Research Office
Legislative Council Secretariat

Fact Sheet

Seawater desalination in Singapore

FSC21/15-16

1. Introduction

1.1 In the 2000s, Singapore started developing desalinated water as an alternative source of fresh water supply under its long-term water supply diversification strategy. Desalinated water has now become Singapore's "fourth National Tap",[1] meeting up to 25% of its water demand. According to the Public Utilities Board ("PUB"),[2] Singapore's daily water consumption is forecast to almost double to 3.6 million cubic metres ("cu m") by 2060. Against this, the Singapore government has planned to expand the current desalination capacity to the extent that up to 25% of future water demand will continue to be sourced from desalinated water by 2060. This fact sheet aims to provide information on the development of seawater desalination plants in Singapore, including the production process of desalinated water.

2. Seawater desalination plants in Singapore

2.1 Being Singapore's national water agency, PUB began as early as in the 1970s the feasibility study of using desalination technology to provide an alternative source of fresh water supply. However, the study did not come to fruition at that time due to the high production cost involved. Subsequent improvement to seawater desalination technologies, particularly the growing global popularity of the reverse osmosis ("RO") technology,[3] has helped lower the production cost. This in turn set the stage for the introduction of seawater desalination in Singapore in the 2000s.

---

1 The other three National Taps are: (a) rainwater collected from local catchment areas; (b) imported water from Malaysia; and (c) NEWater (high-purity reclaimed water).

2 PUB is a statutory board established under the Ministry of the Environment and Water Resources, tasked with managing Singapore's water supply, water catchment and sewerage in an integrated way.

3 RO technology is a desalination process which pushes seawater through a semi-permeable membrane that allows the passage of water molecules but not the dissolved salts.

2.2 There are currently two seawater desalination plants in Singapore, namely the SingSpring Desalination Plant and the Tuaspring Desalination Plant. These two plants are both located in Tuas,[4] adopting RO technology and operating with a combined capacity of producing about 455 000 cu m of desalinated water per day.[5] They were built under a public-private partnership, whereby the private sector had been appointed by PUB to design, build, own and operate the plants, and to deliver desalinated water to PUB for distribution to households and industries.

SingSpring Desalination Plant

2.3 The SingSpring Desalination Plant is the first seawater desalination plant in Singapore. It was constructed in 2004, and commenced operation in 2005 with a designed annual capacity of 50 million cu m (or 136 000 cu m per day). The SingSpring Desalination Plant is also the first water infrastructure project awarded by PUB to the private sector under the public-private partnership approach. Through open tender, SingSpring Pte Ltd ("SingSpring")[6] was appointed to design, build, own and operate the plant, as well as arranging the project financing. Under the water purchase agreement signed between PUB and SingSpring, SingSpring is obliged to deliver desalinated water to PUB over a 20-year period from 2005 to 2025. The price of desalinated water in the first year of delivery was set at S$0.78 (HK$3.64) per cu m.[7] Annual price adjustments for the subsequent years are subject to factors such as fuel price and rate of inflation.

Tuaspring Desalination Plant

2.4 Singapore's second seawater desalination plant, the Tuaspring Desalination Plant, was constructed in 2011. It commenced operation in 2013 with a designed annual capacity of 116 million cu m (or 318 500 cu m per day). Being one of the world's most energy-efficient large-scale

---

4 Tuas is the biggest industrial zone in the western part of Singapore.

5 According to PUB, Singapore consumes about 1.8 million cu m of water per day.

6 SingSpring is a Singapore-based, wholly-owned subsidiary of Hyflux. Hyflux is a global water solutions company operating in countries such as Singapore, China, India and Algeria. It provides solutions in seawater desalination, water recycling, wastewater treatment and potable water treatment.

7 The first-year delivery price, at HK$3.64 per cu m, is much lower than the estimated production cost incurred by the desalination plant proposed to be constructed in Tseung Kwan O (HK$12.6 per cu m at 2013-2014 price level). Yet the former does not include the water distribution to end-users and customer service costs, while the latter is an all-inclusive cost.

desalination plants, the Tuaspring Desalination Plant is equipped with a self-sufficient on-site power plant to provide it with a secure source of electricity supply for seawater desalination. Excess power is sold to the national power grid.

2.5 PUB appointed Tuaspring Pte Ltd ("Tuaspring")[8] to design, build, own and operate the plant, as well as arranging the project financing. Under the bilateral water purchase agreement, Tuaspring is required to deliver desalinated water to PUB over a 25-year period from 2013 to 2038, with the price set at a low of S$0.45 (HK$2.79) per cu m in the first year of delivery.[9, 10] Similar to that of the SingSpring Desalination Plant, subsequent annual price adjustments of the Tuaspring Desalination Plant also take into account factors such as fuel price and rate of inflation.

3. Production process of desalinated water

3.1 In Singapore, seawater is processed into desalinated water which is then blended with treated water from the reservoir for distribution to homes and industries. The desalination of seawater involves the following three processes:

(a) pre-treatment process – filtering suspended solids from seawater;

(b) double pass RO treatment process – removing salt from seawater by double passage of seawater through a semi-permeable membrane;[11] and

---

8 Singapore-based Tuaspring is also owned by Hyflux.

9 Probably reflecting its higher energy efficiency, the Tuaspring Desalination Plant charges a lower price than the SingSpring Desalination Plant.

10 Similar to that of SingSpring Desalination Plant, the first-year delivery price of Tuaspring Desalination Plant does not include the water distribution to end-users and customer service costs.

11 In a single pass RO system, the feed water enters a semi-permeable membrane and exits it as either permeate water (desalinated water) or concentrate water (i.e. water did not pass through the membrane). In a double pass RO system, the permeate water from the first pass becomes the feed water to the second pass. Further treatment of the permeate water through the second pass leads to production of higher quality desalinated water.

(c) post-treatment process – re-mineralizing (adding in minerals)[12] and adjusting pH[13] of the treated water.

3.2 According to PUB, desalinated water is the most energy-intensive source of water supply among the four National Taps. In order to ensure desalinated water to be an affordable and sustainable source of water supply, PUB has been working with industry partners to develop new technologies that can reduce energy consumption during the desalination process, thereby reducing the production cost.

4. Recent developments

4.1 In early 2015, the Singapore government announced that it would construct a third desalination plant in Tuas to strengthen Singapore's drought resilience and help meet the growing water demand in the future. The new plant, which will commence operation in 2017, will be owned and operated by PUB. The Singapore government further announced in September 2015 that it would build a fourth desalination plant in Marina East. The plant will be developed under a design-build-own-operate arrangement. Both new plants will have a designed annual capacity of 50 million cu m.

[12] According to the World Health Organization, desalinated water is low in minerals and hence has corrosive effects on pipes and fixtures during transmission and distribution. Re-mineralization is one of the ways to address the issue. Besides, re-mineralization may contribute to intake of nutritional minerals such as calcium, magnesium and fluoride by consumers. See World Health Organization (2011b).

[13] The term pH is used to indicate how acidic or basic a substance is. According to the World Health Organization, control of pH is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection. The pH of water entering the distribution system must also be controlled to minimize corrosion of water mains and pipes. The optimum pH required is in the range of 6.5-8.5 on a pH scale ranging from 0 to 14. See World Health Organization (2011a).

References

1. Development Bureau. (2015) *Item for Public Works Subcommittee of Finance Committee*. Paper submitted to the Public Works Subcommittee of Finance Committee of the Legislative Council for discussion on 3 June 2015. LC Paper No. PWSC(2015-16)18.

2. Kable Intelligence Ltd. (2016a) *Tuas Seawater Desalination Plant – Singapore.* Available from: http://www.water-technology.net/projects/tuas-seawater-desalination/ [Accessed February 2016].

3. Kable Intelligence Ltd. (2016b) *Tuaspring Desalination and Integrated Power Plant – Singapore.* Available from: http://www.water-technology.net/projects/tuaspring-desalination-and-integrated-power-plant/ [Accessed February 2016].

4. Lee, M.F. (2012) *Managing Operations of PPP Contracts – Case Study: SingSpring Desalination Plant*. Available from: http://environment.asean.org/wp-content/uploads/2013/07/awgrm/Managing-PPP-Contractors-(2Nov2012)(PUB).pdf [Accessed February 2016].

5. Ministry of the Environment and Water Resources. (2015) *Speech by Dr Vivian Balakrishnan, Minister for the Environment and Water Resources, Committee of Supply Debate on 11 March 2015*. Available from: http://www.mewr.gov.sg/news/speech-by-dr-vivian-balakrishnan--minister-for-the-environment-and-water-resources--committee-of-supply-debate--11-march-2015-section-c [Accessed February 2016].

6. Prime Minister's Office Singapore. (2013) *Speech by Prime Minister Lee Hsien Loong at the official opening of Tuaspring Desalination Plant.* Available from: http://www.pmo.gov.sg/media-release/speech-prime-minister-lee-hsien-loong-official-opening-tuaspring-desalination-plant [Accessed February 2016].

7. The Public Utilities Board. (2005) *Press Releases – Fourth National Tap Flows.* Available from: http://www.pub.gov.sg/mpublications/Pages/PressReleases.aspx# [Accessed February 2016].

8. The Public Utilities Board. (2013) *Press Releases - PUB and Hyflux officially open Singapore's second and largest desalination project*. Available from: http://www.pub.gov.sg/MPUBLICATIONS/Pages/PressReleases.aspx# [Accessed February 2016].

9. The Public Utilities Board. (2015a) *Our Water, Our Future*. Available from: http://www.pub.gov.sg/mpublications/OurWaterOurFuture/Documents/OurWaterOurFuture_2015.pdf [Accessed February 2016].

10. The Public Utilities Board. (2015b) *Our Water: The Flow of Progress – Annual Report 2014/2015.* Available from: http://www.pub.gov.sg/annualreport2015/docs/PUB%20AR_2014-15.pdf [Accessed February 2016].

11. The Public Utilities Board. (2015c) *Press Releases – HSL Constructor Pte Ltd to build third desalination plant at Tuas*. Available from: http://www.news.gov.sg/public/sgpc/en/media_releases/agencies/pub/press_release/P-20151112-1/AttachmentPar/0/file/PUB%20Press%20Release_16Nov2015.pdf [Accessed February 2016].

12. The Public Utilities Board. (2015d) *Press Releases – PUB to build fourth desalination plant*. Available from: http://www.news.gov.sg/public/sgpc/en/media_releases/agencies/pub/press_release/P-20150903-1/AttachmentPar/0/file/ME%20desal%20plant%20Media%20Release_Final.pdf [Accessed February 2016].

13. *The Public Utilities Board*. (2016) Available from: http://www.pub.gov.sg/Pages/default.aspx [Accessed February 2016].

14. WaterWorld. (2013) *Singapore's second desalination facility set to open with combined power plant*. Available from: http://www.waterworld.com/articles/2013/09/singapore-s-second-desalination-facility-set-to-open-with-combined-power-plant.html [Accessed February 2016].

15. World Health Organization. (2011a) *Guidelines for Drinking-water Quality (Fourth Edition)*. Available from: http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng.pdf [Accessed February 2016].

16. World Health Organization. (2011b) *Safe Drinking-water from Desalination*. Available from: http://apps.who.int/iris/bitstream/10665/70621/1/WHO_HSE_WSH_11.03_eng.pdf [Accessed February 2016].

Research Office
Information Services Division
Legislative Council Secretariat
26 February 2016
Tel: 2871 2143