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Economic Brief

Saudi Arabia's Water Sector

Overview

Saudi Arabia is the largest producer of desalinated water and the third largest per-capita consumer of water globally. Despite the absence of permanent natural water bodies, the Kingdom has developed an extensive network of water processing, transmission, and offtake systems to meet the needs of a growing population and a growing manufacturing base. The water sector has also presented challenges for the Kingdom: aging and inefficient infrastructure, the environmental impact of groundwater depletion, sustainability of energy demand from desalination, water subsidies leading to overuse, and brine management for the estimated 2.8 billion m^3 of desalinated water produced in 2020.

Recent reforms have led to a significant decline in water use by the agricultural sector, the construction of more energy-efficient reverse osmosis (RO), solar-supported water systems, and the reduction of longstanding water subsidies that kept the consumer cost of water between an estimated 5 and 10 percent of the actual production cost. In 2018, the Kingdom introduced a new National Water Strategy to further address these challenges and secure cost-effective and sustainable solutions for the Kingdom's water demands over the next decade. The strategy includes reducing daily per capita consumption from 263 liters to 150 liters, a 43 percent decrease, by 2030. According to the Ministry of Environment, Water, and Agriculture (MEWA), total water demand in Saudi Arabia stood at 15.98 billion m^3 at the end of 2020.

A new public-private partnership law has opened up the water sector to greater participation by leading international companies while lessening the cost burden on the government. The law offers significant opportunities to U.S. companies with the expertise, experience, and technologies needed to address the Kingdom's critical water challenges. Saudi Arabia's Saline Water Conversion Corporation (SWCC), the largest desalination company in the world, aims to boost the private sector's contribution to water desalination from two million m3/day currently to seven million m^3/day by 2026. SWCC signed a memorandum of understanding (MoU) with the U.S. Department of Energy in 2020 for long-term cooperation in the field of desalination science and technology. The agreement underscores the potential for the U.S.-Saudi relationship to drive knowledge transfer, expertise, and investment into the Kingdom's water sector, addressing the key national objective of sustainable and efficient water resource management.

Market Determinants

Population

Saudi Arabia's population growth and urbanization has placed increased demand pressure on limited

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natural water resources. The total population has grown at a 2.4 percent compounded annual growth rate (CAGR) between 2010 and 2020. Demand for desalination has grown at a 7.4 percent CAGR over the same period. According to forecasts issued by the Saudi Water Partnership Company (SWPC), population in Saudi Arabia's eight largest provinces are expected to grow at a 1.7 percent CAGR through 2025. Municipal water demand in those same provinces is expected to grow at a 0.6 percent CAGR through 2025. Desalination accounted for 29,266 MWh/customer in 2019 compared to 13,113 MWh/customer in 2015, more than doubling the average power demand from four years earlier, according to data from the Electricity and Co-Generation Regulatory Authority (ECRA).

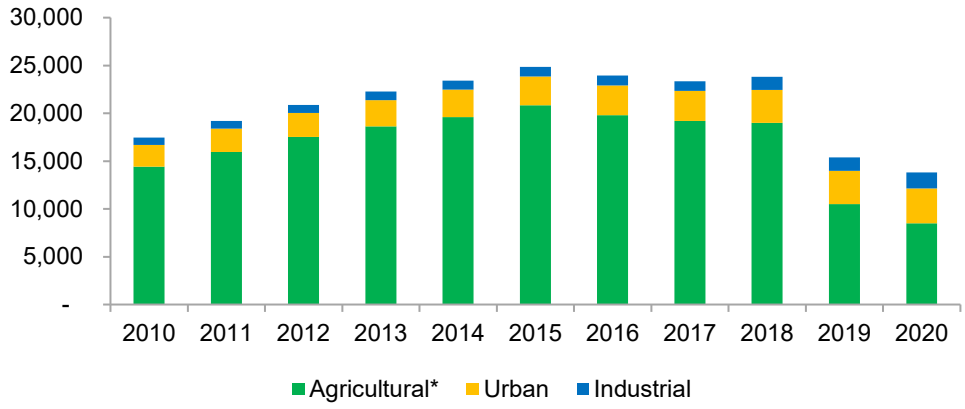
Water-Power Nexus

The conversion of seawater into drinking water via processes such as reverse osmosis (RO) and multi-stage flash distillation (MSF) is a highly energy-intensive process. Increased energy demand from desalination and decreased freshwater supply highlights the importance of the water-power nexus to Saudi Arabia's economic development. Integrating seawater desalination with power plant functionality increases the overall efficiency of operations, making integrated water and power plants a better solution for a country with high electricity and water demands. Saudi Arabia consumed 2.9 million barrels per day (bpd) of petroleum products and crude oil during 2020, much of which is used for desalination and electricity generation. The Kingdom is among the most cost efficient countries to desalinate water, given comparatively low energy prices and the economies of scale at large facilities. The amount of energy consumed by desalination in Saudi Arabia is more than six times the amount used by the industrial sector and accounts for a growing majority of the Kingdom's water sources.

Water Demand

Saudi water demand rose steadily over the past decade but began to decline after 2018 due to reduced water use in the agriculture sector stemming from the elimination of livestock fodder harvesting. Total water demand stood at 15.98 billion m^3 in 2020 with the agricultural sector still accounting for 67 percent of the total. Urban water demand stood at 3.6 billion m^3, or 23 percent of total demand, while industrial water demand stood at 1.7 billion m^3, or 10 percent of total demand. Despite being the smallest demand

Chart 1 - Saudi Water Demand
(million m^3)



Source: MEWA 2020
*Non-renewable sources only

segment, industrial water use has grown at the fastest pace. Water is a key resource for the oil & gas, mining, chemical, and manufacturing sectors which have continued to grow in Saudi Arabia. Urban water use has also grown steadily over the past decade while agricultural water use is less than half of its total just two years ago. Urban water demand was growing at 6 percent per year on average before water subsidy tariffs were updated in 2016. After water tariff reforms went into effect, urban water demand has grown at a declining rate of 4 percent per year on average.

Sector Characteristics

Structure

MEWA is the chief regulatory authority for the sector and also supervises the environmental impact of water infrastructure, provides irrigated water for agriculture through wells and dams, and produces water from groundwater wells. SWCC is the leading government desalination company and accounts for the majority of water desalination output in the Kingdom. SWPC, formerly Water & Electricity Company (WEC), is the primary procurement entity for private sector participation and local engagement in planned projects that include water desalination and sewage treatment plants as well as strategic storage tanks and transmission pipelines.

The Electricity and Co-Generation Regulatory Authority (ECRA) is a government entity that oversees electricity and water desalination for private and semi-private operators. ECRA's duties include some production and transportation of desalinated water in addition to monitoring and assessing the regulatory procedures affecting key stakeholders in the sector. The National Water Company (NWC), created in 2008, is a joint stock company owned by the Public Investment Fund (PIF) and serves as the national water and sanitation company overseeing the operation of urban water distribution. NWC ensures the functionality of water and wastewater connections for household use and the efficient reuse of sewage effluent. Desalinated water is provided for free by SWCC to NWC.

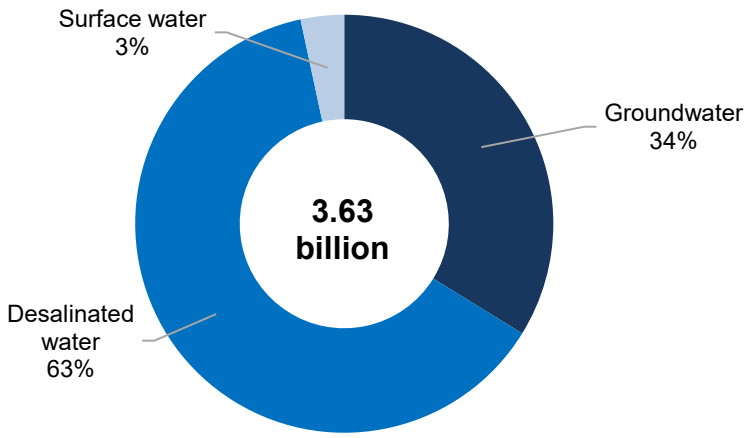
Several Independent Water and Power Projects (IWPP) have also launched since 2002 for integrated power and desalination services. Most recently, Saudi Arabia launched the Rabigh-3, Jubail 3A and 3B, Shuqaiq-3, and Yanbu 4 IWPP projects. One of the largest IWPP projects in the world is the original Jubail IWPP (JWAP), also called the Marafiq IWPP, which produces 800,000 m^3/day using 16 units of gas-fired General Electric (GE) turbines. Other major IWPPs in Saudi Arabia include the Shuaibah and Shuqaiq cogeneration plants.

The Kingdom has also pursued Independent Sewage Treatment Plant (ISTP) contracts more recently which follow a build-own-operate-transfer (BOOT) concession model. Saudi Arabia's first ISTP contract was awarded in January 2019 and was valued at SAR919 million ($245 million). The Dammam West ISTP project was followed by two additional ISTP contracts in Jeddah and Taif which were signed in 2020. The Kingdom has 204 wastewater treatment plants in operation of which 15 are to be privatized during the first phase of the water sector privatization plan implemented by NWC. Saudi Arabia plans to increase national wastewater treatment processing capacity by 50 percent to 8.4 million m^3/day by 2023 to meet rising demand and expects the private sector to play a significant role in the growth of the sector through ISTPs.

Water Sources

Due to a dry climate and limited rainfall, deep groundwater aquifers and desalinated seawater are the primary water sources in Saudi Arabia. However, surface water remains a significant source due to runoff collection at the 522 dams across the Kingdom. The total capacity of Saudi Arabia's dams is 2.3 billion m^3 though utilized levels stand at 1.6 billion m^3 for the purpose of runoff collection, water storage, and groundwater recharge. Surface runoff that enters the ground recharges aquifers located in various areas such as river valleys and plains. This water is called "renewable" groundwater compared to "non-renewable" groundwater found in deeper aquifers that have limited or no natural recharge. Heavy use of non-renewable groundwater, particularly by the agriculture sector, is one of the greatest water security challenges facing Saudi Arabia. The risk of depleting non-renewable groundwater resources in coming decades puts further strain on desalinated water and treated wastewater production. In 2020, urban water demand stood at 3.63 billion m^3 with desalinated water accounting for 63 percent of the total. Groundwater and surface water accounted for 34 percent and 3 percent, respectively.

Chart 2 - Saudi Urban Water Use
(2020, m^3)



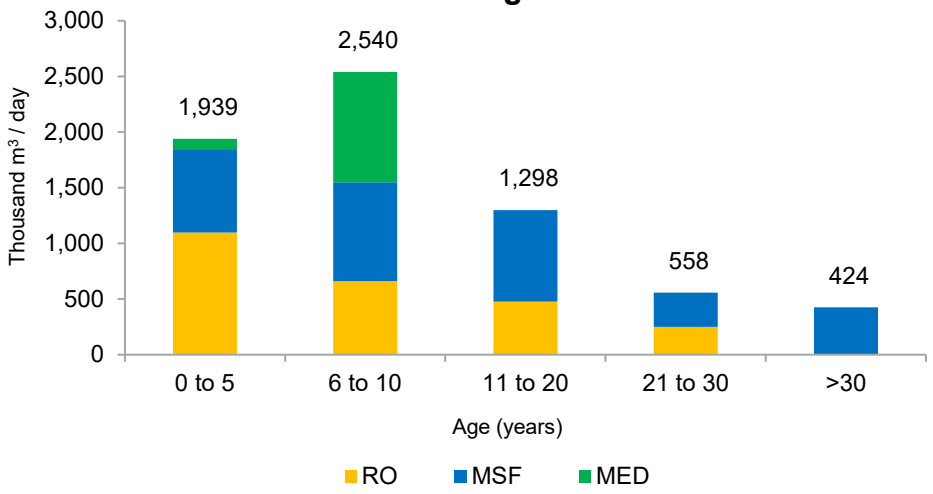
Source: MEWA

Prior to 2010, the majority of Saudi Arabia's desalination capacity came from multi-stage flash (MSF) distillation technology. MSF and multi-effect distillation (MED) are thermal processes that utilize a higher degree of energy and are preferred for large-scale dual-purpose seawater desalination plants. However, Saudi desalination units have trended towards reverse osmosis (RO) technology in recent years. RO is a pressure-dependent membrane technology and is often preferred for single-purpose plants. Plants constructed over the five years prior to 2019 have been 67 percent MSF and 33 percent RO technology, according to the latest available data from ECRA. However, the majority of SWCC desalination plants still use MSF. MSF plants in Saudi Arabia average the highest capacity at 36,000 m^3/day per unit, compared to multi-effect distillation (MED) and reverse osmosis (RO) which average 24,000 m^3/day and 19,000 m^3/day, respectively. Two of the Kingdom's largest and most recent plants completed in 2021, Rabigh-3 and Shuqaiq-3, utilize RO technology.

NWC has also overseen the rollout of a Treated Sewage Effluent Initiative (TSEI) to utilize wastewater through specialized networks that treat and store water for further distribution. The end users for TSE are most commonly industrial, agricultural, or commercial sectors. The quantity of treated wastewater reused

in 2019 amounted to 4.9 million m^3/day. Municipal wastewater production stood at 2.9 million m^3 in 2018 and is expected to reach 5.1 million m^3 by 2050 due to population growth. Due to water scarcity and sustainability concerns, the government aims to maximize the efficient reuse of treated wastewater, raising reuse from 17.3 percent in 2019 to 25 percent by 2025.

Chart 3 - Desalination Capacity by Technology & Age



Source: ECRA 2019

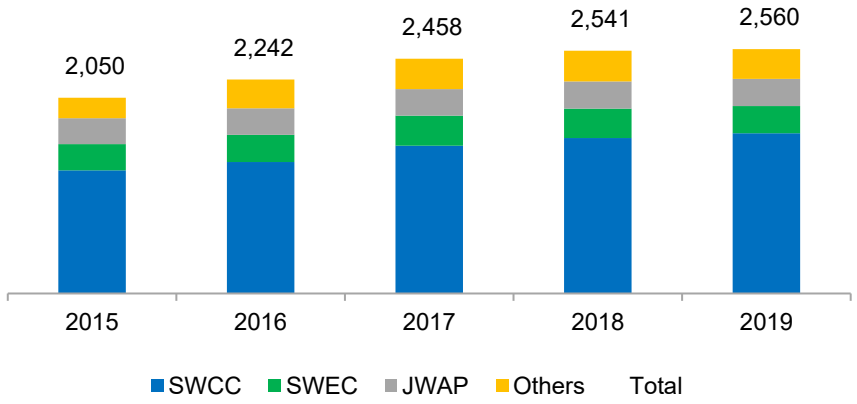
Market Size

SWCC is the largest desalination entity in Saudi Arabia and currently operates 33 desalination plants producing 5.9 million m^3/day. SWCC's water production in 2020 significantly increased compared to 2019, which saw a rise from 1.7 billion m^3/year to 1.9 million m^3/day. SWCC also saw an increase in the delivery of desalinated water in 2020, reaching 2.3 billion m^3/day. According to SWCC's 2020 annual report, it generated approximately SAR1.52 billion ($405 million) in total revenues. This indicates that the government earned SAR0.66 ($0.18) in revenues per m^3 delivered. Furthermore, it highlights that a majority of the deliveries went to consumers in the first two categories of the updated water tariff schedule in Table 1 (page 7). Despite the increase in water tariffs in 2016, users still enjoy extraordinary subsidies as measured by SWCC's SAR41.76 billion ($11.1 billion) costs related to its portfolio of executed projects. Taking the difference between its 2020 revenues and current ongoing project expenses, it may be inferred that total annual subsidies for SWCC's deliveries to consumers amounted to SAR40.2 billion ($10.7 billion).

SWCC's portfolio of desalination plants use MSF as the dominant technology but a growing number of RO and some MED capabilities have been constructed more recently. Given that the average cost of MSF plants is higher than RO and MED, SWCC's estimated weighted average production cost of SAR2.27/m^3 ($0.61/$m^3$) is higher than newer plants that have adopted RO in recent years. According to ECRA, SWCC's MSF plants account for 42 percent of capacity while RO and MED account for 12 percent and 2 percent, respectively. Based on SWCC's estimated weighted average production cost of 2.27/m^3 ($0.61/$m^3$), the 1.9 billion m^3/year in total desalination production resulted in SAR4.3 billion ($1.2 billion) in production costs in 2020.

Entities engaged in IWPPs such as JWAP and others utilize more cost-efficient technologies, which reduces their average production costs. While the Shuaibah Water & Electricity Company (SWEC) utilizes MSF technologies, JWAP utilizes MED, and the aggregate total of other entities use RO. Consequently, the weighted average production cost for non-SWCC entities is estimated to be SAR1.82/m^3 ($0.49/$m^3$). Total production from non-SWCC entities is estimated to have reached 918 million m^3/year in 2020 with production costs amounting to SAR1.9 billion ($518 million).

Chart 4 - Desalinated Water Production
(million m^3)



Source: ECRA

The estimated 2020 aggregate total of all desalination production in the Kingdom is 2.8 billion m^3/year with a weighted average of SAR2.13/m^3. This represents an increase of 10 percent compared to 2019 and is mainly attributed to SWCC's production hike in 2020. Taking the total cost of production only from all desalination entities, the total is estimated to have reached SAR6.3 billion ($1.7 billion) in 2020.

Regulatory Developments

Subsidies & Tariffs

The oil price downturn of 2014 and 2015 and the introduction of an all encompassing diversification strategy necessitated reform to Saudi Arabia's water tariff structure. Prior to the 2016 tariff increase, the government was estimated to be recovering only one to two percent of its costs, according to Global Water Intelligence. Saudi Arabia now utilizes a simple block tariff structure for the entire country, varying between water and sewage use. The first consumption block was lowered to 15 m^3/month, down from 50 m^3 previously, and remained comparably low. However, rates were raised progressively higher on entities with high water usage. For government entities, tariffs charges are now SAR9 ($2.40) per m^3 for users of both water services and SAR6 ($1.60) per m^3 for just water. According to MEWA, the majority of households were not significantly affected by the changes and 52 percent of households saw water bills change by less than SAR1 ($0.27) per day.

Table 1 - Saudi Water Tariffs

Monthly Consumption (m^3/month)	Water Rate (SAR/m^3/ Month)	Sanitary Wastewater Rate (SAR/m^3/Month)	Total Consumption (SAR/m^3/Month)
0-15	0.10	0.05	0.15
16-30	1.0	0.50	1.50
31-45	3.0	1.50	4.50
46-60	4.0	2.00	6.00
60+	6.0	3.00	9.00

Source: NWC

Private Sector Participation Law

A major new Private Sector Participation (PSP) Law entered into effect in July 2021 after public consultation. Broadly defined, the new law will cover any relationships between the government and private sector arising from a contractual agreement exceeding five years relating to the provision of public services. The PSP law introduces several changes aimed at levelling the playing field for foreign investors, allowing direct collection of public fees and revenues, and permitting some exemptions to Saudization employment policies at the discretion of the National Center for Privatization (NCP) and the Ministry of Human Resources & Social Development. Many of these regulatory changes reflect an effort to make public-private partnerships more attractive to foreign investors. The law also appears to open contractual disputes up to international arbitration as a forum for resolution.

These changes follow major reforms in the Saudi business landscape that include implementation of the Bankruptcy Law, Moveable Assets Security Law, Commercial Mortgage Law, and relaxing of rules limiting foreign investors from owning controlling stakes in Saudi companies. The government's commitment to regulatory reform is particularly aimed at attracting foreign direct investment and facilitating the ease of doing business in the Kingdom.

Agricultural

Due to the disproportionate use of limited water resources by the agricultural sector, Saudi Arabia has overhauled agricultural regulations in recent years to limit water consumption. Compared to dates and common vegetable crops grown in Saudi, wheat crop has among the lowest value return on water use. Consequently, the Kingdom effectively ended domestic wheat production starting in 2015 and transitioned to a foreign agricultural investment program model to safeguard its domestic water resources.

The agriculture sector still accounted for the majority of water demand in 2020, standing at 10.7 billion m^3. However, water use by the agriculture sector fell by 19 percent YoY in 2020 due to the elimination of domestic fodder production in 2019. The Kingdom has also implemented incentives and regulations to maximize the use of treated wastewater in the agriculture sector. The National Transformation Plan (NTP) 2025 aims to add 80 million m^3 of treated wastewater into the agriculture sector ecosystem by 2030.

National Water Strategy

The Kingdom's National Water Strategy 2030 (NWS) represents a strategic framework for tackling the most significant water resource challenges over the next decade. NWS aims to reform the water and wastewater sectors to ensure sustainable development while providing affordable services to consumers. MEWA, SWCC, ECRA, and NWC each have corresponding programs aimed at safeguarding the Kingdom's limited natural resources while supporting the national economy and ensuring water access.

Regulatory changes under NWS guidance prioritize water saving, irrigation, and sustainable management for agricultural, municipal, and industrial consumption. The Water Law under Program 1 is a series of comprehensive resource management, investment, licensing, and tariff-adjusting regulations that will guide implementation of the Kingdom's National Water Strategy. Other regulatory developments include a 2021 Cabinet decision which adjusted the National Center for Water Efficiency and Rationalization's responsibilities and mandates to stimulate greater grey water recycling and use. The Qatrah program is another initiative launched in 2019 as part of the NWS framework aimed to educate and incentivize conservation and water reuse among the general population.

National Water Strategy 2030
Strategic Programs

Source: NWC

Sector Developments

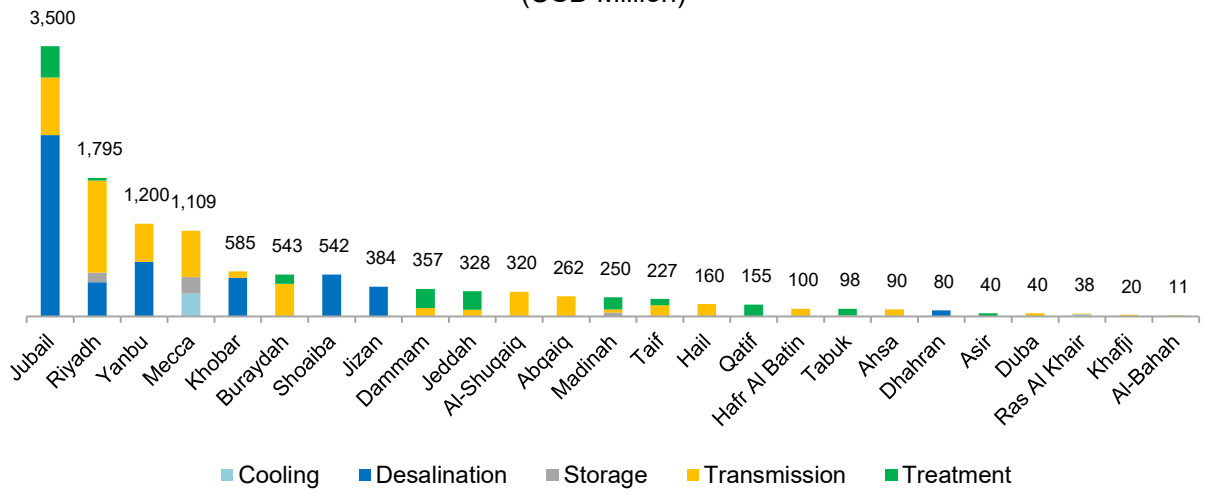
Project Activity

The COVID-19 pandemic delayed some water projects, including the Jafurah desalination plant and the long-awaited Ras Al Khair desalination plant privatization. However, construction contracts awarded in the water sector rebounded 45 percent YoY in 2021, from SAR11.32 billion ($3 billion) to SAR16.4 billion

($4.4 billion), according to USSBC's Contract Awards Index. As construction activity resumed, Saudi Arabia saw the completion of one of the largest RO plants in the world, the SAR2.3 billion ($610 million) Shuqaiq-3 IWP desalination plant. The plant was completed in Q4 2021 and is currently operating at its full 450,000 m^3/day capacity. Additionally, construction was completed on the SAR2.8 billion ($750 million) Rabigh-3 IWP desalination plant. The plant will supply drinking water to more than three million residents in Makkah Province and is seen as an important bulwark to meet demand peaks during Ramadan and Hajj season.

There are currently SAR53.2 billion ($14.2 billion) in water projects under construction in Saudi Arabia, according to MEED Projects. Jubail has the highest value of projects currently in execution, totaling SAR13.1 billion ($3.5 billion) and representing 29 percent of the total value. Jubail water projects are primarily desalination-related which include the SAR2.4 billion ($650 million) Jubail 3A IWP being developed by Jazlah Water Desalination Co. in partnership with a consortium led by ACWA Power, Al Bawani, and Gulf Investment Corporation. Riyadh represents 15 percent of water projects in execution, the majority of which are transmission and storage projects. Yanbu and Makkah follow with 10 percent and 9 percent, respectively.

Chart 5 - Water Contracts Under Execution
(USD Million)



Source: MEED Projects

Desalination projects represent 42 percent of water construction projects currently under execution in the Kingdom. Transmission projects represent 41 percent of the total. Water treatment, storage, and cooling represent 11 percent, 4 percent, and 2 percent of current projects, respectively. SWPC also signed SAR2.4 billion ($630 million) in contracts with private local and international firms for the construction of three sewage treatment plants in Madinah, Qassim, and Tabuk Provinces due to come online at the end of 2024.

Water Privatization

The National Water Strategy, aligned with the Vision 2030 Privatization Program, outlines private sector involvement in the Saudi water and wastewater sector as a key focus for driving foreign direct investment, building domestic capacity, and creating local jobs. The NCP has currently approved 68 projects in 'water

& agriculture,' several of which are currently accepting bids. Plans to privatize the production sector of the SWCC and the Ras Al Khair desalination and power plant have been delayed but remain in place, according to official sources. The Ras Al Khair Independent Water Project, one of the key privatization goals of the government's delivery plan, was in the RFP phase along with ISTPs in Madinah, Tabuk, and Buraidah. However, the Ras Al Khair privatization was postponed due to economic conditions relating to the pandemic and its effect on the Saudi economy.

Contracts to be offered by the NWC for operating its water distribution assets, six in total, will run for a period of between three and seven years, with long term goals to transfer these contracts into concession arrangements lasting 25 to 30 years. NWC offered its third operation and maintenance (O&M) tender to local and international private firms in March 2021 for water and sanitary drainage infrastructure for all cities and governorates in the Eastern Province. The first O&M contract, which comprises water services in Madinah and Tabuk, was awarded in December 2020 to a Saudi-French-Philippine consortium and is valued at SAR198 million ($53 million).

MEWA and SWCC also established a new water transmission company, the Water Transmission and Technologies Company (WTTCO), that will manage 8,400 kilometers of Saudi water pipeline infrastructure. The state-owned transmission company will seek SAR60 billion ($16 billion) in private investments including PPP before a planned IPO on the Tadawul. The Yanbu-4 IWP plant, Saudi Arabia's first renewable integrated, seawater RO project that was awarded in February 2020 to a consortium led by France's ENGIE is expected to be utilized in future water service contracts. The project is the first water pipeline in Saudi Arabia developed under the public-private-partnership (PPP) structure and is expected to achieve one of the most competitive power consumption efficiency levels in the Kingdom.

New Technologies

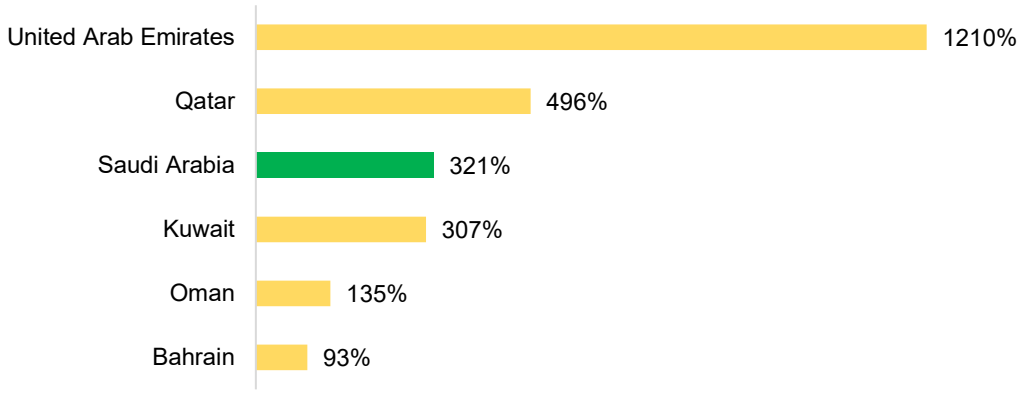
Saudi Arabia is currently developing a solar-powered RO plant, the Taweelah IWP, which will be the world's largest and first partially solar-powered RO plant, utilizing the least energy per gallon of water produced in the Kingdom. Saudi Arabia constructed its first desalination plant that utilizes solar nanotechnology in Khafji in 2012 but has lacked large-scale solar-support desalination operations. A major expansion of Yanbu-4, in partnership with General Electric, will boost water output by 450,000 m^3 (119 million gallons) and be supported by a 20 MW solar farm. In 2020, the Kingdom also installed 2 million smart meters to enhance water service infrastructure and increased the capacity of sewage treatment plants by 118,000 m^3/day while achieving the highest production capacity of desalinated water globally at 5.9 million m^3/day.

Sector Challenges

Sustainability

Current levels of groundwater extraction in Saudi Arabia exceed the level of natural recharge. For example, the Al-Ahsa aquifer in the Eastern Province experienced an estimated drop of 150 meters over the past 25 years. The usable volume of aquifers is also difficult to estimate and is suspected to range between 259 and 761 billion m^3 with an annual recharge of 886 million m^3, according to a 2015 study by King Saud University. The rate of groundwater abstraction as a percentage of renewable volume stood at 321 percent, according to a U.N. Water report.

Chart 6 - Groundwater Abstraction
(as % of Renewable Volume)



Source: UNW, UNDESA

Unconventional water resources such as desalination and municipal wastewater are seen as a key strategy to preserve natural water resources. Saudi Arabia has reduced water use by the agriculture sector by nearly 60 percent since 2015 in an effort to save its endangered groundwater resources. The Kingdom has a stated aim of raising the proportion of renewable water consumption in the agriculture sector from 9.5 percent to 22.3 percent by 2025. Saudi Arabia has also invested in managed aquifer recharge projects with the majority depending on treated wastewater as the recharge source.

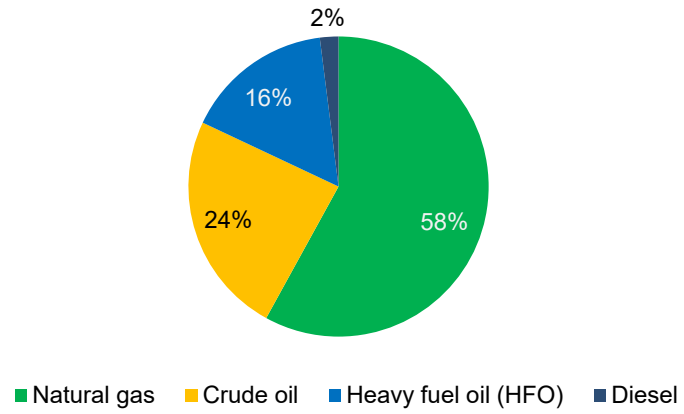
Cost

Fuel Use

The Kingdom's abundant oil resources and competitive extraction costs has limited fuel monetization. This refers to the consumption of fuel in desalination processes that would otherwise be sold at market prices. Fuel consumption for cogeneration and seawater desalination stood at 502 million KWh in 2019, according to ECRA. SWCC primarily uses natural gas to power its desalination plants while IWPPs use a mix of natural gas and crude oil. The Kingdom's longstanding and generous water subsidies have also discouraged efficient use of a scarce resource which has further contributed to fuel monetization challenges.

The trend in Saudi Arabia towards RO technology in recent years is in part due to its greater energy efficiency. According to market studies, RO was found to be the most exergy-efficient (30.1 percent) followed by MED (14.27 percent) and MSF (7.73 percent). RO and MED require comparatively less power to produce water. MSF has an energy demand that is roughly triple the energy needed by RO and MED technology. With the adoption of cost efficient technologies, SWCC has been able to achieve production costs of SAR1.27/m^3 ($0.39/$m^3$) for its new desalination plants.

Chart 7 - Desalination Fuel Consumption

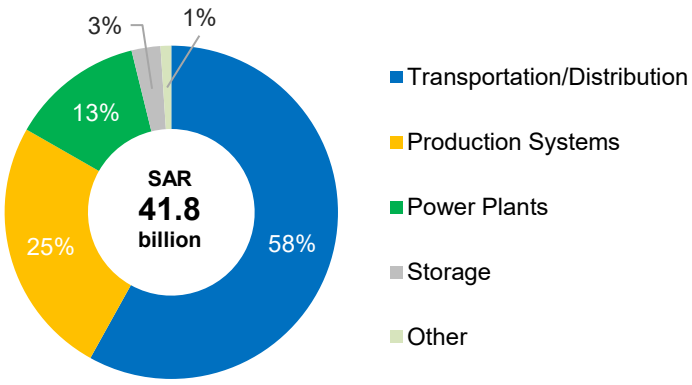


Source: ECRA

Water Subsidies

Despite the introduction of water tariff reforms in 2016, a significant gap between what consumers pay for water compared to SWCC's total portfolio of project costs is steep. As mentioned earlier, the government earned revenues of SAR1.52 billion ($405 million) versus its desalination project costs of SAR41.8 billion ($11.1 billion). Transportation and distribution accounted for SAR24.3 billion ($6.5 billion) or 58 percent of spending. By comparison, water production related costs accounted for SAR10.5 billion ($2.8 billion) or 5 percent, power accounted for SAR5.4 billion ($1.4 billion) or 13 percent, and storage accounted for SAR1.2 billion ($312 million) or 3 percent. Based on SWCC's 2020 annual water production level of 1.9 billion m^3, it could be inferred that the total project cost per m^3 was SAR22 ($5.90). As Saudi Arabia progresses with its long-term diversification strategy, there is sizeable room for the government to further reduce its water cost burden in line with global benchmark prices paid by residents.

Chart 8 - SWCC Project Costs in Execution
(SAR, 2020)



Source: SWCC

Brine Management

Another currently unavoidable challenge posed by large-scale desalination is brine production and management. Desalination plants take in seawater or brackish water and yield two products: treated freshwater and brine, a concentrated salt that contains various chemical contaminants. Brine production and management represents a key barrier to expansion of the desalination industry as extracting minerals from brine is possible but it limits the commercial viability of operations. According to the U.N., 22 percent of global brine is produced in Saudi Arabia.

Interest has grown in recent years for new technologies that enable more resource-efficient processing of brine output. The recent MoU signed between SWCC and the U.S. Department of Energy specifically outlined the harvesting of valuable minerals and metals from seawater brine as an area of economic, academic, and commercial cooperation. Thermal desalination technologies such as MSF and MED produce roughly four times as much brine per m^3 of clean water compared to RO plants. Consequently, the Kingdom has invested more in RO and hybrid technologies that lower energy consumption and brine output.

Other downside impacts on the Saudi water sector include leakage from dilapidated infrastructure which has led to several repair and rebuild construction projects across the Kingdom in recent years. It is estimated that inefficient infrastructure leads to 600-800 thousand m^3/day loss before reaching end users.

Sector Outlook

Regulatory changes and government initiatives will present significant commercial opportunities for the private sector over the next decade. Both local and international firms will be essential partners to meet SWCC's official target of raising private sector contribution to seven million m^3/day by 2026 compared to the current level of two million m^3/day. SWPC has invited EOIs and RFPs for several projects in 2021, including the development of two independent strategic water treatment and reservoir projects at Al Ahsa in the Eastern Province with a treatment capacity of 4.9 million m^3/day and Juranah.

SWPC forecasts municipal water demand to grow the fastest in Jizan Province and Qassim Province, of the eight provinces for which official estimates have been released. Recent reforms in the agriculture sector that decrease the use of surface and groundwater will disproportionately affect provinces such as Jizan and Qassim that have large agriculture sectors. These areas will require treatment and transmission infrastructure to facilitate the use of unconventional water resources. SWPC forecasts the cities of Riyadh, Taif, Jeddah, and Tabuk will see the greatest rate of population increase over the next four years, driving demand for water infrastructure and resource management.

Table 2 – Municipal Water Forecasts
(Thousand m^3)

Municipal Area	2020	2025	Municipal Water Demand (2020 - 2025)	Population Forecast (2020 - 2025)
Jizan	412	436	5.8%	7.2%
Qassim	240	250	4.2%	6.6%
Tabuk	1,600	1,650	3.1%	9.2%
Eastern	330	340	3.0%	8.1%
Riyadh	1,710	1,760	2.9%	9.2%
Taif	2,440	2,510	2.9%	9.0%
Jeddah	743	763	2.7%	9.1%
Makkah	226	232	2.7%	7.9%

Source: SWPC

Opportunities

U.S. companies have played an important role in Saudi Arabia's water sector across a range of services such as OEM parts manufacturing and installation, engineering, and consulting. For example, Kansas-based Black & Veatch served as the engineering and design consultant for SWCC's Shuaibah-4 desalination plant. Other examples include a Jeddah Municipality water drainage project and a seawater cooling supply project for the Royal Commission for Jubail & Yanbu (RCJY) for which U.S. firms AECOM and Bechtel provided project consulting services. U.S. water technology company Xylem has further expanded its longstanding presence in Saudi Arabia with a SAR188 million ($50 million) investment agreement with the Ministry of Investment in 2019 (then SAGIA).

As Saudi Arabia develops its manufacturing and industrial capabilities, the increase of desalinated water for the industrial sector is expected to drive water demand. The expansion of Yanbu-4 with GE's 20 MW solar farm heralds a new paradigm for Saudi Arabia's desalination sector in which lower energy costs and maximized water reuse are prioritized. The recent sewage treatment projects signed by SWPC will use both sequencing batch reactor technology as well as solar technology to treat and process wastewater. Renewable energy and water recyclability are two broad areas that Saudi Arabia is keenly interested in soliciting foreign investment and partnerships. Smart metering and offshore desalination are other technology areas for which international expertise will contribute to the Kingdom's sustainable resource management.

Conclusion

Water scarcity represents one of the foremost developmental challenges of Saudi Arabia. Conservation and water loss minimization efforts must be matched by new technologies through investments that ensure sustainable use of water resources. The Kingdom has attracted numerous investments into its growing water desalination sector, yet it faces challenges with water consumption patterns. Municipal water usage, which has improved since updating the water tariff schedule in 2016, would further benefit from lower subsidies and provide a substantial revenue stream.

Despite the government shouldering a majority of the current project costs, the private sector will necessarily play a key role in meeting the growing demand driven by population trends and a growing industrial sector. Maximizing the use of treated wastewater and increasing the efficiency of water networks will require significant investment in construction, engineering, and operations. U.S. firms with water sector expertise are well-positioned to meet many of the demands of the Saudi water sector over the next decade.

Appendix:

Table 3 - SWPC Project Schedule

Type	Name	Province	Operation date	Capacity m^3/day
		Under Procurement		
IWTP	Riyadh – Qassim	Qassim	2022	685,000
	Rayis – Rabigh	Madinah	2022	900,000
ISTP	Al-Haer	Riyadh	2023	200,000
	Khamis Mushait	Asir	2023	25,000 to 50,000
	Riyadh East	Riyadh	2023	50,000
	Dammam outfall pipeline ISTP	Eastern	2023	560,000
	Madinah 3	Madinah	2024	200,000 to 375,000
	Tabuk 2	Tabuk	2024	90,000
	Buraidah-2	Qassim	2024	150,000
IWP	Ras Mohaisan	Makkah	2024	300,000
IWTP	Ras Muhaisen – Baha – Makkah		2024	185,000
ISTP	Jizan Cluster	Jizan	2025	134,400
IWP	Rabigh-4	Makkah	2025	600,000
ISTP	Jizan Cluster	Jizan	-	104,500
ISWR	Juranah (Makkah 1)	Makkah	-	2,500,000
IWTP	Jubail – Buraydah	Eastern	-	650,000
		Future Projects		
ISTP	Abu Arish 3	Jizan	-	25,000 to 50,000
	South Najran	Najran Region	-	25,000 to 50,000
	North Jeddah	Makkah	-	25,000 to 50,000
	Southern Cluster	Madinah	-	60,000
	North-western Cluster	Various	-	49,000
	Northern Cluster	Various	-	143,000
ISWR	Moghammas (Makkah 2)	Makkah	-	8,000,000
	Jeddah (Makkah 3)	Makkah	-	5,000,000
	Asir	Asir	-	5,220,000
	Jizan	Jizan	-	4,460,000
IWP	Jubail 6	Eastern	-	300,000
	Ras Al-Khair-2	Eastern	-	600,000
	Ras Al-Khair-3	Eastern	-	400,000
	Tabuk 1	Tabuk	-	400,000
	Jizan 1	Jizan	-	300,000
	Shuqaiq 4		-	400,000
	Rabigh-5	Makkah	-	400,000
	Jubail 4	Eastern	-	300,000
	Rayis-2	Madinah	-	300,000
IWTP	Rabigh – Jeddah	Makkah	-	600,000
	Jizan	Jizan	-	300,000
	Tabuk – Ula	Tabuk	-	497,000

Source: SWPC