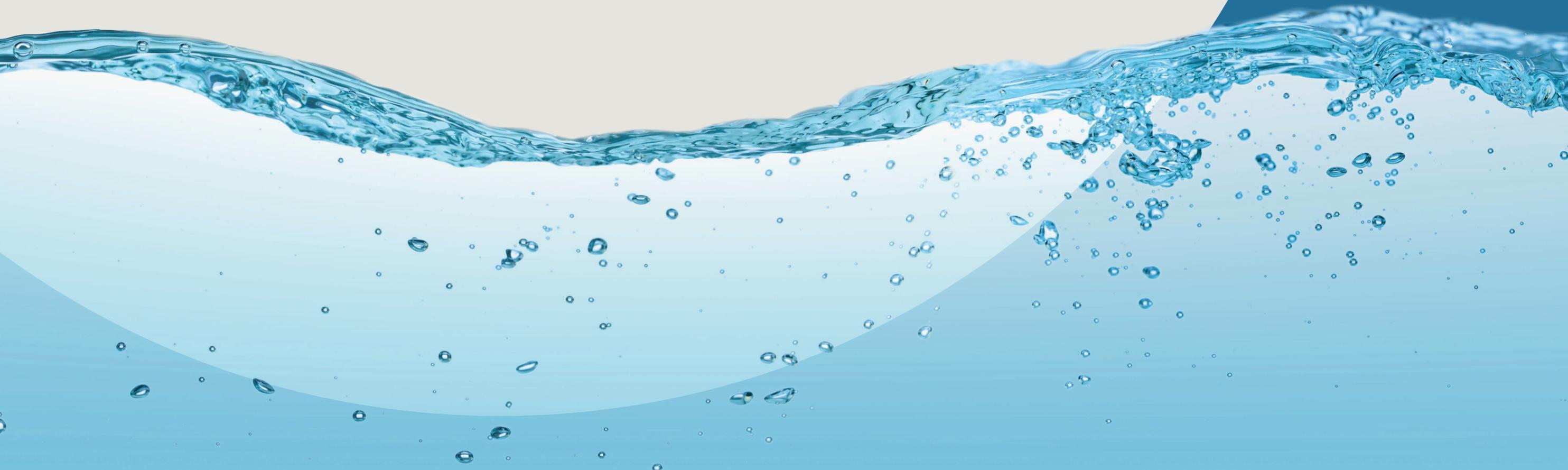


Fresh thinking on desalination

Innovative, sustainable
solutions to improve
water resource security



Quenching the world's thirst for water

Desalination can help meet the interlinked challenges of population growth, climate change and water scarcity.

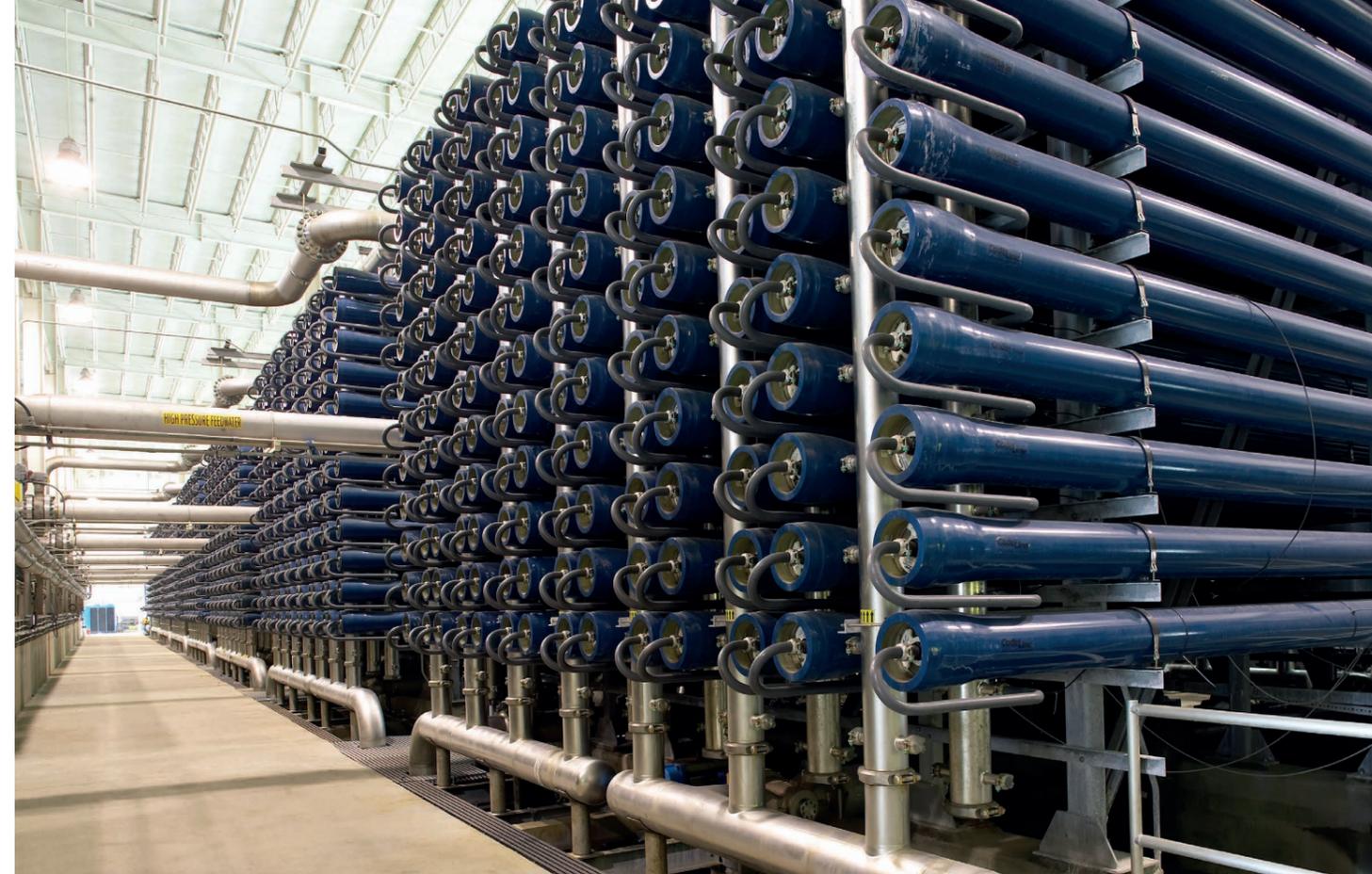
Improving water security

Our world is getting thirstier. Population growth and climate change are putting ever more stress on existing freshwater resources for domestic, municipal and industrial use.

For many countries desalinated water is becoming an increasingly important source of potable water, strengthening overall water resource security and improving quality of life for their people.

Advances in technology are making the process of desalination – removing salt and impurities from seawater, brackish water and wastewater – less expensive and less energy-intensive. Plants can now be built and operated within ecological constraints and in line with national carbon-reduction targets.

Desalination has a key role in water management strategies for the 21st century. We can help you to utilise its potential in the most efficient and sustainable way possible to meet your water production and reuse challenges.



Decades of experience

For more than 40 years we've been at the forefront of developing new sources of desalinated drinking water for communities all over the world. This includes some of the world's largest multi-stage flash (MSF) and multi-effect distillation (MED) facilities.

Today our focus is on designing and delivering seawater reverse osmosis (SWRO) desalination plants, including facilities powered by renewable energy, and we are actively involved in research and development in areas such as zero liquid discharge and resource recovery systems.

Our desalination team is uniquely placed at the intersection of our global energy and water sectors. We can leverage this capability to deploy specialists across the full spectrum of power generation, water treatment, transmission, operations, maintenance and asset management.

As an expert advisor, designer and project manager, we've supported national and municipal governments, financiers, water utility companies, technology suppliers, developers and contractors.

In the process, we've examined desalination projects from many angles, and evolved a deep understanding of the different pressures each client faces and the outcomes they want to achieve for themselves, for their clients and for end users.

Whatever your goals, we have the skills and experience to steer your project to success. It's about providing the right specialisms for the task, with the benefit of big picture knowledge. It's about solving problems, which is what we do best – at small scale, and large.

How we can help you

Our technical advisory and engineering design services cover every aspect of desalination and each stage of the project lifecycle:

- Investment appraisals
- Feasibility studies
- Technical and environmental due diligence
- Risk, technology and environmental impact assessments
- Concept design and design reviews
- Site selection and commissioning support
- Intakes, outfalls, computational fluid dynamics and thermal/salinity plume modelling
- Power grid connectivity
- Regulatory advice
- Detailed design and engineering
- Project management
- Procurement and supply chain advice
- Construction supervision
- Asset management
- Operations monitoring
- System optimisation
- Carbon management and climate resilience

Maximising efficiency, minimising impacts

We can advise you on how to implement the optimum whole-life solution to improve financial, social and environmental performance.



Focused on outcomes

We take a holistic view of problems to find the best ways of solving them. It's the outcomes that matter. Ultimately, that means developing a supply of treated water that is reliable, viable and sustainable when balanced against competing alternatives.

Typically, we evaluate desalination at the highest strategic level in the context of water masterplans. That enables us to look at alternative options, such as demand management, improvements to existing distribution networks or water reuse systems, or new source development.

Our specialists will only recommend desalination when our analysis shows it is the best option to achieve the desired outcomes where naturally occurring sources are inadequate or polluted, or water recycling cannot meet demand. At all times we take into account the location and capacity of energy supplies.

Cutting costs, cutting carbon

The optimum solution lies in getting the economics right and understanding the local environment and social dimensions as well as the technology.

Desalination is an energy-intensive process but we know how to reduce its carbon footprint. Our teams optimise existing technologies and integrate renewable energy systems to cut emissions and improve sustainability.

Our work developing PAS 2080, the voluntary standard for carbon management of infrastructure, enables us to speak with authority on carbon-reduction strategies that will ultimately reduce whole-life costs.

The solutions we devise always take into account environmental impacts, in particular on marine life and ecosystems. The proximity of habitats, breeding grounds and fisheries is assessed when selecting the location of water intakes and outfalls.

Impartial advice

We carry out robust evaluations of all the development options. Our global experience with international financiers and lenders has earned us a reputation for providing impartial advice on technology, commercial risk, construction methods and programmes.

Plus, we have the skills to determine, assess and manage environmental and social risk in development projects in accordance with the Equator Principles and other international frameworks.

Our specialists can fulfil a wide range of roles according to client requirements:

- Authority engineer
- Owner's engineer
- Sponsor's technical advisor
- Lender's technical advisor
- Tender designer/detailed designer
- Expert witness
- Asset management specialist

Harnessing renewable energy and emerging technologies

Finding new solutions to improve the sustainability and efficiency of desalination.

Effective water-power cogeneration

Advances in water production technology and power management are driving down the cost of freshwater produced from seawater, brackish or used water.

Over time, membrane treatment has become the dominant desalination process and, in parallel, renewable power generation has become essential to mitigate against environmental and climate impacts.

The industry has reached a point where the combination of state-of-the-art desalination and renewable power generation may be considered a viable solution for a number of applications – either with a standalone renewable power supply or as part of a risk-balanced energy mix.

Although renewable energy desalination has long been recognised as a potential solution to solving the water resource gap in the Middle East and Africa, the direct application of renewables, until recently, has been limited to small-scale desalination units.

Increased integration

Advances in technology enable large-scale renewables – notably, photovoltaic, concentrated solar and wind – and energy storage to integrate, so there is a robust power supply 24 hours a day even in standalone configuration.

Potential applications include off-grid water-power cogeneration plants in remote areas, where water storage capability combined with energy storage will provide increased operational flexibility.

Coupling desalination with renewable energy sources is a complex challenge. We are uniquely placed to assemble creative solutions that focus on minimising operational carbon while ensuring the commercial longevity of critical assets.

Using our full understanding of power grid optimisation, we can advise you on the best way to integrate renewables and energy storage to secure a reliable power source for your desalination plant.

Pushing the boundaries

We are actively tracking the viability of the latest technical advances and improvements to proven technologies to ensure our engineering solutions provide maximum commercial benefit, which is fundamental for new-build opportunities. These areas of focus include:

- **Seawater reverse osmosis (SWRO)** – new systems which recover energy from high-pressure concentrate to reduce energy consumption to extremely competitive levels.
- **Brackish water reverse osmosis (BWRO)** – more robust membranes offering higher flow rates, lower energy consumption, better fouling resistance and greater product purity, making this process a viable solution for use in municipal water treatment facilities, even in temperate regions.
- **Forward osmosis (FO)** – its potential lies in the utilisation of low-grade heat for driving a membrane-based process and treatment of highly impaired wastewater streams for concentration and reuse.
- **Hybrid SWRO with distillation** – advantages of this solution include increased product water purity, greater operational flexibility, and a reduction in the amount of seawater withdrawal.
- **Digital and smart technologies** – using remote sensors, for example, to monitor water quality and guide process selection, cutting pretreatment costs.



10 ways our expertise in desalination can help you

1.

Improve sustainability

Seawater desalination is vital for arid countries and their reliance on this source is expected to grow fast. This growth will only be possible by continuing to improve the sustainability of related technologies. We have extensive experience in controlling the carbon footprint of desalination projects and mitigating their impact on the marine environment.

2.

Keep pace with new technology

Reduced energy consumption is the key to making desalination more sustainable. We are always among the first to adopt advances in technology that can improve the energy efficiency of desalination processes. The synergies between our water and energy sectors means we are able to provide in-depth technical advisory services on renewable-driven desalination projects.

3.

Get the right fit

Every client's needs are different and we develop our solutions in response to each individual situation, matching technologies with budgets and operational requirements. We will evaluate the benefits of options, such as pretreatment, as well as the risk of not implementing them, and make carefully considered decisions. During all phases of the project lifecycle, we will provide tailored advice.

4.

Understand risks

Our track record on some of the world's largest desalination projects gives us a detailed understanding of project risk and of the associated commercial consequences. We have the right experience to advise on finance, procurement strategy and supply chain management.

5.

Add value

At the start of every project, we search for the opportunity to add value. We interrogate the project brief to achieve the most cost-effective outcome, using our comprehensive in-house cost databases to balance capital outlay and whole-life costs to optimise total cost of ownership. Unlocking innovation and ensuring best value are key criteria for all the solutions we develop.

6.

Optimise asset management

Asset management optimises efficiency and performance, builds resilience, avoids unplanned outages and aligns assets with strategic objectives. It should be central to the procurement of new plants and the operations of existing ones. Our expertise covers both. We have specialists providing strategic advice to a number of global utilities – in addition, we have several teams certified as auditors to ISO 55000/PAS 55.

7.

Increase efficiency

Our specialist teams are experienced in delivering large infrastructure projects through building information modelling (BIM), which brings major efficiencies to the design and construction process. We also use BIM, 3D modelling and other digital technologies to monitor plant operations and optimise performance. We design smart infrastructure with advanced digital asset management systems that drive efficiency and sustainability.

8.

Use our local knowledge

Our desalination group has specialists located around the world. We have managed projects all over the Middle East and in North Africa, the United States, Chile, Australia, Singapore and the United Kingdom. Our policy is to ensure continuity in staffing so our project teams have deep local knowledge of the technical, regulatory and commercial contracting environment.

9.

Find more funding

Many desalination plants have been procured using public private partnerships (PPP/P3). This will continue. We have an excellent track record on PPP/P3 projects in the water sector and are the world's leading technical advisor on infrastructure finance. Our experience covers business case development, procurement strategy and tender support, engineering, procurement and construction (EPC) contracts, and lenders' technical advisory services.

10.

Benefit from our experience

We have technical knowledge and practical experience of a wide range of desalination processes, including the thermal processes associated with power production, stand-alone reverse osmosis and hybrid plants. Our teams have the competences to deliver your plant, whether it is on the mainland or offshore, and whether the capacity is a few cubic metres or hundreds of thousands of cubic metres of product water per day.



Integrated 3D model optimises plant's design

Project

Sohar IWP

Location

Sohar, Oman

Client

Sohar SWRO
Construction Company

Expertise

Building information modelling, multidisciplinary engineering including civil and structural, electrical, instrumentation and control, piping, utilities process and mechanical

Opportunity

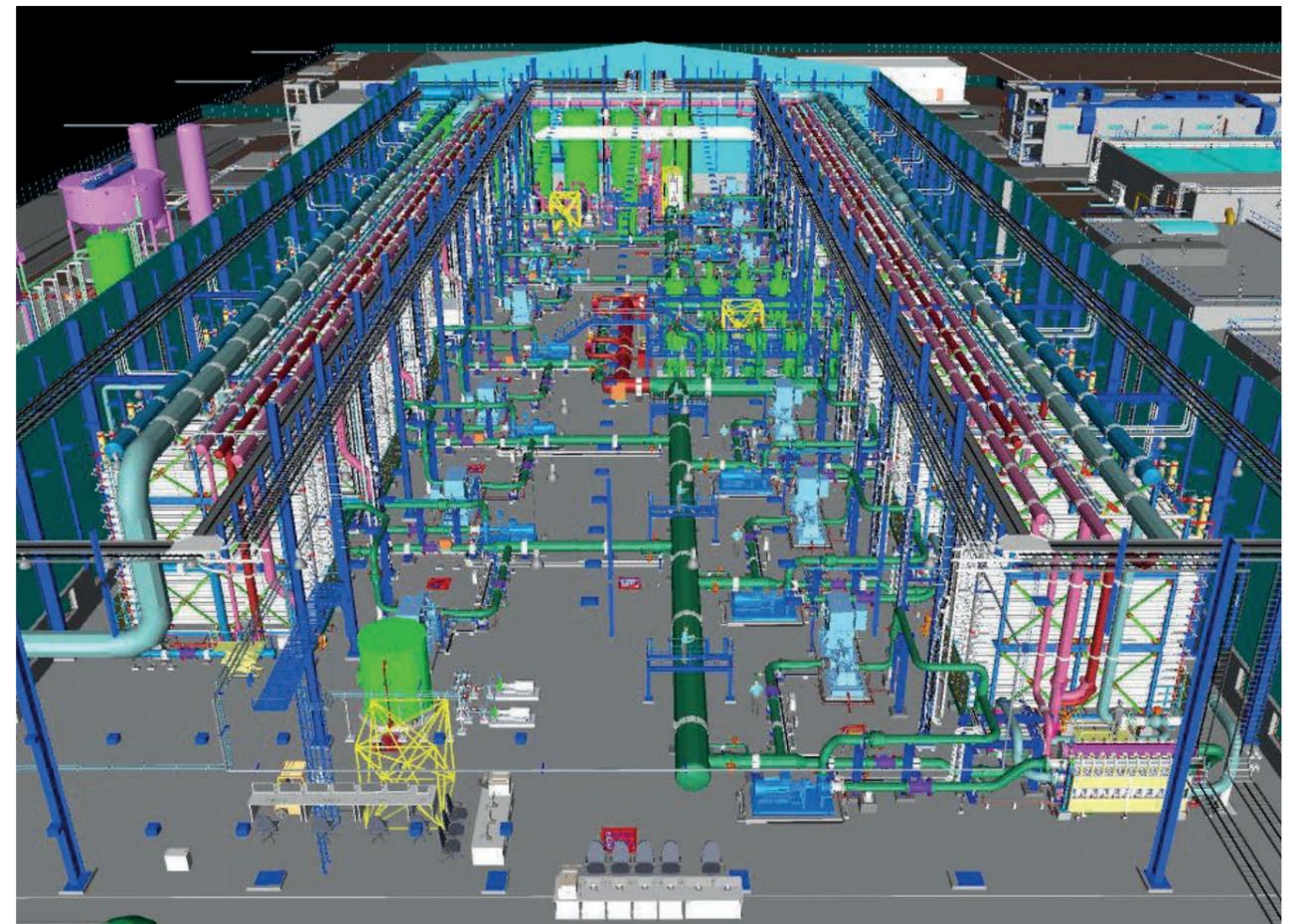
The Sultanate of Oman is facing increasing demand for potable water due to a growing population and an expanding economy. The Oman Power and Water Procurement Company (OPWP) is mandated to manage the development of new resources to meet the higher demand. Seawater desalination projects form a key element of OPWP's strategy to provide sufficient water production capacity at the lowest cost.

Solution

The Sohar Independent Water Project (IWP) comprises the design, construction, financing, ownership, operation and maintenance of a 250,000m³/d seawater desalination facility, using reverse osmosis technology. Sohar SWRO Construction Company, OPWP's contractor, tasked us with developing an integrated 3D BIM model of the entire plant, including civil structures, mechanical and electrical equipment, piping, cables and cableways. Our completed model facilitated the production of a consistent set of detailed civil drawings, piping isometrics, cable layout diagrams, shop drawings and the bill of quantities.

Outcome

In the early stages of the project, we recommended a number of modifications to the original plant arrangement, enabling significant savings in the procurement of bulk materials and related installation works. The comprehensive data and drawings generated by our 3D BIM model also dramatically reduced the risks of extra works and delays during construction. When completed, Sohar IWP is expected to meet about 80% of water demand in the fast-growing Al Batinah North region, supporting Oman's overall economic development and strengthening the country's water security.



80%

of regional water
demand will be met

Project

Tampa Bay Seawater
Desalination Plant

Location

Tampa Bay, Florida, USA

Client

American Water-Acciona Agua JV

Expertise

Process review, detailed design,
permitting assistance, design
verification and certification

Redesigned SWRO plant supplies 2.5M people

Opportunity

To increase supplies of drinking water to the City of Tampa and neighbouring areas of south-west Florida, a 114,000m³/d seawater reverse osmosis desalination plant, the largest of its kind in the USA, was constructed at the Big Bend Power Plant. It failed to perform as intended due to membrane fouling and was soon shut down. Tampa Bay Water, the facility's owner, selected American Water and Acciona Agua to modify the desalination plant and then operate it under a 20-year contract.

Solution

We were responsible for the structural, architectural, mechanical and site infrastructure design of the planned modifications, which included new pretreatment, residuals treatment and chemical systems, as well as an improved reverse osmosis piping network. New process units were integrated with minimal impact on existing structures and equipment while preserving sufficient space for future plant expansion. Our fast-track design approach enabled our client to meet a challenging project schedule and to successfully complete performance tests – up to the specified high rate output of 130,000m³/d – to validate the capabilities of the modified facility.

Outcome

The re-engineered Tampa Bay Seawater Desalination Plant provides around 10% of the Tampa Bay area's drinking water supply, serving the needs of 2.5M people. It improves the drought resilience of the region's water supply network and has an expected lifespan of up to 50 years. The plant's consistent supply of high-quality potable water has restored the confidence of both the public and the water industry in large-scale seawater desalination plants. It serves as a practical, viable model for other North American coastal communities seeking to ease their water supply challenges.



“Mott MacDonald was able to meet the stringent schedule under the design build contract and even accommodated changes to the design as pilot testing of the process modifications proceeded.”

John S Young

Chief operating officer, American Water



First IWPP plant in Gulf region

Project
Taweelah A2

Location
Abu Dhabi, UAE

Client
CMS Energy

Expertise
Technical advisory services, concept design, tender specifications

Opportunity

Abu Dhabi Water and Electricity Authority's first privatisation project – and the first independent water and power project (IWPP) in the region – was Taweelah A2. This 720MW combined cycle power and 228,000m³/d multi-stage flash (MSF) desalination plant is located 80km north-east of Abu Dhabi City.

Our client CMS Energy formed part of a consortium – Emirates CMS Power Company (ECPC) – established to build, part-own and operate the plant, and we were appointed as technical advisors for the tender and subsequent project phases.

Solution

The concept design we developed – the first installation of a combined cycle for water-power cogeneration – comprises three gas turbines, each rated at 185MW and equipped with heat recovery steam generators. The high-pressure steam generated is expanded through two 111MW back-pressure turbine generators, whose exhaust steam is supplied to four 57,000m³/d MSF distillers, equal in capacity to the largest units ever built at that time.

The high thermal efficiency of the combined cycle and MSF plant minimises fuel consumption, heat rejection and carbon emissions. It is also able to meet wide variations in electrical load on the grid, while maintaining full water production.

Outcome

Taweelah A2 has proved to be a reliable source of power and water for the people of Abu Dhabi. The effectiveness of our solution – which pioneered the integration of large, high-efficiency combined cycles with seawater distillers – meant output costs were roughly half of existing cogeneration plants, allowing ECPC to offer competitive tariffs.

Taweelah A2 provided the framework for many successful IWPP projects in the UAE, and across the region. These have strengthened energy resilience and water security, improved efficiency and service levels, and reduced government funding by attracting substantial private sector investment.

Plant's decade of top performance

Opportunity

A redevelopment of Taweelah B, one of Abu Dhabi's key power generation and water desalination assets, involved the construction of a new US\$3bn cogeneration plant on the same site, boosting the complex's overall power generation capacity to 2GW and water production capacity to 727,000m³/d.

The project presented a two-fold challenge: installing four very large 79,000m³/d multi-stage flash distillers – setting a new world record in terms of the output capacity of desalination units – and achieving financial close on a 20-year public private partnership agreement to design, build, finance and operate the plant.

Solution

On behalf of the lenders, we completed a full technical due diligence survey of the project, helping to bring it to a successful financial close. We then monitored the construction and commissioning of the new power and desalination units.

We continue to help monitor and optimise the plant's performance and advise on preventing operational problems that may affect rentability. Our specialists have also guided our client through several operational challenges, including outsourcing maintenance of the desalination units.

Outcome

We have been monitoring operations at Taweelah B for more than a decade and in that time its desalination units have recorded excellent year-on-year performance: plant availability is consistently above 95% and more than 200Mm³ of potable water is produced every year.

The efficient, sustainable operational performance of Taweelah B is playing a key role in helping Abu Dhabi to meet growing domestic and industrial demand for electricity and drinking water.

Project

Taweelah B

Location

Abu Dhabi, UAE

Client

Taweelah Asia Power Company

Expertise

Lenders' technical and environmental advisor, asset management



Water security will boost Morocco's economy



Project

Agadir/Chtouka desalination plant

Location

Agadir, Morocco

Client

SEDA

Expertise

Lenders' technical advisory services

Opportunity

Morocco's exploitable groundwater reserves have dwindled over recent decades and it is today one of the world's most drought-affected countries. The situation is expected to worsen in the future due to the continuing decline in rainfall (10% less precipitation is predicted between 2021 and 2050).

At the same time socio-economic development and tourism is creating more demand. Existing infrastructure that supplies potable water to 900,000 inhabitants in Agadir, Inezgane and Ait Melloul, as well as water for irrigation, needs to be upgraded and expanded to cope.

Solution

ONEE (Office National de l'Electricité et de l'Eau Potable), Morocco's main water utility, together with the country's Ministry of Agriculture and Fishery, launched a public private partnership to finance, design, construct, operate and maintain a 275,000m³/d desalination plant. SEDA (a joint-venture company formed by Abengoa Water and InfraMaroc) and the SPV Aman El Baraka will construct and run the plant – which will use state-of-the-art ultrafiltration pretreatment systems and reverse osmosis technology – under a 30-year build-operate-transfer contract.

We are tasked with undertaking technical due diligence by monitoring the design and construction of the plant and analysing potential risks for the lenders. We are also responsible for reviewing administrative procedures and supervising the handover process.

Outcome

The plant will meet domestic demand for drinking water in addition to demand for irrigation water in the region, contributing to the development of the tourism and agricultural sectors, and preventing the over-exploitation of aquifers. The plant's capacity has the potential to be increased by an additional 125,000m³/d, providing even greater water security.

This is the first privately financed contract that ONEE has introduced. Its successful financial close is expected to lead to further PPP projects, unlocking new sources of investment and helping to deliver more desalination plants, which have previously been unaffordable due to their high capex and opex costs.

400,000m³/d

potential water production capacity



Review gives plant new lease of life

Project

SingSpring Desalination Plant mid-life review

Location

Singapore

Client

SingSpring Pte Ltd

Expertise

Asset management

Opportunity

The SingSpring Desalination Plant is capable of supplying up to 136,380m³/d of desalinated potable water, representing approximately 10% of Singapore's current water demand. The facility is operated under a long-term water purchase agreement (WPA) with the Public Utilities Board. A mid-life review was required to assess the plant's performance to date and current asset conditions, including anticipated future investments should an extension of concession be granted.

Solution

We reviewed the plant's compliance against the WPA, operation and maintenance contracts, and other applicable laws and regulations. Our MEICA team conducted a full plant audit, reviewing the operation and maintenance records to establish plant and equipment condition and energy usage, and provide a detailed investment programme.

Outcome

A crucial recommendation from our review was that an asset management system could provide significant savings in spares held on site, as well as providing a far more targeted maintenance programme. The energy efficiency assessment concluded a further 5% of energy savings could be achieved by using the latest version of the DWEER energy recovery device without any major reconfigurations of the plant. Further recommendations included reviewing the storage of the membranes, and exploring new technological developments in desalination that may result in additional savings.

Fast-track supply solution for Saudi Arabia

Project

Shuaibah III

Location

Jeddah, Saudi Arabia

Client

ACWA Power

Expertise

Owner's engineer

Opportunity

Shuaibah's original water production capacity of 880,000m³/day was sufficient to meet the requirements of 3M people in the Jeddah region. With accelerating demand due to the increasing number of pilgrims visiting the Holy City of Mecca, the Saudi government requested the plant's capacity be increased by 150,000m³/day – and within an exacting timeframe of just 20 months.

Solution

The Shuaibah III facility uses reverse osmosis technology in a two-pass arrangement and state-of-the-art energy recovery equipment, designed to achieve the specification for potable water quality with minimum electrical power consumption. As the owner's engineer, we were responsible for reviewing and verifying the innovative design, supervising construction and commissioning, and verifying the plant's performance in service.

The installation – which also includes seawater intake, multimedia filtration, post-treatment equipment, potable water storage tanks and a common outfall with the existing plant – was completed in just 18 months, from signing of the contract documents to full commissioning.

Outcome

The expanded Shuaibah complex is one of the largest desalination plants in the world, with a total production capacity in excess of 1Mm³/d. It has proved to be a reliable supply of drinking water to the driest region of Saudi Arabia, and plays a critical role providing sufficient supplies of water for the enormous influx of people visiting the kingdom during the annual Hajj pilgrimage. Shuaibah III, built quickly and cost-effectively, and operating efficiently, has paved the way for similar privately financed projects across the Middle East.

Project

Al Khaluf forward osmosis pilot

Location

Al Khaluf, Oman

ClientPublic Authority for
Electricity and Water**Expertise**

Technical advisor

Forward thinking on desalination

Opportunity

Conventional reverse osmosis desalination consumes a lot of electricity where seawater is highly saline or has high levels of contaminants. Newly developed forward osmosis (also known as manipulated osmosis) technology reduces operating costs and provides a more environmentally sustainable alternative to traditional desalination by significantly reducing energy and chemical consumption.

Solution

The desalination plant at Al Khaluf, Oman, is the first in the Middle East to trial forward osmosis technology. The project has demonstrated the effectiveness of the technology, producing high-quality drinking water at a third of the cost compared to conventional processes, and operating reliably in technically challenging operational and environmental conditions. We contributed to the success of the trial by conducting an independent technical review of the plant's technology on behalf of Oman's Public Authority for Electricity and Water (PAEW).

Outcome

The supply of freshwater has had a hugely positive impact on the daily lives of the local community, who previously had to complete a 70km journey to collect water. PAEW is committed to providing water access to all Omanis, with the objective of supplying piped water to more than 90% of the population in the next two decades. With 85% of Oman's tap water coming from seawater, the development of new technologies, like forward osmosis that improve the efficiency of desalination, will help PAEW to deliver sufficient and reliable water production capacity at economic cost.



70km

the distance the local
community had to travel
to collect water before
the plant opened

New plant eliminates water restrictions



Project Management Institute
International Global
Project of the Year Award



Project

Adelaide Desalination Plant

Location

Adelaide, Australia

Client

SA Water Corporation

Expertise

Concept design, process design, plant layout and general arrangement, technical specifications

Opportunity

The city of Adelaide, with more than 1M residents and a growing industrial and commercial sector, has been historically solely dependent on the Murray River for the supply of drinking water. Increasing consumption and climate change is putting this resource at risk. To provide long-term water security for South Australia until 2050, the state government financed the construction of a reverse osmosis desalination plant with associated intake and outfall conduits to the sea, a pumping station and 20km product water transfer pipeline.

Solution

In association with Aurecon, we were responsible for developing the plant's concept design and prepared the technical requirements for the proposal documents. Our responsibilities included seawater and product water quality assessment, pretreatment and treatment requirements, membrane train configuration, post-treatment process, potable water disinfection and backwash water treatment. An innovative feature of our design is hydropower generation on the reject stream from the desalination plant. Using energy from renewable sources is one reason why the plant has one of the smallest carbon footprints of any desalination operation in the world.

Outcome

The Adelaide Desalination Plant has the capacity to produce up to 300,000m³ of drinking water per day, about half of Adelaide's annual water needs. As a climate-independent water source, it is able to increase production in times of drought, compensating for scarcity in conventional sources, and decrease production when the state experiences high rainfall. This asset, which was commissioned on budget, on schedule and meets stringent environmental regulations, eliminated water restrictions in South Australia and improved the diversity and resilience of water supplies to domestic and business customers.

50%

of Adelaide's annual
water needs

Opening opportunities with connected thinking.

Talk to us: desalination@mottmac.com

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Fresh thinking on desalination

Innovative, sustainable
solutions to improve
water resource security

