GWI

WATER IS OUR CONCERN

GLOBAL WATER INTELLIGENCE MAGAZINE

12

DECEMBER 2022

THE WORLD'S TOP 50 PRIVATE WATER OPERATORS

WITH MORE AND MORE PEOPLE NOW GETTING WATER SERVICES FROM THE PRIVATE SECTOR, WHO IS AT THE TOP OF THE TABLE?

WETICO'S BIG BREAK IN ALGERIA

A BRACE OF DESAL CONTRACTS OFFERS A ROUTE BACK TO THE TOP FOR SAUDI CONTRACTOR

EMISSIONS POSSIBLE: BEATING THE N2O PROBLEM

GWI SURVEYS THE TECHNOLOGIES MONITORING, MODELLING AND MITIGATING NITROUS OXIDE

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Media Analytics Ltd.
Suite C, Kingsmead House
Oxpens Road
Oxford OX1 1XX
United Kingdom
T: + 44 (0)1865 204 208
F: + 44 (0)1865 204 209

E-mail domain name:
globalwaterintel.com

Publisher:
Christopher Gasson (E-mail: cg@)

Editor-in-Chief:
Ian Elkins (E-mail: ie@)

Editor:
Tom Scotney (E-mail: ts@)

Editorial Director:
Sebastian Lennox (E-mail: sl@)

Technology Editor:
Charlotte Oakes (E-mail: charlotte.oakes@)

Technology Consultant:
Tom Pankratz (E-mail: tp@)

Asia Analyst:
Maisie Hockin-Boyers (E-mail: maisie.hockinboyers@)

China Correspondent:
Yingjia Qian (E-mail: qyj@)

Marketing Director:
Chantal Marchesi (E-mail: cmarchesi@)

Sales Director:
Jack Ceadel (E-mail: jmc@)

Head of Global Sponsorship:
Abigail Edwards (E-mail: abigail.edwards@)

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DEC 2022

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NEED TO KNOW

French industrial water manoeuvres; New battlegrounds for PFAS treatment; African Development Bank adopts radical new water strategy; Changing patterns of power for desalination; Energy spikes take their toll on UK water profits; all the latest news from around the world this month.

COMPETITORS RISING

● GWI publishes its latest Top 50 ranking of private water operators by population served this month (*see page 9*). **Veolia's** acquisition of Suez helped it to reclaim the top spot, while **Suez** drops to fourth place, just behind **Wabag**. The most impressive risers in the table were the Brazilians, who were able to take advantage of a lack of international competition to win big as the domestic concessions roll-out picked up pace.

● **Saur's** industrial ambitions showed no sign of slowing this month as it entered exclusive negotiations with **Veolia** to buy **Suez's** industrial water O&M business in the UK. Late last month it completed its acquisition of Veolia's 400-strong mobile water fleet, with the latter's drinking and process water focus complementing Saur's 100 industrial wastewater units (*see story p14*).

● German pumps supplier **Wilo** is also diversifying rapidly. Its water treatment business unit, led by **Remondis** veteran Dirk Wittenberg, is increasingly looking to develop projects using the in-house expertise gained from a decentralised hydrogen production plant at its state-of-the-art Dortmund campus. Fellow European pump suppliers **Grundfos** and **Sulzer** have also made the quantum leap into the higher-growth water treatment space (*see story p15*).

REGULATORY WARFARE

● Institutional investors managing $8 trillion in assets joined the PFAS fray this month, urging producers to phase out the compounds. The latest battleground is Europe, where EU legislation aims to crack down on PFAS levels in natural water sources, while turning the screws on industrial polluters. Utilities are caught in the crossfire. The tightest pressure is in Northern Europe, where standards as low as 4ppt in Sweden and 2ppt in Denmark have whipped up a litigation frenzy. Utilities are suing polluters, and customers are suing utilities. Who will ultimately foot the bill, and how much will it cost (*see story p10*)?

● Even the tightest European standards pale in comparison to the parts per quadrillion health advisories from the US EPA. Even before it has released proposals for enforceable water standards – due by the end of this month – the regulator is already having to fight litigation from industry groups. Yet the regulatory net continues to tighten. This month the EPA sought to close a 'de minimis' loophole that had enabled some industrial PFAS polluters to avoid reporting, and urged states to include PFAS sampling in NPDES permits. A regulatory review board in Pennsylvania, meanwhile, approved new maximum contaminant limits for PFOA and PFOS, which now just await a rubber stamp from the Attorney General.

● The dangers of short-term funding decisions were also on the mind of Osward Chanda, water head at the **African Development Bank**, this month. He spoke to GWI about putting utility autonomy at the heart of his radical new strategy for the world's tenth-largest water lender. The bank is seeking to lend directly to municipalities and utilities, not just central ▶

KINSHASA'S CRISIS

Devastating floods killed at least 120 people in Kinshasa, the capital of the Democratic Republic of the Congo, earlier this month. Infrastructure in the city of 15 million was also severely damaged. The latest disaster compounds the challenges facing national water utility Regideso. The poorly performing utility is facing a government-led restructuring programme that will see it split into a number of autonomous operators after stuttering attempts to bring in private expertise. Long-time donor the World Bank is rolling out a new performance-based financing package to support the latest attempt at reform. The $300 million initiative will depend on success in delivering cost-recovery tariffs, claiming back sums due from government departments, and hitting operational performance targets (*see story p23*).

Source: Reuters

governments, and empower them to take their agenda to governments (*see story p24*).

DESAL RECOVERIES

● **Algeria** has put local contractors in the driving seat for its large-scale desal revival, as it looks to learn lessons from a chequered history with foreign developers. The majority of the desal plants built by Spanish developers in Algeria's first build-out faced operational difficulties, as did the mammoth Mactaa plant built by Hyflux. The locals have contracted desal plant supply on the first two 300,000m³/d facilities to Saudi Arabia's **Wetico**, which has disrupted rival Metito's winning streak to bag its first large-scale references in years (*see story p22*).

● **Wetico** is planning to use the two plants as a springboard to take it back into the top echelons of the desal market (*see story p23*). The company has had a new lease of life since long-term part-owner **Abunayyan Group** took full control in 2020, and it is now chasing down the largest-scale opportunities in the desalting business. Rumours suggest that it is lining up a bid as EPC contractor for one of the major independent water projects in its home market of Saudi Arabia.

● The Saudi private desal project market is heating up after a couple of relatively quiet years. **ACWA Power** (part-owned by Wetico controller Abunayyan) has been revealed as the lead bidder for the next major desalination plant at Rabigh, while processes are underway to procure two further plants at Ras Mohaisen and Jubail (*see Project Tracker, p48*). The projects are all being overseen by the Saudi Water Partnership Company.

● Morocco, meanwhile, is looking to tap Israeli expertise for its desalination and reuse build-out. Power and water body **Office National del'Electricité et de l'Eau Potable (ONEE)** and Israel's national water company **Mekorot** last month signed an MOU covering water and sanitation, with a focus on alternative water supplies. It is the latest fruit of the 2020 Abraham Accords, which normalised relations between Israel and some Arab countries.

UTILITY STRATEGIES

● The Colorado Water Quality Control Commission's landmark ruling on direct potable reuse has unlocked a crucial tool for water-stressed utilities in the state. GWI spoke to a number of utilities about their plans to use DPR, and the technological, ideological, and practical hurdles they face in doing so (*see story p30*).

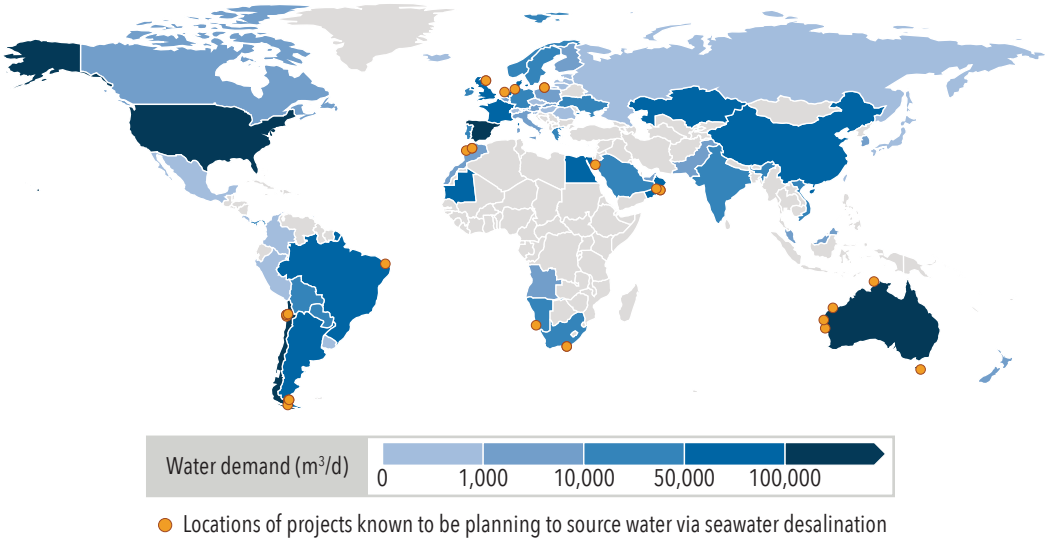
● Malaysia is merging its Ministry of Water and Environment with the Ministry of Energy and Natural Resources. Utilities there are hoping that bringing water, energy, and climate change together under one umbrella will provide an environment to develop more circular water programmes and reinvigorate faltering non-revenue water reduction plans (*see story p26*).

● Most of the large UK water and sewerage companies saw their operating profits take a dive over the first half of 2022/23, as the Russian invasion of Ukraine led to the steepest surge in energy prices – and general inflation – for well over two decades. **Pennon** was one of the worst hit, with its costs doubling to £49 million over the period. Only two companies were able to report an improvement in operating profit in H1 (*see story p12*). ■

CHART OF THE MONTH: WATER DEMAND FOR GREEN HYDROGEN

This month's chart shows the estimated demand for demineralised water for electrolysis to produce green hydrogen by 2030. The data forms part of GWI's latest research update on the green hydrogen market, where a booming project pipeline will drive opportunities for the water sector, with an estimated 2 million m³/d of demineralised water expected to be required by the end of this decade. Australia is expected to be by far the largest market for the production of green hydrogen, followed by a diverse list of countries in Europe and Latin America – and the United States. Investment in green hydrogen projects and the water required to supply them has been mainly driven by countries' decarbonisation strategies, and further boosted by the high oil and gas prices triggered by the war in Ukraine this year, which caused countries to seek alternatives to fossil fuels. Ambitious goals for electrolyser capacity and hydrogen production by 2030 are driving demand and creating a growing project pipeline. Countries with plentiful access to existing renewable resources like Chile and Namibia are leaning on the potential of hydrogen as an export. The need for water of almost ultra-pure quality as feedwater for the electrolysis process will mean growing opportunities for technologies such as reverse osmosis, ion exchange, and electrodeionisation. Almost half of the green hydrogen projects which specify a source of water are opting to rely on desalinated seawater. With a significant number of projects that have yet to specify a water source located in port and coastal areas, many more are likely to follow, creating yet more investment in desalination and brine management technologies. In water-scarce regions, opportunities might arise for the co-location of hydrogen production at wastewater treatment plants: a number of synergies can lower the levelised cost of hydrogen either by using treated wastewater as feedwater in electrolysis, or by using oxygen (a by-product of hydrogen production) for aerated wastewater treatment. While many of these technologies are already mature, the crucial role of water for the efficiency and performance of the electrolytic process is set to give a new impetus to this part of the water market. ■

To read more about the newly published green hydrogen research update or to schedule a free trial of the research portal, visit www.gwiwaterdata.com.



Source: GWI WaterData

GWI WATER INDEX

Is this the end of ESG investing?

A backlash against some of the top investors in water equities over their ESG policies could have far-reaching implications for the net zero agenda in water.

The modest rise in the GWI Global Water Index this month was spectacularly overshadowed by the events unfolding in the US regarding the ESG policies of some of the largest holders of listed water equities, most notably BlackRock and Vanguard.

Republican state treasurers have been falling over themselves to liquidate their investments in BlackRock over the past few months, with the prevailing argument being that BlackRock's ESG policies are detrimental to states that are heavily dependent on fossil fuel revenues.

BlackRock's reluctance to divulge the details of its ESG policies resulted in a subpoena from the State of Texas in late November, while Vanguard sought to head off a similar storm by announcing its withdrawal from the Net Zero Asset Managers initiative on 7th December, implying that it no longer supports the goal of net zero greenhouse gas emissions by 2050.

It is not difficult to see the reasons behind the backlash. BlackRock's flagship iShares ESG Aware MSCI USA ETF (which has holdings in Xylem, Essential Utilities, Ecolab and Danaher) is down 18% year-to-date, while Vanguard's ESG U.S. Stock ETF is down 20.5% YTD. By contrast, shares in fossil fuel bellwether ExxonMobil are up 56% since the start of the year, while Chevron is up 39%.

Meanwhile, the two largest US water utilities by market capitalisation – which have spent a great deal of time and money trying to convince investors of their ESG superiority – are both down YTD, and must be wondering whether the ESG bunfight was all worth it.

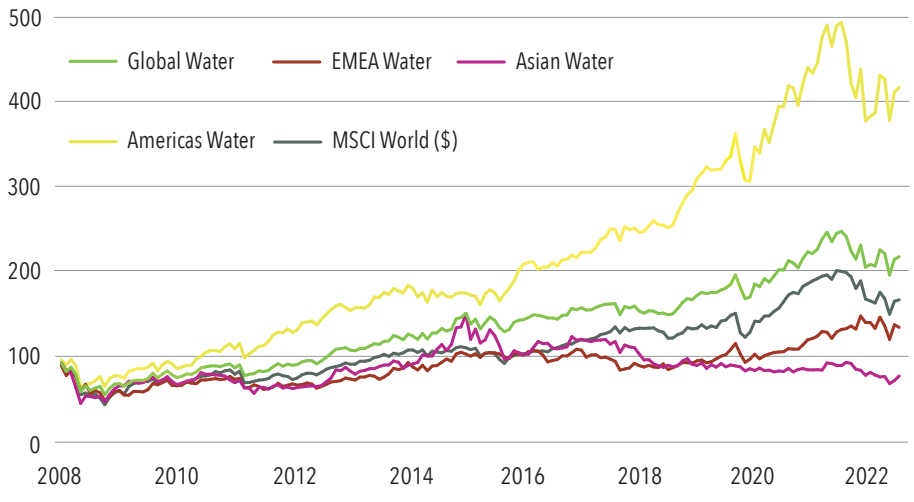
In terms of stock performance this month, it was Asian names which led the parade, nudging the Asian segment of our index up to its highest level since July. Perspective is everything, however, and despite jumping 30% this month, Guangdong Investment shares are still down more than 20% since the start of the year, while Yunnan Water stock is off nearly 60% YTD, despite posting a 25.8% rise this month.

The real winner was Wabag, which remains the top Asian-domiciled performer in our index this year (up 8% YTD). Outgoing CEO Rajiv Mittal can look back on an overwhelmingly positive tenure at the helm of the company, with the market cap having grown by more than 25% since the IPO in 2010 (after adjusting for stock splits and bonus shares).

One final observation: Moya's imminent delisting means it will be removed from the index with immediate effect. ■

HOW DID WATER STOCKS PERFORM THIS MONTH?

Asian names bounced back with a vengeance this month, although most are still heavily under water since the start of the year.



1st January 2008=100. Calculated on 10 Dec. Index has 69 stocks, weighted by market capitalisation and water exposure.

REGIONAL TRENDS

GWI Index	Value on 10 Dec	Change
Global Water	**217.76**	1.44%
Asian Water	**78.96**	7.20%
EMEA Water	**135.55**	-2.16%
Americas Water	**414.44**	1.28%

10 BEST PERFORMERS

Company	Monthly change (10 Nov-10 Dec)
Guangdong Investment	30.02%
Yunnan Water	25.81%
VA Tech Wabag	20.94%
Ranhill Holdings Berhad	15.79%
Manila Water	15.76%
Alkhorayef Water & Power Tech	15.19%
Beijing Enterprises Water Group	11.60%
SIIC Environment	10.98%
Poten Environment Group	9.96%
Organo Corp	8.17%

10 WORST PERFORMERS

Company	Monthly change (10 Nov-10 Dec)
Consolidated Water	-19.19%
ACWA Power	-12.57%
Select Energy Services	-11.64%
Qatar Electricity & Water Co.	-10.79%
Aris Water Solutions	-7.07%
Beijing Water Business Doctor	-6.91%
Metawater	-6.31%
Tetra Tech Inc.	-5.68%
Shanghai Safbon	-5.23%
Kangda International Env.	-5.00%

BIG WATER

Company	Monthly change (10 Nov-10 Dec)
Evoqua	6.34%
American Water	5.85%
Veolia	4.39%
Essential Utilities	3.92%
United Utilities	1.12%
Severn Trent	0.85%
Sabesp	0.63%
Kurita Water Industries	0.00%
Pentair	-0.07%
Xylem Inc.	-0.46%

EVENTS DIARY

All the key events coming up in the global water and wastewater industry.

JANUARY 2023

15-19	**IWA Conference on Reclamation and Reuse.** Chennai, India
23-25	**Water for Texas 2023.** Austin, TX, USA
24-26	**American Water Summit 2023.** Los Angeles, CA, USA

FEBRUARY 2023

14-16	**Filtech 2023.** Cologne, Germany
20-21	**Arab Water Convention 2023.** Dubai, UAE
20-23	**Membrane Technology Conference.** Knoxville, Tennessee
20-23	**WWETT 2023.** Indianapolis, IN, USA
26-1 Mar	**Global Water, Energy & Climate Change Conference.** Manama, Bahrain

MARCH 2023

12-16	**Oman Sustainability Week.** Muscat, Oman
14-15	**MENA Desalination Projects.** Abu Dhabi, UAE
22-24	**Water Philippines.** Manila, Philippines
27-29	**Water India – Smart Cities 2023.** New Delhi, India
28-29	**International Desalination Conference.** Santiago, Chile

APRIL 2023

17-18	**Smart Water Systems.** London, UK

MAY 2023

8-10	**Global Water Summit 2023.** Berlin, Germany. Feat. **Global Water Awards**

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IN FUTURE EDITIONS...

JAN	● Water's role in the green hydrogen revolution ● GWI's annual water stocks review ● Where next for Saudi listed water?
MAR	● Global Water Awards 2023 shortlist

FROM THE PUBLISHER

What is the best model for the water utility sector?

Christopher Gasson says that there are three metrics that really determine success.

I was asked by the engineering firm Atkins to present an international comparison of regulatory systems for their Assurance and Regulation Conference in London this month. It made me wonder how we should judge between different models for delivering water services. The most basic question should be: "Does it do what it is supposed to do?", but whether an institutional model meets expectations seems to break down into three separate questions:

1) Does the model deliver value for money to those who finance it? Here I am talking about all those who put money into utility services: ratepayers, taxpayers, and international financial institutions. They are wasting their money if service delivery is inefficient, if the procurement model does not encourage competition and innovation, if poor maintenance accelerates the rate of capital depreciation, and if unnecessary investment projects are allowed to go ahead. There need to be mechanisms to manage all of these issues.

2) Does the model attract or repel capital for investment? Water services need capital investment like humans need oxygen. They die without it. The problem is that paying for investment adds to water bills. If water services are to thrive, there has to be a mechanism to ensure that expensive, but necessary investment in infrastructure can be made.

3) Does the model allow for political accountability? Water utilities always act within a framework of political priorities, and it is important that those who make decisions about the cost, level of service, and environmental protection answer to stakeholders for their decisions.

The table below shows how I would score the systems in different countries. Australia comes out on top. The combination of profit-making state-owned utilities and economic regulation is a powerful one. Its main weakness is the fact that economic regulation happens at the state level, and can be subverted by politicians. The main weakness of the Netherlands model is that it doesn't really have a mechanism to squeeze efficiency out of the utility sector. It relies on a rather unconvincing benchmarking system instead of proper economic regulation. England and Wales undoubtedly has the best economic regulatory system in the world, but it is completely politically inept. There is no proper accountability for the priorities the regulator sets. Japan's water sector has some awesome utilities, but they are unconscionably capital-intensive.

As the world grapples with climate change and its implications for water, a number of countries are rethinking the institutional design of their water sectors. If they ask themselves how their system delivers value for money, attracts investment, and allows political accountability, they will make the world of water work better. ■

WHAT IS THE BEST INSTITUTIONAL MODEL FOR WATER?

Scored out of ten according to value for money, ability to attract investment, and political accountability.

Country	Val.[1]	Inv.[2]	Pol.[3]	Total	Country	Val.	Inv.	Pol.	Total
Australia	8	9	9	26	Brazil	7	8	7	22
Netherlands	7	9	9	25	Japan	4	9	8	21
Singapore	8	9	7	24	China	7	8	5	20
Germany	6	9	8	23	Spain (canon)	7	4	7	18
US municipal	6	7	10	23	Saudi Arabia	7	8	3	18
France (deleg.)	8	7	8	22	Italy	6	5	6	17
England/Wales	10	10	2	22	India	5	3	6	14
US inv-owned	7	10	5	22	Nigeria	4	1	6	11

1).Value for money *2) Ability to attract investment* *3) Political accountability* *Source: GWI*

THE LIST

The world's top 50 private water operators

Veolia regains the top spot after absorbing a chunk of Suez's global portfolio earlier this year. Acciona and Aqualia move up, but the biggest risers were local players able to exploit the fact that markets like Brazil are still largely closed to international companies.

A new analysis undertaken by GWI this month into the number of people served by private water operators has revealed major changes at the top of the league table, with Veolia regaining its top spot after taking over Suez's operations in the Americas and Spain.

We have had to estimate the true number of people served by Veolia, as the massive task of rationalising two global portfolios has not yet been completed by the company. The apparent minimal increase versus our last survey in March 2021 is partly explained by the fact that Veolia has since sold its stake in Shenzhen Water, effectively wiping 30 million off its previous total.

The global data suggest that more than 1.3 billion people receive either water or wastewater services from the top 50 private water companies alone (after eliminating double-counting). This takes into account both regulated utility operations and non-regulated services under long-term O&M and concession contracts.

We have opted not to include Saudi Arabia's six 'cluster' contracts – where private water teams provide management and operational services covering the Kingdom's 35 million residents – because they focus more on management and support of water operations through the National Water Company (NWC) than providing the underlying services themselves. In addition, significant parts of the NWC's infrastructure operating responsibilities are already contracted out to the private sector through direct O&M agreements. This will change in future when the cluster contracts morph into full-blown concessions.

One caveat is that our list almost certainly does not reflect the top 50 private water companies active in the world today. Remondis would have likely made the list if it had disclosed how many people it serves, and the same is true for Larsen & Toubro.

There is also the question of what constitutes a private water company. The partial IPO of the Dubai Water & Electricity Authority earlier this year theoretically means it is eligible for inclusion (although with 4.7 million people served, it would not have made it into the top 50).

The way that companies calculate the number of people they serve varies widely, and we have allowed a certain degree of licence in this regard. For example, assuming an average per capita consumption rate for India of 90 litres per day rather than, say, the 135 litres set out by the Ministry of Housing and Urban Affairs for urban areas, can make a big difference to the population served figure for a single treatment plant.

Similarly, a single contract can make a big difference to where a company appears in the table. Aegea leapt from 39th place to 21st largely on the back of a big concession win in Rio de Janeiro, while pan-African specialist Eranove's win in Benin virtually doubled the number of people it serves. ■

PRIVATE WATER IN CHINA

Chinese private operators look for new growth avenues

Roughly half of China's population is now served by private water companies. Where will the next wave of growth come from?

Approximately 700 million people in China now receive water and/or wastewater services from the private sector, accounting for around half of the country's total population.

Those are the findings from a new survey conducted by GWI this month, which concluded that 20 of the largest 50 private water operators in the world are domiciled in China.

We have listed SIIC Environment and General Water separately this year, as presenting them under the umbrella of partial shareholder Shanghai Industrial Holdings distorted the true figures.

The past year has remained tough for Chinese project developers, as the country's strict zero-COVID measures further exacerbated their debt problems, resulting in construction delays and deferred payments from financially squeezed local governments. A great number of operators are struggling with expanding their footprints due to a lack of capital, although some have sought to utilise alternative financing vehicles, such as initial public offerings and infrastructure real estate investment trusts (REITs), in a bid to obtain cash to fund new projects.

More than a dozen local water utilities – especially in wealthier eastern coastal areas like Zhejiang, Jiangsu, and Tianjin – are preparing for REIT stock exchange offerings by selecting good quality water concessions as underlying assets, following up on the success of Beijing Capital, which issued China's first wastewater asset-backed infrastructure REIT in June last year.

At the same time, some players have succeeded in further strengthening their water portfolios under China's various environmental initiatives.

The "urban-rural integration" initiative, mostly promoted in the country's new first-tier cities where urbanisation has acquired speed and requires capacity upgrades to treat increased flows, is likely to further boost the population served by the private sector. Operators with significant portfolios of water assets in urban areas, for example China Water Affairs and Guangdong Investment, have benefited from this initiative by extending their water service scope to nearby rural areas.

Besides bidding for projects under China's massive Yangtze River and Yellow River environmental remediation programmes, Chinese water companies are also seeking opportunities for growth in capital-light O&M contracts abroad. China Everbright Water secured a win in Mauritius in 2021, while Beijing Enterprises Water Group and Beijing Origin Water are eyeing the municipal wastewater O&M market in the Middle East. ■

Rank	Company	Country	Water revenues	People served	Notes
1	Veolia	France	€10.8bn	141,600,000	Suez merger drove growth in the Americas and Spain
2	Beijing Enterprises Water	China	HK$27.9bn	112,206,958	Steady growth at home; eyeing O&M-related contracts overseas
3	VA Tech Wabag	India	INR29.8bn	88,896,154	2022 number higher, despite international contract expiries
4	Suez	France	€4.125bn	88,634,996	Portfolio slimmed down due to asset disposals to Veolia
5	Beijing Capital	China	RMB14.3bn	60,000,000	Secured projects under the Yellow River Basin Eco initiative
6	Acciona Agua	Spain	€1,052m	50,594,192	Big wins in Saudi Arabia, Egypt & Spain, with more desal to come
7	SIIC Environment Holdings	China	RMB5.5bn	44,226,457	Active in water and wastewater projects nationwide
8	China Water Affairs	China	HK$12.3bn	41,814,882	Rapid expansion nationwide; may spin off water supply business
9	Aqualia	Spain	€1.17bn	35,500,000	Expansion in Egypt, Colombia, Georgia, and France
10	Guangdong Investment	China	HK$17.8bn	35,026,497	Successful under China's "urban-rural integration" initiative
11	Beijing Origin Water	China	RMB8.0bn	35,000,000	Paid $148m compensation to its state backer after acquisition
12	Sabesp	Brazil	BRL19.5bn	28,400,000	Out-of-state concession expansion remains a long-term objective
13	Chongqing Water Group	China	RMB7.3bn	26,639,540	Acquired seven water concessions in Kunming in November 2022
14	Alkhorayef WPT	Saudi Arabia	SAR569m	26,500,000	The market leader in Saudi water infrastructure outsourcing
15	China Everbright Water Ltd.	China	HK$6.9bn	25,827,788	Expanded overseas through new wastewater O&M in Mauritius
16	Shanghai Chengtou Group	China	RMB13.9bn	24,259,065	Includes Shanghai Chengtou Water and Shanghai Env. Group
17	General Water of China	China	HK$2.4bn	20,998,387	Owned by CECEP Capital (55%) & Shanghai Ind. Hldgs (45%)
18	CECEP Guozhen Environment	China	RMB4.5bn	20,758,217	Leveraging state-owned stakeholder's robust access to finance
19	Tianjin Capital Environmental	China	RMB3.8bn	20,655,777	Water & wastewater utility for Tianjin, with projects nationwide
20	Vishvaraj Infrastructure	India	INR3.8bn	21,300,000	New orders drive sharp post-COVID surge in population served
21	Aegea Saneamento	Brazil	BRL2.94bn	21,000,000	Big wins in Rio de Janeiro in 2021; entered State of Ceará
22	Chengdu Xingrong Env.	China	RMB5.9bn	20,781,976	Chengdu's water & wastewater utility, with projects nationwide
23	Saur	France	€1.7bn	20,000,000	Organic growth in France; selling Colombian water concessions
24	Jiangxi Hongcheng	China	RMB5.9bn	18,803,419	Controls 80% of Jiangxi Province's sewage treatment market
25	Yunnan Water	China	RMB4.3bn	17,663,642	Sold 100% of Yun Shui Technology to SIIC Environment in Nov
26	ACWA Power/Nomac	Saudi Arabia	SAR2bn	16,800,000	Portfolio includes the world's largest RO desal plant at Rabigh
27	Kangda Int'l Environmental	China	RMB2.9bn	16,089,937	Steady growth from new municipal BOT contracts across China
28	BRK Ambiental	Brazil	BRL3.454bn	16,000,000	Missed out on the big-ticket contract wins in 2021 and 2022
29	Thames Water	UK	£2.177bn	15,000,000	Some reversal of London population outflows due to COVID-19
30	Hua Yan Water	Hong Kong	HK$2.4bn	14,511,797	Subsidiary Foshan Water currently preparing for A-share listing
31	American Water Works	US	$3.93bn	14,000,000	Sold New York regulated business; very active M&A elsewhere
32	Eranove	France	-	13,720,000	Benin concession adds 6.7 million people (live in July 2022)
33	Tus Environmental	China	RMB1.1bn	13,226,054	Under investigation after state rescue package collapsed
34	Jacobs	US	$1.9bn	12,500,000	Big wins in North America could boost total further in future
35	Sound Global	China	-	12,099,214	Delisted from the Hong Kong Stock Exchange in Sep 2022
36	Copasa	Brazil	BRL5.18bn	11,800,000	Organic growth within established Minas Gerais franchise area
37	Manila Water	Philippines	PHP20.29bn	11,796,256	Steady growth at home; making headway in the Middle East
38	Metro Pacific Investments	Philippines	PHP23.12bn	10,634,443	No big project wins in 2021; data includes Maynilad concession
39	Acea	Italy	€1.3bn	10,042,068	Population estimates trimmed in latest sustainability report
40	Sanepar	Brazil	BRL5.2bn	10,000,000	Incremental organic growth in core franchise area in Paraná
41	Jiangsu United Water	China	RMB836m	9,437,387	IPO application in Shanghai approved in July 2022
42	Aguas Andinas*	Chile	CLP506bn	8,000,000	Pop. also included in Veolia total due to majority ownership
43	Severn Trent	UK	£1.94bn	8,000,000	Figures include the Hafren Dyfrdwy company in Wales
44	Iguá Saneamento	Brazil	BRL1.058bn	8,000,000	Total boosted by big concession win in Rio de Janeiro in 2021
45	Penyao Env. Protection Co., Ltd.	China	RMB2.0bn	8,000,000	Steady growth in wastewater PPP business in China
46	United Utilities	UK	£1.86bn	7,400,000	Includes Manchester, one of the fastest growing cities in Europe
47	GS Engineering (incl. Inima)	South Korea	-	7,293,068	Figures boosted by desal expansion in Oman
48	Anglian Water	UK	£1.40bn	7,000,000	One of the UK's fastest-growing regions in terms of population
49	SPML Infra	India	-	6,808,000	Population served stays flat even as revenue recovers
50	Socamex	Spain	-	6,800,000	Change of ownership in 2022 could shake things up in future

** Also included in Veolia's total*

Source: GWI WaterData, Company data

EMERGING POLLUTANTS

What will the price tag be for Europe's PFAS problems?

The EU wants to get serious on PFAS. With estimates of the cost of treatment ranging from €17bn up to €170bn, the question of who pays is becoming a political and legal minefield.

Last month, global investors managing $8 trillion in assets urged chemical companies to phase out the production of per- and polyfluoroalkyl substances (PFAS), also known as 'forever chemicals'. The development came soon after an amendment to the EU's surface and groundwater standards placed 24 species of PFAS within the regulatory crosshairs for the first time (*see GWI November 2022, p12*). However, the rising tide of voices calling for action have not yet solved the key issue: who will pay the cost of PFAS treatment in Europe – and how much will it be?

The most comprehensive effort to estimate the cost of managing PFAS contamination comes from the Nordic Council. In its much-cited Cost of Inaction report, published in 2019, the Council used existing case studies to forecast the cost of PFAS treatment and remediation in the European Economic Area (plus UK and Switzerland) over a 20-year period. The study forecast potential combined capital and operating expenditure on environmental screening, monitoring, treatment, remediation, and health assessment of €16.9 billion, but acknowledged that in a worst case scenario, this figure could be as much as €170.8 billion. The forecast figures (*see table, below right*) were backed by two key assumptions: that 3% of Europe's population is exposed to PFAS concentrations above regulatory action levels, and that no further regulatory moves will be taken to phase out the production of 'forever chemicals'.

Other models have supported the more extreme end of the Nordic Council's eye-watering estimates, which were undertaken to highlight the economic consequences of regulatory inaction. Analysis from UK Water Industry Research suggested last year that £21 billion (€24.5 billion) would be needed to treat and incinerate PFAS at affected wastewater treatment plants in the UK and Ireland for environmental pollution mitigation. When it comes to protecting consumer health, the European Commission has suggested €9 billion in additional EU-wide costs if reverse osmosis (RO) were needed to remove PFAS from drinking water, although the Commission has insisted regulatory intervention on polluters will be enough to avoid these costs.

THE BURNING ISSUE

A ban on the use of PFAS in firefighting foams being considered in the EU could reduce the burden on water bodies dealing with the 'forever chemicals'. But with some experts warning PFAS is already endemic in natural water sources, it is likely to remain an expensive worry for the sector.

Source: Shutterstock

Reducing the financial burden of a Europe-wide PFAS clean-up has now risen to the top of the regulatory agenda, with the EU Commission signalling its intention to place polluters under pressure with aggressive source control measures. This includes a coming restriction on the use of PFAS as a group in firefighting foams (currently under consideration by scientific committees), alongside last month's new surface and groundwater standards, which target industrial producers. However, the jewel in the crown of the Commission's strategy is a wide-ranging Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) ban on PFAS in all but essential applications – a move that many see as the only way to bring down existing levels of environmental contamination. "[Utilities] cannot treat these chemicals while they are still being produced and discharged. It is only the regulation that can stop it being produced, and lower levels over time," Marko Filipovic, environmental consultant and company manager at Sellen & Filipovic, told GWI. However, despite the Commission's ambition, delays to the legislation's submission process mean the ban could still miss an important 2025 implementation target.

In the meantime, the European PFAS treatment landscape offers more questions than answers, even where member states have already pressed ahead with national drinking water standards. In Sweden, a drinking water limit of 4 nanograms per litre/parts per trillion is set to take effect next year, while Denmark has already moved ahead with a threshold value of 2ng/L for four PFAS species. However, ▶

THE WIDE RANGE OF PFAS COSTING IN EUROPE

Research carried out by the Nordic Council put an initial best estimate of €16.9 billion on the aggregated cost of environmental screening, monitoring, soil treatment and health assessment to manage PFAS over 20 years in the European Economic Area plus Switzerland*. However the range of variables is colossal, with the Council acknowledging that a worst-case situation could push the overall cost as high as €170.8 billion.

Action required	Est. cost (€ million)
Basic screening programme	14
Monitoring at contaminated sites	71
Water treatment works to reduce exposure to PFAS above possible limits	8,906
Soil remediation	7,128
Health assessment when contamination is found	783

** Including UK as an EEA member at the time research was carried out*

Source: Nordic Council, 2019

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the real regulatory void lies on the industrial and municipal wastewater side of the market, where clients are scrambling to understand their liabilities. "You can sense the nervosity of the market. Some of the most proactive utilities are saying 'we do not have the solutions at scale; we do not have the regulations, and we don't even know what problem we need to solve'," Sylvie Braekevelt, a senior consultant at Ramboll, told GWI. In the Danish market, Braekevelt said that technology-agnostic 'functional tenders' have taken precedence over specific technology requests, chiefly due to the absence of proven treatment options. "Clients are now testing ion exchange, activated carbon, flocculants, and foam fractionation," she added.

The results of these operational pilots will offer important indicators as to which solutions are feasible for more widespread contracts going forward.

Will polluters pay?

The specific technology challenges are, however, dwarfed by capital concerns, with the question of who pays for PFAS treatment on the lips of all affected parties. The 'polluter pays' principle which has driven EU planning (*see GWI November 2022, p10*) has faced some harsh practical realities. "In Sweden, we have cases where the water companies are suing the polluters, and cases where people are suing water companies for PFAS violations, as they are classed as food producers," noted Filipovic. This challenge has plagued regional utility Ronneby Miljö & Teknik, which was sued by consumers in 2016 after PFAS levels in drinking water exceeded local regulatory standards. Last year, a district court ruled against the municipality, despite a nearby military base being widely suspected as the original source of the contamination. Similar woes affected municipal water company Uppsala Vatten, which took the Swedish Armed Forces to court over PFAS source pollution. In October 2021, the Land and Environment Court ruled against the utility, with the Armed Forces claiming it was not possible to prove that the chemicals were a result of their activities.

Part of the challenge behind the polluter pays principle is identifying original polluters, with large-scale source tracking projects becoming increasingly common in the Nordic region. However, with PFAS now present in oceans, rainwater and often surface runoff, isolating specific polluters is an increasingly challenging endeavour. "This is the real question: where does the water to the wastewater treatment plants really come from? REACH has not been strong enough to regulate these compounds in time," Filipovic said. In worst case scenarios, Braekevelt suggested that both source remediation measures and downstream treatment might be needed in order to meet compliance levels. "Economically, it's an enormous challenge."

The EU's increasing efforts to tackle PFAS are not without their challenges, and any new regulation must ultimately contend with a legacy of widespread contamination. "PFAS have been around for 60 years now, and the pollution that is already done is often diluted," Braekevelt noted. This fact makes any broad clean-up effort an especially expensive task, as treatment costs are typically based on volume as opposed to concentration levels. While for a select number of consultants and technology vendors, the EU's PFAS worries represent an immense commercial opportunity, how the multi-billion euro treatment bill can be footed is a question that continues to go unanswered. ■

UK RESULTS SEASON

Unhedged energy exposure hits UK water companies' interim profits hard

Inflation and rising net finance costs conspired to ensure an uneasy results season for the English and Welsh water companies. Neither phenomenon will last forever, though, and the subdued numbers ought to make for easier comps in twelve months' time.

Most of the large UK water and sewerage companies saw their operating profits take a dive over the first half of 2022/23, as the Russian invasion of Ukraine led to the steepest surge in energy prices – and general inflation – for well over two decades.

As small businesses across the country had to contend with gas and electricity bills that tripled over the first nine months of the year, WaSCs that had not substantially hedged their energy costs also faced savage hikes.

Pennon was one of the worst hit, as its overall power costs over the six-month period shot up from £24 million to £49 million (although £2 million of that increase was attributable to an additional two months' accounting for Bristol Water compared with the previous year).

As the overall rate of inflation soared into double figures by the fourth quarter of the year, the WaSCs saw most of their other operational costs – chemicals and transport in particular – also rise sharply and eat further into the profit figures.

Apart from Southern, where the year-on-year result was heavily distorted by the impact of the record £90 million fine for which it had to account in the first half of 2021/22, only two companies were able to report any improvement in operating profit over the period.

In both cases, however, these gains were minimal when set against the substantial increases in turnover that the pair enjoyed over the six months – a clear indication that their margins had also come under significant pressure.

Severn Trent achieved a meagre £6.1 million (2.4%) increase in its operating profit, despite generating £103.6 million more revenue than it did this time a year ago, while Anglian managed a slightly more impressive gain of £12 million (5.5%) on revenues that were up £64.8 million on 2021/22.

The other seven WaSCs to report interim figures for 2022/23 (Northumbrian is not obliged to do so under a unique provision in its licence) registered declines in operating profit that ranged from 9% at Yorkshire to 23.7% at Pennon.

It was interesting to note that the other remaining listed company, United Utilities, was the second-worst performer in this respect, as its profit figure fell by 22% on the previous year.

Both Pennon and UU nevertheless increased their dividends to shareholders by 10.8% and 4.6% respectively, while most of the privately owned WaSCs continue to make no equity distributions to their ultimate shareholders.

As well as the impact on operating expenditure, the soaring rates of inflation in the second and third quarters of the year meant that the cost of accretion on index-linked debt was much greater than in the comparable period in 2021/22.

Although this non-cash cost should largely balance out over time, given that allowable company returns and regulated asset values are also index-linked, it nevertheless produces dramatic hikes in the financing costs that companies have to report in their annual profit-and-loss ledgers.

The surge in these costs over the first half of 2022/23 had a bigger impact on pre-tax profit figures in most cases than the hike in operational expenditure had on the operating profit numbers.

Anglian was a prime example, as its net financing costs rose from £198.1 million in the first half of 2021/22 to £336.2 million this time around, after the two main inflation indices – the RPI and CPI – recorded year-on-year increases of 8% and 7.2%, respectively. These increases bumped the company's indexation bill up from £176.3 million to £259 million.

The prospect of many – if any – of the WaSCs turning the situation around in the second half of this fiscal year looks remote, as there are clear signs that regulatory and political pressure on the sector is ramping up once again.

The individual performance reports ▶

UK WATER AND SEWERAGE RESULTS AT HALF-TIME

Profit growth was hard to come by for the English and Welsh water and sewerage companies as they reported their interim results this month.

Listed groups (£m)

Company	Turnover (2021/22)	Profit (2021/22) [a]	Profit change	
Severn Trent	1,061.8 (958.2)	261.7 (255.6)	+2.4%	▲
United Utilities	919.3 (932.3)	258.5 (332.8)	-22.0%	▼
Pennon Group (incl. Bristol)	425.5 (389.3)	97.2 (127.4)	-23.7%	▼
Unlisted groups (£m) [b]				
Anglian Water	789.6 (724.8) [c]	230.5 (218.5)	+5.5%	▲
Southern Water	417.2 (424.9)	25.4 (-14.6)	+273.9%	▲
Thames Water	1,092.8 (1,062.3)	174.5 (226.5) [d]	-23.0%	▼
Welsh Water	426.7 (399.6) [c]	33.4 (39.9)	-16.0%	▼
Wessex Water	266.8 (259.9)	67.2 (79.6)	-15.6%	▼
Yorkshire Water	577.2 (561.7)	124.0 (136.2)	-9.0%	▼

a) Profit figures refer to operating profit, except for Severn Trent, where underlying PBIT is given
b) Northumbrian Water is not required to publish interim results under the terms of its licence
c) Restated from 2021/22
d) Underlying (excluding Bazagette Tunnel Limited)

Source: Company data

that Ofwat published earlier this month identified six WaSCs – Anglian, Northumbrian, South West, Thames, Wessex, and Yorkshire – that the regulator deemed to be "lagging behind" on various commitments that they had made for the AMP7 period.

Ofwat said that it had initiated "live enforcement cases" against the six over potential failures at sewage treatment works that may have resulted in environmental pollution – among other shortcomings – and that it would be requiring them all to produce "clear action plans" to rectify these failures and perform to acceptable standards.

At the same time, the House of Lords' Industry and Regulators Committee is pursuing an aggressive investigation into what it maintains has been a failure on the part of Ofwat and the Environment Agency to hold water companies sufficiently to account over a range of issues, including pollution incidents, continuing leakage, excessive returns, and executive pay.

Committee chairman Lord Hollick wrote to Environment Secretary Thérèse Coffey at the start of this month, seeking formal written answers to a list of nine questions on such matters before she testifies to the committee in January. ■

UK PRICE REVIEW

Ofwat set to crack down on leverage at PR24

The regulator stuck to its guns in its final methodology for the next price review. Will it result in more equity issuance from the sector?

Ofwat confirmed on 13 December that it will impose a more restrictive regime on water companies at the next price review in 2024 in order to strengthen the sector's overall financial resilience.

Publishing its final methodology for the PR24 process, which will set the industry's pricing structure for the five years from April 2025, the regulator announced that it would reduce the notional company gearing – on which it bases its key cost-of-capital assumptions – from 60% to 55%.

Although every company in the sector objected to this reduction during the consultation phase that followed the publication of the draft PR24 methodology in July, Ofwat remains convinced that the move is necessary to ensure the sector maintains the degree of resilience it will need in a more uncertain future.

"Our view remains that there is a case for a stronger role for equity in the notional capital structure," the final methodology document concluded. "We consider there are benefits to adopting a lower notional gearing level at PR24."

It added that alerting companies to the plan at this relatively early stage would give those that were so inclined time to "align their structures" with the new notional level ahead of the actual review.

At the same time, Ofwat will fully transition the annual indexation of regulatory capital values (RCVs) to the CPIH benchmark – a move that it acknowledged would initially place pressure on customer bills.

The regulator is not proposing at this stage, however, to provide companies with any additional allowance for the costs associated with this transition. It simply noted that by 2025 the sector would have had almost ten years to prepare for the move, and added that in the longer term, CPIH indexation would offer equity investors the benefit of lower levels of volatility on their investments.

The notional capital structure that Ofwat will adopt at PR24 will furthermore assume that companies are going to enter the AMP8 period with 33% of their debt index-linked.

On dividend payments, Ofwat said it considers that a baseline level of 4% would represent a reasonable annual yield over the course of AMP8, but warned that there could be "a number of reasons" why lower levels might be appropriate for some companies.

The regulator also confirmed that it would go ahead with a proposal it put forward at the draft stage that would require companies to retain any financial benefits that accrue from high levels of inflation within the business, and not distribute them as dividends. ■

INDUSTRIAL WATER

Saur steps up M&A to boost recurring revenues

By purchasing two of Veolia's industrial water businesses in Europe, Saur will meaningfully increase the visibility of its revenue flows. Exporting the acquired expertise to other markets presents a new set of challenges.

Saur this month entered into exclusive negotiations with Veolia ahead of the acquisition of Suez's industrial water O&M business in the UK, which will complement its purchase last month of Veolia's European mobile water operations.

Saur's Industrial Water Solutions division is already manufacturing a new batch of mobile water treatment units to meet growing demand from its client base, and industrial water boss Menno Holterman wants to optimise the fleet by retrofitting it with Saur's proprietary i-Monitoring technology, while enhancing the service offering as part of a group-wide ambition to boost recurring revenues.

"This was really a once in a lifetime opportunity to expand in order to offer a very comprehensive range of mobile water services and solutions," Holterman explained to GWI. "We already had about 100 mobile water systems in the wastewater treatment spectrum, and with the integration of the Veolia mobile water services assets, we're adding clean water and processed water capabilities. For us, it's highly complementary – we're adding reverse osmosis, ultrafiltration, and ion exchange, including all the service capabilities to regenerate the resins."

One of the reasons it made sense for Saur to pay top dollar for Veolia's mobile assets is the condition of the fleet, which Holterman says is well maintained, with an average age of under five years. This not only helps to ensure high fleet utilisation rates (which are understood to be near 100% for some of the membrane and IX suites), but minimises maintenance and replacement costs.

The importance of fleet age as a differentiating factor cannot be underestimated, given that clients rely on mobile water solutions to keep mission-critical processes running during planned downtime, and expect rapid deployment and high reliability in emergency situations.

"Emergency is really a play where you need to be on top, and most of the emergency calls come after 9 p.m. on Friday and before 4 a.m. on Monday morning," observes Holterman.

Clients are also increasingly demanding sustainable solutions for water management, and rental contracts are no exception. "We're going to further optimise the power consumption of our mobile water units, and we have a programme to reduce the use of chemicals," said Holterman. "We're also changing the construction of some of the units to make them more lightweight and save on transportation costs, and we're investing in our online i-Monitoring technology to extend asset life."

Short-term reliability is a cornerstone of Saur's core value proposition, which aims to create a 'customer for life' by becoming an indispensable partner when the client most needs it. "There's a Dutch expression that says: 'Nothing is as permanent as semi-permanent'. More and more clients are also looking for manned operations under a 'rental-operate-return' model, and flexibility and agility are absolutely crucial if you want to grow market share in the mobile water business," Holterman proclaims.

This flexibility increasingly extends to the way contracts are structured. A hybrid solution could involve Saur supplying a portion of a client's needs in the form of a fixed plant, and the remainder on a temporary basis until it becomes clear what the eventual capacity or treatment level will be.

Holterman also cites the example of a refinery client uncertain of the changes a shift in its production menu will have on its future wastewater streams. By providing a temporary mobile solution paid for out of the client's operating budget, Saur can build up knowledge of the changing water characteristics, and is then in pole position to design and supply a new fixed solution when the client receives the necessary capex budget approval.

Saur's industrial water division has negotiated ten M&A deals since 2020 (*see table above*), and is on track to generate pro forma revenues of around €360 million this year. With organic growth in the first ten months of this year standing at an eye-opening 51% and a sizeable backlog in hand, Holterman is confident of piercing the €400 million barrier in 2023.

"We have global key accounts who want us to be as close as possible to them, and they are investing at the moment in the Middle East, in Asia Pacific, and even in Africa. The Middle East will grow rapidly, but in certain parts of Asia, clients do not want to rely on mobile – when they are convinced that the technology works, they want to own the asset," he explained.

"Saur's industrial water solutions division now one of Europe's leading players, and we strongly believe that if we anticipate market trends and developments well, we can gain market share in Europe and beyond." ■

SAUR'S INDUSTRIAL ACQUISITIONS SCORECARD

The company has shown a laser focus on boosting its technology flowsheet, geographical presence, and recurring revenues through a series of targeted acquisitions. It is not finished yet.

Vendor	Asset	Notes
Veolia	Suez Industrial Water Ltd.*	Suez's UK industrial water O&M arm
Veolia	European mobile water services unit	Adds clean and process water assets
Crimson Investment	Aqua-Chem	Water purification systems manufacturer
Privately held	Flootech	Water treatment & recycling in Finland
Privately held	Sodai	Industrial EPC and O&M in Italy
Privately held	Byosis	Resource recovery from wastewater
PWN	PWN Technologies	IX and ceramic membrane systems
Privately held	Nortech Group	Industrial engineering services provider
Privately held	Econvert Climate & Energy	Anaerobic wastewater/biogas treatment
Privately held	Unidro	Engineered solutions/process equipment

** In exclusive negotiations as of December 2022*

Source: GWI WaterData

COMPANY STRATEGY

A new direction for Wilo's water treatment arm

The pump giant's fledgling water treatment business wants to move into project development. It already has a key reference in hand.

German pumps and pump systems supplier Wilo has quietly been building a global water treatment division which it expects will make a meaningful contribution to the group's newly established strategic growth goals.

The kernel of Wilo's water treatment business unit was formed out of the Abionik business it bought last year, which added membrane systems, stormwater treatment technologies, chemical dosing, and odour control systems to the legacy GVA brand of aerators and decanters.

Shortly after that, Wilo took on Remondis Aqua's former director of international business development Dirk Wittenberg to oversee the business unit, which grew further this summer through the acquisition of mechanical pre-treatment outfit FSM (*see chart below*).

Having developed an onsite hydrogen generation plant with Schneider Electric, which uses photovoltaic solar energy and water collected on the rooftop of Wilo's flagship CO_2-neutral campus in Dortmund, Wittenberg now sees potential to promote the group's project development capabilities further through a newly formed unit housed within the water treatment division.

"We have a second line under the roof of water treatment called Wilo Projects GmbH," Wittenberg explained. "We could act as a consultant or an EPC contractor for this type of project, and we would also consider working together with a financing partner. Currently we are concentrated on hydrogen, and with the current energy price developments, we are looking at return on investment periods for decentralised plants of below ten years. We also intend to look at developing stormwater management and storage projects."

The concept of European pumps suppliers diversifying out of a core mature market into the faster-growing water treatment space has seen Grundfos acquire Eurowater and MECO within the last two years, while Sulzer's 2021 acquisition of Nordic Water Products gave it an instant reference base on which to build.

Similarly, Wilo's Abionik and FSM deals have given it an established global footprint, with the FSM transaction bringing with it a customer base in the US. With a clear mandate to grow – and the requisite support for further acquisitions from parent Wilo SE – Wittenberg has not ruled out a future acquisition in the US, where domestic manufacturing capabilities will become increasingly important, thanks to the Build America, Buy America legislation (*see GWI October 2022, p25*).

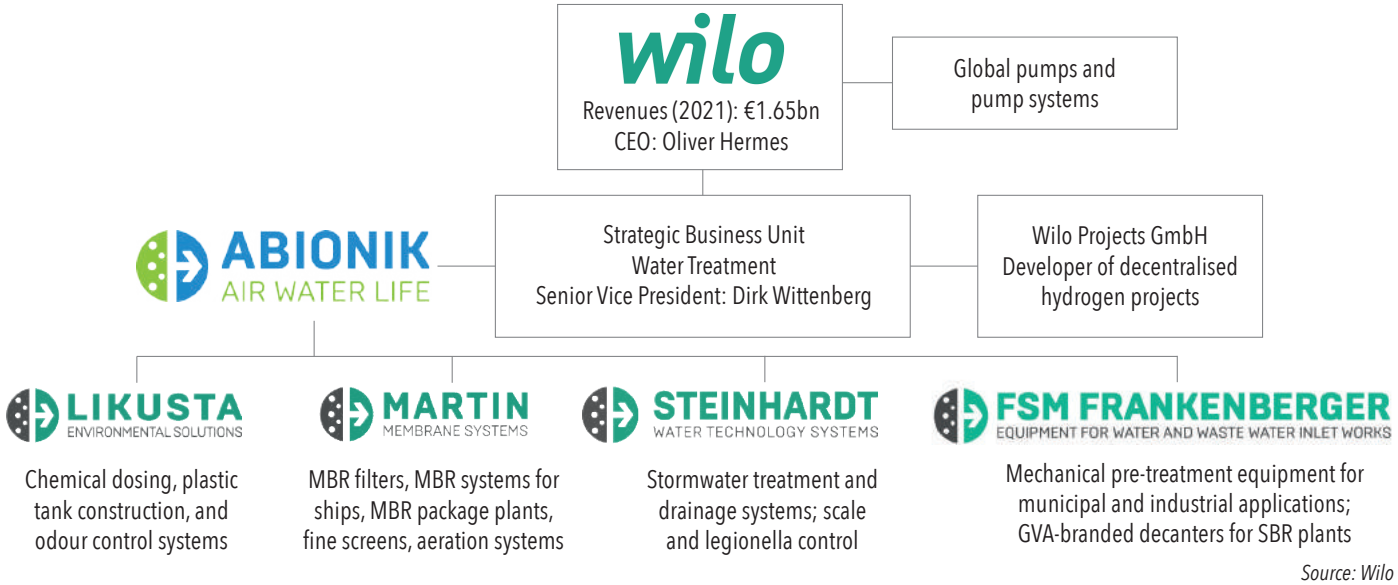
While acquisitions naturally add incremental revenues, Wilo's water treatment division has had a challenging year organically, partly due to the cancellation of a series of MBR system orders for marine vessels, following a Baltic shipyard bankruptcy. Despite this, the SBU expects to grow its revenues by 50% between now and 2025 through a combination of organic expansion and further acquisitions, in line with the group's wider expansion ambitions.

As a supplier of both components and systems, Wilo's water treatment division has historically been reliant on capital sales to sustain its growth. While Wittenberg does not see potential for channel conflict (subsidiary Martin Systems sells MBR filters to OEMs, as well as pre-assembled MBR systems), he is keen to grow the service side of the business, which currently accounts for 10-15% of sales.

"I would appreciate getting that significantly higher, because I originate from the service and O&M business," he explained. "We are not yet there – that's one of my tasks for future development." ■

WILO'S WATER TREATMENT PORTFOLIO AT A GLANCE

A series of acquisitions has given the German pumps group a foothold in the global water treatment market. The portfolio is rapidly starting to resemble that of its larger compatriot, Huber.



Source: Wilo

EUROPE IN BRIEF

- German ceramic ultrafiltration membrane manufacturer **Cerafiltec** completed a €30 million growth capital round earlier this month, led by **Circularity Capital**. The money will help the company to expand internationally and to develop new products.

- Meanwhile, Agtech firm **Alvátech** hit its £500,000 crowdfunding target in a matter of hours, paving the way for it to scale up international sales of its solar-powered water treatment technology.

- **WTE Wassertechnik** has acquired the 50% interest held by **Huber** in the companies' ten-year-old sludge-to-energy joint venture **sludge2energy GmbH**.

- **Sacyr** has appointed **Garrigues** and **Deloitte** as legal and financial advisors, respectively, for the planned sale of a 49% equity stake in **Sacyr Agua**. **Société Générale** was previously chosen to oversee the sale.

- **Severn Trent** launched a new £400 million 12-year sustainable bond at the end of November, paying a 4.625% coupon.

- AIM-listed **Strix Group** has completed the acquisition of **Waterlogic's** multi-functional taps unit, **Billi**. The move was a pre-requisite to the closing of the seller's big-ticket business combination with **Culligan**.

- UK-based **Renew Holdings** has boosted its water capabilities by acquiring **Enisca Group** for £15.6 million. Enisca has long-term MEICA framework agreements with eight major UK water utilities.

- **AECOM's** former European water boss Jon Robinson will take on the global directorship of **Royal Haskoning-DHV's** Water & Maritime division with effect from 5th January 2023.

- **Galliford Try** has acquired **Ham Baker's** engineered products division serving the water industry.

- **Uponor** shares survived a profit warning on 21 November, following a ransomware attack earlier in the month. ■

COMMENT

We need to learn more about our global water resources

A new attempt to map out the state of global watersheds reveals the pressing climate crisis – and the gap in our knowledge base – argues David Lloyd Owen.

At the end of November, the World Metrological Organisation launched its first *State of Global Water Resources*, report, which is is set to become an annual publication. The report is based on data collected from 1991 to 2021 and so the 2021 findings are compared with those from the last three decades. The 1991 cut-off date reflects the earliest point in which the historical data is regarded as being sufficiently reliable for comparisons to be made. Earlier data helps put matters into the context of long-term climate change. Given the toxic political climate we live in, there is no room for ambiguity – accuracy and robust verifiability are too important to overlook.

Even so, our knowledge too often remains at an early stage. Actual observed data for river basin discharges in 2021 was available for just 7% of the world's 515 major river basins. Data for the other basins came from seven different global hydrological modelling systems. The most spectacular measurements came from the Manaus station in Brazil, where water levels were 29 metres above the emergency point, while 350,000 people were evacuated from floods in Henan, China.

The three chief themes are rainfall (and so flood and drought), groundwater resources and the cryosphere (water derived from snow and ice melt). Their interactions matter, as a river like the Indus with evenly balanced rainfall and snow and ice melt resources is (for now at least) less vulnerable to extreme weather years than more rainfall-dependent rivers such as the Ganga. 1.9 billion people live in areas fed by snow or ice melt. This will grow in importance as the report highlights the broad evidence that glacier mass is decreasing and at an accelerating rate.

All regions reported extremes during 2021, either flood or drought and sometimes both. This is further confirmation of the disruptive nature of climate change. While mitigation is essential in the longer term, climate change adaptation is playing an increasingly urgent role in many river basins. It was noticeable that for both river flows and terrestrial water storage, noticeably high or low values were found in quite a few river basins. Indeed, basins with "normal" conditions in 2021 were in the minority, which was not usually the case in 1991-2020.

A lot is also being found out about the nature of the information being obtained. For example, in Africa, continent-wide increases in total water storage (groundwater) are not reflected by localised droughts, highlighting the need for local assessments. What the report emphasises is that there is no substitute for local data for assessing the actual impact of flood and drought events. Water resources respond to changing climatic circumstances in ever more complex patterns. Meanwhile, a WMO global early warning system for extreme climate events is planned to become operational by 2027.

What is particularly encouraging is to see the explicit appreciation as to where the data is taking us and to what level of confidence we can attach to this data. They have started from this standpoint at the onset rather than a belated recognition four decades on as we saw with the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP). Those who have toiled at the JMP's data coalface are often heroic examples of selfless public service. It can be desperately hard to admit that things are less than perfect. Doing so is about letting go.

The United Nations 2023 Water Conference ought to matter for many reasons. It is to be hoped there will be an emphasis on why the SDG6 targets will not be met by 2030 and what to do about this. Being in a position to make informed decisions also matters. That will mean moving from a world governed by estimates (how water coverage is currently assessed) and guesswork (where even estimates are a pipe dream) to some hard numbers. The way the data is being used in this publication and some others gives us room for hope, if not expectation. ■

CLEANTECH INVESTMENT

Canada promotes its water technologies to the world

A new list showcasing the ten most investible water tech companies in Canada is a direct invitation to the international investor community to engage. Where does the value lie?

This month in the Americas:

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18 Growing investment in stormwater solutions
18 Americas: News in brief
19 Private equity thinks again on water exits
20 Ryan Connors: The Climate-Industrial complex is real and growing

Clean tech accelerator Foresight Canada this month revealed the country's ten most investible water start-ups, which are actively looking to raise up to Can$70 million of funding over the next six months (*see table below*).

The companies form part of the broader Foresight 50 pitchbook list for 2022, and are an integral part of the not-for-profit's mandate to promote Canadian technologies internationally, while accelerating the country's net zero transition.

"Our long-term vision is to help Canada be the best place in the world to develop and commercialise new water technologies, and we've worked with over 90 ventures this year, across all water-related applications," said Alan Shapiro, director of Foresight's waterNEXT initiative. "We recognise that a lot of the markets are abroad and that a big percentage of Canadian water tech companies are exporters. We view it as providing Canadian water solutions for global water challenges," he told GWI.

WaterNEXT is the natural successor to WaterTAP Ontario, which ceased operations in June 2019. It has grown from being an early-stage accelerator in British Columbia to a national organisation committed to supporting companies engaged with the water and climate narrative in Canada. The water companies in its network have raised Can$111.9 million of capital since the start of 2021, across the full range of capital instruments.

"The biggest thing that we've heard from our companies over the past few months has been that while water makes the priority list in Canada, it's not at the top of the list," Shapiro laments. "There are not a lot of end users that have their arms raised to pilot new solutions or to test out things that are a little bit more creative, and that's part of where we're focusing. Climate has been a really big push for Canada over the last few years, and we want to help support water tech companies in making that link. There are a lot of very strong water value propositions out there, both on the adaptation and the mitigation side."

Foresight's 40-strong team is supported by a diverse network of around 180 executives in residence, and it also enjoys strong relations with academic institutions, ensuring the spring of innovative ideas never runs dry. As well as advice around commercialisation strategies, the accelerator also helps innovators find piloting opportunities, while putting start-ups in front of its international network of investors, around 20% of which are open to curated introductions arranged by Foresight.

"We're working with our innovators to make sure that what they're doing is problem-driven, and not just a solution in search of a problem," explained Shapiro. "We're doing a lot of adoption-focused work, but one of the things we hear from Canadian utilities is: 'Your solution improves our efficiency by less than 10%. It's not worth the risk to us.' We see a lot of solutions that fall into that category, and so we're really working on the challenge of getting that industry engagement on behalf of the companies in our network."

One of the ways in which Foresight Canada is helping to foster dialogue is through innovation challenges. Earlier this year, it partnered with the UK's United Utilities on a pair of challenges addressing water quality and combined sewer overflows, with FREDsense Technologies and Grande Water Management Systems being declared the respective winners.

Other recent challenges involved companies being tasked with finding ways to manage fibrous content in pulp and paper sludge, and reducing the water use intensity of mining operations in Canada.

"These are typically done with companies that want to get creative and be a little bit bolder with their solutions, so we help them find that funnel and shortlist the ▶

FORESIGHT CANADA'S TOP INVESTMENT OPPORTUNITIES IN WATER FOR 2022

Canada's national cleantech accelerator views water as an integral part of its mission to promote the country's net zero transition.By taking a problem-driven approach to innovation, it hopes to bridge physical and existential challenges in a bid to "Accelerate from Anywhere".

Company	Line of business	Exp. 2022 revenues	Funding plans
Axine Water Technologies	Electrochemical oxidation to treat organic pollutants	Can$1.1m	Can$10-20m Series B round sought
CarboNet	Specialty chemicals for industrial water recycling	Can$24m	-
Copperstone Technologies	Field robots to enhance safety at water installations	Can$2.074m	Can$20m+ sought in the next 18 months
Digital Water Solutions Inc.	Real-time network leak detection using AI	Can$0.545m	Can$1.5m seed round closing imminently
FREDsense Technologies	Biosensors for contaminant detection in water	Can$0.4m	Can$5m Series A round currently sought
Livestock Water Recycling	Fertilisers, biogas, and recycled water from manure	Can$16m	Can$6-8m round sought in H2 2022
Permalution	Fog and cloud water collection technology	Can$0.1m	-
Proteus Waters	Developer of decentralised membrane-based STPs	Can$0.05m	Can$7-10m round sought in early 2023
Swirltex Inc.	Buoyancy-enhanced membrane treatment systems	Can$4.5m	Can$4m Series A round sought in early 2023
Viridis Research	Retrofittable microfibre capturing technologies	-	Can$2m round sought in May 2023

Source: Foresight Canada

AMERICAS IN BRIEF

● As GWI went to press, winter storms had boosted **California's** Sierra snowpack to 204% of normal for the time of year. The dangers of celebrating a wet start to the 2021/22 winter are still fresh in the memory, however, after a dry start to this year saw last December's euphoria (literally) melt away.

● **Core & Main** shares dipped in early trading on 14 December, despite the company's adjusted EBITDA for fiscal Q3 rising by 45.5% to $275 million, on net sales of $1.8 billion (up 29.4%). The company simultaneously upped its full-year fiscal 2022 adjusted EBITDA guidance to $910-930 million.

● Latin American companies with water exposure are increasingly embracing sustainable debt, with Mexico's **Orbia** completing an MXN10 billion ($500 million) two-tranche issue of certificados bursátiles last month, while **BRK Ambiental** priced the first blue debenture from a private company in the region. The oversubscribed BRL1.95 billion ($367 million) 20-year issue will help fund the capex required under the company's water and wastewater concession in Maceió.

● At the same time, Brazilian national development bank **BNDES** has negotiated a long-term financing package of up to BRL19.32 billion ($3.64 billion) with **Águas do Rio**, the **Aegea-led** concessionaire responsible for achieving universal water and sanitation services in two major areas of Rio de Janeiro by 2033.

● **Pennsylvania American Water** looks to have been awarded a return on equity of around 10% in its rate case settlement earlier this month, which saw the state PUC award the company a total annualised revenue increase of $138 million.

● **Accenture's** venture arm has invested in data intelligence specialist **Ketos**, which offers a software-as-a-service platform to enable clients to monitor water efficiency and quality.

● **Bertzman Social Ventures** has provided a working capital line of credit to real-time water quality monitoring platform **Sentry**. ■

companies they should be working with," commented Shapiro.

The customer discovery process is vital to addressing the technology adoption challenge. "At a high level, we have quite a bit of engagement with academic institutions," Foresight Canada CEO Jeanette Jackson told us. "We start with our climate connections, where we're bringing industry problems to the academic institutions for research consideration, and from there, we have more curated, specific engagements."

By getting involved at a very early stage, Foresight believes it has the best chance of shaping a company's path to adoption. "Our philosophy of problem-driven innovation means the earlier we can find a company, the more support we can offer them," said Shapiro. "If we can help them with customer discovery and help them tweak their business model early on, that helps get their path to market down a little bit more. We want our good solutions to succeed faster and we want our bad solutions to fail faster, so those founders can go back and come up with better solutions." ■

PRIVATE EQUITY

Finding a concrete reason to invest

Private equity firms have been flocking to the precast concrete infrastructure market as stormwater mandates come into force. How green are the alternatives on offer?

A pair of private equity investments in precast concrete stormwater infrastructure players in the US last month underscores a growing desire to take exposure to a sector which is benefiting from increased regulatory oversight and higher municipal spending.

MiddleGround's purchase of Dutchland adds to its 2021 acquisition of Lindsay Precast, while Ember Infrastructure made its inaugural water investment by buying Low Impact Development Technologies (LID Tech).

"LID Tech has some unique green infrastructure IP via Porous Technologies LLC that drew us to the company," explained Caleb Powers, a principal at Ember Infrastructure. "Due to its porous composition, Stormcrete – the company's flagship product – already uses c.30% less concrete (and thus has a lower carbon footprint) than the impervious material it replaces. It also reduces waste relative to standard cast-in-place roadway alternatives due to the longer lifespan and removable/replaceable nature of Stormcrete panels," he told GWI.

The LID Tech business also benefits from recurring revenues through its Stormwater Compliance LLC inspection and maintenance business, supporting the infrastructure-like nature of the investment.

"Cities and states are responding to stormwater runoff-driven water quality issues, as well as more frequent and extreme urban flooding events, by investing in green infrastructure programmes, and through increased regulation of stormwater management on private property," noted Powers. "Beyond regulatory drivers, customers are motivated to implement green infrastructure solutions that have lower lifecycle costs and superior sustainability and climate resilience characteristics versus traditional solutions. We see a lot of opportunity for organic growth." ■

PE INVESTMENTS IN CONCRETE STORMWATER INFRA

2022 was the year in which private equity emerged as a major rival to trade buyers seeking to boost their exposure to precast concrete stormwater infrastructure.

Year invested	Company	Private equity backer/s	Home state
2022	Dutchland Inc.	MiddleGround Capital	PA
2022	Low Impact Development Tech	Ember Infrastructure	ME
2022	StormTrap	PSP Capital	IL
2022	Bonna Sabla	EIM Capital	France
2021	Lindsay Precast	MiddleGround Capital	OH
2020	Capital Precast	Texas Next/Swiftarc Ventures	TX

Source: GWI WaterData

WATER M&A

Private equity rethinks timing of water exits

Macroeconomic conditions have forced a rethink on the path to realising value from private equity-backed water platforms. What are the dynamics at play?

Private equity owners of companies active in the water space are re-evaluating the timing of potential exits as rising interest rates threaten covenant compliance, precipitating a marked contraction in deal flow as year-end approaches.

"We're seeing a pronounced slow-down in terms of opportunities and active mandates, and I think there are a lot of factors outside of the industry that are affecting people's decisions to go to market today," one broker told GWI. "Some private equity firms are delaying transactions until after the New Year, when they will then assess the attractiveness to go to market."

While deals are still getting done, most of the current flows are in the form of smaller bolt-on transactions which go through at modest multiples – typically undertaken by established platforms backed by private players with ample dry powder (*see table below*).

"I think we've burnt a lot of the backlog, and this period is probably necessary to rejuvenate the pipeline," the broker summarised.

Private equity lives and dies on leverage, and a rising interest rate environment not only makes it more expensive to borrow, but has knock-on implications for the balance sheets of investee companies that were laden up with debt when it was cheaply available.

"All of these businesses that have got debt in them still need to make their covenants, and private equity is focused on that right now," observed a senior source at an industry advisory firm. "Interest rates have gone from zero to 3-4%, so that's going to have a material impact on valuations – I would fully expect to see a 2-turn reduction," he told GWI.

While private equity is perhaps less willing to engage at the moment when it comes to transactions that move the needle in terms of enterprise value, strategic buyers are arguably less likely to pass up a once in a lifetime opportunity, as was the case with Saur's purchase of Veolia's European mobile water business – for which it is said to have paid a multiple in excess of 20x EBITDA (*see story p14*).

As market conditions increasingly conspire against full-blown exits for private equity owners at the desired multiples, one way of generating a return for limited partners is to look for a partial exit by syndicating down a portion of the equity, typically to one or more institutional investors.

Earlier this year, Aurora Capital Partners sold a portion of its position in water testing roll-up Pace Analytical Services to private equity house Leonard Green, while Saur's owner EQT is understood to be close to realising the sale of a 49% stake in the business, after apparently reconsidering the earlier idea of a full-blown exit.

"A lot of these private equity firms need to raise new funds. Often, they want to show limited partners and institutional funds that they achieved a great return, but they can only do that if they realise an investment. One way to do that in a poor environment is by controlling that outcome," commented one broker. "You're probably less likely to get the maximum valuation, but you can get something fairly attractive."

With many of the big privately owned water properties such as Culligan, Waterlogic, and Solenis having changed hands comparatively recently, market observers are looking to the past to define how 2023 might play out. The logic goes that the further in the past a private equity house started to build its water platform, the more keen it is likely to be to look at a full-scale liquidity event when markets return to some kind of stability.

A glance at some of the most active acquirors could give some early clues as to who might approach the market in the next 12-18 months, although commentators cautioned that it could be another six months before activity really begins to pick up again. Watch this space. ■

WHO ARE THE MOST ACTIVE US PRIVATE EQUITY INVESTORS IN WATER?

Deal flow has been brisk for private equity-backed platforms with significant amounts of dry powder looking to ramp up their exposure to water. Who will be first to score an exit?

Operating/holding entity	Private equity backer/s	Year invested	Business focus	M&A summary
Vessco Holdings	Gryphon Investors	2020	Manufacturers' reps + service business	Has closed 18 acquisitions since 2018
Pace Analytical Services	Leonard Green/Aurora CP	2022/2016	Water testing laboratories portfolio	M&A rhythm up sharply in 2021/2022
EIS Holdings	Sun Capital Partners	2021	Soil and water remediation services	First two acquisitions completed in 2022
United Flow Technologies	H.I.G. Capital	2021	Manufacturers' representatives' roll-up	Seven acquisitions completed since 2021
Flow Control Group	KKR	2021	Distributor of flow control, industrial automation and life sciences products	M&A rhythm maintained in 2022; 21 add-on acquisitions under previous owner
Ardurra	RTC Partners	2017	Infrastructure engineering and design	At least 17 deals completed since 2018
Denali Water	TPG Growth	2020	Organic residuals management	At least 11 deals completed since 2020
Culligan	BDT Capital Partners/ Advent International	2021	Point-of-use water treatment systems/ bottleless coolers/multi-functional taps	Along with Waterlogic (acquired November 2022), one of the top water co. acquirors
Solenis	Platinum Equity	2021	Specialty chemical products & solutions	17 deals since 2015; 4 under new owner
Apex Companies	Sentinel Capital Partners	2018	Water and land restoration services	M&A covers engineering and operations

Source: GWI

COMMENT

The Climate-Industrial Complex is real: time will tell if that is a problem

ESG investing is showing signs of inappropriately siphoning decision-making authority from frontline water industry professionals, argues Ryan Connors.

Echoing President Dwight Eisenhower's famously prescient farewell speech in her dissenting opinion on the adoption of mandatory climate disclosures, Commissioner of the Securities and Exchange Commission Hester Pierce noted earlier this year that expanding the scope of the SEC's mandate into Environmental, Social, and Governance (ESG) standards will "enrich many, and facilitate the growth of the Climate-Industrial Complex".

With the ink barely dry on Commissioner Pierce's March 2022 warning, a major bellwether company in the water sector relocated its corporate headquarters to Washington, DC – less than a mile from the seat of the United States Congress. There could hardly be a more telling sign that the Climate-Industrial Complex continues to expand.

Meanwhile, the concluding statement from the recent COP27 meetings came under bipartisan criticism for being mealy-mouthed, but that didn't stop the formation of a multi-billion dollar fund that will create major commercial opportunities for US and European engineering and manufacturing firms.

All of which is creating historic valuation discrepancies in the water sector – with the price/earnings spread between the ESG "haves" and "have-nots" recently expanding to unprecedented levels.

But what if the lesson from Eisenhower's speech is that government and big business will *always* be joined at the hip – often to *favourable* effect? After all, the "Military-Industrial Complex" may have enriched many people, but it also won the Cold War, right?

True enough, but at least weapons design and manufacture was left to the experts. With ESG, there are rising concerns that the tail is beginning to wag the dog – driving questionable decisions on product design, M&A, and other issues that could lead to inferior stakeholder outcomes.

On a recent investor call, the CEO of a prominent manufacturer of water infrastructure products expressed frustration that ESG investors have been pushing for the greater use of recycled raw materials, noting that a higher "ESG score" (and hence a higher price-to-earnings (P/E) multiple) was contingent on the company's compliance.

Never mind that the company's engineers have concluded that the current recycled/virgin raw material mix is optimised for the necessary metallurgical properties, and that further tilting the balance toward recycled materials would compromise product performance and risk sizeable warranty charges.

On the M&A front, companies now regularly seek out acquisitions that carry strong ESG bona fides, and would therefore be likely to boost a company's P/E multiple.

M&A activity in water tech sectors such as advanced metering and leak detection offers a case in point. These product lines carry considerable ESG pizzazz, leading to lofty valuations, but in practice they have often lagged more staid, legacy water infrastructure product lines in terms of both profitability and growth.

Chart Industries recently learned the hard way that there's more to stock performance than getting the ESG talking points right. The company's recently announced acquisition of Howden was predicated in large part on enhancing Chart's exposure to secular growth opportunities aligned with sustainability trends.

"Both Howden and Chart work to help customers achieve ESG targets, and both companies have an internal ESG focus as well", said management on announcing the deal, adding that Howden has set an ambitious "Net Zero" target of 2035.

The market didn't seem to care – slashing the company's stock price by 50% in a brutal sell-off following the announcement of the deal.

Obviously, criticism of ESG is raised delicately, if ever, in polite water industry circles. After all, ESG's beneficiaries far outnumber its casualties at industry summits and Wall Street conferences.

This may be in part due to a prevailing view that ESG is an unstoppable train. Either hop on board or let it pass, but whatever you do, don't jump in front of it.

Still, like all of history's nobly intentioned initiatives, ESG will require regular self-reflection and course-correction if it hopes to meet its objectives. Recent developments suggest that now may be the time for a reevaluation of where the ultimate decision-making power should lie: with the companies and utilities who operate in the water industry every day – or with Wall Street?

The current ESG mindset seems to cleave to an old-fashioned view of corporations as exhaust-spewing tycoons of industry who would gladly dump toxic effluent into any and all local waterways if only those pesky ESG investors would let them.

In reality, corporations have evolved dramatically, and the vast majority have their hearts in the right place when making decisions that impact the environment.

Let's free them to do their jobs of delivering safe and reliable water services, without armchair quarterbacking from we MBAs and CFAs.

This way, trusting but verifying the sustainability bona fides, investment professionals can get back to doing what *they* do best – analysing financial statements and valuing securities.

● *Ryan Connors is a managing director at Northcoast Research Partners, where he focuses on the water sector.* ■

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DESALINATION

Wetico gets its big break as Algeria tries again on desal

Algeria wants to turn the page on a chequered history of domestic desalination with a new set of plants. The company delivering the first two is in its own process of revival.

This month in the Middle East and Africa:

22 Algeria's next generation of desalination
23 Wetico's route back to desal's top table
23 The World Bank's new approach in the DRC
24 The AfDB's business case for African water
25 Tom Scotney: The Gulf's NRW problem is an information problem
25 Middle East: News in brief

Resurgent Saudi EPC contractor Wetico has been appointed to design, supply and commission two 300,000m³/d desalination plants in Algeria, kicking off what the country hopes will be a second generation of desal. Wetico will also operate the plants for three years.

The Béjaïa and El Tarf plants represent a major victory for Wetico, which is staging a comeback (*see story, facing page*), as well as a potential new dawn for desalination in Algeria. After seeing mixed results with key plants developed under its PPP programme, the country decided to go down an alternative procurement route by directly awarding all the civil engineering works, including the marine infrastructure, to Algerian oil and gas construction companies, and entrusting them with the job of finding desalination partners.

Mohamed Hemeida, president of Wetico, acknowledged the unusual nature of the arrangement to GWI, but said that SARPI and ENAC, the clients and civil contractors at El Tarf and Béjaïa, respectively, are very capable and just need some light handholding on desalination.

"Our scope is to prepare all the engineering related to civil works and review their civil design and marine works," he said. "It's quite hectic for us, but we thought: 'why not take this opportunity to maximise our input during the project's lifecycle?' So we have committed a fully-fledged team on the ground." Hemeida added that he believes going the extra mile contributed to the double contract win. "The client appreciated this," he said. "We have given them our full assurance and support that resources will be deployed on the ground. That gave us a lot of leverage."

ENAC and SARPI both started groundwork in August, and Hemeida is confident that the plants can be delivered in the tight 24-month schedule, with Wetico's contract due to be formally signed by the end of the year. With its contracts priced at $145 million apiece, Hemeida said that Wetico bid "competitively" for the plants, claiming that competitor Metito's offer was about 15% higher.

The stakes are high for Algeria, which desperately needs the additional resources in the face of increasing water scarcity. However, the authorities are also keen to avoid a repeat of the technological failures it faced in the past with projects awarded to ill-fated developer Hyflux, or the contractual issues it had with Abengoa.

The two new plants will be handed over to the Algerian Energy Company when completed, and will be financed by a combination of public funds and a loan from a pool of Algerian banks. Hemeida added that Wetico had received letters of credit for both projects. The two awarded plants are part of a series of desalting facilities planned in Algeria (*see table below*). Because of its wins at Béjaïa and El Tarf, and the measures put in place by the authorities to prevent one company from winning too many references, Wetico was disqualified from the Fouka tender (which was later mothballed) and may also be disqualified from the Cap Djinet tender.

With Spanish desalters unable to participate because of diplomatic issues between the countries (Tedagua is an exception thanks to its 2021 takeover by France's Vinci), the bidders for the remaining plants, each with a 300,000m³/d size, hail mostly from the Gulf and China. ■

A NEW DAWN FOR DESAL IN ALGERIA?

The country is hoping the planned El Tarf desalination plant and its twin at Béjaïa will create a successful new generation of projects with greater participation from Algerian companies. For Wetico, the pair of contracts will mark its largest references to date as it looks to re-establish itself in a rapidly changing market.

Source: Wetico

WHO WILL BUILD ALGERIA'S NEXT DESAL PLANTS?

Bidders for Algeria's upcoming desalination contracts largely hail from the Gulf and China.

Plant	Bidders	Status
Cap Blanc	Hangzhou Water Treatment Technology Development Center (HWTT); Metito	May be awarded by end of 2022
Fouka	Tedagua; MES; Wetico; Metito	Tender put on hold on 14 Dec
Cap Djinet	China National Technical Import and Export Corporation (CNTIC); Metito; Sepco III; Wetico; Archirodon	Award expected in Q1 2023

Source: GWI

DESAL STRATEGY

Wetico plans a route back to desalination's top five after securing major contracts in Algeria

The Saudi company has been largely off the radar in recent years. Its breakthrough in Algeria this month is the start of a new era.

For Wetico, which saw its last major-scale reference in the form of a 150,000m³/d BWRO plant in 2017, winning two 300,000m³/d seawater desalination contracts is nothing short of a coup. "It means a lot to us," said Wetico president Mohamed Hemeida.

The company is a wholly-owned subsidiary of Saudi water pioneer the Abunayyan Group, which was a founding owner of developer ACWA Power and operator/concessionaire Miahona, as well as a number of other water-focused names. Wetico, which was originally set up as Saudi Berkefeld by Abunayyan alongside a German partner in the 1990s, picked up some large references in the seawater sphere, such as two desalination barges operating in the Red Sea, and the groundbreaking 240,000m³/d Jeddah 3 reverse osmosis plant delivered for state desal company SWCC. But as the Kingdom's desalination market evolved, the company shifted to a strategy focusing on small desal plants for industrial clients.

Since 2020, when the Abunayyan Group acquired 100% of the company, it has been preparing a comeback. "Since 2020, we have been working on our new strategy, building our competency and high-calibre team, and going into joint ventures," said Hemeida. "We want to be positioned in the top five in the desalination industry."

Wetico notably set up a joint venture with a group of ex-Abengoa engineers in 2021, the Innovative Water Applications Co. (IWAC).

"They are our catalyser," Hemeida said, explaining that the company would act as a source of know-how to add value throughout project lifecycles.

Hemeida said that Wetico is especially keen to break into new markets in the Middle East and North Africa, and to work on large water, wastewater, and desalination projects. Algeria, he noted, is a particularly strong market because of its political stability, the ongoing drought, and rising hydrocarbon revenues. Morocco and Egypt also stand out as key target markets.

"We can compete because we have a strong technical team, and this will differentiate us," he observed. "Next year, we will be well positioned as a major industry player in the Middle East and North Africa region."

Market rumours are already linking the company to the EPC portion of a leading bid for one of the huge privately financed independent water projects (IWPs) in Saudi Arabia. ■

DEVELOPMENT FINANCE

World Bank aims to incentivise African water

In a first-of-its-kind project in the Democratic Republic of Congo, the Bank is aiming to overcome institutional failings and safeguard its investment by linking funding to sectoral reform.

The World Bank is preparing for the start of its first performance-based sectoral reform programme in the Democratic Republic of Congo as it looks to support progress in the country's water sector. The move, due to start next year, follows previous failures to turn the sector around, and is underscored by the bank's desire to safeguard its large infrastructure commitments.

Under its seven-year Access, Governance and Reform of the Electricity and Water Sectors Project (AGREE), the bank has committed more than $100 million to infrastructure, mostly in the provinces of Nord Kivu in eastern DRC and Kasai Central in the centre of the country. Meanwhile, Kin Elenda (2022-2026), another programme currently underway that focuses on the capital Kinshasa, has also earmarked $200 million for water capex.

Under AGREE, the bank has also committed $65 million to performance-based sectoral reforms, including restructuring of state-owned enterprises such as national water utility Regideso. The utility currently performs poorly, and the government approved a restructuring programme in 2021 to turn it around. The goal is to set up provincial infrastructure directorates and regional subsidiaries of Regideso that will act as autonomous operators.

The incentives are structured around a clear list of targets and deliverables, such as publishing decrees updating tariffs to cost-recovery levels, the execution of a permanent payment order for 12 months of water bills owed by national level government agencies to Regideso, or the new utilities hitting at least 75% of their performance targets. Results will be independently verified before the incentives are disbursed.

"World Bank experiences in several countries indicate that the financial viability of large water utilities is typically undermined by inefficient operations and high dependence on unreliable fiscal transfers from the central government eroding local accountability," the project report commented. "The project addresses such systematic governance weaknesses."

Nestor Manduku, who heads up the project at the Water Project Management Unit (CEP-O) of the Ministry of Hydraulics, said that the results-for-performance approach would take some getting used to, but could prove instrumental in resolving deep-rooted issues such as the list of institutions or individuals entitled to free water.

AGREE will also encourage more active private sector participation. Performance-based contracting incentives have been earmarked for existing private operators (including user associations), and a pilot DBO contract for greenfield infrastructure in Goma West is on the cards. ■

DEVELOPMENT FINANCE

AfDB takes a business-like approach to water

The African Development Bank's leader for water sees scope to increase lending, despite the challenge of higher interest rates.

Investment in Africa's water sector will continue to grow despite rising interest rates – if governments and utilities are prepared to think about efficiency, according to the African Development Bank's Director of Water and Sanitation Development, Osward Chanda. Speaking to GWI at the COP27 conference in Egypt, Chanda said: "We do know that the latest chunk of resources are coming from within, either from sovereign funding or from the collections of these utilities. The big question is, are these resources being used efficiently? I hope that increased interest rates will force utilities and governments to look at their numbers and look at the value for money that they are getting from their resources."

Chanda's remarks reveal his professional background. Before joining the AfDB in 2009, he was responsible for setting up Zambia's water regulator and using its powers to drive the efficiency of his native country's water sector. This experience also means he is well aware of the institutional obstacles water utilities face as they try to finance capital projects. "One of the biggest challenges that we have seen is this annual budgeting cycle. It's totally a killer. It does not work for capital investment." He believes that three- to five-year budgetary cycles for capital projects help utilities focus on the way that international resources can be leveraged to bring in external resources. Autonomy is another major institutional challenge that needs to be addressed.

"If there's one thing that I would like to see in Africa that would make a total difference, it is for the sovereign authorities to make these utilities independent in the mobilisation of resources. At the moment, what has been happening is it's been driven by sovereign entities who provide resources to utilities. But what if it's the other way around? Let the utilities take the initiative, drive the agenda, and put these demands before the government and say: 'Look, for us to get to this place, these are the needs. These are the resources that we need, and this is the framework for which we want to offer it.'"

This emphasis on utilities taking the initiative reflects a new direction for the AfDB. Historically it has lent exclusively to sovereign entities (i.e. central government bodies). "We have now started working with sub-sovereigns [i.e. municipalities and utilities] and the private sector as well. We are seeing an increasing number of public-private partnerships." The bank has an initiative called the African Water Facility to help utilities and other entities which don't have the internal capacity to develop projects on their own.

The AfDB has committed to lending $6.5 billion to the water sector between 2021 and 2025. It has four focus areas: water for sanitation and hygiene (WASH), hydropower generation, irrigation, and climate change adaptation. Chanda believes that governments like to work with the AfDB because they trust the bank. Outside partners come to the bank for its local understanding. "They come to us and say: 'Well, African Development Bank, you've been working in these countries for so long, could you go in with us?'"

The bank is also developing a reputation for innovation within the development finance world. This is reflected in Chanda's interest in supporting decentralised water and wastewater projects. "A lot of boreholes have been drilled on this continent, but I think that era has passed. Just by introducing a solar panel with a storage tank, you completely revolutionise what can happen in that space. So we are saying to sovereign entities: 'Listen, don't think of drilling new boreholes at the moment. Make a difference. Empower your communities by providing them with this energy, and increasing the availability of water. We know that from this increased availability of water new ideas come. People have gardens. People increase the number of animals that they can keep, and so on.'" Chanda also sees the potential for micronetworks to grow out of the solar pump and elevated storage tank combination. He mentions an entrepreneur in Mozambique who had hundreds of black pipes running from three elevated tanks fed by boreholes. Each pipe connection was metered, and users were surcharged for water during periods of peak demand. Chanda believes this kind of thinking will change water.

"This entrepreneurial mindset, the bringing in of private sector thinking into the water business and into the sanitation business, is going to make a huge difference. Currently the approach is more: 'Well, what is the social mood? You know, you can't charge for water what others are charging', but that's not correct.

"We have seen quite different pricing, but that comes with a mindset. Until we run water as a business, until we run sanitation as a business, it will be very difficult to sustain. Look at all the utilities that have managed to sustain water and very good services – Senegal – even South Africa. Rand Water is listed on the Stock Exchange. So you can't run water as a social charity. No! You need to run it as a professional business." ■

A REGULATOR'S EYE

Osward Chanda was appointed director of water and sanitation development at the African Development Bank in December 2021. During his 12 years at the bank prior to that appointment, he built a $4.5 billion portfolio of water investments, including the $150 million Abu-Rawash Wastewater Treatment Project in Egypt and the Kigali Bulk Water Supply Project in Rwanda. Before that, he set up and ran Zambia's water regulator, the National Water Supply and Sanitation Council. It is still today considered the gold standard for water regulation in the continent.

Source: AfDB

COMMENT

The non-revenue water problem is a data problem

Even when done on a no-win no-fee basis, non-revenue water contracts have struggled in the Gulf. An open approach to information is the first step, says Tom Scotney.

Recently I was watching an excellent presentation from HydrOptimise's Joe Dalton, looking at one of those paradoxes that seem to crop up so often in the water sector: why do the high-income countries in the GCC have such difficulty implementing programmes to address non-revenue water (NRW) when in theory they are the countries where this action is both most needed and easiest to implement? You can see the presentation at bit.ly/3Y7YI8x.

Dalton, who claims one of the few successful performance-based NRW programmes in the region with a contract concluded in Bahrain in 2016, has created a screening tool for identifying countries that are suitable for non-revenue water initiatives.

Countries in the GCC region fit very well with all of the criteria identified in the screening tool. They have arid conditions; a high marginal cost of water often produced by desalination; significant demand growth; access to funding for improvement works; and addressable levels of losses.

Looking at the economics, performance-based NRW contracts should be the easiest sell in the world – utilities are essentially given the chance to pay a risk-free fee for improvements that will increase their income without the need for large capital investment. In a region where water is either scarce or produced at high cost through desalination (or both), it seems like a no-brainer.

But all too often, performance-based NRW contracts have failed in the region. Dalton highlights a number of reasons for this, including:

- A focus on baselining programmes and pilot projects instead of ones that achieve results.
- A pressure to get results fast that means programmes are not given the lengthier periods of time they need to make a difference.
- Slow procurement processes that mean programmes lose impetus between conception and the starting line.

But perhaps the key issue at hand is the availability of genuine data to quantify and address the problem. Non-revenue water, whether it's a result of physical, commercial or bureaucratic failures, is not only an operating problem for utilities, but a public relations one too. In a region where water and the cost of water are an ever-present issue, utilities and governments are very reluctant to be open about how much is being lost or wasted, even if it's not their fault. If you ask a Gulf utility representative what their NRW figure is (and they're in a candid mood), you're liable to be asked back: "Do you mean the official one or the real one?"

Without access to accurate and up-to-date information on water losses, it's next to impossible to address them in a systematic way and make genuine improvements to utility operations.

Now you can't ignore the realities of the situation – no government or utility in the region is going to want to invite criticism and lay the inner workings of their operations bare if they don't have to.

But there should be a way to make information available for programmes that make a difference, without having to commit to full public transparency.

The Water Services Association of Australia keeps an open but anonymous ledger of performance by that country's utilities on a number of benchmarks, including non-revenue water. Each utility knows its own NRW figure, and where that places it in terms of ranked performance, but does not know how its neighbours compare directly.

Creating a regional database for the Gulf that accurately expresses non-revenue water performance would give an idea of what a good regional benchmark looks like, and would also give countries and utilities a solid idea of how they compare to their neighbours.

It would be a huge step towards creating a system that can take advantage of the wealth of experience out there in addressing non-revenue water. ■

MIDDLE EAST IN BRIEF

- Israel has completed works on the transmission project linking Lake Kinneret with the Western Galilee desalination project which is under development by **IDE Technologies**.

- Abu Dhabi utility body **Taqa** has completed the acquisition of new energy body Masdar, alongside co-investors Mubadala and ADNOC.

- Saudi new city development **Neom** has taken on consultant **Worley** to advise its energy and water utility Enowa on the development of water and wastewater infrastructure.

- The **Saudi Water Partnership Company** has opened bidding to 17 qualified companies for the development of the country's first privately financed water reservoir project.

- Saudi project developer **ACWA Power** has inked a provisional deal to build a 363,480m³/d desalination plant as part of a private power, water, and steam development in Indonesia.

- Senegalese asset holding company Société Nationale des Eaux du Sénégal (Sones) has issued an RfEI from consultants to provide it with technical assistance on asset management, affermage oversight and sector regulation for a period of 18 months. Separately, Sones has appointed consultants **SGI Ingeniérie/Antea/SGI Senegal** to update the drinking water supply master plan for urban areas outside Greater Dakar.

- Angola's Ministry of Energy and Water has issued an RfEI from consultants to provide technical assistance to the Water and Electricity Regulatory Entity for three years.

- Togo has secured XOF157 billion (€232 million) of financing from the World Bank, the West African Development Bank, Agence Française de Développement, and the European Union to expand access to drinking water.

- The World Bank has approved $250 million for the implementation of the Bamako Urban Resilience Project in Mali, a programme to improve access to water and sanitation. ■

POLITICS

Malaysia looks to join the dots on water, energy, and climate

The country has made a major change to the way its government handles water in a bid to bring life to reform programmes. Will it be a catalyst to achieve real change in the sector?

This month in Asia Pacific:
26 Malaysian government gets serious on water
27 Maisie Hockin-Boyers: Good and bad in KL
28 GHD's big-tent approach to water
29 Charles Bodhi: China water on the comeback
29 Asia Pacific: News in brief

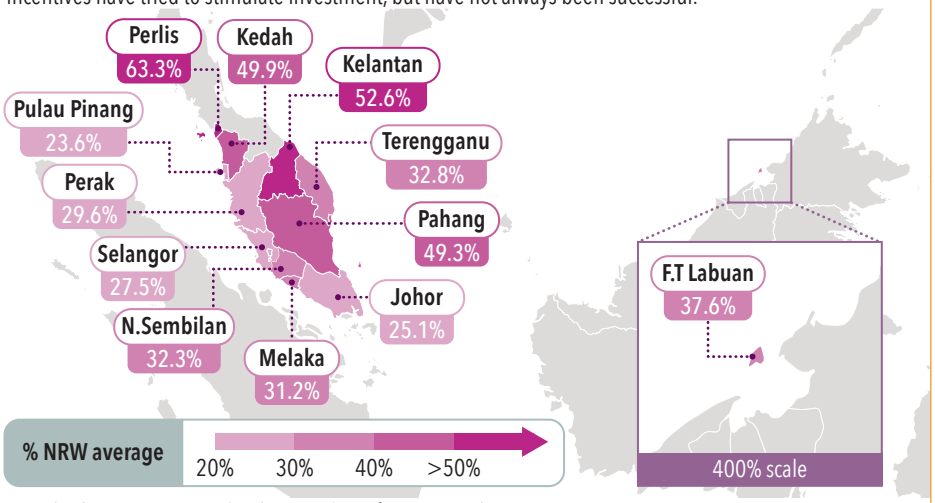
This month, Malaysia announced it will be merging its ministry for water and environment (KASA) with the ministry for energy and natural resources as it looks to streamline the water decision-making process and help the country's long-running water reform plans.

The new Ministry of Natural Resources, Environment and Climate Change will bring water utilities under the same umbrella as energy and long-term environmental issues.

Government policies to highlight the value of water and improve services, such as the Green Technology Master Plan (GTMP) launched in 2017, the non-revenue water programmes, and water reclamation for industry plans have often involved several different ministries with numerous and sprawling targets. Key players in the industry told GWI that they are positive that forming partnerships for the advancement of these sustainability goals would now be easier under one unified ministry.

MAPPING OUT NON-REVENUE WATER IN MALAYSIA

The performance by Malaysia's states* when it comes to non-revenue water is mixed. Government incentives have tried to stimulate investment, but have not always been successful.



* Mainland Borneo states regulated separately; no figures quoted

Source: SPAN (2021)

A framework for reuse

The newly formed ministry comes as a welcome change for national sewerage company Indah Water Konsortium (IWK), which joined forces with water utilities Air Selangor (the country's largest operator) and Syarikat Air Melaka in 2021 to try to kickstart a wave of water reclamation projects (*see GWI April 2021, p18*). Under the GTMP, KASA set a target of producing 1.5 million m^3/d of reclaimed water by 2030.

Since the launch of Central Water Reclamation – the special purpose company jointly owned by Air Selangor (60%) and IWK (40%) – the process has seen major challenges, however. Reclaimed water must be treated to the standard required by the industry buying the water, which with its first client, a latex glove manufacturer, meant treating it to a higher standard than potable water. Currently, KASA does not have any policies or incentives that encourage industries to buy reclaimed water – a situation that both IWK and Air Selangor hope the new ministry will address. "We want policies that support us, because these things are government-driven," Lim Pek Boon, green technology manager at IWK, told GWI.

"If our potable water is cheaper than our reclaimed water, they will go for potable water – that's the simple economics of it," agreed Abas Abdullah, director of operations at Air Selangor. Treatment of wastewater to a standard where it can be reused is a incredibly capital-intensive process due to sewage treatment plants being located downstream and having to transmit the water upstream to water treatment facilities, Abdullah added.

IWK also has plans to accelerate projects that harness energy and nutrient value in wastewater. Under the GTMP, IWK set a goal of recycling 100% of sludge and 33% of treated effluent by 2030. Ongoing projects aiming to achieve these goals include using biogas technology to produce animal feed, as well as introducing anaerobic digestion into large-scale sewage treatment plants to produce biosolids. Currently, progress is slow, according to IWK, but the company added that under a new ministry it expects to have more access to partners with compatible sustainability goals.

"I am very hopeful that the link between water and energy will be even more clear and more precise under the new ministry, because we can't talk about water or energy on their own," said Boon. "The wastewater that comes to us contains energy value, nutrient value and water value, so this needs to be integrated. Under one ministry we will be able to utilise this nexus."

Troubles with financing its ambitious plans have often stalled IWK's progress in reaching its sustainability goals. The wastewater tariff in Malaysia was raised for the first time in 28 years in September this year. This has meant IWK has had to be creative with its approach, taking actions such as repurposing land around some of the 7,000 sewage treatment plants it currently operates into community spaces which can also generate income.

The ministry of energy and natural resources that was previously separate from the ministry of environment and water used to own the land that sewage plants were built on, meaning IWK had to seek approval each time it formulated a plan for land use. Head of corporate planning at IWK Azuan Ahmad Zahdi explains: "Going forward we see that our plants should become ▶

resource centres [...] Since getting approval from the government to use the land for other purposes in 2021, we have started to open recreational centres, such as football pitches and badminton courts, as part of the facilities [...] We try to change people's view of sewage treatment plants and utilise the land." IWK has identified 3,700 sites to lease for other purposes, and it hopes this process will now be streamlined as the decision-making will be under a single government body.

Non-revenue water

There is also scope for change on one of the key challenges facing the sector – non-revenue water (NRW). Key players in the market want to see reformed policy and investment under the new ministry that drive the NRW targets mutually set by the government's National Water Service Commission (SPAN).

SPAN introduced a two-pronged approach to tackling NRW in 2020. The first part applies to states with NRW above 40%, where it provides grants to install the necessary infrastructure and equipment to get accurate measurements of NRW. The second approach is for states with NRW below 40%, in which utilities can set a mutually agreed NRW target for the year which, if achieved, earns them a 50% reimbursement from SPAN on their investment.

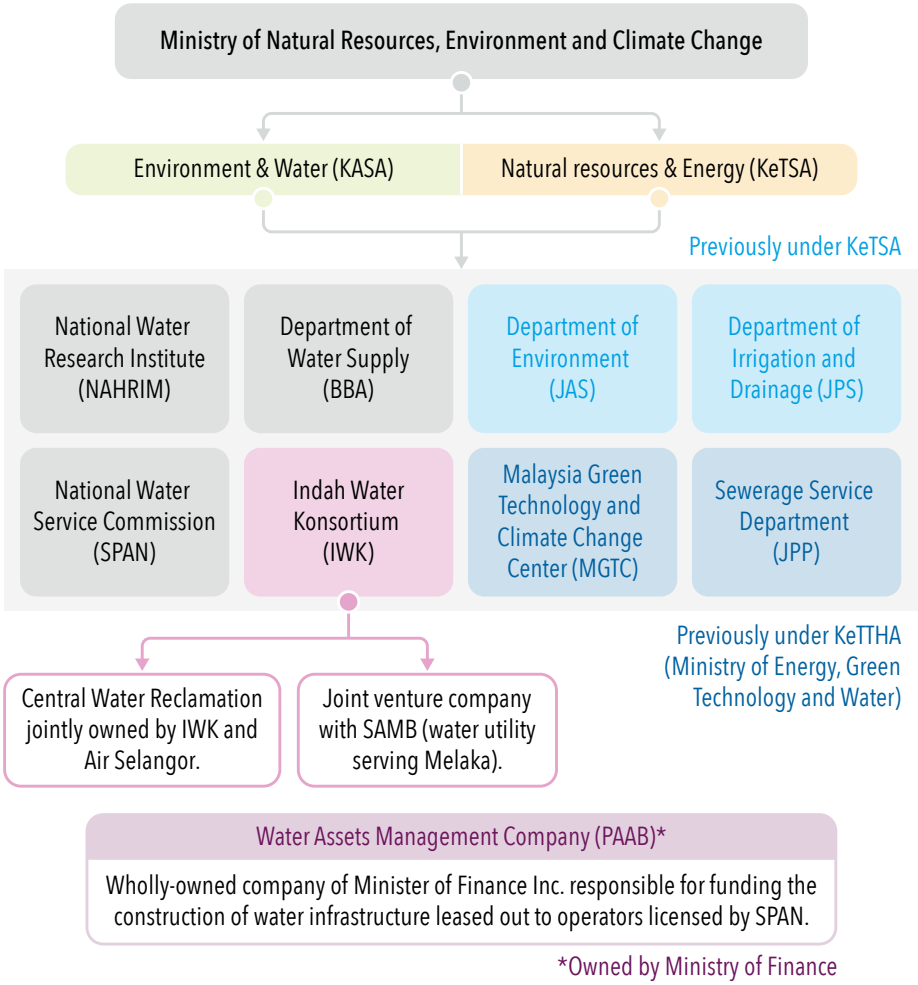
This approach is not universally popular, however. Ranhill SAG, the private utility and water supplier for Johor Province, currently has one of the country's lowest levels of non-revenue water, at 25.1%. "The investment return scheme is very risky, because sometimes you don't get the target. Not many water operators are keen on doing it. [...] The target also gets harder to reach each year because the pipes get older and older," explained Khairul Effendy, director of networks at Ranhill.

Ranhill is still pursuing NRW targets despite the lack of incentives. "We have revenue growth from expanding our network and acquiring new customers, but other than that we have to cut down on resources in order to make a profit. We don't rehire for a position when people retire, and have started replacing people with technology," Effendy went on.

Profits generated by utilities in Malaysia, both public and private, are capped and collected by SPAN. Effendy explained that as well as not knowing what happens to the money that is collected, the tariff, which should be reviewed by SPAN every three years, has not been reviewed for the last two cycles. Some states have not had a tariff increase for 20 to 30 years, he added. ■

WHAT WILL THE NEW WATER SECTOR LOOK LIKE?

Malaysia's water sector has historically been fragmented, slowing down decision-making. The new ministry maps out a more cohesive water sector which key players hope will help them hit sustainability goals.



Source: KASA

COMMENT

Utilities don't get the support they need

Progress on water reform needs to come from the top, says Maisie Hockin-Boyers.

I attended Asia Water in Kuala Lumpur this month and was excited by the ambitious plans put forward by the water and wastewater operators in the country. I cannot say the same for the policy-makers. Collaboration between utilities and other water bodies is driving reform in the Malaysian water sector on the ground, and aggressive targets set by the government to reach sustainability goals are met with creativity and innovation. Unfortunately, these efforts seem somewhat dimmed by the lack of support and incentive provided by the policy-makers. Utilities are unable to flourish and achieve their ambitions because they are stunted in the process. Profits are capped, investment into NRW is risky, and creative solutions for generating more income – such as repurposing land – are met with long-winded inter-ministerial processes. A lot of the ideas and systems are already in place to make the Malaysian water sector one of the most successful in Southeast Asia, but it is ultimately up to the policy-makers to incentivise utilities and industries to push towards real reform. I hope the new ministry will streamline decisions in water to accelerate toward a bright future for the Malaysian water sector. ■

STRATEGY

GHD looks to the big picture for growth

The Sydney-based firm is looking to stay ahead of the commoditisation of the engineering sector by playing a bigger strategic role in water infrastructure development. Global water lead Rod Naylor explained the employee-owned firm's approach.

Australian engineer GHD is looking to reposition itself higher up the value chain as it grows its international position in the water sector. The firm is perhaps the only employee-owned engineering firm to grow its international footprint dramatically over the past 15 years, expanding beyond the Asia Pacific region into the UK, North America, and the Middle East. While other employee-owned firms have struggled to compete with the resources of the major publicly traded engineers such as Jacobs and AECOM, success at home, and the strong Australian dollar, have enabled GHD to buy and build its way into new international markets over the past decade and a half. Today the firm is looking for growth in a different direction, according to global water lead Rod Naylor. "The thing that has changed dramatically has been our strategic ambition," he said, speaking to GWI during last month's COP27 conference in Egypt. "It is about shifting perceptions of GHD and GHD's ability to contribute at a strategic phase, rather than being very focused on delivery".

It is significant that we were speaking in Sharm El Sheikh during the COP27 event. Climate change is driving demand for the strategic advisory services that GHD wants to be more involved in. "Conventionally. everyone was queueing up to design a wastewater treatment plant," he said. "If you start looking at it in an integrated way and you are bringing climate into it, you're actually likely to challenge yourself at the planning and strategic level and think differently about investment going forward. We'd be actively using the integrated water cycle management and adaptive planning approach, promoting but also scaling our capabilities in that across Australia. We have got it into the US, and the UK is next."

> "We're trying to create the time so people can think a bit differently, challenge the industry, and infuse that into the thinking.
>
> Rod Naylor, GHD

GHD'S ROD NAYLOR

The Australian engineering firm's global water lead joined the company in 2018 after a short spell at Downer Utilities, and before that a long spell at Veolia. Beside leading the French company's Australian and New Zealand operations, he was also General Manager of Veolia Water North America, working on its Peer Performance Solutions contract in New York City.

Source: GHD

GHD has invested in a number of thought leadership initiatives, including its Aquanomics water risk analysis (*see GWI September 2022, p18*), the Water Sensitive Cities Index, and its Future of Water marketing theme. The latter complements GHD's Future of Energy and Future of Communities initiatives. "It's tying together the nexus with energy and decarbonisation back to water and rethinking how we live and how we want our cities and our lived experience to be, and bringing that into the strategic conversation," Naylor said. "That's a very different ambition from what GHD had ten years ago." This approach helps differentiate the firm from its publicly traded competitors, Naylor added. "It is part of why we are a bit more like Arup than those other guys [the investor-owned engineers]. We're employee-owned, so we are not beholden to the stock market for capital growth. All of those businesses are driven by share price growth, and that is not how we see our future. Growth for us is about performance, and higher quality revenue. The capital growth that happens is sustained but conservative, and we're more purpose-driven as shareholders in terms of where we want to work and the contribution we want to make."

GHD's overall revenues for the financial year ended 30 June 2022 were A$2.3 billion (US$1.6 billion), and of these 17% or A$395 million (US$271 million) came from water. Its US revenues are now as large as its Australian revenues.

Besides expanding its advisory capabilities, GHD has also been building its digital services position. This focuses on the user experience of infrastructure assets. "We're helping asset-owners and operators to manage and deliver better services through better information in real time." He gave the example of Scottish Water's combined sewer overflow monitoring system. Better information systems have dramatically reduced the amount of money that might be required to address the problem. He thinks this capacity to infuse conventional hard engineering skills with digital insights and strategic perspectives reinforces GHD's market position. "If you're purely commoditised, you haven't got time for that, right? You've got to grind out work to keep your margins. So we're trying to create the time so people can think a bit differently, challenge the industry, and infuse that into the thinking."

Naylor was somewhat disappointed by his experience of COP27: "It just doesn't seem to be the place you set the dialogue." That said, GHD was committed to and involved in delivering the principles for what COP stands for. It had ten staff at the event covering communities, energy, international assistance, and water. The synergies between GHD's main practice areas mean that it is well placed to take advantage of the opportunities that grow up between them, such as hydrogen. It is already a big business for GHD in Australia on both the water and the energy side, and Naylor hopes to take that leadership to the world. ■

COMMENT

Get ready for the water rebound as China moves on from zero-COVID

Signs of economic recovery are in the pipeline for China as it takes a more relaxed approach to lockdowns. This will filter through to the water sector, says Charles Bodhi.

So it's finally happened. After months of denying the obvious, widespread protests on an unprecedented scale were needed before the Chinese leadership relented on its zero-COVID policy. The policy didn't just make headlines around the world, but also baffled countless observers of the country: why the need for the strict guidelines if the country was confident of its own vaccine quality and production capacity? And if it wasn't confident as such, why not take the practical path of importing vaccines from abroad? And if that was because its leadership was just too proud, then the big question becomes: what social, economic and political cost would it take for Beijing to relent?

I was in Thailand when the news first broke about demonstrations in China because of deaths in Xinjiang after a fire broke out in an apartment block that was under a COVID lockdown. The bitter irony didn't escape me: I was watching the news on TV in a hotel lounge with others from around the world, all of us enjoying a tipple or two, unmasked and unencumbered for months now, while over a billion people continued to languish under unfathomable strictures because of a leader that had just recently surrounded himself with loyalists who would utter nary a word of objection to him. That the protests led to an easing of lockdowns while China registers new highs in infections makes clear the fact that the government is finally beginning to come to its senses again, and that the people's frustrations need to be heard and acted upon.

This is not to be sneezed at. China's economy has been closed to the world for too long, and even its domestic market is hampered by the vagaries of local governments as they over-react to infection cases with sudden shutdowns, making almost any form of infrastructure project or even equipment trade next to impossible to plan or predict. This certainly dampened any investment interest, even if one talks only of Chinese companies supplying the solutions to Chinese customers.

One needs only to look at how the country's property market as a whole was brought to its knees because of the zero-COVID policy. With demand kept to a bare minimum and supply constrained on multiple fronts, even within a country as vast as China, one can imagine that the scale of any planned water project, industrial or municipal, must have been severely diminished, if it still exists at all.

What we are seeing, then, are likely to be the first signs of recovery. There is immense pent-up demand for investments and trade on multiple fronts, with industrial projects starting to hum again, triggering the need for water treatment facilities.

Even basic consumables like water treatment chemicals, membranes, and the like will quickly be in demand again, and the whole virtuous cycle of supply and demand will return to life. In all likelihood, China will see what the rest of the world saw earlier this year, albeit on a smaller scale, where certain parts of the supply chain take longer to catch up, leading to snarl-ups with deliveries and driving up costs, before the market eventually finds its footing in a new normal.

But this also means there will be growth in the economy again, and hopefully when supplies run low, this will trigger a greater willingness for the country to open its borders again, both literally by allowing visitors without the horrors of protracted quarantine, and figuratively in terms of welcoming new suppliers and technology in order to ease supply shortages.

All of this will bode well for the water industry as a whole, even if it remains to be seen how sustainable the easing will be in the first instance, and how freely the government will allow market forces to play out, knowing full well such chaos only lays bare the travails of its zero-COVID policy. As the year draws to a close, perhaps this is a good time to prepare for the opportunities to come out of China. Watch this space. ■

ASIA PACIFIC IN BRIEF

- Shares in **Downer**, which bills itself as the largest provider of outsourced water services in Australia and New Zealand, plunged 20% earlier this month after the group delivered a profit warning, citing accounting irregularities in its utilities business.

- **Wabag's** long-standing CEO Rajiv Mittal this month handed the day-to-day running of the company over to Pankaj Malhan. Mittal will remain as chairman and managing director.

- **Kurita** intends to hold a series of water and environment events between now and March 2023, to showcase its capabilities to the global audience. The plan is to visit Europe and the Middle East at the end of January, South Korea in late February, and North America towards the end of March.

- Singapore's **PUB** has followed up the S$800 million 30-year bond it issued in August with a second deal, in the form of a S$300 million 3-year issue, carrying a coupon of 3.663%.

- Shares in ASX-linked **Fluence Corporation** rose by more than 9% after the company announced its first industrial water contract in Cambodia. The company also announced a reorganisation designed to shave US$3 million off its annual operating expense bill.

- **Moya** shareholders have voted through a voluntary delisting of the company from the Singapore Stock Exchange, following an offer made earlier this year by majority shareholder **Tamaris Infrastructure**, which is controlled by Indonesian billionaire Antoni Salim.

- The **EBRD** has approved four €2 million 15-year sovereign loans with 4-year grace periods to finance four local water projects in the Kyrgyz Republic. At the same time, the bank also approved a €3.745 million sovereign loan to fund water and wastewater infrastructure in the municipality of Bazar-Korgon.

- Indian pipeline robotics firm **Solinas** has raised INR45 million ($550,000) of equity to expand internationally. ■

UTILITY PERFORMANCE

THE VIEW FROM THE UTILITY

Colorado utilities welcome new direct potable reuse regulation

If they can solve its steep costs and the brine issue, Colorado utilities say they will pursue direct potable reuse to shore up their precarious water supplies – but in what timeframe?

The addition of direct potable reuse (DPR) to the Colorado Primary Drinking Water Regulations in October this year (*see GWI November 2022, p21*) was the culmination of years of negotiations and stakeholder engagement with and by utilities in the state. Population growth, aridification and Colorado's complex water rights laws are putting increasing pressure on communities to diversify their water supply. The new regulation sets out a clear framework for utilities to take advantage of the opportunity.

True to their nature, municipal utilities are taking a slow and steady approach to ensure they make the most of the new opportunity to reinforce water resilience without jeopardising their financial stability. "We're excited about the possibility, because it gives us the ability to open up that tap a little more and give us a little more flexibility in how we operate our system, but we need to better understand what the requirements are," said Greg Baker, manager of public relations at Aurora Water. Aurora is a city of just under 400,000 citizens located east of Denver. "I want to see: is this viable, and does it make sense?". Mark Marlowe, director of the water department at Castle Rock, a small municipality between Denver and Colorado Springs, agreed, saying:: "One of the internal questions we're asking ourselves right now is are we able to do this financially?". Both utilities confirmed that the biggest barrier to implementing direct potable reuse would be the cost of complying with the stringent requirements the regulation demands in terms of water quality. This includes very high standards of biological safety, as well as strict limits on pollutants such as pharmaceuticals, hormones and other emerging contaminants of concern. Although both utilities fully support the state's regulation and stress that they agree the standards need to be strict to protect public health, "the key is how to comply with those regulations in a way that's financially efficient and makes sense," says Marlowe. According to Baker, finding the right technology (and one that they can afford) will be the key challenge for Aurora Water. Over at Castle Rock, Marlowe is more concerned about the cost of additional monitoring, instrumentation and operational capability required.

Reuse culture

Utilities in Colorado are already ahead of the curve when it comes to reuse. Even utilities such as Denver Water who do not plan to immediately pounce on DPR now ▶

that it is a possibility have a strong knowledge of the subject. "We've been engaged in looking at DPR for over 20 years," said Jim Lochhead, the CEO of Denver Water. "We've participated in conferences, we're involved in the potable reuse association. We have a recycled water plant and our new administration building has an in-building wastewater treatment system. It's not something we're writing off, especially given climate change. It's down the road."

Both Aurora Water and Castle Rock Water have invested heavily in indirect potable reuse over the past ten to fifteen years. Indirect potable water flows downstream from a wastewater treatment plant through an environmental barrier (for example a river or well) before being withdrawn again and treated to drinking water standard. In 2016, Castle Rock Water decided to upgrade its recently developed surface water purification plant to allow them to use indirect potable reuse. The utility pumps water from a creek downstream from the wastewater treatment plant back up to the advanced purification plant. The advanced water purification technologies installed at the plant include ozonation, micro-filtration, advanced oxidation, granular activated carbon filtration and UV. "With respect to treatment technology the good news is we already have that in place," says Marlowe. But the system relies on a creek that is susceptible to drying out during droughts. "If the creek dried up our indirect reuse infrastructure will not work because we won't be able to get the water down. Direct reuse would allow us to ensure that we continue to get that reusable water supply even if the creek dries up," said Marlowe. For direct potable reuse, the effluent would be pumped directly from the wastewater treatment plant to the purification plant without first flowing down the creek. To make that a reality would require a year's worth of monitoring and data collection to ensure the quality of the water can be maintained, and cost would be a sticking point. "We will have to develop plans with the water reclamation plant on how to ensure the effluent quality is consistent, and how to respond if that quality goes bad for some reason so we don't bring it into the water purification facility," said Marlowe.

The infrastructure however, is pretty much in place. "For indirect reuse we built a pumping station and a big pipeline back to our water purification facility but that pipeline runs right past the water reclamation facility. So when we built it we left the blind flange for a future connection directly to the reclamation facility," said Marlowe.

LEADING THE WAY

Mark Marlowe, director of Castle Rock Water (left) is going full steam ahead on DPR, whereas Jim Lochhead, the CEO of Denver Water (right) is taking a more cautious approach.

Source: Castle Rock Water/Denver Water

"The bottom line is we think it will be a 4-to-5-year process to get final approval for direct potable reuse."

Aurora Water is a little more cautious regarding its timeline. . "Will we get there? I suspect we will," said Baker. "It's a question of whether we do it in 5, 10, 20 or 30 years." The utility quite recently invested heavily in its Prairie Waters indirect potable reuse system. Prairie Waters uses riverbank filtration, where a system of wells pulls the water through alluvium to remove nitrate, pathogens and trace organic chemicals. Then follows technological treatment in the purification plant which includes UV and activated carbon. "When we built our Prairie Waters system between 2007 and 2010, we were very fortunate that it came in under budget, but it still cost us $638 million," said Baker. "We had a series of double-digit rate increases to support that, and there were a lot of consequences. So we have to be careful if we're going to pursue that with direct potable reuse, we have to understand why, how, and how are we going to fund it. Rate education is a component of cost."

Therefore, another massive investment into direct potable reuse may not be on the cards just yet. "It's not the only project we have, we have a couple of reservoirs we need to build and our system is getting to a point where we have to increase our operational replacement as well" said Baker.

Brine woes

Denver Water warned cost of compliance isn't the only challenge. Jim Lochhead sees brine from reverse osmosis (RO) processes as the biggest barrier to direct potable reuse in Colorado. Reverse osmosis is a treatment technology commonly associated with direct potable reuse, which Lochhead said he considers the gold standard in terms of achieving the water quality standards required for DPR. "But with reverse osmosis there's a significant brine stream and nowhere to put it. We're not next to an ocean, rivers in Colorado are not large and already have significant water quality problems. Disposing of it underground wouldn't work because of energy costs, environmental impacts and earthquake potential," says Lochhead.

Greg Baker from Aurora Water also acknowledged the issue, saying it was the reason the utility would try to avoid using RO if it pursued direct potable reuse. "There are a lot of constraints to doing RO in Colorado, that's why we're looking for solutions that don't take that avenue. There are lots of solutions out there so we're trying to be as active as possible." Similarly, Castle Rock's advanced purification plant, which came online in 2021 and treats water for indirect potable reuse, does not rely on RO to avoid brine issues. However, Marlowe is concerned about salt being introduced to the system from elsewhere, ▶

saying: "locally we put a lot of salt down on the roads in the winter, and that drives up total dissolved solids in the wastewater effluent. With indirect potable reuse we generally have enough water supplies [from the river] to blend the salt down and ensure that it's not an issue." But for direct reuse, the salty wastewater effluent would be fed directly into the water purification plant, and without RO the utility has no way of treating that salt. "At some point we may need side stream treatment for blending, using RO," Marlowe admitted.

Other challenges to DPR, such as the high energy cost (particularly for RO) and what to do about treating PFAS are also on the utilities' minds. "We're working locally on trying to control the source of PFAS in the water. Most of that comes from anything that's water repellent, clothing, carpets, furniture that ends up in a wastewater stream, and thus in our water stream," said Baker. "We have a fairly good idea of how to remove it from the water, but you never truly it from anything, because it is a forever chemical. And it's just one of the constituents out there." Baker said they were testing various technologies and were seeing good results with granular activated carbon.

Hearts and minds

Colorado's new regulation on direct potable reuse requires utilities to conduct outreach to their customers to dispel concerns regarding safety and water quality. Neither Aurora Water nor Castle Rock Water believed public perception would be a significant hurdle. "We've done outreach with our customers over the past decade with respect to reuse. It's fairly well accepted here in Castle Rock at this point," says Marlowe. Baker reckons public acceptance is a concern that's "easy to mitigate": "people can talk about 'toilet to tap concept,' and those phrases we hate. But we were well ahead of it, because we had already done that outreach with our community with our Prairie water system. So we understood the community's capacity to handle this, and to be perfectly honest, absolutely no pushback. We haven't had a single water quality complaint we've been able to attribute specifically to that source water." As a public relations manager, Baker has seen first hand how a small thing can go a long way to help with public perception, saying "branding is so important, if you have a good name associated with it, something benign like 'Prairie Waters', that's great."

More than the 'yuck factor', a concern for Colorado utilities is the taste of water. Coloradans are using to the taste of mountain water, which reused water may not be able to emulate. "We have a very high expectation from our customers about what our water tastes like," says Baker. Aurora Water would have to meet that expectation if it were to pursue direct potable reuse.

First come, first served

The state of Colorado has a particularly complex system of water rights. Access to water in the state is determined by the principle of 'first in time, first in right'. "The way it works is the older water rights get satisfied first by the available water supply and then the newer rights only get satisfied if there's enough excess water supply above that," explained Marlowe. More recent communities such as Aurora and Castle Rock do not benefit from senior water rights like older towns such as Denver do. What's more, many older water rights are owned by agricultural interests, leaving small, young municipalities literally high and dry. Being last in line means there can be little water allocated in dry years, deepening the utilities' need to create a more resilient supply.

These pressures on water rights have led municipalities such as Aurora and Castle Rock to be early implementers of water conservation policies and water reuse. "We do a lot of things that maybe some of the older utilities have not had to do as quickly," said Marlowe. With climate change causing many water sources in the Western United States to dwindle, resilience is ever more pressing. "You talk about drought as a year-to-year or decade-to-decade thing, but with climate change, we're seeing long term aridification. We're in the 23rd year of a drought," says Baker. Aurora Water has been pushing an aggressive water conservation programme and is now treating less water than in 2000 despite a 50% increase in population.

With all the water scarcity constraints faced by Colorado and the rest of the Western United States, all three utilities agree that direct potable reuse is ultimately an inevitability. "I think it's inevitable that just about anybody in any arid and water-constrained environment has to implement some reuse," said Baker. Jim Lochhead from Denver Water is also thinking about the repercussion of Colorado's regulation for other states: "the usefulness of this is that Colorado can demonstrate to a state like California that it can be done. I would say California is probably the state with the greatest potential and the greatest need right now to start investing in direct potable reuse. ■

REUSE TECHNOLOGIES FOR WATER

Castle Rock's indirect potable reuse facility deploys a plethora of advanced treatment technologies, including ozonation.

Source: Castle Rock Water

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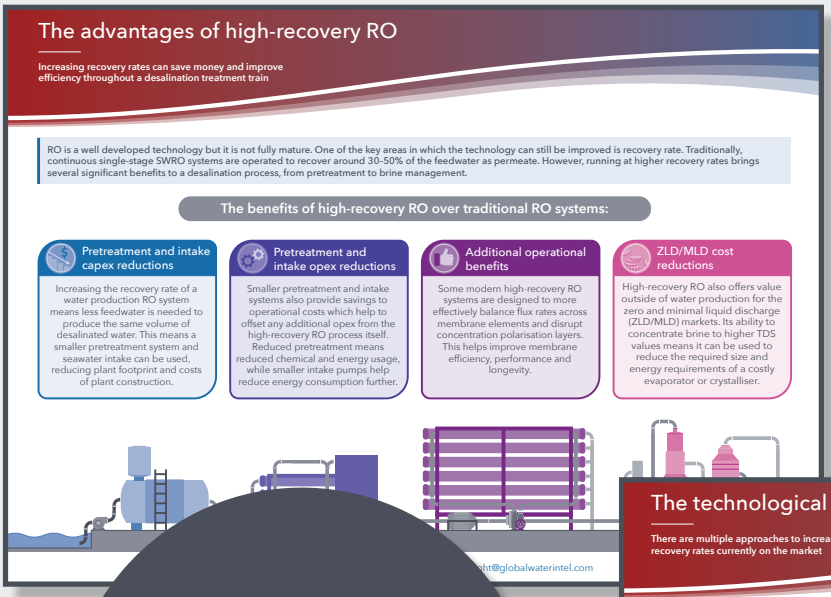

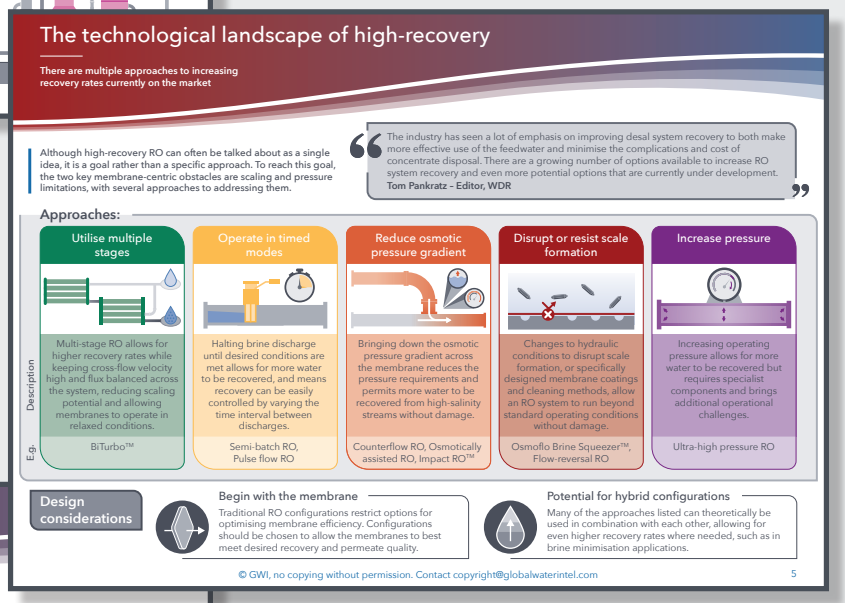

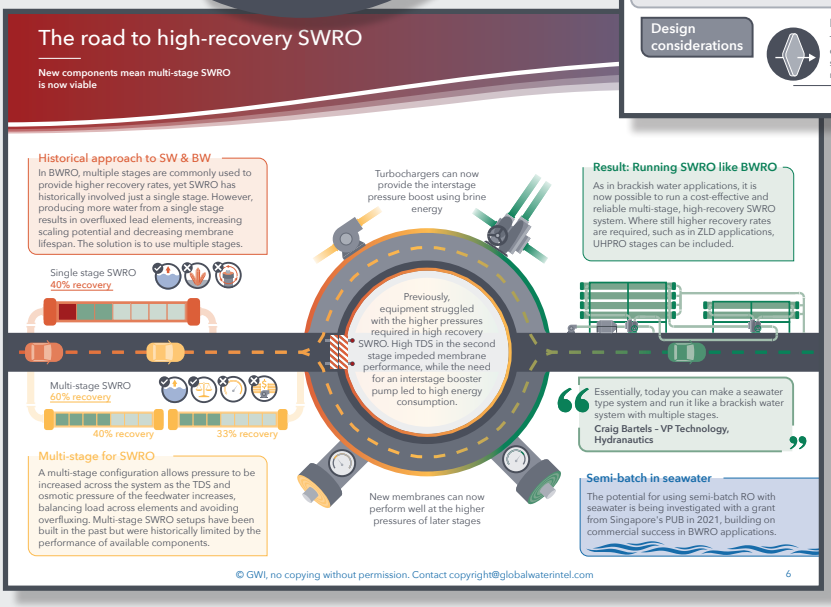

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FROM THE CHIEF TECHNOLOGY OFFICER

How will the water industry navigate the path to net zero?

Direct emissions from treatment processes, including nitrous oxide, are under the spotlight. Monitoring and mitigation methods will play a critical role, explains Kelly Thompson, GWI's research lead for technology.

The United Nations Race to Net Zero campaign was the catalyst for many water utilities to make a climate-focused commitment. Increased coverage at COP26 and 27 will continue this trend. GWI now tracks 81 utilities globally, mostly in Europe and Asia/Pacific, that have set net zero commitments to some degree. While energy efficiency and using biogas from digesters for energy production has been the low-hanging fruit on utilities' journeys, increased coverage is now focusing on direct (scope 1) greenhouse gas emissions from mainly wastewater and sludge treatment processes and tanks.

GWI's Water Without Carbon research brings more visibility to the emissions of the water sector. The white paper and accompanying webinar, sponsored by Xylem and Cambi, explores our model quantifying water's carbon footprint – from both centralised water and wastewater treatment infrastructure to onsite sanitation. Over the next three months, CTO will look into three different aspects of these direct emissions – nitrous oxide and methane emissions, as well as efforts to sequester carbon using water-related infrastructure.

The Global Methane Pledge signed at COP26 will hopefully bring much-needed visibility to fugitive emissions and digester design that is poorly optimised for sustainability. If digesters are uncovered, have leaks, or are followed by unsealed storage tanks, the amount of methane that leaks into the atmosphere can wipe out all the benefits of offsetting fossil carbon by using the biogas.

Utilities are looking into how carbon can be sequestered out of the atmosphere using biochar or algae. There is also the potential to beneficially use the carbon dioxide released during treatment processes. However, progressive utilities are now beginning to step into relatively new waters – the release of nitrous oxide emissions from biological treatment systems.

In 2020, nitrous oxide accounted for 7% of total greenhouse gas emissions from all human activities in the US, according to the EPA, but its potency is much higher than that of carbon dioxide and even methane – making it an immediate concern. GWI estimates that 32% of sewered wastewater emissions (or 11% of total water sector emissions) are made up of nitrous oxide. It's unsurprising that our industry is waking up and smelling the coffee.

The key question I hear utilities first ask when nitrous oxide is mentioned is: how do we quantify it for our plant? We are seeing lots of novel approaches ranging from dissolved gas measurements to AI models. The digital realm can also help treatment plants level their peak flows and optimise aeration performance (without wasting energy), to mitigate some of their nitrous oxide emissions. With many solutions that leverage existing infrastructure, there are lots of easy pickings for treatment plants.

For particularly climate-forward operators, technology solutions that offer nitrous oxide reduction can also feed into the wider circular economy movement. The recovery of fertiliser products is currently a hot topic, with existing fertiliser supply chains disrupted. Phosphorus recovery is the frontrunner in this market, but the recovery of ammonia is also of interest. Using non-biological nitrogen removal, and subsequently recovering the end-product both reduces emissions and creates a recycled fertiliser.

> "The key question I hear utilities first ask when nitrous oxide is mentioned is: how do we quantify it for our plant?

After 2025, the Danish government is looking to tax nitrous oxide emissions from wastewater activities and is taking an active interest in making sure utilities report N_2O measurements. Could it be that other countries, particularly those in Europe with more active climate agendas, will start to stipulate something similar? In some parts of the world, net zero pledges are more binding than others – such as in Victoria, Australia, where a "Statement of Obligations" has been signed by the local utilities. If we see more examples like this, there could be a flurry of activity for technologies promising direct emission reduction, whether that's for nitrous oxide or methane. ■

For more information or to download GWI's Mapping water's carbon footprint *white paper, supported by Cambi and Xylem, visit www.globalwaterintel.com/water-without-carbon*

MARKET MAP

Monitoring, modelling and mitigating nitrous oxide emissions

The greenhouse gas emissions of the water sector are rocketing up the agenda, turning attention towards nitrous oxide. How can the technology market step up to tackle this potent problem?

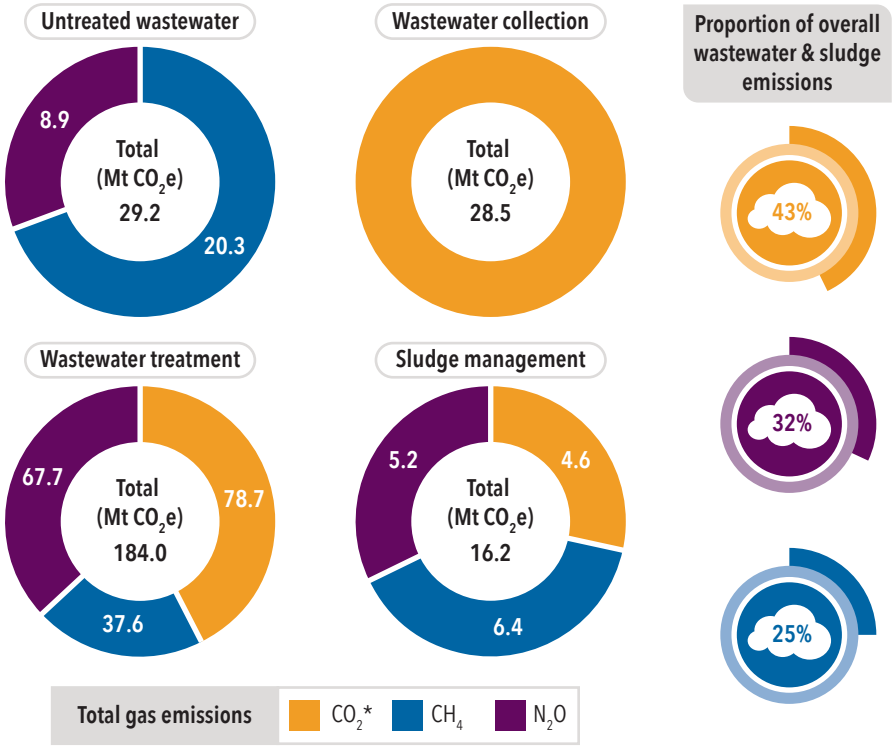
As many utilities aim to decarbonise, with some on a race to reach net zero, nitrous oxide (N_2O) direct emissions are fast becoming the elephant in the room. Although other greenhouse gases are emitted from water and wastewater treatment processes, such as methane and carbon dioxide, even a small volume of N_2O could have a significant global warming impact. While energy efficiency is now a mainstay of utility performance agendas, a number of treatment plants, mostly in richer regions, are looking to assess their climate impact through this potent greenhouse gas.

Effective monitoring to understand how much N_2O is emitted comprises the most imminent priority – finding out the where and why is crucial to implementing the correct optimisations for individual sites. Once the necessary baselines have been established, solutions ranging from the balancing of aeration requirements to the installation of membrane aerated biofilm reactors (MABRs) have shown promise for mitigating N_2O emissions, with scope for further innovation.

Emerging technologies in the space generally have other benefits and do not have N_2O emission mitigation as their only driver. However, the market for solutions including non-biological nitrogen removal (and subsequent recovery) is developing as the circular economy ethos takes hold.

BREAKING DOWN THE PROBLEM

GWI estimates that water infrastructure has a carbon footprint similar to that of the aviation industry. Direct emissions from wastewater and sludge are a significant contributor to this. Nitrous oxide comprises around one third of wastewater and sludge process emissions.



*The carbon dioxide emissions indicated are emitted from the energy used in treatment processes only. Direct CO_2 emissions are biogenic and do not lead to a net-positive carbon effect on the atmosphere, unlike fossil carbon sources.

Source: GWI

Monitoring & understanding nitrous oxide

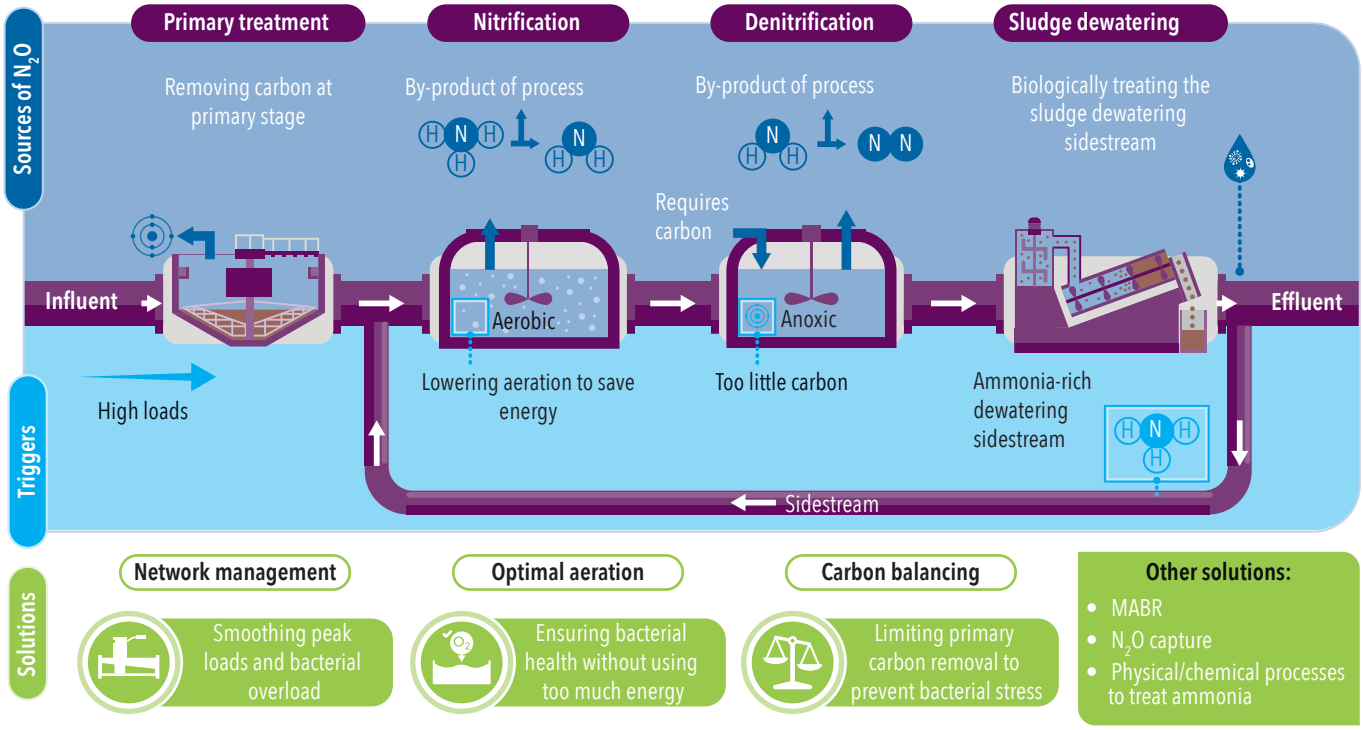
Of all the released greenhouse gases from water treatment processes which contribute to the sector's emissions footprint, N_2O is the most newly discovered and least understood. GWI's research model suggests that the gas represents 32% of sewered wastewater treatment emissions (*see chart, left*), and increasingly stringent nutrient removal regulations are likely to exacerbate the issue. The gas is frequently released when slight changes are observed in the conditions of biological treatment tanks – the key method in which utilities remove nutrients from their wastewater – with deviations from optimal oxygenation conditions and changes in temperature being two key causes (*see image, facing page*). As a greenhouse gas, N_2O is also 273 times as impactful as CO_2.

Although little has emerged in the way of regulations thus far to drive this market, Denmark has drafted proposals to begin taxing N_2O emissions in 2025, for plants with a population of at least 25,000 person equivalent. The country is the frontrunner here, with a number of Danish utilities working on monitoring and mitigating their emissions, including VCS Denmark and Aarhus Vand, which have both used enhanced process control in their biological treatment to mitigate N_2O. UK utilities are also beginning to show an interest in the problem. With growing pressure on utilities to set net zero targets across Europe and beyond, demand for methods of both quantifying and avoiding N_2O emissions is expected to soar in the coming years.

"In general there's more interest in Europe than in North America, but there are some clear signs that this will start shifting and balancing out," observed Jose Porro, founder and CEO of Cobalt Water Global, a company that provides machine ▶

THE PATHWAYS AND THE SOLUTIONS

A wide list of variables can cause the emission of nitrous oxide. Equally, there are a plethora of mitigation options available for a treatment plant, some of which involve the optimisation of existing processes and do not include large amounts of capital investment.



Source: GWI

> If we know at certain times there is a peak nitrogen load, and therefore peak N2O risk, we could optimise treatment with a dynamic network holding back some of the flow.
>
> Paul Lavender, Royal HaskoningDHV

learning solutions for nitrous oxide emissions. "Europe and Australia are further ahead in their net zero targets, so that's why there's naturally more interest there in nitrous oxide." As of yet, only two utilities across the US and Canada have set net zero targets, but it is likely that others will follow suit over the coming years.

Effective monitoring is critical to understanding the pathways of N_2O emissions, and as a result unlocking targeted treatment options. "In the past we have built treatment works with the primary intention of meeting consents, with a secondary consideration to operational cost and energy efficiency. However, the extra element of process emissions produces a more complex picture," explained Paul Lavender, director for water utilities at Royal HaskoningDHV. "More advanced control systems will come into play to be able to balance and compromise between those elements, as it is impractical to achieve this through manual decision making, no matter how skilled the operational staff may be," he continued. Monitoring of N_2O is still an emerging field – many claim measurements are expensive, and direct measurement of airborne emissions is generally difficult.

One approach followed by Royal HaskoningDHV is using nitrite as a proxy measurement for N_2O. The company's AI-based technology Twinn (formerly known as Aquasuite PURE) is hardware agnostic and its machine learning capabilities have been applied to advise operators on their N_2O levels, through direct and indirect measurement. "The disadvantage to direct monitoring is cost and complexity," explained Lavender. Furthermore, the company is also looking to involve the wider network in its digital solution. "If we know at certain times there is a peak nitrogen load, and therefore peak N_2O risk, we could optimise treatment with a dynamic network holding back some of the flow," continued Lavender.

Elsewhere, German company Variolytics received seed funding in December of 2022 to the tune of seven figures for its patented measurement technology and AI-based process to avoid greenhouse gas emissions in wastewater treatment. The technology monitors and adjusts the aeration system within the biological treatment in order to prevent N_2O releases. Meanwhile in October this year, the Belgian modelling specialist AM-Team announced a new partnership with engineering firm Binnies to leverage its expertise in com- ▶

TOP OPPORTUNITIES

Particularly climate conscious utilities may feel an increasing need to install methods to mitigate their N_2O emissions, however the key priority for most utilities is to accurately quantify the gas coming from their treatment plants.

Source: GWI

> "There remains a big gap in the market for real time monitoring of nitrous oxide and methane in the treatment process.
>
> Austin Alexander, Xylem

putational fluid dynamics to make N_2O mitigation recommendations (*see GWI October 2022, p40*).

There are others in the market also looking to offer modelling-based options. US-based Cobalt Water Global is currently working with around fifteen clients to leverage its AI and machine learning-based model for predicting N_2O emissions at treatment plants across key markets including Denmark, the Netherlands, the UK and Australia. Before monitoring N_2O each site can be assessed in terms of its N_2O emissions and opportunities to reduce N_2O drawing on a library of over 50 models to match the appropriate process conditions to identify the first sites for monitoring. Then, once initial physical monitoring has taken place, each site gets its own machine learning model for continued monitoring after the physical monitoring campaign. While there is still a space for traditional N_2O monitoring, the digital model offers advantages in terms of cost, time saved, ease of operation and the locations where we can monitor N_2O. "In our N_2ORisk decision support system platform, knowledge of the pathways and influencing factors is applied," explained Porro. "We use AI to mimic the reasoning process that an N_2O expert would follow in looking at that data and being able to say whether there was risk of emissions or not. Combined with machine learning, this gives us a robust solution for reducing and monitoring N_2O." Going forward, the company will seek to broaden its horizons to account for other types of emissions typical of water utility operations.

Renewed focus on direct monitoring

Although traction has been seen in the modelling market, direct measurement of N_2O is a more difficult task. "There remains a big gap in the market for real time monitoring of nitrous oxide and methane in the treatment process," outlined Austin Alexander, vice president sustainability and social impact at Xylem. Looking to address this need in an emerging market is monitoring specialist Unisense, which offers a robust sensor equipped to monitor N_2O emissions in real time at 200 wastewater treatment plants across the globe. By comparing the particular parameters of a treatment train with correlations in N_2O emissions, plant operators are better-equipped to make targeted optimisations. "Linking the process of the treatment plant to that nitrous oxide build-up is only possible if you measure in the liquid phase," explained Bastian Piltz, sales engineer at Unisense, commenting that off-gas measurements cannot detect denitrification-based N_2O.

With more utilities likely to set out their net zero targets over the next few years, the time is ripe for digital specialists to play a critical role in helping to understand emissions baselines. "There's still a lot to learn," commented Amanda Lake, head of carbon and circular economy at Jacobs. "It comes back to the need to be doing the data collection now, as well as in parallel implementing mitigation solutions today – using digital and modelling approaches to support this."

Existing technologies for N_2O reduction

While many utilities are just getting to grips with monitoring their N_2O emissions, attention over the next few years is expected to turn to technological solutions for the problem inside wastewater treatment plants (*see image, left*). For many plants, in the absence of robust regulation as a driver for CAPEX spending, manipulating the conditions within existing assets will be the first port-of-call. A number of operational processes that are undertaken to offer benefits such as energy saving and production, can actually make N_2O emissions worse. For example reducing aera- ▶

tion in the secondary treatment in order to minimise energy use (and therefore scope 2 emissions) can actually cause stress to the bacterial microbiome and lead to more direct N_2O emissions from the treatment tanks. Furthermore, attempting to divert carbon in the primary treatment for conversion to biogas can also cause bacterial stress, leading to the same effect.

A balancing act must be struck between all these processes so that treatment plants can reduce their N_2O emissions, without partaking in unsustainable practises elsewhere. "Xylem's treatment system optimisation tool helps to operate our local control treatment system and say, how can I really optimise not only energy, but other metrics that can have outputs on your nitrous oxide and methane production?" outlined Alexander. "That's where we'll start to see the biggest gains in the next five years because the technology exists and typically has OPEX savings for the utility operator, so it makes financial sense."

It is also important to note that the overloading of a treatment plant due to peak flow conditions can increase emissions. Therefore, methods of balancing the flow through the network (without leaving water to stagnate for too long and release methane instead), such as with Royal HaskoningDHV's Twinn, can help treatment plants without going forward with large-scale CAPEX builds.

However, there are a number of established technologies on the market that utilities may choose to install that offer the benefit of reducing N_2O emissions (*see image, right*). It is important to note that this is usually not the main driver for the installation of such technologies, which often have other benefits such as increased energy efficiency and intensification of secondary treatment processes. However, the impact of utility operations on the environment is likely to become more prominent over the coming years, and emissions reduction is set to become a stronger selling point.

One example of these technologies is Royal HaskoningDHV's Nereda, which can be manipulated using its integrated software in such a way that N_2O emissions are minimised through cycle optimisation. The conditions that minimise N_2O production include efficient denitrification periods, optimised co-current nitrification/denitrification and ceasing treatment as soon as the required effluent quality is achieved. The company is also capable of designing seasonal aeration regimes as the temperatures change – a key variable in the level of N_2O released in biological treatment systems.

Other established options on the market include MABRs, which improve the aeration conditions and reduce the chance of unfavourable oxygenation conditions forming. A study carried out across nine WWTPs in Denmark from 2018-20 indicated that N_2O emissions from treatment using MABRs were an order of magnitude lower than those from conventional activated sludge. Furthermore, Fluence claims its MABR is able to produce 50-60% fewer emissions than other standard wastewater treatment processes. "We're seeing full-scale projects go in with MABRs in part because they're expected to be lower emissions, and we see continued development around mainstream anaerobic processes and downstream nutrient separation that won't actually generate nitrous oxide," commented Lake.

Ammonia recovery

Although action surrounding N_2O is encouraging, it is exceedingly unlikely that direct emissions from wastewater can be fully eliminated. This is because there is no downward trend in biological treatment on a global scale, as nutrient removal requirements continue to proliferate worldwide due to eutrophication concerns. However, there could be opportunity for emerging physical/chemical nitrogen removal and subsequent recovery methods to gain a foothold in the future. These technologies do not release N_2O but instead transform the nitrogen into useful products. "If we recover it, we can avoid the nitrous oxide and then potentially we can do something with the nitrogen as well, which could have an impact on fossil-based fertilisers," explained Lake. UK-based engineering company Atkins also recently presented research at the European Biosolids & Bioresources Conference that stated 2-3% of the UK's total ammonia production could be offset using dewatering liquors from sludge.

Examples of emerging technologies in this space come from Swedish company EasyMining – which already has ▶

SELECTED MARKET PLAYERS

There are relatively few treatment technology companies offering bespoke solutions for the sole benefit of nitrous oxide reduction. However, this is not the case for monitoring companies, as a number of ways to measure the gas enter the market.

Company	Type	HQ country	Activity
AM-Team	Monitoring & modelling	Belgium	Partnering with Binnies to leverage its N2O model into mitigation strategies
Suez	Monitoring & modelling	France	Set to measure N2O and methane at three Southern Water WWTPs in the UK
Unisense	Monitoring & modelling	Denmark	Specialising in robust N2O sensors for wastewater
Variolytics	Monitoring & modelling	Germany	Announced a seven-figure seed funding round in December 2022
Cobalt Water Global	Monitoring & modelling, Mitigation	USA	Leveraging AI and machine learning for N2O modelling
Royal HaskoningDHV	Monitoring & modelling, Mitigation	Netherlands	Mitigating N2O via Nereda and Twinn digital monitoring
EasyMining	Mitigation	Sweden	Developing an ammonia recovery technology that does not produce N2O
Fluence	Mitigation	USA	Promoting the N2O-mitigating benefits of its MABR
Nijhuis Saur Industries/Byosis	Mitigation	Netherlands	Acquired Byosis Group in 2022 to enhance ammonia recovery capabilities
Organics Group	Mitigation	UK	Piloting its ammonia stripping technology with two UK water utilities
OxyMem (DuPont)	Mitigation	Ireland	Worked with VCS Denmark to evaluate the use of MABR to mitigate N2O
Veolia Water Technologies & Solutions	Mitigation	USA	Offering the Zeelung MABR formerly part of the portfolio of Suez WTS
Xylem	Mitigation	USA	Working with clients to improve monitoring and enable process optimisations

Monitoring & modelling Mitigation

Source: GWI

activities in the recovery of other nutrients from waste. The company is developing Aqua2N, a technology that uses an adsorption chemical to recover nitrogen fertilisers from wastewater. EasyMining is currently working on an EU-funded project to scale up this technology from lab pilot scale to industrial pilot scale, with the most recent site being at Denmark's largest wastewater treatment plant in Copenhagen.

Other technologies in the ammonia recovery space include stripping. These technologies manipulate the temperature of the influent, sometimes along with the pH, to force ammonia out into a counter-flowing gas stream. The useful nitrogen product can also then be precipitated out if desired. A key player in the area is Byosis, purchased in 2022 by Nijhuis Saur. Organics Group, a provider of thermal stripping, is installing two pilot projects with Northumbrian Water and Severn Trent in the UK. A key focus for these pilots is to prove a viable ammonium end-product, with some early testing of how green hydrogen can also be produced using cracking.

However, both mentioned providers see the drive towards net zero to be a key driving force in the future development of their technologies. Both are claiming that their systems are a low-energy option, contributing to the reduction of scope 2 emissions – something utilities are laser-focused on. "You wouldn't really install our product just to capture the end-product, it's multi-faceted, and the nitrous oxide is also only just one aspect of it," outlined Organics Group development director Keith Richardson.

Finally, Royal HaskoningDHV is involved in a project alongside the Foundation for Applied Water Management Research (STOWA) in the Netherlands, and a consortium of participants, called the Water Factory. This project looks to harness all carbon and nutrients in wastewater using a sequence of physical-chemical processes to provide "zero oxidation" treatment. Within this treatment train, particulate nitrogen would be removed by fine sieving and coagulation/flotation, whilst soluble ammonia is removed by ion exchange. Ensuring that no biological (or chemical) oxidation is employed means that all carbon can be potentially utilised or sequestered and no N_2O can be produced.

> "We've got the ambition, but we don't have the regulatory framework that's requiring enough action on nitrous oxide or wider greenhouse gas emissions across our assets and the urban water cycle.
>
> Amanda Lake, Jacobs

Terminology

Aeration: The addition of air or oxygen to water or wastewater, usually by mechanical means, to increase dissolved oxygen levels and maintain aerobic conditions.

Ammonia recovery: Removing the nitrogen from wastewaters without oxidising it into a gas, and recovering it often in the form of a fertiliser for beneficial reuse.

Biological treatment: Also referred to as the secondary treatment system, the biological treatment step uses bacteria to remove key contaminants from wastewater, such as nutrients and carbon. It can be a key source of nitrous oxide emissions due to some of the bacterial metabolic pathways.

Membrane aerated biofilm reactors (MABR): Uses an attached growth biofilm system which allows for aeration through a gas permeable membrane rather than blowers. Increases the energy efficiency of the aeration system and improves the overall oxygenation of the biomass.

Nitrification/denitrification: A key process within some biological treatment systems that can cause N_2O emissions if the bacterial conditions are upset.

Nitrous oxide (N_2O): A potent greenhouse gas that also causes damage to the ozone layer. It is separate to the term "nitrogen oxides" which refers to the two gases nitric oxide (NO) and nitrogen dioxide (NO_2).

Scope 1 emissions: Direct greenhouse gas emissions from water and wastewater treatment processes, such as methane that is directly released from the sludge mass and nitrous oxide emissions from wastewater treatment processes.

Scope 2 emissions: Indirect greenhouse gas emissions that are released from the generation of energy purchased for on-site processes, such as the electricity required for aeration of the biological treatment step.

Future directions

Given the anticipated uptick in demand for N_2O removal, there is significant scope for innovation to develop different methods of tackling the gas in wastewater treatment. One possibility is to provide targeted treatment for the off-gas from MABRs. "If you have a very contained volume of gas with most of the nitrous oxide, maybe you can treat it, but I don't think there's any technologies that are there to do that," commented Piltz.

To date, it has been proactive utilities in countries such as Denmark which have propelled research into N_2O emissions pathways and the evaluation of different technology options. "Just getting utility commitments on the table is a really important milestone that triggers a lot of innovation and movement down the line," highlighted Alexander. Many stakeholders agree that while the growing conversation around N_2O emissions is an encouraging sign, stronger drivers are needed to ensure this nascent market continues to command attention.

Europe is expected to be a core market, with N_2O studies already carried out in Denmark, the Netherlands and Sweden, yet the recently-revised EU Urban Wastewater Treatment Directive made little mention of the gas and instead focused on methane reduction recommendations. "There's some criticism because nitrous oxide isn't being explicitly called out in that, [although] methane is," observed Lake. "We've got the ambition, but we don't have the regulatory framework that's requiring enough action on nitrous oxide or wider greenhouse gas emissions across our assets and the urban water cycle." While the regulatory landscape catches up with the water sector's growing net zero ambitions, strategic technology providers are already unlocking valuable insights to drive process optimisation and curtail the climate impact of N_2O. ■

SMART WATER WATCH

New players and partnerships unlock growth in the digital plant design market

While market leader Transcend focuses its efforts on partnerships with technology providers, new entrant Kurita and Fracta Leap is targeting the semiconductor industry. GWI explores these diverse approaches to promoting generative design.

Momentum is building in the generative design market as Transcend pushes ahead with an ambitious product roadmap, while Kurita and its subsidiary Fracta Leap are seeking to transform water treatment design in the untapped semiconductor sector. Pushed more than ever to plan for uncertain climate impacts and maximise investment budgets, asset owners are demanding new ways of reaching optimal design proposals, which has created growth opportunities for those that can cater for an increasing digital appetite.

Generative design software offers clients the ability to automatically create multiple capital improvement scenarios, enabling project planners to meet a range of operational restraints while identifying optimal water and wastewater treatment plans. This approach offers significant productivity gains for asset owners, freeing up time – and capital – for later stages of the design process.

Transcend is the poster child of this market and has tripled in size since GWI last covered its progress in 2021 (*see GWI February 2021, p45*). Its solution is mainly used for improvements on existing sites and is applied to the first 30% of the design process. A recent partnership with Autodesk will now better enable the firm's models to be leveraged further down the line. "Frequently, people do early designs, set their budgets, and then somebody new comes in and starts over again. Working with Autodesk allows us to move further up that design curve," explained Ari Raivetz, CEO of Transcend. One potential growth avenue for the partnership includes the generation of baselines for digital twins, with design models now able to move into operational phases following the completion of capital improvement plans.

A distinguishing feature of Transcend's strategy is its move to integrate new technologies into its designs, exemplified by recent partnerships with NX Filtration, Royal HaskoningDHV and Xylem. "This is an opportunity for innovative technology to be incorporated into the platform, enabling utilities and engineering firms to evaluate multiple options before they set a budget and build," Raivetz commented. Transcend's CEO contested the idea that partnering with specific companies risked making the firm a gatekeeper for scaling emerging technologies. "We're a software company, so we're not actually recommending technologies." Raivetz did, however, concede that some level of vetting would be required before technologies could stake their claim in Transcend's design software.

Meanwhile, high-profile market entrant Kurita is looking to capitalise on the mounting appeal of early-stage design automation via its subsidiary Fracta Leap, specifically focussing on bringing the value proposition to new markets. Kurita, who onboarded Fracta's proven AI skills in 2018 with majority investment in the company, announced the release of a beta version of its plant design solution last month. "This solution focuses on up-stream design, where we cover the water processing equipment composition, layout, and construction plan," noted Shinya Murai, chief product officer of Fracta Leap.

The solution for layout optimisation is powered by a series of unique algorithms, which focus on aspects such as minimising pipe length and achieving optimal equipment orientation for operations and maintenance. "We will also offer a design tool for the water processing phase, which automatically offers several equipment composition plans by inputting operational requirements," Murai said. This could be the volume and quality of raw and permeated water required, along with power consumption, initial and operating costs, as well as carbon dioxide emissions.

While some might see Kurita and Fracta's market entry as a challenge to Transcend's dominance, the firm will initially compete on a separate plane, targeting growing opportunities for its specialised tools in the semiconductor market. "In Japan, there are quite a number of facilities that are planning to be built, so that is our first focus," explained Yuushi Maeda, general manager of the engineering division of Kurita. From here, Kurita will pursue opportunities in East Asia and the US, spurred on by global demand for microchip manufacturing sites. The firm's strong footprint in system integration and technology sales will aid market access, though Maeda did not rule out shifting focus to other utility and industrial sectors in the future.

Kurita's entry is a sign of the growing levels of demand and untapped opportunity at the heart of the automated design market, which continues to capture the attention of a broad array of end-users. Transcend's customer base now spans technology specialists, asset owners and consultants, with a roughly equal split between the three end-user groups. This broad addressable market suggests Kurita's entry will not represent a direct assault on Transcend's market share, and will instead look to attract new end-users to the space with a highly specialised set of design tools. Ultimately, the early-stage market holds room for both innovators to grow, with few able to deny the quantifiable productivity gains offered by early-stage automation. ■

OPTIONS ON THE TABLE

Transcend and Kurita will look to make simulating design scenarios a key pillar of capital planning, enabling clients to meet complex process requirements while maximising investment value.

Source: Shutterstock

CTO OUTLOOK

Driving innovation for a greener future

Tackling tricky contaminants is a speciality of Envirogen Group, which applies innovative solutions across myriad industries and applications. CEO Joe Higgins shares his outlook on the water opportunities within green hydrogen and local circular economies.

JOE HIGGINS

Chief Executive Officer, Envirogen Group

Joe Higgins has a Technical MBA, a Master of Engineering, a degree in civil engineering and a degree in Environmental Science and Technology. He is a Chartered Engineer and Scientist and a fellow of the Institute of Engineers. His 25-year career in water in the UK, Europe, and North America has culminated in his current role as Group CEO for Envirogen. Throughout his career, he has concurrently held positions of responsibility for engineering and technical development as well as profit & loss.

What are the main drivers of your water technology strategy?

Developing sustainable solutions that are customer-centric is the key driver of our technology strategy. We are "technology agnostic". When developing an offer our objective is to provide the optimum solution with the lowest overall costs, including installed capital and operating, over the project's life. Whole-life costs are often forgotten when considering a solution, but these can be a substantial part of the overall project costs.

What are the key technology areas you are looking at in your R&D and why?

For our flagship fluidised bed reactor (FBR) technology, we are continuously enhancing the performance of our water remediation systems to reach sub ppb levels of nitrate, perchlorate, selenium, hexavalent chromium and 1,4-dioxane. Over the past two decades, Envirogen's FBR has successfully treated water and wastewater streams containing contamination from rocket fuel, solvents and toxic metals.

In addition, we are currently piloting various technologies with our customers for emerging contaminants such as trinitrotoluene (TNT), 2,4-dinitroanisole (DNAN), hydrazine, 1,2,3-TCP, arsenic, and nickel. In parallel, we are enhancing our rare earth metal recovery process to provide a more economical solution for markets such as acid mine drainage.

On the potable and industrial water production side, we are enhancing our technologies for nitrate and hexavalent chromium and further developing our solutions in aquaculture and recycling/reuse.

Where do you look outside of Envirogen Group for innovation?

We regularly partner with universities, government agencies and other technology companies. For example, we are working with the US government (Department of Defense) to further the development of our FBR technology to treat recalcitrant contaminants. I'm particularly interested in combining our technologies with complementary ones to enhance the efficiency and capability of our technology to optimise our solutions for our customers.

What gaps do you see in the Envirogen Group water technology portfolio that could be strengthened?

Our strength is in delivering bespoke and innovative solutions to our customers, particularly in treating emerging contaminants, reuse, odour control and industrial water. As a company, we are cognisant that we must sometimes integrate complementary technologies to provide an optimum solution for our customers. In that regard, we have developed strong partnerships to allow us to offer turn-key solutions. Notwithstanding this, a fundamental tenet of our offering is that we take full responsibility for our solutions through long-term operations and service contracts.

For example, we built and operate the Nevada Environmental Response Trust (NERT) facility in Henderson, Nevada, the world's largest oxyanion treatment facility. This treatment system utilises Envirogen's FBR technology to significantly reduce these oxyanion contaminants from groundwater, eventually discharging this treated water to the Las Vegas Wash, Lake Mead, and the Colorado River. In performing this treatment, we protect significant downstream potable water receptors.

Which of the industrial markets that Envirogen Group is active in have the greatest need for water & wastewater treatment innovations and why?

We are very active in the food & beverage market, where we see the integration of water reuse and recycling needing more acceptance by our customers.

In the mining, military, chemical and power markets, we see a requirement to reach sub-ppb levels for both traditional and emerging contaminants. Our approach is to provide proof of concept by piloting, which allows us to offer performance guarantees. In terms of piloting, the focus is predominantly on treatability. Often, the optimisation step is not a customer focus, where we see huge potential for reducing whole-life costs.

The use of biological treatment for drinking water, and in our case using the FBR, is an area that requires further industry acceptance. This is particularly relevant in the current economic climate where ▶

biological treatment can significantly reduce OPEX or where waste disposal is limited or not a preferred option. Nanofiltration is also becoming more commonplace, particularly in drinking water treatment.

What developments do you see in the water reuse technology market?

For us, the key enabler of reuse is applying hollow fibre nanofiltration in conjunction with appropriate pretreatment. We have successfully implemented several hollow fibre nanofiltration projects, all of which have beneficial return on investment for our customers and contribute to reducing their water footprint.

What changes are you seeing in the water disinfection market?

From our perspective, a key driver for the disinfection process is to limit the use of chemicals. For example, we often use UV in conjunction with hydrogen peroxide. The UV operating at a wavelength of 254 nm can damage the DNA of bacteria and most waterborne microorganisms, preventing their reproduction. Meanwhile, hydrogen peroxide offers the significant advantage of only degrading into water and oxygen; it oxidises organic matter and does not generate by-products as chlorine or bromine do. Using UV and hydrogen peroxide together provides a very efficient and safe disinfection method without any by-products. For applications that call for chemical addition, we prefer chlorine dioxide due to its sterilising capacity and ability to generate it on-site, which negates the requirement to transport chemicals.

How do you see the water technology market responding to growing concerns regarding emerging contaminants?

Our approach to new contaminants has been their degradation and removal using a combination of physical, chemical, and biological treatment techniques. As every situation is different and experimental data is insufficient to provide precise predictions for the mechanistic degradation and removal fate of emerging contaminants, we tend to pilot for proof of concept.

I believe the market will move more towards using advanced oxidation processes (AOP), biological treatment technologies and nanofiltration. Combining technologies is particularly appropriate for recalcitrant emerging contaminants, where one technology (e.g. AOP) produces partial degradation while a second technology (e.g. FBR) completes the degradation and a third technology (e.g. nanofiltration) removes any residuals. Where applicable, we prefer biological treatment, applying our FBR, as it generally provides the most sustainable and cost-effective treatment solution.

What are your activities in hydrogen production and what changes do you see for the future of this water-related market?

I believe with the deployment of CO_2 policy and hydrogen incentives, demand for hydrogen will rise, and its use will gain traction. As evaporatively-cooled coal power plants become obsolete, the large amount of water they consume will be reallocated. Freeing up that water supply will permit new electrolytic hydrogen production in renewable energy-rich areas, which are currently considered water-constrained. In my opinion, using hydrogen as a renewable energy source will lead to water savings, not expenditures, in the long term. Improvements are needed in the energy efficiency of electrolysers, which is currently the limiting factor.

In our experience, the cost and complexity of producing demineralised water highly depend on source water quality. This is essential, as water infrastructure can be up to 10% of hydrogen projects' installed cost. Many regions may turn to large-scale wastewater reuse to support water demand.

Much of the water consumed in electrolysis can be recovered if hydrogen is used in processes that permit steam recovery. We are working with customers to reuse the by-product water from the industrial use of hydrogen. Hydrogen production yields large quantities of oxygen. For each megawatt of electrolyser power, approximately 3.9 tons per day of oxygen is released. This poses an enormous opportunity for developing innovative oxygen-dependent applications, including wastewater treatment and aquaculture.

What do you think will be the game-changing technologies in the water sector in the next ten years? What is ripe for disruption?

There is scope for further innovation in membrane filtration systems, AOP, biological remediation, hybrid natural and advanced treatment systems, microbial fuel cells, and electrochemical and nanotechnology. However, business-as-usual approaches and traditional technological choices for water management will not be able to address the many future challenges sufficiently. The way we think about water is ripe for disruption. I believe there will be a move towards semi-centralised approaches to locally extract maximum benefit (e.g. nutrients, energy and water) from each specific water resource using a range of technologies, giving the potential for a green local economy.

Disruptive innovation may come in the form of making benefits from today's larger-scale innovative technologies viable at a smaller scale. This would permit local application and allow water to be harvested for resources and reused multiple times locally through cascading water-use approaches depending on water quality requirements.

Also, the nexus between water production and energy utilisation needs to continue towards increasing efficiency. This has improved over the years with RO systems having more efficient pre-treatment and utilising two- and three-stage pass systems. Still, more R&D is required to reduce the energy footprint of the transport and treatment of water. I see the updates in electrodialysis technology as one of these potential game-changers. ■

THE RECIPE FOR SUCCESS

Envirogen Group's enhanced water treatment solutions are boosting the manufacturing capabilities of end-users such as the soft drinks manufacturer Britvic.

Source: Envirogen Group

PATENT TRACKER

Closing the loop with circular solutions

The circular economy is high on the agenda for innovators this month, with patent applications spotlighting thermochemical sludge treatment and ammonia recovery. A solution claiming to offer less energy-intensive zero liquid discharge is also on the cards.

THERMAL SLUDGE

Continuing with the circular economy theme observed across CTO this month, a patent application has emerged from Swedish company C-Green for an innovative take on a thermochemical sludge treatment process. The technology heats the sludge to around 200°C in a hydrothermal carbonisation process (HTC) in which the organics in the sludge are partially carbonised and removed in a slurry phase. The slurry is then dewatered on a filter press into a solid hydrochar. The water separated in the process contains dissolved organics, and is treated using oxygen in a wet oxidation (WO) reaction – an exothermal process that produces heat. That extra heat is used to power the whole system. The combination of HTC and WO is apparently what sets C-Green's technology apart from other systems.

Sterilisation of the sludge is also achieved, which the company claims is a key selling point for the future when the presence of antimicrobial resistant bacteria in sludge streams comes into the spotlight. The waste heat can also be utilised to speed up the kinetics of the sidestream treatment in the wastewater treatment plant. The technology can be used ahead of an incinerator to reduce the volume of feedstock and reduce the CAPEX and OPEX required for incineration. This is a particularly helpful trait as more municipalities resort to incineration in the future, due to dwindling sludge disposal routes.

C-Green sees potential for its technology in both industrial and municipal sludges, in the US, Asia, Latin America and Western Europe, and also claims the system is well suited to medium-sized plants, where choosing incineration instead would not be a commercially viable option. The thermochemical treatment market has grown significantly over the last few years as the desire for higher quality end-products is increased, as well as concerns surrounding pollutants in sludge going to land. It should be noted, however, that only technologies using extremely high heat can generally destroy micropollutants, and C-Green's technology is not targeted towards this application specifically.

CLOSING THE LOOP

The value-from-waste theme is further highlighted this month by an ammonia recovery patent from Organo Corporation, a specialist in industrial water treatment. Although existing methods of recovery usually focus on stripping or precipitation, the Japanese company appears to be drawing on its membrane-based knowledge by proposing a distillation process.

The company does not state whether the best applications for its technology would be municipal or industrial wastewaters, and it is yet to be seen how the economics of this process would stack up. It is, however, likely that a tipping point will be reached for many technologies offered within the ammonia recovery space as nutrient discharge consents are squeezed, and recycling sludge dewatering liquors to the front of the plant makes less sense. Recovering ammonia as opposed to destroying it can help utilities meet these consents, and reduce energy costs and greenhouse gas emissions.

Another, more environmentally friendly approach to wastewater treatment, when compared to traditional and established methods, is the use of microalgae to treat key contaminants – namely nutrients, but other contaminants have been explored. Such organisms can significantly reduce the level of aeration required, as their main source of energy is from sunlight. Kyungpook National University in South Korea has been working with algae, more specifically species from the *Chlorella* and *Desmodesmoses* genera, to treat contaminated waters.

Interestingly, the university is working on both sewage and reverse osmosis concentrates containing high nutrient salts, ions and metallic elements – the latter of which is a less well-explored application. The patent also mentions the production of biofuel in the form of fatty acid methyl esters whilst treating contaminated waters. There are a number of commercial companies attempting to scale up their offerings in this market – for example, Clearas Water Recovery is in the midst of installing a number of reactors in the US. UK-based company Industrial Phycology also has a number of plants completed or under construction with utilities in its domestic market.

ZERO LIQUID DISCHARGE

Elsewhere in the market this month, Magna Imperio Systems is building on its work in electrodialysis and desalination. The company has filed a patent for a direct solvent contact crystallisation technology for zero liquid discharge (ZLD) applications. Achieving ZLD requires high energy consumption, particularly as traditional techniques have used sequen- ▶

tial processes along a concentration gradient – becoming increasingly energy intensive as the salt content increases. The emerging market of solvent contact crystallisation, which overcomes some of the energy consumption issues experienced by more traditional techniques, is undergoing continuous improvement from technology providers, Magna Imperio included.

Its patent application details that the water is first bound to a solvent solution, then the solvent is removed by using a recovery agent. The key benefit to the company's technology, it claims, is that it can replace the latter, more energy intensive portion of the ZLD treatment train, which treats concentrated brines to solid salt and freshwater. ■

SELECTED PUBLISHED PATENT APPLICATIONS OVER THE LAST MONTH

Oxidation processes are sparking interest among patent applications this month, with Obayashi Corporation targeting 1,4-dioxane treatment and Evoqua investigating the use of onsite biocide generation for advanced oxidation. Elsewhere, Veolia is seeking to regenerate activated carbon by using microwaves.

Patent title	Description	Organisation	Patent office	Application number
Use Of Polymers Of Acrylic Acid For Scale Inhibition In Desalination Systems	Acrylic acid polymer for scale inhibition	BASF SE	WIPO	PCT/EP2022/063836
Silica Reducer Compositions And Methods For Treatment Of Produced Water From Thermal In Situ Bitumen Or Heavy Hydrocarbon Recovery Operations	Silica reducer composition for hydrocarbon recovery from produced water	Baymag Inc	USPTO	17/706,857
System And Process For Quaternary Ammonium Hydroxide Treatment Or Recovery	Electrodialysis unit for tetramethylammonium hydroxide removal from wastewater	BL Technologies Inc	WIPO	PCT/US2022/029418
Methods And Systems For Sludge Treatment	Incorporating wet oxidation and hydrothermal carbonisation steps to treat sludge	C-Green Technology AB	WIPO	PCT/SE2022/050468
A System For Extracting Hydrobromic Acid From Bromine-Containing Wastewater And A Method For Treating The Same	System and method of removing bromide ions from industrial wastewater	Dalian Bomei Technology Co Ltd	CNIPA	202211194348
Regulation Of Onsite Peroxide Generation For Improved Peroxone Advanced Oxidative Process Control	Controlled advanced oxidation using an electrochemical cell which produces peroxide to treat ozonated water	Evoqua Water Technologies LLC	WIPO	PCT/US2022/030258
Bidirectional Water Treatment Equipment Of Integrated Type Using Ceramic Membrane And Uv Ozone Circulation Type Reaction, And Water Treatment Method For The Same	Combined filtration and UV-ozone disinfection unit	Korea Institute of Civil Engineering and Building Technology	KIPO	10-2021-0061823
Composition For Treating Contaminated Water Containing Microalgae As An Active Ingredient And Its Use	Microalgae composition for water treatment	Kyungpook National University	KIPO	10-2022-0038070
Direct Solvent Contact Crystallization Zero-Liquid Discharge Desalination With Volatile Hydrophobic Recovery Agent Regeneration	Zero-liquid discharge desalination using solvent crystallisation	Magna Imperio Systems Corp	USPTO	17/824,116
A Method For Treating Contaminated Water	Oxidising 1,4-dioxane contaminant using sodium persulfate	Obayashi Corporation	JPO	P2022-69074
Water Treatment Method And Water Treatment Apparatus	Apparatus and method for recovering ammonia and other resources from water using thermal distillation and RO membrane filtration	Organo Corporation	CNIPA	202210548016
Water treatment method and apparatus	Recirculating water during chemical treatment to avoid membrane fouling caused by inorganic coagulants	Swing Corporation	JPO	P2021-81035
Apparatus And Method For Continuous Separation Of Solid Particles From Solid-Liquid Slurries	Brine concentration and water purification by cooling	University of Oklahoma	USPTO	17/750,113
Process for the treatment of water by adsorption on activated carbon in micro-grains integrating regeneration by microwaves of the activated carbon	Activated carbon use in water purification and its regeneration using microwaves	Veolia Water Solutions and Tech Support	INPI	21 05492

Source: CNIPA; INPI; JPO; KIPO; USPTO; WIPO

MEKOROT
Israel National Water Co.

Mekorot congratulates Onee on our new collaboration!

Together we will find new solutions for all end users within the water sector.

PROJECT TRACKER

Double dose of desal for the Golden State; Saudi Arabia goes all-in at Jubail; Corsan privatisation suspended; Latin America eyes EPC opportunities; all the latest project news from around the world.

DESAL'S GOLDEN HOUR

● The approval of two seawater desalination plants in quick succession in California this month gave a glimmer of hope for the Golden State's future water security mix – just as winter storms helped to increased the Sierra snowpack to more than double the average for this time of year. The projects at Dana Point and Monterey are still embroiled in the permitting process, however, although procurement activity is expected to kick off soon.

● Saudi Arabia's procurement body SWPC, meanwhile, has combined the planned Jubail 4 and Jubail 6 independent water projects into a single 600,000m³/d plant, and this month invited expressions of interest from prospective developers in the combined initiative.

● Meanwhile, a decision from the South Australian government is expected by Q2 next year on whether to move ahead with a new seawater desalination plant with a capacity of up to 260,000m³/d at Whyalla. If it moves ahead, it would represent the country's largest desal plant to be built in more than a decade.

BRAZIL (NOT) FOR SALE

● As GWI went to press, the privatisation process for Corsan, the state-owned water utility in the Brazilian state of Rio Grande do Sul, had just been suspended. Ironically, the timing could hardly have been better for the selling shareholder (shares in Sabesp, the publicly listed water utility serving the State of São Paulo, are hovering near all-time highs). With president-elect Lula's election rhetoric downplaying privatisation, however, it remains to be seen how much power the state governors will retain if deals such as this are to move ahead.

LATAM VISIBILITY

● We are ramping up our coverage of Latin American water and wastewater projects in response to a significant uptick in interest from international companies that want to do business in the region. While Latin America has been notoriously slow to crank out water and wastewater PPPs over the past decade, there are some chunky EPC contracts on offer which could offer a way in for players keen to position themselves in stable markets with significant infrastructure needs.

● Bids for a 116,640m³/d wastewater treatment DBO in Panama are due in early January, while opportunities in Ecuador, Paraguay, and El Salvador are also moving forward.

● For all the latest updates from around the world, visit our website's Project Tracker: http://tinyurl.com/gwi-tracker. ■

WHAT'S HOT THIS MONTH?

Ten water and wastewater projects to watch in GWI's project tracker this month.

No.	Name	Description	Update
1	Jubail 4 IWP	600,000m³/d seawater desal plant	This project has been combined with the Jubail 6 IWP, and expressions of interest in the combined 600,000m³/d plant are due in on 9th January 2023.
2	Mlathuze SWRO	New SWRO plant	Mlathuze Water has issued a request for proposals from consultants to carry out pre-feasibility studies for a seawater desalination plant. The submissions deadline has been set at 30 January 2023.
3	Doheny Desalination Project, CA	56,775m³/d SWRO plant	On 9th December 2022, the California State Lands Commission unanimously approved the project's General Land Lease. The progressive DBO contract could be awarded by the end of 2023.
4	Corsan privatisation	Utility privatisation	On 9th December 2022, the Tribunal de Justiça do Estado do Rio Grande do Sul suspended the privatisation process.
5	Karachi water supply project	454,600m³/d water transfer project	Bids from pre-qualified contractors are now due in by 12 January 2023, after the submissions deadline was pushed back.
6	Ahmedabad STP (New Pirana)	420,000m³/d sewage treatment plant	The project is currently in the planning stages, and a tender for the construction of the works is likely to be released during 2023.
7	Arraiján/La Chorrera, Panamá Oeste	116,640m³/d WWTP	Bids are now due in by 5th January 2023, after the submissions deadline was pushed back once again.
8	Lake Ypacaraí WWTP	New 500,000 PE WWTP	Funding still needs to be secured for the project,, although greater visibility is expected following the outcome of the Paraguayan general election in April 2023.
9	Pure Water Monterey expansion, CA	Expansion of advanced water treatment plant	Construction bid packages are likely to be launched soon for the AWPF expansion.
10	Walnut Creek WWTP expansion, TX	94,625m³/d plant expansion	27 firms are understood to have been represented at the contractor open house and plant tour held on 2nd December 2022.

THE GWI PROJECT TRACKER – DECEMBER 2022

All the project updates generated in the last month in the key markets tracked by Global Water Intelligence.

B Build O Operate F Finance

DESALINATION PROJECTS

Type	Country	Project name	Description	Status
B	Algeria	Béjaïa SWRO	New 300,000m³/d SWRO plant	Contract awarded
B	Algeria	El Tarf	300,000m³/d SWRO	Contract awarded
B	Australia	Belmont desalination plant	Seawater desalination plant	Technical advisor appointed
B	Australia	Whyalla desalination plant	260,000m³/d desalination plant	Conceptual stage
B	Cape Verde	Santiago Island SWROs	40,000m³/d of SWRO capacity across two sites	Bids due in January 2023
B O	India	Ennore offshore desalination plant	Offshore desalination plant	Consultancy bids due in December 2022
B	India	Hetero SEZ desal plant	15,000m³/d industrial desal plant	Siting issues brought into question
B O	India	Kamarajar Port (Ennore) desal plant	1,000m³/d SWRO plant	Five bids under evaluation
B O	India	Tuticorin thermal desal	2 x 1,000m³/d thermal desal plants	Single bid under evaluation
B O F	Philippines	Cebu desalination projects	Multiple desalination plants	One unsolicited offer submitted
B O F	Saudi Arabia	Jubail 4 IWP	600,000m³/d seawater desal plant	EoIs due in January 2023
B O F	Saudi Arabia	Jubail 6 IWP	300,000m³/d desalination plant	Subsumed into larger project
B O F	Saudi Arabia	Rabigh 4 IWP	600,000m³/d SWRO	Low bidder identified
B O F	Saudi Arabia	Ras Mohaisen IWP	300,000m³/d desalination plant	RFP issued
B	South Africa	Mlathuze SWRO	New SWRO plant	Consultancy bids due in January 2023
O	Spain	Abona desal O&M, Tenerife	O&M of desalination plant	Contract awarded
O	Spain	Mutxamel (Marina Baja) SWRO O&M	O&M of 50,000m³/d SWRO plant	Bids due in January 2023
B O F	UAE	Hassyan SWRO, Dubai	545,520m³/d SWRO desalination plant	29 EoIs submitted
B O	United States	Doheny Desalination Project, CA	56,775m³/d SWRO plant	Key permits approved
B O	United States	Kalaeloa Seawater Desalination Project, HI	New 6,435m³/d SWRO plant	Funding sought
B	United States	Monterey Peninsula Water Supply Project, CA	24,224m³/d SWRO plant	Permit approved
B	United States	Santa Cruz desal/reuse, CA	Long-term water supply augmentation	Long-term conceptual plan
B	United States	WRD saline plume remediation, CA	Up to 67,589m³/d of desalination capacity	Monitoring well bids due in January 2023

UTILITY PROJECTS

O F	Brazil	Corsan privatisation	Utility privatisation	Bidding process suspended
B O F	Brazil	Eunápolis concession	Water and wastewater concession	Bidding process suspended
B O F	Brazil	Porto Alegre concession	Water and wastewater concession	Tender possible in Q2 2023
O	Greece	Athens bulk water O&M	Bulk water O&M	Tender cancelled
B O	India	Ahmedabad peri-urban livability project	Water and wastewater infrastructure build-out	Visalpur bids due in December 2022
B O	India	Shimla 24x7 water supply	24x7 pressurised water supply	Re-tender awaited
O	Spain	Campo de Cartagena O&M, Murcia	O&M of pumping stations	Bids due in December 2022
O	Spain	Granada water & sewerage network O&M	O&M of water and sewerage network	Bids due in December 2022
O	Spain	Mairaga/Zona Media network O&M, Navarra	O&M of water and sewerage network	Bids due in December 2022
O	Spain	Pájara, Fuerteventura desal/WWTP O&M	O&M of desal plant and WWTP	Bids due in January 2023

Type	Country	Project name	Description	Status
O	United States	Benton Harbor O&M (2022), MI	Potential long-term O&M of water system	Conceptual stage
O	United States	Bridgeport O&M renewal, CT	O&M of wastewater assets	SoQs under evaluation
O	United States	Florida State Fire College O&M, FL	O&M of water and wastewater infrastructure	Single bid under evaluation
O	United States	Greenville County Schools O&M SC	O&M of wastewater assets	Bids due in December 2022
O	United States	Hagerstown pelletiser O&M, MD	O&M of pelletiser facility	Bids due in January 2023
O	United States	Jenks O&M, OK	O&M of wastewater assets	Preferred bidder identified
O	United States	Joint Base Cape Cod groundwater O&M, MA	O&M of groundwater treatment facilities	Conceptual stage
O	United States	King George County O&M, VA	O&M of wastewater treatment plants	Preferred bidder selected
O	United States	Lauderhill O&M renewal (2022), FL	O&M of water treatment plant	Contract awarded
O F	United States	Montebello system sale, CA	Sale of water system	CPUC approval granted
O	United States	Passaic wastewater O&M, NJ	O&M of wastewater assets	Contract awarded
O	United States	Quitman O&M, GA	O&M of water, wastewater, public works and natural gas	Award decision imminent

WATER TREATMENT PLANTS				
B O F	Pakistan	Karachi water supply project	454,600m³/d water transfer project	Bids due in January 2023
B O F	El Salvador	San Salvador WTP	New potable water treatment plant	Tender possible in 2023
B O F	Greece	Crete dams and WTP	Dams and new water treatment infrastructure	Three EoIs submitted
B O	India	Bikaner District water supply	47,660m³/d water treatment plant	Three bids under evaluation

Type	Country	Project name	Description	Status
BO	India	Chhindwara district WTP (Machagora)	91,000m³/d water treatment plant	Bids due in December 2022
BO	India	Jhumri Telaiya WTP	35,500m³/d water treatment plant	Bids due in December 2022
BO	India	Jite WTP	270,000m³/d water treatment plant	Bids due in December 2022
BO	India	Medininagar WTP	17,000m³/d water treatment plant	Bids due in December 2022
BO	India	Nagaur water supply	Expansion of water treatment plant	Bids due in December 2022
BO	India	Pratapgarh District WTP	43,690m³/d water treatment plant	Bids due in December 2022
BO	India	Punjab Municipal Services Improvement Project	1.02 million m³/d of water treatment capacity	Ludhiana bids due in December 2022
BO	India	Rewa District water supply (Rewa-Bansagar)	187,200m³/d water treatment plant	Bids due in December 2022
BO	India	Salauli WTP expansion	100,000m³/d WTP expansion	Bids due in January 2023
BO	India	Satna District water supply (Satna-Bansagar 2)	181,300m³/d water treatment plant	Bids due in December 2022
BO	India	Sidhi District water supply (Sidhi-Bansagar)	100,000m³/d water treatment plant	Bids due in December 2022
O	India	T.K. Halli WTP O&M (Stage-IV, Phase-I)	O&M of 400,000m³/d water treatment plant	Bids due in January 2023
O	Spain	Campo de Montiel WTP O&M, Ciudad Real	O&M of water treatment plant	Five bidders in the running
B	United States	Grants Pass, OR	New water treatment plant	Contract awarded
B	United States	Hallandale Beach RO expansion, FL	7,570m³/d RO expansion	Preferred bidder identified
		WASTEWATER TREATMENT PLANTS		
B	Canada	South Niagara Falls WWTP	New 30,000m³/d WWTP	Consultancy bids due in January 2023
B	Croatia	Divulje WWTP expansion	WWTP expansion and upgrade	Bids due in December 2022
B	Croatia	Stupe WWTP upgrade	WWTP upgrade	Bids due in December 2022
B	Ecuador	Lumbisi WWTP	New 86,400m³/d wastewater treatment plants	Funding sources sought
B	Ecuador	Portoviejo WWTP	New 96,000m³/d wastewater treatment plants	Design consultants appointed
B	Ecuador	Tumbaco Cumbayá WWTP	New 44,236m³/d wastewater treatment plants	Design consultant appointed
BOF	Ecuador	Vindobona WWTP, Quito	652,320m³/d wastewater treatment plants	Project scope under review
BOF	El Salvador	Santa Ana WWTP	New wastewater treatment plant	Tender possible in 2023
BO	India	Ahmedabad STP (New Pirana)	420,000m³/d sewage treatment plant	Tender likely in 2023
BOF	India	Ahmedabad tertiary STP	150,000m³/d TTP + 230,000m³/d sewage treatment plants	Tender likely in 2023
BO	India	Bagalakote infrastructure works	13,000m³/d sewage treatment plant	Re-tender awaited
BO	India	Belagodu tertiary upgrade	Tertiary treatment upgrade	Conceptual stage
BO	India	Buxar STP	New sewage treatment plant	Consultancy bids due in Dec 2022
BO	India	Dehradun STP (Sapera Basti)	15,000m³/d sewage treatment plant	Bids due in December 2022
BO	India	Delhi Keshopur STPs upgrade	27,276m³/d sewage treatment expansion	Bids due in December 2022
BO	India	Dhaulpur and Hindaun STPs	Two sewage treatment plants	Four bids under evaluation
BO	India	Guwahati Sewerage Project	187,000m³/d of STP capacity	Consultancy EoIs under evaluation
BO	India	Hoshangabad WWTP	21,000m³/d wastewater treatment plant	Three bids under evaluation
BO	India	Jaipur STP (Sushilapura)	20,000m³/d sewage treatment plant	Bids due in January 2023
BO	India	Kolkata (Bagjola) STP	41,000m³/d sewage treatment plant	Re-tender awaited
BO	India	Kosi Kalan STP	12,000m³/d sewage treatment plant	Bids due in January 2023
BOF	India	Mathura STP	60,000m³/d sewage treatment plant	Bids due in January 2023

Type	Country	Project name	Description	Status
BO	India	Mumbai (Colaba) TTP	12,000m³/d advanced tertiary plant	Bids due in December 2022
BO	India	Noida Sector-123 STP upgrade	Upgrade of 80,000m³/d STP	Bids due in December 2022
BO	India	North Dum Dum STP	33,000m³/d sewage treatment plant	Bids due in December 2022
BO	India	Pimpri Chinchwad STP augmentation	15,000m³/d sewage treatment plant	Preferred bidder identified
BOF	India	Saharanpur STP	135,000m³/d sewage treatment plant	Bids due in January 2023
BO	India	South Dum Dum STP	27,000m³/d sewage treatment plant	Bids due in December 2022
BO	India	Varanasi STP (Namami Gange)	55,000m³/d sewage treatment plant	Bids due in December 2022
BO	India	Versova WWTP, Mumbai	180,000m³/d WWTP	Contract awarded
BO	India	Vrindavan STP	13,000m³/d sewage treatment plant	Bids due in January 2023
BOF	Iran	Babak & Khorsand STP	New wastewater treatment plant	SoQs due in December 2022
BOF	Iran	Falavarjan STP	29,000m³/d wastewater treatment plant	IoIs due in December 2022
BOF	Iran	Khorramabad STP	98,600m³/d wastewater treatment plant	IoIs due in December 2022
BOF	Iran	Mobarakeh STP	10,000m³/d wastewater treatment plant	SoQs due in December 2022
BOF	Iran	Nazarabad STP	45,411m³/d wastewater treatment plant	Investor responses due in December 2022
BO	Iran	PGIDSCO reuse plant	85,000m³/d water reuse plant	Five groups qualified
BOF	Iran	Shiraz WWTP No. 2 expansion	150,000m³/d of wastewater treatment capacity	SoQs due in January 2023
BOF	Iran	Takab STP	11,435m³/d wastewater treatment plant	IoIs due in December 2022

GWI PROJECTS

Type	Country	Project name	Description	Status
B	Jordan	West Irbid WWTP	New wastewater treatment plant	Funding approval expected Feb 2023
B O F	Korea (South)	Uijeongbu City WWTP	157,000m³/d wastewater treatment plant	Preferred bidder identified
B	Kyrgyzstan	Karakol WWTP	12,000m³/d wastewater treatment plant	Award possible in December 2022
B O	Panama	Arraiján/La Chorrera, Panamá Oeste	116,640m³/d WWTP	Bids due in January 2023
B	Paraguay	Ciudad del Este WWTP	New WTP + WWTP	Tender possible in H2 2023
B	Paraguay	Lake Ypacaraí WWTP	New 500,000 PE wastewater treatment plants	Funding sources sought
B	Paraguay	Lambare Basin water/wastewater project	New WTP + WWTP	Tender possible in H2 2023
B	Paraguay	Mariano Roque Alonso WWTP	New 115,776m³/d wastewater treatment plant	Tender expected in 2023
B O	Peru	La Atarjea WWTP	Phased WWTP build-out	Bids due in December 2022
B O F	Poland	Czernica WWTP	New wastewater treatment plant	Single bid under evaluation
B O F	Qatar	Al-Wakra & Al-Wukair STP	150,000m³/d sewage treatment plant	Contract awarded
B O F	Saudi Arabia	Haier ISTP	Independent sewage treatment plant	Bids due in March 2023
O	Spain	Amorebieta wastewater O&M, Bizkaia	O&M of wastewater treatment plants	Bids due in January 2023
O	Spain	Baix Penedès WWTPs O&M, Tarragona	O&M of multiple wastewater treatment plants	Eight bidders in the running
O	Spain	Besòs Tordera WWTPs O&M, Barcelona	O&M of wastewater treatment plants	Preferred bidders selected
O	Spain	Calatayud WWTP O&M, Zaragoza	O&M of wastewater treatment plants	Bids due in January 2023
O	Spain	Ejea de los Caballeros WWTP O&M, Zaragoza	O&M of wastewater treatment plants	Bids due in January 2023
O	Spain	Guadarrama Basin WWTPs O&M, Madrid	O&M of 16 wastewater treatment plants	Contract awarded
B	Spain	Guadarranque, Cádiz	Tertiary WWTP	Four bidders in the running
B	Spain	Palma II WWTP, Mallorca	90,000m³/d wastewater treatment plant	Contract awarded
O	Spain	Sur WWTP O&M renewal, Madrid	O&M of wastewater treatment plant	Preferred bidder identified
B	Spain	Valle de Vinalopó WWTP upgrade	Wastewater treatment plant upgrade	Preferred bidder identified
B	Switzerland	ARA Region Bern micropollutants	Micropollutant treatment upgrade	Bids due in December 2022
B	United States	Bainbridge Island reuse, WA	Reuse of treated wastewater	Feasibility study ongoing
B	United States	Carpinteria reuse, CA	Advanced treatment infrastructure	Single design bid received
B O	United States	East County Advanced Water, CA	43,528m³/d advanced water treatment plant	Energy recovery award awaited
B O F	United States	Lake Oswego WWTP, OR	New wastewater treatment plant	Preferred bidder selected
B	United States	Napa Valley potable reuse, CA	18,925m³/d potable reuse plant	Conceptual stage
B	United States	Pure Water Antelope Valley, CA	Advanced water treatment plant	Demo equipment awards awaited
B	United States	Pure Water Monterey expansion, CA	Expansion of advanced water treatment plant	WPA final approval granted
B	United States	Pure Water Project Las Virgenes-Triunfo, CA	28,388m³/d advanced water treatment plant	EIR approval awaited
B	United States	Pure Water San Diego Program, CA	Multiple reuse upgrades	Phase 2 engineering bids due in December 2022
B	United States	Pure Water Southern California, CA	567,750m³/d of phased reuse capacity	CEQA process underway
B O F	United States	Silicon Valley AWPC expansion, CA	Expansion of advanced treatment infrastructure	Capacity and cost increased
B	United States	Walnut Creek WWTP expansion, TX	94,625m³/d plant expansion	Conceptual stage
B	Uzbekistan	Bukhara WWTPs	Four wastewater treatment plants	Design consultant appointed
SLUDGE MANAGEMENT				
O	Spain	Sur sludge drying plant O&M, Madrid	O&M of sludge drying/cogeneration plant	Contract awarded
O	Spain	Villalonquéjar sludge treatment, Burgos	O&M of sludge plant	Bids under evaluation
B O	United States	Brockton biosolids management, MA	Biosolids processing facility	Eols due in December 2022

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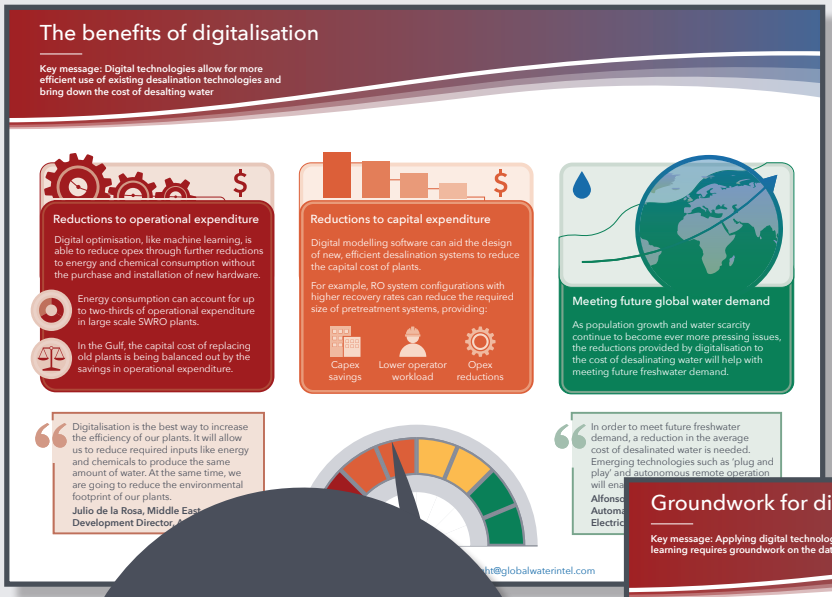

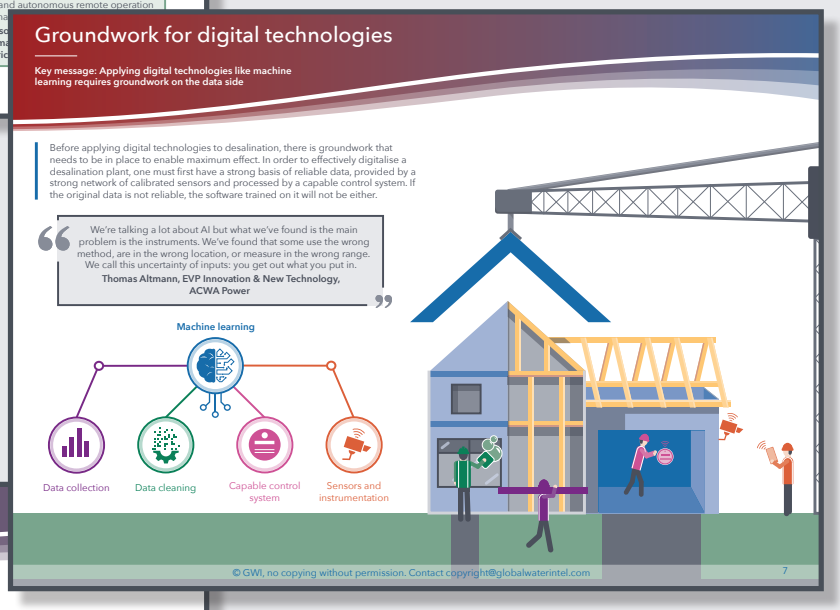

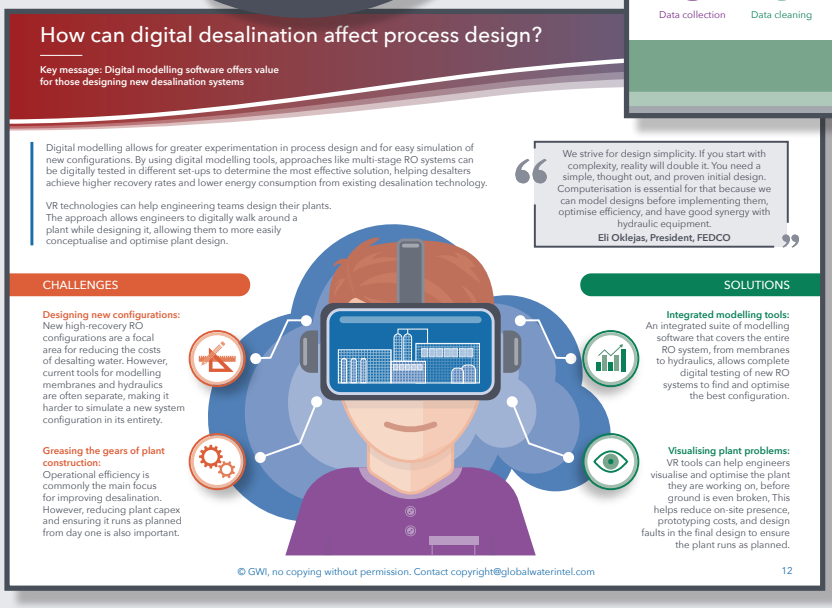

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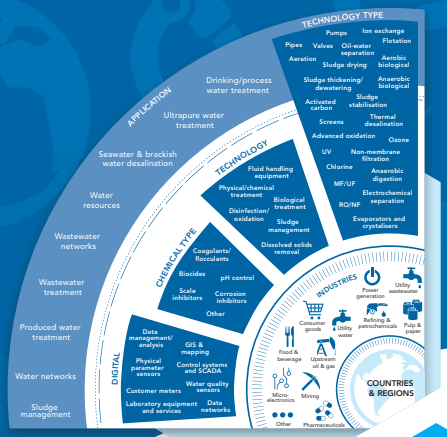

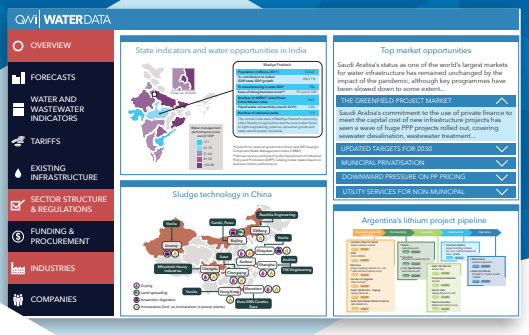

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