing most of these seawater desalination projects largely hinges on Environmental Impact Assessment (EIA) requirements. This is in contrast to the integrated nexus approach considering the dynamic interplay between water, energy and climate change purported in the National desalination strategy. The current drought crisis and projected water deficits present an opportunity for re-directing the course of desalination implementation in South Africa by integrating water, energy and climate change aspects in planning and decision-making. Systematically balancing the relationships between water, energy and climate change can contribute to the increased sustainability and resilience of desalination as an assured water supply option. A recently completed Water Research Commission study provides more insights on the role of desalination within the water-energy-climate nexus; with or without drought; and explores opportunities for achieving water-energy-climate change security in the context of desalination.

Techno-economic analysis of the water-energy-climate approach to desalination

This study considered several strategies and evaluated the costs and economic viability of certain implementation options. The linkages between desalination, energy and climate change were identified, with a specific focus on the following:

- Identifying opportunities to optimise the operation of desalination plants, balancing the cost of water production in terms of energy requirements and cost, energy utilisation, capital expenditure and recovery, operational cost and operability.
- Considering integrated water/energy solutions, with the exploitation of the potential benefits of co-location and cooperation of water and energy generation (and storage) technologies.
- Dovetailing of desalination with renewable and non-carbon-based energy sources, and the implications of such strategies.
- Considering desalination as a climate change adaptation strategy to reduce the impact of increased variability in weather patterns and reduced long-term rainfall.

Summary of findings

Findings showed that the economics of desalination are tied to the cost and quantity of energy used for the process, as energy is the single largest variable cost for a desalination plant. Membrane processes (ie Reverse osmosis) is more cost-effective than thermal processes (eg Multi Effect Distillation, MED) unless a free source of low-grade heat is used as a thermal input. South Africa currently does not have access to low-cost natural gas but, MED may still be an option if coupled with low-grade waste heat from solar thermal and nuclear power generation plants. This, however, is not yet cost competitive as a desalination process due to the high cost of thermal energy storage and the need for MED to operate at high load factors.

Construction costs vary significantly, are highly site-specific, and dependant on brine disposal and other environmental requirements. Co-location of desalinisation and thermal plants, such as nuclear power plants, at coastal sites could potentially reduce construction, storage and transportation costs. Continuous operation of a desalination plant is more cost effective than periodic use of the same plant, maintenance costs excluded. Co-location of desalination with e.g. gas-to-power and nuclear energy at a coastal location should be considered ideally during the project planning stages. Other solutions to achieving a water-energy balance for desalination include use of alternative (renewable) energy sources, incorporation of energy recovery and storage in the design of the plant. Results obtained show that it is possible to operate multiple options for energy efficiency, notably installation of energy recovery devices to RO pumps, using pumped storage, and then released later to augment supply as and when necessary. Findings from this study further emphasize the importance of an integrated water-energy planning approach for desalination is important for managing water supply risks, particularly during periods where the demand for the desalinated water decreases, eg during non-drought periods, which may result in plants being turned off and requiring costly maintenance and repairs to start up again.

To manage the demand-side risk, desalination should only be considered as part of a long-term water supply strategy and when there is a demand for a high assurance of supply. Each of the different implementation options investigated in this study have their own benefits, limitations and drawbacks which makes it suitable for specific interventions. The optimal mix of technologies is specific to a particular water management area. The justification of investment in desalination should be made based on the economic cost of unserved water and/or the cost of suppression of economic development – or opportunity cost – as a consequence of a lack of secure water supply. The required capacity and justifiable cost, however, have to be determined based on stochastic analysis of natural water availability, probability and economic consequence of various levels of drought.

Conclusions

Desalination is not a silver bullet solution to our country's sustainable water future. There are specific applications, however, especially in water-stressed areas with limited alternatives, where desalination is likely to play an important part in the longer-term solution. When planning desalination, an integrated approach considering both the water supply and demand risks is necessary. Also, it is important to consider the economic activity of the area/basin in which it is applied and specifically the level of resilience of that area to water shortages, as well as the economic impacts that could be unlocked through access to a more secure, less variable water supply.

Policy recommendations

Need for strengthening the implementation of desalination – While a national strategy for desalination has been developed, implementation lags behind. Establishment of the appropriate implementation agencies as stated in the strategy is long overdue. At the minimum, identifying a champion for desalination within the Department of Water and Sanitation can serve a great deal as an interim measure.

Need for an integrated nexus approach - This study considered the key policy instruments for possible adjustments to enable equitable investment in desalination and other water supply options. Policy research recommendations to better value certainty of supply are as follows:

- Harmonising the policy and legislative frameworks to enable the implementation of an integrated and strategic approach in order to guide technology research development and deployment to address regional water-energy issues, yielding information that can be applied nationally and globally.
- Strengthening policies that enhance the integration of data and models to inform regulators, decision-makers, and the public. At this stage there are no models and/or combination of models that can:
  - Facilitate decision making and options analysis for based on an integrated water-energy-climate nexus approach
  - estimate the cost of unserved water and the value of certainty in supply;
  - determine the value proposition of desalination and other alternative water options at the hand of different tariff schemes.

Enabling cost recovery - Desalination differ markedly from traditional water resources in that it is simultaneously a more expensive supply but also high supply certainty. Indications are that the current desalination market failure in South Africa is due to the current tariff structures, as they are not fully cost reflective. Assured water supply is not appropriately valued and supply certainty does not attract an appropriate premium in tariff, accordingly sectors that are both willing and able to pay a premium e.g. tourism are precluded from doing so. Economic regulation policies and water pricing strategies should be cognisant of desalination as an expensive means of assured supply. Due to the increased need for using alternative water resources with varying cost and certainty of supply attributes, conventional tariff structures need to be adapted considering a more holistic water resources pricing approach. The investment in desalinisation processes should be made in contrast with the economic cost of unserved water and/or cost of economic development suppression due to lack of a secure water supply. Desalination is expensive, but the supply is certain.

Associated project:

Framing desalination within the water-energy-climate nexus (**K5/2778**). For more information, contact Publications at Tel: (012) 761 9300, Email: orders@wrc.org.za or Visit: www.wrc.org.za.