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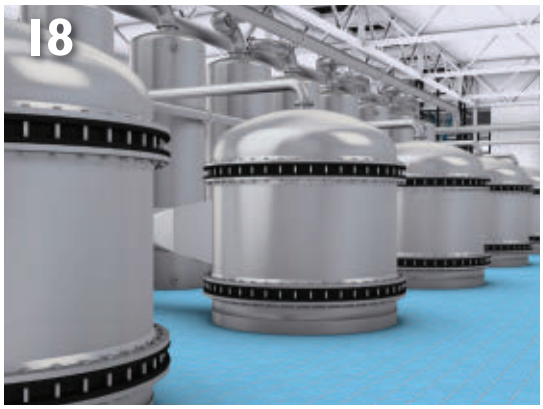

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EDITOR'S NOTE

Tom Freyberg cheif editor

PERSEVERANCE IS KEY

This issue's Leader Interview with Hyflux's Olivia Lum proves that we need to get behind innovative and disruptive technologies today which could prove to be the back-bone of many water processes in 25 years' time.

As many readers will know, it's not often that we include a single person on the front cover of WWi magazine. During my reign editing 30 editions of WWi over five years, it has happened twice: firstly with Robert F. Kennedy Jnr and then with Carsten Bjerg, the former CEO of Grundfos.

For this issue, the decision to include Hyflux CEO Olivia Lum on the cover was a no-brainer. She has a remarkable tale to tell. Often cited as the great entrepreneurial story of the water market – Lum's "rags to riches" tale is worth a read on pages 10-13.

Personally, I always enjoy reading entrepreneur's stories documenting what gave them the impetus to create their empires, or what marks them different to others and why they excel.

In the example of Amstrad creator and businessman Alan Sugar, from a young age he could see value in products which others thought were junk. Even at school he was selling old photographic film to friends, before going on to build his electronics empire.

For Virgin boss Richard Branson, he got stuck in Puerto Rico while trying to get to the British Virgin Islands to see a "beautiful lady". After a cancelled flight, he hired a plane, borrowed a blackboard, wrote "Virgin Airlines" as a joke on the top and charged people $39 for a single fare to the islands. He managed to fill his first plane. When he got home he called Boeing to find out if they had any 747 airplanes for sale: an airline was born. And it all stemmed from a man's desire to see a lady!

It was in the early 90s that Olivia Lum took a punt on membranes, long before they had grown to a billion dollar business. In 2005 she successfully won the SingSpring desalination bid to provide a 136,380 m^3/day plant in Singapore – the largest of its kind at the time. She later did the same thing for the Magtaa project in Algeria – proposing a 500,000 m^3/day project, again using membranes.

Like any business, Hyflux has not had it easy, facing tough conditions for global desalination. Yet the recent Qurayyat win in Oman, together with an expected pick up in the global market, will no doubt help Hyflux and other desalination companies to continue growing.

As with Sugar selling old photographic film, or Branson renting out a private jet, or Lum backing membranes – it takes a certain boldness to go against the grain and propose an idea that most people think is crazy, stick with it and make it work. So let's give new technologies a chance. Who knows - the next technology that might seem crazy now might just grow into a billion dollar business over the next 25 years.

» LUM'S 'RAGS TO RICHES' TALE IS OFTEN CITED AS ONE OF THE GREAT STORIES OF THE GLOBAL WATER MARKET

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WORLD NEWS

1

DENVER, US

A guide has been released to help water utility managers detect and control cyantoxins, the algae-related contaminants, which impacted Toledo in Ohio last summer. The American Water Works Association and Water Research Foundation released the Q&A style guide on both websites, ahead of a health advisory expected to be published in the summer by the US Environmental Protection Agency. Cyantoxins can arise from cyanobacteria – often referred to as blue-green algae in lakes and reservoirs.

2

WASHINGTON, US

Technology designed by Massachusetts Institute of Technology (MIT) and Jain Irrigation Systems took first place in the Desal Prize with a photovoltaic-powered electrodialysis reversal system. Winning $200,000, the system desalinates water using electricity to pull charged particles out of the water further disinfect using ultraviolet rays. Second place went to the University of Texas at El Paso Centre for Inland Desalination Systems, who designed a Zero Discharge Desalination technology that reduces wastewater in the desalination of groundwater.

3

PERU

Capital city Lima's water utility, SEDAPAL (Servicio de Agua Potable y Alcantarillado de Lima) plans to allocate 5% of water fees collected towards green infrastructure following landslides in the country, which reportedly killed multiple people and left hundreds homeless. The funds will be divided between two activities: 1% of the total water tariff, or PEN 70 million ($23 million), will go explicitly to green infrastructure, while 3.8%, or PEN 266 million ($89 million) will be used for climate change adaptation and disaster risk reduction more generally.

4

BRAZIL

Now being called the "Saudi Arabia of Latin America", the 2016 Olympic hosting country continues to face water struggles following two years of dry rainy seasons. Sao Paulo faces intermittent disruptions in water supply with the threat of water rationing hanging over the city. Aljazeera America reported that 50 tons of dead fish were removed from a Rio de Janeiro lagoon where Olympic events are expected to be held.

5

GHANA

West Africa's first major desalination plant was inaugurated in Ghana to supply 60,000 m^3/day of water to Accra residents and the surrounding areas. Spanish firm Abengoa undertook the project under a build-own-operate-transfer model, selling water to the Ghana Water Company over a 25-year period. The plant went through a two-month commissioning phase prior to being opened by the president of Ghana, H.E. John Dramani Mahama.

10 **UK**

A £11.7 million design and build flood management project has been awarded by Derby City Council to a joint venture comprising Galliford Try & Black & Veatch to restore "insufficient flood protection" of Derby city centre. Three kilometres of flood defences will be part of the work, under the Environment Agency's Water & Environmental Management Framework. A total of 1,450 homes and 800 businesses are expected to be protected by the end of the engineering work.

9 **GERMANY**

Water Systems provider Aquarion Group has added to its recent tally of acquisitions with the purchase of German membrane company, Membran-Filtrations-Technik (MFT), for an undisclosed sum. The acquired company also has a patented circular disc (CD) module for wastewater treatment and reuse. Headed by managing directors Frank Jacobs and Andreas Flach, MFT's management team will remain in place. Further details and terms of the acquisition were not disclosed.

8 **SOUTH KOREA**

South Korean EPC contractor, Posco E&C, has awarded Norwegian firm Cambi a contract to supply its thermal hydrolysis technology for the Anyang Sewage Treatment and co-digestion project. Representing a breakthrough for Cambi in the country, it follows contracts signed previously in China. The system for the underground wastewater plant will co-digest 27,000 dry tons of organic waste per year, of which 65% is sewage sludge and 35% food waste. After digestion, remaining high dry solids will be dried and blended with millet grass to produce a biomass fuel for co-firing in existing power plants.

6 **SOUTH AFRICA**

Dutch technology, Nereda, will be installed at the Hartebeestfontein wastewater treatment plant to increase capacity by 5,000 m^3/day. The East Rand Water Care Association issued the tender to Johannesburg-based WEC Projects to deliver the technology for engineering consultancy, Royal HaskoningDHV. The aerobic granular technology purifies wastewater by "controlling the growth and formation of microorganisms", according to the firm. Previously the technology had been used in the Gauteng province.

7 **SINGAPORE**

Singapore and Korean national water utilities – PUB and Korea Water Resources Corporation – have signed a memorandum of understanding (MOU) to collaborate on "knowledge sharing and developing innovative solutions". Four areas have been identified for the work, including automatic meter reading (smart water grids), rapid detection of contaminants (water quality monitoring), photovoltaic systems (green energy) and membrane technology (wastewater treatment processes).

BAHRAIN WTE BID FROM ACWA/ FCC TO INCLUDE DESALINATION PLANS

An alternative bid from a consortium including ACWA Power for Bahrain's 390,000 tonne per year waste to energy (WtE) facility will include the provision to provide desalinated water.

Consisting of power and water provider ACWA Water, local waste management company Beatona and Spanish infrastructure firm, FCC, the consortium has submitted a tender offer to the Ministry of Works, Municipalities Affairs and Urban Planning.

The proposed Integrated Waste Management System (IWMS) would be tendered on a Build Own Transfer (BOT) basis under a 25 Year Public-Private Partnership Concession. A statement from the consortium said four alternative proposals have also been submitted and that one of these incorporates a "Waste to Water Facility which can provide the Kingdom of Bahrain with Desalinated Water utilising a renewable and sustainable source of energy in the process".

Alternate bids for the project include France's Suez Environnement and Singapore/Malaysia consortium, Keppel/EAG.

Although the waste to energy project was first tendered in 2008 and awarded to France's CNIM Group, the project was later cancelled and retendered.

BWB WINS £2.5M TSAKANE CONTRACT IN SOUTH AFRICA

UK firm Bluewater Bio International (BwB) has secured its fourth order in South Africa for its HYBACS activated sludge process, HYBACS.

The project, valued at 44.4 million South African Rand (£2.5 million) has been secured via BwB's licensee partner in Sub Saharan Africa, Headstream Water.

The project includes the extension of the Tsakane Sewage Treatment Plant (STP), located 25 miles southeast of Johannesburg and operated by East Rand Water Care Company (ERWAT). The original STP at Tsakane was designed to treat an average of 10,800 m^3/day of wastewater however following rapid population growth, the STP became overloaded.

The HYBACS upgrade has been designed to more than double the capacity of the existing plant, thereby servicing a 75,000 population equivalent (PE). The upgrade includes 12 of BwB's SMART units to double the plant's capacity.

Tsakane represents BwB's fourth order for HYBACS in South Africa.

For more news visit us at wwinternational.com

OSMOFLO CONVERTS FORTESCUE CONTRACT

Australian company Osmoflo has been awarded a contract to supply a 4,500 m^3/day desalination plant to Fortescue Metals Group (Fortescue) at Port Hedland, Australia's highest tonnage port.

Osmoflo was originally engaged by Fortescue to supply a rental plant, which has been in use since 2011. The original plant was delivered, fully installed and operational in 12 weeks. Following a review of Fortescue's water requirements, the rental contract has been converted into a longer-term build, own and operate contract.

The seawater desalination plant, inclusive of intake and pre-treatment, has a capacity of 4,500 m^3/day to supply Fortescue with an additional capacity to supply third parties within the region. The plant is set to be completed and fully operational by July.

DOW TOPS GLOBAL MEMBRANE MARKET

The top six suppliers of Reverse Osmosis (RO), ultrafiltration (UF) and microfiltration (MF) membranes have more than 60% market share, according to an analysis by the McIlvaine Company.

In a $1.4 billion market, Dow ranks number one, with GE second, followed by Toray, Pall, Nitto Denko and finally Koch Membrane Systems. The food industry was quoted as experiencing faster growth than most industrial segments for membranes.

Although the Middle East was not surprisingly quoted as the leading market, China is expected to become the biggest purchaser over the next several decades. Investment in new coal-fired power plants in India, Vietnam and certain other Asian countries is creating a substantial membrane market, according to McIlvaine Company.

With gas turbine combined cycle power plants expected to replace coal-fired power plants in many countries, this could drive RO sales with a need for ultrapure water systems.

PUB'S KRANJI PLANT TO TRIAL ENERGY-NEUTRAL TREATMENT

Singapore's national water agency, PUB and French environmental services provider SUEZ environnement have signed an agreement to collaborate on three research projects in used water treatment, stormwater management and automated meter reading.

The used water treatment development will see a 1.5 year project, testing an "AB-process" in a 50 m^3/day pilot plant at the Kranji Water Reclamation Plant. The end goal is to achieve an energy-neutral wastewater treatment process.

Both parties will also work together to use information and communication technologies to develop a smart water grid. The three projects will be supported by a TechPioneer grant.

A graduate from the National University of Singapore in 1986 with an honours degree in chemistry, Lum built Hyflux to generate revenues of over S$650 million in 2012

OLIVIA LUM

The Secret Behind Singapore's Water Entrepreneur

Five years in the making, WWi was recently granted an exclusive interview with Olivia Lum, CEO of Singapore water firm Hyflux. Here she talks to Tom Freyberg about the Qurayyat deal in Oman, progress in India and what it takes to grow a multi-million dollar global water business

By Tom Freyberg.

Singapore entrepreneur Olivia Lum's 'rags to riches' success story can be likened to her home nation. As an independent country back in 1965, Singapore lacked resources. Under the guidance of the country's first prime minister – the recently deceased Lee Kuan Yew – the nation fostered multinationals and educated its workforce, mandating that English was taught in schools. Today it's a thriving, self-sustaining economic hub in Asia.

The entrepreneurial spark

And the well documented rise of Hyflux's CEO is a similarly impressive tale. Adopted at birth, Lum didn't have it easy. "I went through a very poor childhood," she tells me, referring to a time when she grew up in difficult conditions.

Yet it was this period that could be attributed to the entrepreneurial spark that marks the difference between the good and great CEOs. "Earning your own pocket money was something that you really had to do – otherwise you had no money," she says. "So, as a child how do you earn money? You sell papaya or fruit along the street. Maybe that was my training as an entrepreneur.

"It trains you how to approach customers. It trains you how to have a certain discipline that if you don't sell, you probably won't have money to get through the day."

From selling papaya many years ago, last year her company generated group revenue of S$321.4 million for the year ending December 31, 2014. Profit was S$57.5 million. The journey from survival to becoming one of Asia's top business women running a multi-million dollar business however was not all smooth sailing.

After graduating from the National University of Singapore in 1986 with an honours degree in Chemistry, Lum was picked up by Glaxo Pharmaceuticals as a chemist, where she was tasked with looking after wastewater treatment.

Two and a half years later "having no contact and not knowing the outside world", as she describes it, Lum moved forward with her dream to start her own business. Armed with only S$20,000 in 1989, she offered her services as an agent for large water companies.

She describes it as a "hard sell" knocking on people's doors and although wanting to give up in the first and second year, she never did. Despite selling other companies' products into Malaysia and Indonesia, Lum wanted to create and sell her own technology.

"During that time nobody had heard of membranes and I told myself that I needed to get into the membrane business because membranes are the most energy efficient operation compared to many operations, like distillation and evaporation and so on," she says. "I saw it as the most effective way to clean up water."

Membrane pilot and public listing

After getting support from her lecturers at the National University of Singapore, she built a small membrane-based pilot project in 1992. It was this foresight with a then unproven technology that could be attributed to much of Hyflux's success today.

"That's how I started water recycling in Singapore. People did not want to build a large scale plant because it [membranes] were still not tested," she says.

After nearly bankrupting the company by venturing into China, now offering built systems such as water filters and softeners, Lum survived the Asian financial crisis in 1997 while many of her competitors, involved in the Thailand, Indonesian and Korean markets, took a big hit.

It was then in 1998 that the Singaporean government starting promoting water recycling. The companies "remembered us", Lum says, from her earlier work doing pilot plants and demonstrations, which she says "got us in". Lum then helped implement water recycling in Singapore for various industries.

In 2001 the CEO raised between S$6-$7 million from listing Hyflux as a public company, despite what could be called bad timing. "It was another financial crisis," she says. "It was the dotcom bubble burst. So nobody wanted to subscribe to my shares. We had to sell it very cheaply to the market."

SingSpring/Magtaa breakthrough

Four years later and in 2005 Hyflux was put on the map. It built and opened Singapore's first major desalination plant – the 136,380 m^3/day SingSpring project. "At the time I can claim I built the largest desalination plant globally," Lum says proudly.

"SingSpring was a real breakthrough for us," she adds. "It was a huge risk but because we had been handling membrane systems for a long-time from 1992, we had nearly nine years' experience. Membranes are a very scalable technology. It's like a fridge: you can build one fridge, you can build 10 fridges to 1000 fridges – you just put them together. This project was the breakthrough for us – we accepted the challenge and built the first one."

Pre-empting the needs of water supply utilities and communities falls in

Powering ahead: The opening of the Tuaspring 318,500 m^3/day project - Singapore's second desalination operation. A co-located 411 MW power plant, due to be commissioned later this year, will supply 50 MW to run the desalination plant

Money Talks: Hyflux financial results (2011-2014)				
	2011	2012	2013	2014
Revenue	S$460.2m	S$654.8m	S$535.8m	S$321.4m
Profit before tax	S$61.7m	S$76.2m	S$51.6m	$53.1m
Profit After tax	S$55.7m	S$64.7m	S$42.9m	$58.9m

line with Lum's success. For SingSpring, she insisted that a membrane plant of this scale would work, despite the doubters and critics. The result? The largest membrane-based desalination plant in Asia at the time.

This was the same for Hyflux's winning bid for the Magtaa desalination plant in Algeria, North Africa. Lum insisted that a 500,000 m^3/day plant using membranes would work for the region. The result? The largest membrane-based desalination plant in Africa. Notice a pattern here?

Despite delays, including a warehouse fire, Magtaa was inaugurated in November 2014. Water will be supplied to Oran, Algeria's second largest city and neighbouring provinces under a 25-year water purchase agreement with L'Algerienne Des Eaux and Sonatrach.

"We are now on the road to operating the Magtaa plant," the CEO says. "It's not 100% fully operating yet – we are waiting to tie up with the main water pipeline but I expect full flow to be anytime."

Investing in Oman

In March Hyflux signed a water purchase agreement for its 200,000 m^3/day independent water project (IWP) in Qurayyat, Oman. Construction of the US$250 million plant is expected "soon" with the project scheduled to start operation in May 2017. Water will be supplied to the Oman Power and Water Procurement Company (OPWP) under a design, build, own and operate model (DBOO).

"We're not new to Oman," says Lum. "We built a smaller plant as an engineering, procurement and construction (EPC) contractor a couple of years ago for Salalah. We look to Oman as a very progressive country when it comes to water conservation and management. Winning Qurayyat gives us more confidence in that country and also from Oman, we'll be able to launch into other countries nearby."

She adds: "We saw the [membrane over thermal] trend coming a couple of years ago but because of the Arab Spring and financial crisis, they have slowed down progress. Now there is pent up demand in the desalination market and membranes will be the choice compared to thermal."

The CEO believes that future desalination projects will be delivered across MENA as both mega plants – at the scale of Magtaa – particularly in industrial areas where water is needed but also smaller desalination plants, ranging from 10,000 m^3/day – 50,000 m^3/day for coastline communities.

Going big in Africa: the inauguration of the 500,000 m^3/day desalination plant in Magtaa, Algeria. Lum says Hyflux is waiting to tie up with the main water pipeline

Three out of three in Singapore?

Singapore's second desalination project – the 318,500 m^3/day Tuaspring – was also delivered by Hyflux as a DBOO project with a fixed low price of S0.45 per cubic metre for the first year. Uniquely, in the company's bid, Lum included a promise to build co-located a 411 MW combined gas turbine power plant.

The plan was that around 50 MW would be used to power the desalination plant with the remaining 361 MW being exported to the grid. This marked Hyflux's entry into the power project segment. The water production element of the project started operation in September 2013, with the power side expected to be delivered later.

"The power generation is now on track to start commissioning the second half of this year," adds Lum. "Next year will be full flow."

Power generation to one side, WWi recently reported how Singapore will soon be looking to build a third desalination plant, after SingSpring and Tuaspring. Will the CEO be looking to make it three out of three bid wins for Hyflux?

"Of course," she adds confidently. "We are keen on any large scale desalination plant, not just in Singapore but worldwide as well. The tender is not out yet so it's still too early to talk about it."

Insight on India

The start of engineering, procurement and construction of Hyflux's venture into India –a 336,000 m^3/day desalination plant being delivered in partnership with Hitachi – was highlighted in the Annual Statement as a reason for "lower revenue".

Lum is cautious when commenting on this project, saying "Dahej took longer than expected to close" and that partner Hitachi "is the one driving the project and they are still working on it with the Indian government". Naturally, the CEO does not want to put a timeline against the Dahej development at this time.

HYFLUX'S LANDMARK PROJECTS	CAPACITY
Magtaa, Algeria	500,000 m^3/day
Souk Tleta, Algeria	200,000 m^3/day
Tuaspring, Singapore	318,500 m^3/day
SingSpring, Singapore	136,380 m^3/day
Zunyi wastewater treatment, China	150,000 m^3/day
Tianjin Dagang, China	100,000 m^3/day
Qurayyat Independent Water Project, Oman (under development)	200,000 m^3/day

International revenues

Looking at the bigger picture, Hyflux to date now claims to have more than 1,300 membrane products and systems installed in over 400 locations worldwide. In FY2014, Singapore contributed 72% of total revenues, with China contributing 15%, MENA 7% and others 6%. Lum says with revenue dominated by EPC rather than operation and maintenance (O&M), this is reflected in the figures.

"The Hyflux business today is dominated by EPC revenue," says the CEO. "We do have O&M revenue but this is small and relative to the EPC business. It all depends on where the demand is. For example, when we have a big project like Tuaspring and we are executing the EPC phase, the revenue from this region will dominate."

Lum goes onto add: "Asia has grown very strongly so therefore you can see that we get a lot of our revenue from Asia. We do see a pick up from the Middle East, as well as Africa, so we do expect that over the next couple of years we will see some balance in revenue in Asia, Africa and Middle East."

Forecasts suggest recovery is in sight for the desalination market as project delays and cancellations gradually give way to new project announcements and tenders. With a 61% growth rate expected for the desalination market, expected to become a US$21 billion a year industry by 2019, this could help even out Hyflux's balance sheets.

Perseverance is key

There's so much I want to chat with Lum about it's almost impossible to squeeze it into a short telephone interview and article. There's the company's 30,000 m^3/day "floating desalination vessel" it launched at the Singapore International Water Week '14. The CEO says they're working on many enquiries. And there's a partnership with Danish pump giant, Grundfos, to explore the potential of using pumps with ultrafiltration membranes in a packaged application. Results from this research are now in but Hyflux "has not decided what to do next".

Concluding the interview, I want to find out what has driven Lum to grow the business she has. What marks her different to other CEOs and why she, as female in a male engineering dominated industry, has succeeded where others have failed.

"Perseverance," she says astutely. "A lot of entrepreneurs may have a great idea, good products and good suggestions but they give up easily. They don't persevere enough. As an entrepreneur – perseverance is a must have attitude. Water is a sunrise business. Don't easily give up. Water is becoming more and more scarce. Population and industrial growth mean there is more polluted water. These are critical elements that will propel water to the next level."

Hyflux's CEO finishes by saying: "There may be people who are not keen on the water industry or business but I think someone has to do something about it and that's what we're doing."

It's this humble attitude that has earned Lum the respect she deserves in the global water market. When retelling her story, she repeats the phrase "I told myself", when referring to making a decision on her next move: whether it's quitting Glaxo, launching her own water technology or bidding against the odds for SingSpring in Singapore or Magtaa in Algeria.

The CEO clearly has inner entrepreneurial voice guiding her, as well as a dogged determination that has driven her to scale up the business and keep growing.

Lum is an inspiration to every water professional out there wanting to grow a business, and human being – no matter how tough your start in life – on sticking with your dream until it becomes a reality.

Omani opportunity: Hyflux will deliver the 200,000 m^3/day Qurayyat project in Oman, slated to start in May 2017, supplying water to OPWP

Tom Freyberg is the chief editor of WWi magazine. For more information on the article, please email: tomf@pennwell.com

THE BIG QUESTION

Now a multi-million dollar business, membranes form the backbone of many modern water supply systems. Recent advancements have seen materials such as ceramics adopted and even graphene considered. As part of WWi's ongoing technology series, we ask several manufacturers: Is polymeric membrane integrity suitable for modern day water production demands, or should new materials be considered?

Careful selection needed

Manwinder Singh, senior VP, technology, Koch Membrane Systems

Historically, polymeric membranes have been the backbone of microfiltration (MF) and ultrafiltration (UF) for water treatment due to the low cost, wide variety of pore sizes, configurations, and manufactures.

Alternatively, other materials (ceramic membranes) have been used when conditions are too aggressive (high temperatures and aggressive chemical conditions) for polymeric membranes. Polymeric membranes do have advantages over ceramic, including less cost.

Further improvements to polymeric membranes are also improving robustness to handle aggressive aeration and cleaning conditions. Improvements in polymeric membrane formulation and membrane spinning techniques are resulting in more chemically stable formulations. These improvements have resulted in membranes that can withstand chemical exposure with wide range of chemicals without any deterioration in chemical properties of membranes.

Supported, braided polymeric membranes where the membrane is casted and penetrates the support layer have proven to increase membrane life and practically eliminate fiber breaks. These membranes were traditionally used in wastewater applications but with further advancements in polymer coating technologies, they are being applied in water treatment applications.

Specific polymeric membrane selection can prove to have excellent membrane life for particular applications.

Where Polyvinylidene Fluoride (PVDF) membranes are ideal for applications where regular chlorine cleaning is required to remove organic foulants from Natural Organic Matter (NOM), Polyether Sulfone (PES) membranes can handle high pH cleans.

Overall, polymeric membranes are currently the most cost effective for MF or UF applications but careful selection must be implemented to provide the end user the most reliable product.

Hybrid polymeric architecture

Dr Jeff Koehler, principal scientist, LG NanoH2O

Historically, all commercial membranes for water purification have been based solely on polymers synthesised from similar monomer classes.

This stagnation in developing new chemistries has yielded similar membranes across the industry. These membranes obviously have their performance benefits but they suffer from robustness issues upon repeated cleanings, chlorination events, etc.

A great deal of interesting research has delved into new chemistries and molecules (i.e., aquaporins, graphene, etc.), which show very interesting and improved performance. Yet these tend to be very costly processes for full commercialisation.

While developing new chemistries for membranes, we must always keep in mind that membranes for the water industry are commodities, and as such, cannot be made of materials that significantly raise the cost of the end membrane module. Polymeric compounds are still the most cost effective route to obtain excellent quality water, but small amounts of nanoparticles and other additives can greatly enhance the performance of the membrane.

Over the next few years we will be testing a variety of new chemistries that will be based on a hybrid polymeric architecture. We cannot limit ourselves to the same polymer chemistry that has been used in the past, but we will continue to develop chemistries (polymer, hybrid and potentially inorganic) that are ready for commercialisation which will improve the performance, longevity and chemical resistance of the finished product.

Grouping ceramic membranes together

Loet Rosenthal, director of drinking water, PWN

Polymeric membranes have been used for water production demands for a very long time. In 1999, PWN was the first utility in the world that implemented a fully integrated polymeric membrane plant at its Heemskerk facility. During that time polymeric membranes were the best solution available on the market for our challenges and to date our Heemskerk facility operates well, especially in terms of water quality, although we have had some issues with membrane fouling and integrity.

For our water treatment plant in Andijk, that needed to be upgraded because of its age, capacity and water quality, we compared existing technologies with the new innovations developed and tested by our R&D team. The results clearly indicated that a combination of suspended ion exchange to remove dissolved organic matter, nitrate and sulphate, and ceramic membrane filtration led to less waste, a smaller footprint, less energy consumption and a better water quality.

There were multiple reasons why we chose ceramic membranes. In the first place ceramic membranes have a very long lifetime and high durability. Also, their high permeability and high backwash rates allow for much higher gross fluxes (three to four times) at a stable operation leading to less membrane area and therefore a smaller footprint.

The only limiting factor for the application of ceramic membranes in the past has been the high capital costs because of the huge amount of steel and valves associated with the production of a ceramic membrane plant. One soultion - CeraMac - developed by our R&D team, combines up to 192 ceramic membrane elements into one vessel, making it a highly economical and compact solution.

Life cycle costs are especially important to consider when weighing the different technologies. For ceramic membranes, the benefits need to be looked at over the long-term.

Public utilities like our own have an obligation to develop and introduce new technologies to make our processes more reliable, sustainable and cost efficient. We believe that ceramic membrane filtration is becoming the new water treatment standard.

Integrity at lower life-cycle cost

Dave Holland, senior application engineer, Aqua Aerobic Systems

The main advantage of a low-pressure polymeric membrane over one made of an alternate material - such as zirconium oxide – remains its lower capital cost. However, the price gap between the two is narrowing as manufacturing processes and costs improve.

When one looks at the total life-cycle cost of the plant, some systems with non-polymeric membranes are already less costly to operate and maintain over the long run. And adding to the overall cost of many polymeric systems are expenses related to the lack of membrane integrity, which several studies have attempted to quantify and found that this is not an insignificant value.

While non-polymeric membranes have been gaining traction in the US even for drinking water treatment, there are still some reasons for not giving up on polymeric membranes. For one, the American engineering community has been slow to convert. Even though many alternate membrane materials have been shown to achieve much higher fluxes, fear of the unknown (not altogether unjustified) causes many consultants to derate the new materials, resulting in artificially-high life cycle costs that either penalise the client or prevent the sale in the first place.

Second, there have been some recent improvements to polymeric membranes that have improved their overall integrity. Most manufacturers are now using the more-flexible polyvinylidene fluoride (PVDF). Many now also produce the membrane using a thermally-induced phase separation process (TIPS). Lastly, polymeric membranes continue to make improvements in operating costs. To improve flux, coagulants are sometimes injected into the feed; this can be done continuously, but injecting it periodically to "pre-coat" the membrane surface saves chemicals.

For low-solids applications, an inside-out membrane can be used, which doesn't require air scouring. And many membranes now use small bursts of backwash water and/or air to clean the membranes, requiring less power.

More hydrophilic materials – such as polyethersulfone (PES) or various hydrophilic additives – resist fouling and require less backwash water/air and cleaning chemicals.

In summary, the answer is "yes" - recent advances in polymeric membrane technology give the material more integrity at a lower life-cycle cost, yet non-polymeric materials with even better integrity continue to add value to the market. Time will tell if the contest will end with a clear winner or in a tie.

Meeting ZLD standards

Will Yeo, regional marketing lead – process systems, Asia, Pall

Polymers have been the go-to- material for a significant amount of time in water solutions, and have been regarded as the backbone of some of the most important membrane technologies that have solved our pressing resource needs for a long time.

Even in the light of new materials being developed, from ceramic membranes to nanotechnology, the polymeric membrane remains highly important in meeting today's water production demands. What is equally, if not more important than membrane material, is the design of the overall product and solution around the polymer, that will allow us to see yet more significant developments in today's water-starved world.

Specific to the area of zero-liquid-discharge (ZLD) and brine minimization, both of which are key to ensuring our water needs today are met, polymeric membranes can be designed as disc-tube reverse osmosis (RO) modules to ensure the molecular and ionic separation of the whole spectrum of pollutants in all aqueous environments: from suspended matter to the smallest ions, including colloids, bacteria, viruses and organic matter.

Such effects can be achieved when the polymeric membrane module is integrated with spacing discs separating the membrane cushions, thereby offering even better filtration and hence water production solutions than traditional spiral or tubular RO modules.

This is because there will be greater turbulence in the feed stream, lowered clogging or crystallising risks, even distribution and self-cleaning hydraulic circulation and hence more effective cleaning, longer operating life and lowered operating expenses.

Moreover, the design of the module can be further enhanced by using an open channel technology, leaving the module even less vulnerable to fouling and scaling. If the module is designed so that it can also be opened easily, the membranes can be easily investigated, tested for the optimum cleaning procedure and easily subject to laboratory investigations.

On top of the membrane material as well as module design, one key aspect of ensuring the product's suitability for meeting water production needs today is its ability to work under extreme conditions, for maximum recovery.

Today, there are modules that can operate up to 160 bars of pressure, thereby ensuring the meeting of ZLD standards, if not significantly lower brine minimisation results than most other technologies. This is the case despite the use of polymers, and in the absence of any new materials. Such is a prime example of how innovation in the design around the polymer can nevertheless propel the industry forward in meeting today's water challenges.

Uncovering new application fields

Claudia Staudt, principal scientist, advanced materials & systems research, BASF

Despite a broad availability of various polymers today, ultrafiltration (UF) membranes are mainly produced from polysulfone (PSU), polyethersulfone (PES) or polyvinylidene difluoride (PVDF).

The hydrophobic nature of these polymers, however, causes a fouling phenomenon, which demands a frequent chemical cleaning procedure.

Membranes made from Ultrason polymers (PSU, PES) exhibit excellent chemical resistance to caustic soda (sodium hydroxide) and high resistance to sodium hypochlorite.

Equipping these membranes with anti-adhesive surface will reduce the chemical cleaning requirement and thus improve the operational efficiency and sustainability. The development of new polymeric materials needs to consider the fact that the production of porous membranes using a non-solvent or temperature induced phase inversion process is well established.

Often, with new bulk polymers, many production parameters require some adjustment to obtain porous structures with desired pore size and distribution as well as high porosity.

In addition, new membrane materials with specific functionalities usually require complex synthesis routes, such as block-copolymers with precise block lengths.

Therefore, the current trend today is to use polymeric additives applicable in the conventional membrane production in order to achieve higher hydrophilicity and/or surface functionality.

Furthermore, different ´post treatment´ techniques have been developed, e.g. hydrogel and coating approaches, grafting and cross-linking in order to functionalise the membrane and pore surface.

Major traits of these approaches are that the parameter adjustment in production process is minimal and that only small amount of additive chemicals is needed for the functionalisation. The membrane pore could also be adjusted to smaller size via coating approaches.

The aforementioned concepts could lead to a new generation of high performance membranes. Surface properties can be tuned deliberately between purely anti-adhesives to cross-linked, enabling the uncovering of new application fields, such as heavy metal removal/recovery and produced water treatment applications, by using only one type of polymer as the basis.

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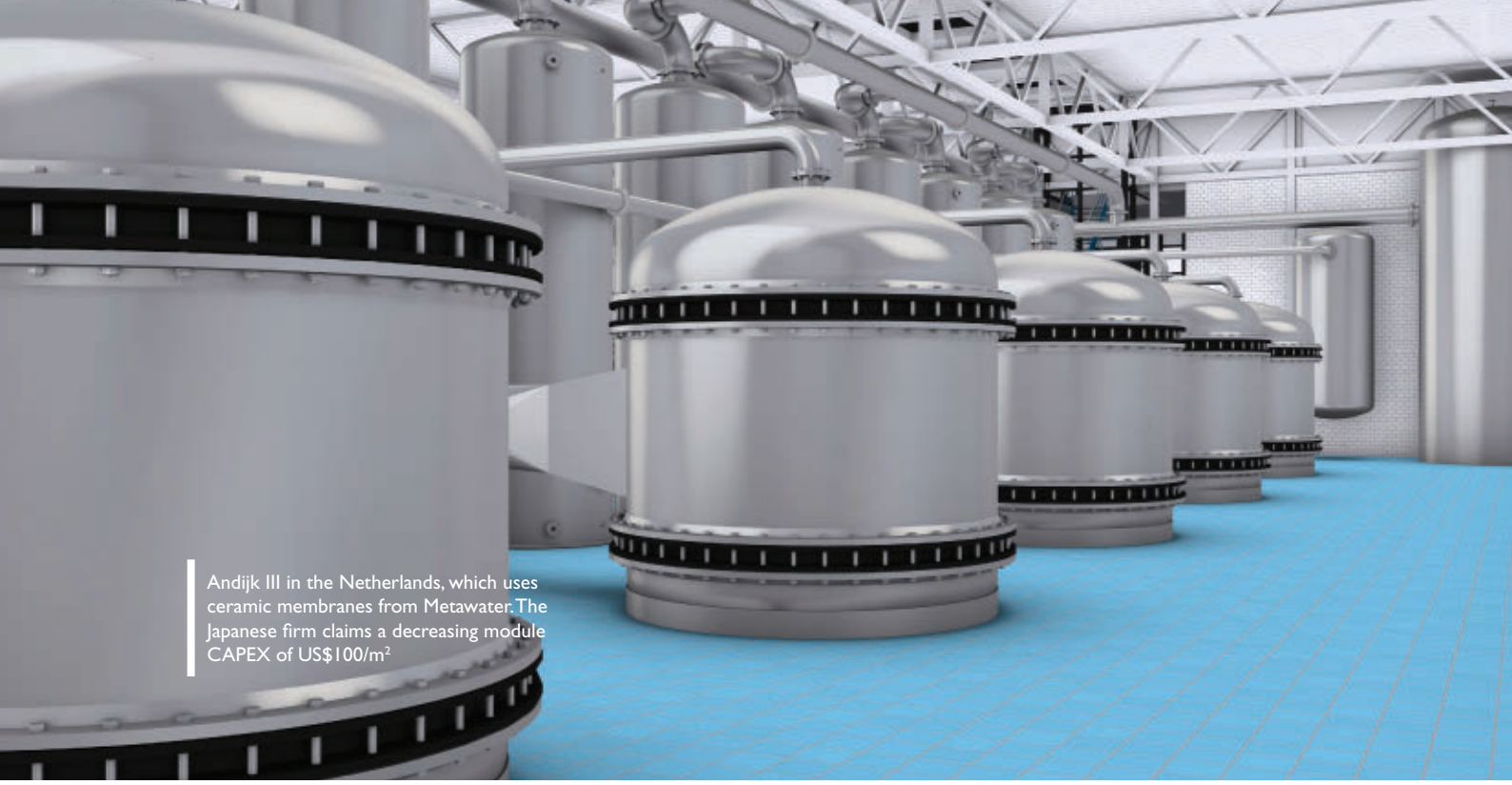


Andijk III in the Netherlands, which uses ceramic membranes from Metawater. The Japanese firm claims a decreasing module CAPEX of US$100/m^2

TOUGH TALKING

INNOVATION AND APPLICATIONS FOR CERAMIC MEMBRANES

Big promises have been made regarding ceramic membranes yet they still have only 2-3% of the membrane market. In a recent Insight Report on ceramic membranes, BlueTech Research, has reviewed their adoption in water and wastewater treatment, improvements in life-cycle costs, key markets and recent innovations.

By Tyler Algeo and James Fotouhi

The development of ceramic ultrafiltration (UF) membranes predates that of their polymeric counterparts. Yet ceramics only make up a fraction of the market for membrane filtration products in water and wastewater treatment. While the US$500 million UF treatment market continues to grow in applications such as reverse-osmosis pre-treatment, municipal wastewater and drinking water treatment, ceramics comprise only a 2-3% market share.

Adoption of ceramic membranes has been fairly modest, with an estimated 200+ treatment plants, representing a population equivalent of roughly five million people, over the past 20 years.

The past five years has seen a small uptick in the cumulative installed capacity, with two large-scale plants developed by PWN and Metawater (>100,000 m^3/day) becoming operational in 2014.

Historically the primary barrier to ceramic membrane usage is the much higher CAPEX compared with polymerics (up to three times as much).

The process advantages of ceramic membranes (pH resistance, higher flux rates, longer membrane service life) have enabled suppliers to carve out a few niche markets such as in produced water treatment, oil/water separation, commercial pool treatment and radium removal from groundwater.

DRINKING WATER TREATMENT

The robustness of ceramics compared with polymerics has led to many suppliers targeting industrial and difficult-to-treat waters, however the largest market by volume of membrane sales is still drinking water treatment.

In North America and Europe UF membranes (primarily polymeric membranes) found considerable market success in drinking water treatment because the membrane is a physical barrier for microorganisms such as cryptosporidium. Outbreaks of cryptosporidium contamination in the early 90s in Nevada and Wisconsin made removal of disinfection resistant microbes a critical priority for municipalities.

▲ By grouping 200 ceramic elements into one vessel, PWN claims this will cut down on the amount of energy needed when backwashing the membranes

Recent large-scale drinking water installations completed by PWN (Metawater/NGK) indicate that ceramics are beginning to show life-cycle cost competitiveness with polymeric membranes. A principal challenge with evaluating ceramic life-cycle cost to date was validating the service life claims of the membranes (estimated by suppliers at 15-20 years).

Commercial installations by companies such as Purifics have now been active since the early 1990s, many of which are still using the original membrane module. The validation of this claim, combined with Metawater's decreasing module CAPEX (estimated at US$100/m^2) and the market's growing familiarity with the technology indicate strong potential for future growth in drinking water treatment.

A recent project tender for an upgrade to the 7 MGD (26,500 m^3/day) Butte-Silver Bow Public Works Department's Basin Creek Water Treatment Plant in the US revealed that the proposed Metawater ceramic monolith system showed a better 20-year life cycle cost than the three competing UF systems proposals.

Two of the proposals were disqualified due to compliance failures in the scope, but the other accepted bid was more than US$0.9 million more than Metawater's US$8.7 million tender. Provision of a warranty for the system, a specific request of the project owners, may have contributed to Metawater's cost advantage.

Recently complete large-scale projects include the 171,000 m^3/day plant in Yokahama, Japan, the 120,000 m^3/day Andijk III plant in the Netherlands, and a 37,000 m^3/day plant in Colorado. In late 2014, a 90,000 m^3/day project was tendered in Plymouth, UK.

The added fouling resistance and ease of cleaning ceramic modules led

Table 1: Application for ceramic membranes

Markets for ceramic membranes	Application frequency	Suppliers active
Drinking water treatment	Majority of installations and installed capacity of ceramic membranes	Metawater (PWN), Purifics, ITN, Liqtech, Likuid
Groundwater treatment	Few installations	Purifics, ItN Nanovation, Meidensha
Industrial process water/ wastewater treatment	Many installations, much smaller in size (100-1000 m^3/d) compared with DW	Tami, Atech, Liqtech, Likuid
Commercial pool water treatment	Few installations	Liqtech
Produced water treatment	Minimal installations	Veolia, Liqtech, Cerahelix

many to speculate that produced water treatment and oil/grease removal represented a strong market opportunity for ceramics. Installations in the oil and gas industry have been few, with Veolia (CeraMem) the most active company in this area. Veolia claims to have three installations (300-400 m^3/day in size) to date despite seven years of aggressively targeting the market.

Given the challenge with commercialising new water technologies in the oil and gas sector, this can be viewed as a minor success. However, given the recent decline in oil prices that are straining the targeted market segments (Canadian Oil Sands and US Shale Oil) growth potential in this area appears limited. Nevertheless, this market continues to be one targeted by ceramic membrane companies.

EARLY STAGE INNOVATION

Young companies around the world are developing novel methods of producing ceramic membranes, even as key established producers strive to bring down the price to compete with polymeric membranes on a whole-life cost basis.

Ceramic membranes are typically produced by applying a slurry of oxide particles and solvents onto a supporting substrate and sintering the membrane in a kiln. It is a multi-step process involving successively finer layers on a substrate to produce smaller pore sizes (an important difference to polymeric membranes that can be produced "asymmetrically" in a single step).

A crop of innovative companies has appeared over the last few years offering unique and new ways to produce ceramic membranes. Some of the new methods may lead to lower production costs, while others provide enhanced performance characteristics that may swing the economics for other reasons. The following four companies are among the innovators.

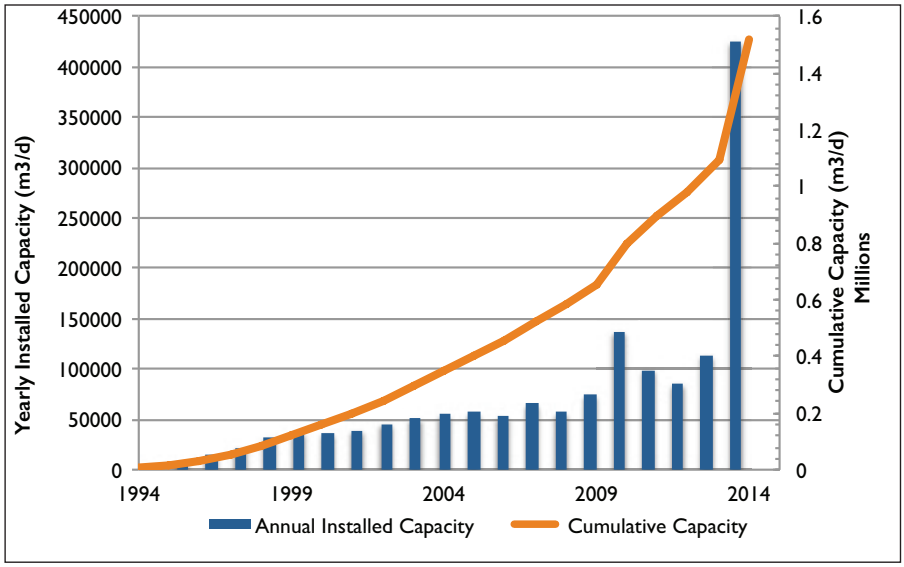


Figure 1: Ceramic S-Curve - Ceramic ultrafiltration membrane adoption for water and wastewater applications over the previous 20 years.

METAL MEMBRANES

Metal Membranes takes a thin sheet of metal, aluminum or titanium and exposes it to a plasma arc. The plasma arc creates a highly oxidising environment at the surface of the metal plate that forms a metal-oxide layer (i.e. a porous ceramic layer – either aluminum oxide or titanium dioxide).

The reverse of the metal plate is then etched to leave just the ceramic layer exposed. A metal plate is used as a structural support. One of the potential advantages of this manufacturing approach is that you can create very thin, layered ceramic membranes. The company indicates that it can get pore sizes in the <1nm (0.001µm) range.

CERAHELIX

The Helix NFM is a ceramic nanofiltration membrane with pore sizes of approximately 1nm. The membranes are based on a (non-crystalline) titania ceramic that enables Cerahelix to narrow the pore size range. Titania is more expensive than alumina and has relatively high permeability, high hydrophilicity, a wide pH range, and is suitable for UF, nanofiltration (NF) and as a substrate.

The core of the Cerahelix technology is the method of producing the membrane layer on the substrate. A solution is produced containing DNA strands. The solution forms a gel in which the DNA strands are aligned.

This gel coats the ceramic substrate and during the sintering process the DNA is burned off, producing a ceramic membrane with a tight pore size range and straight pore channels. The straight pore channels and thinness of the active membrane layer holds the promise of better flux rates than other ceramic membranes.

Current pilot units consist of tubular or multi-channel membranes operated in cross-flow. Cerahelix has produced flat-sheet membranes as well and, for high-volume applications, will offer monoliths with more channels than its current multi-channel systems.

NANOSUN

NanoSun has developed a novel flexible membrane based on titanium dioxide nanofibers with a pore size ranging

from 0.1µm to 1µm (microfiltration). Lab testing has shown the membrane to have several key advantages including

- Very high flux (up to 960LMH has been demonstrated in the lab)
- Low fouling rates, high temperature tolerance (it can be heated to 250°C to burn off organic foulants
- The ability to perform photocatalytic oxidation by exciting the titanium dioxide nanofibers with UV radiation.

The TiO2 nanofiber membrane forms a scaffold type structure and has inherent biocidal properties as well.

NanoSun's membrane is fabricated using a 3D-printing technology developed at Nanyang Technological University (NTU) with nanofibres fabricated from an electrospinning process are used as an input material. Although there are TiO2-based ceramic membranes, there are no commercial TiO2 nano-composite membranes on the market, and no other membranes are produced currently through 3D printing.

This suggests that if the membrane qualities claimed by NanoSun can be validated, the technology could be highly disruptive to the membrane market. Current testing has been done using flat-sheet plate and frame membranes; however the flexible nature of the membrane is enabling NanoSun to explore spiral-wound form factors.

LANCE ENERGY SERVICES

Lance Energy Services has developed a novel chemical treatment to produce "nano-functionalized ceramic membranes". The majority of testing to date has been with 0.2µm pore size (200nm) membranes.

The company indicated that the chemical treatment is not simply a coating of the membrane but results in an impregnation of the original ceramic membrane. As a result of the penetration of the chemical treatment, the modification does not wear out or disassociate from the membrane. The result of the chemical treatment is that the membrane becomes strongly hydrophilic and, as the company describes it, "organo-phobic".

According to the patent, the result is a ceramic membrane with "functionalised alumoxane nanoparticles, and zitterionic cysteic acid molecules" that make the membrane hydrophilic and prevent oil from attaching to the membrane surface.

The key advantage of the Lance Energy membrane is its anti-fouling properties with respect to oils and bacteria. The "organo-phobic" behaviour is believed to be due to the formation of an aqueous layer on the surface of the membrane that provides an entropic barrier, preventing oil droplets from contacting the surface of the membrane.

LONG-TERM SUCCESS INDICATED

Growing numbers of installations by major technology providers like Metawater, as well as new innovations that look to fundamentally change the production of ceramic membranes, combine with a growing market competitiveness to indicate a strong future for ceramics.

Author's note: Tyler Algeo is director of research and James Fotouhi is a water technology market analyst at BlueTech Research. For more information, email: sefan.urioc@bluetechresearch.com.

ENERGY POSITIVE WASTEWATER TREATMENT

A Lesson from Hamburg, Germany

German utility Hamburg Wasser is expecting its electricity production to exceed consumption by 15% and this year half its energy bills to €4 million. Using a combination of on-site biogas and wind energy, the water company explains why merging conventional and unconventional thinking led to a win-win solution.

By Lueder Garleff

Germany's largest wastewater treatment plant (WWTP) "Köhlbrandhöft / Dradenau" processes the wastewater of almost two million people and the industry of Europe's third biggest seaport. Operated by Hamburg Wasser with an electricity demand of 80 MWh p.a. it is still one of the biggest public energy consumers in the city.

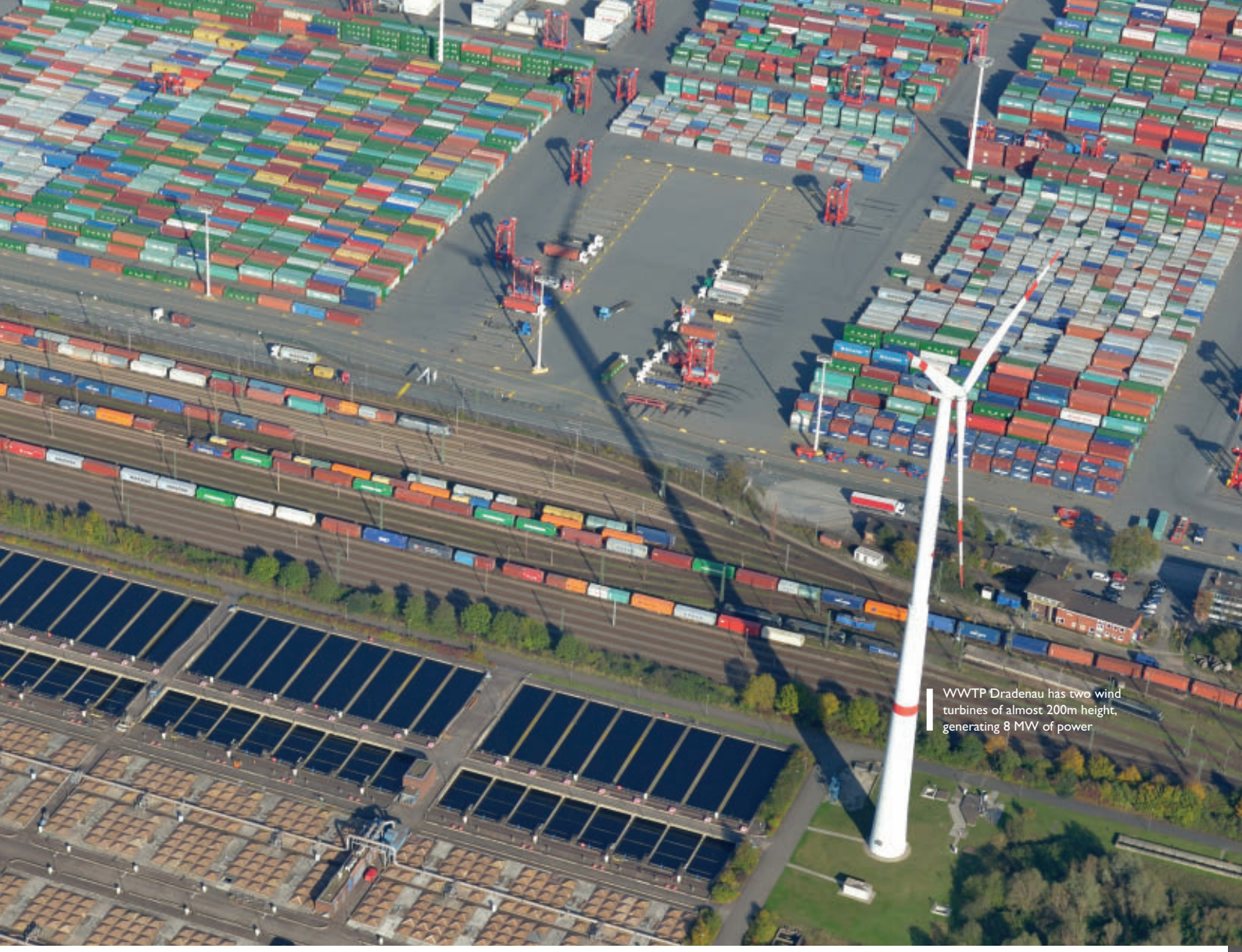
Before 1995 the energy-world was relatively simple: the energy demand was covered by electricity bought from the local supplier and natural gas from the grids. There was a monopoly of grid operators and a very small range for negotiating energy prices in Germany at that time. Climate change and renewable energy were not yet the main topics in public discussions.

Only with the liberalisation of the electricity market in 1998, energy management had a real chance to combine technical and economic aspects to gain considerable benefits. This prospect then made Hamburg Wasser address energy management with the task to reduce energy costs using legal, economic and technical framework conditions. These aspects became more and more important, when energy prices increased from 2004 onwards.

Following the urging challenges to counter climate change, the utility enforced its efforts and defined the official target to create an energy-self-sufficient WWTP until 2011. By doing this, the public owned company also supported the political targets of the Free and Hanseatic City of Hamburg, as the official "European Green Capital" of 2011.

1ST APPROACH: SLUDGE ENERGY

The first and most important technical change arose from changing conditions for the disposal of sewage sludge in the early 1990s. Hamburg, as a city with high population density, had always dumped its sewage sludge on landfills. Due to the high amounts of sludge, agricultural use ceased to be an option because transporting the sludge became more and more expensive.



WWTP Dradenau has two wind turbines of almost 200m height, generating 8 MW of power

Instead, digesting the sludge on site was a way to decrease the amount of sludge. In a first development phase, the digester gas was then used for heating the digesters, but not for effective electricity production. When sludge disposal on landfills was prohibited, Hamburg decided to invest in a high-tech solution to dry and incinerate the sewage sludge in a combined process with the usage of digester gas for electricity generation. The incineration plant named VERA was put into operation in 1998 as a showcase project of the World Exhibition 2000 in Hannover, Germany. Today it is still the backbone of the treatment plant´s energy supply.

After mechanical dewatering and thermal drying the sludge is incinerated in fluidised bed incinerators. The heat is used to produce steam, driving a steam turbine for electricity production. So far the process is similar to common power plant technology. The highlight, however, is the very close interconnection of heat and digester gas systems. VERA covers the high heat demand of the thermal sludge drying plant on a high temperature level.

For this purpose, steam is withdrawn from the two-stage steam turbine from a tapping behind the first stage. The residual waste heat of the thermal drying process on a low temperature level is subsequently used to supply the digesters, all buildings of the WWTP and – since 2009 - even the neighboring container terminal of the Hamburg seaport. By this, the heat demand was covered by 109% in 2013.

EFFICIENT DIGESTER GAS

Using digester gas for electricity generation has become a general standard solution for wastewater treatment plants. In Hamburg this is also integrated in the VERA. Digester gas is combusted in a gas turbine of 5 MW and a gas engine of 2 MW rated power. The exhaust waste heat is then again used for steam production, feeding the same steam turbine as the sludge incineration. This combination leads to a very high electrical efficiency of 42%.

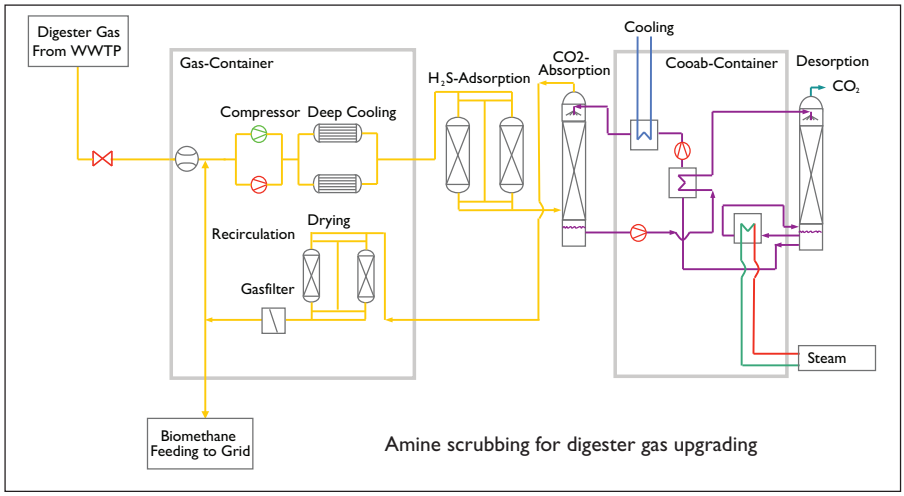
However, energy self-sufficiency could not have been gained solely by extending energy production. Reducing energy consumption is equally important and more valuable from the ecological point of view. As a result, Hamburg Wasser implemented a number of projects as a result of a systematic data acquisition and analysis of the energy demand of every single sub-process. For example, a modern aeration system reduces the plant's electricity demand by almost 18%, several additional projects lead to an overall saving of more than 20%.

FILLING THE GAP: WIND ENERGY FOR INDUSTRIAL SELF PROVISION

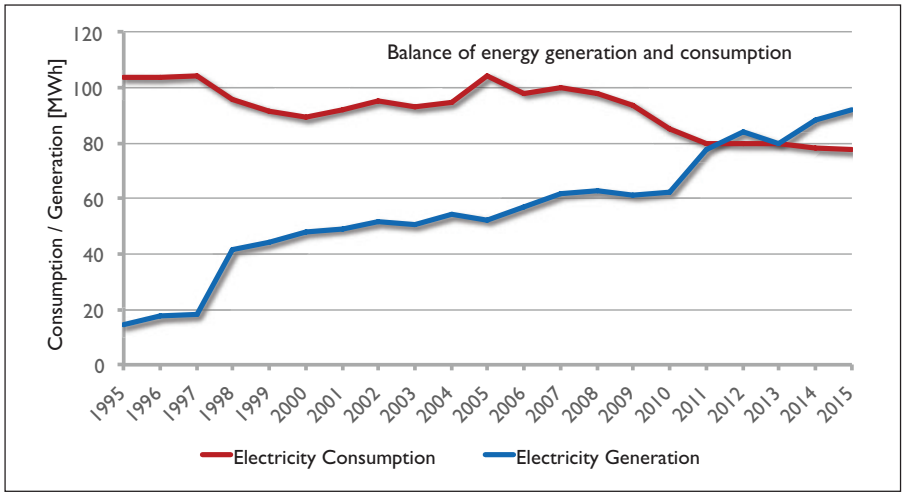
The geographical situation of Hamburg not too far from the North Sea provides a considerable potential for using wind energy.

However, the idea of using it for self-provision of an industrial plant was not that common and required new

VERA is a high-tech solution for the combination of sewage sludge incineration and digester gas usage



Amine scrubbing for digester gas upgrading



legal and contractual models for energy procurement and sale. Furthermore, the turbines had to be equipped with advanced and multiple safety systems e.g. for ice detection, machine monitoring, fire extinguishing. This was required to ensure that the plant could not pose any risk to the WWTP itself, but also for the surrounding container terminals and seaport traffic.

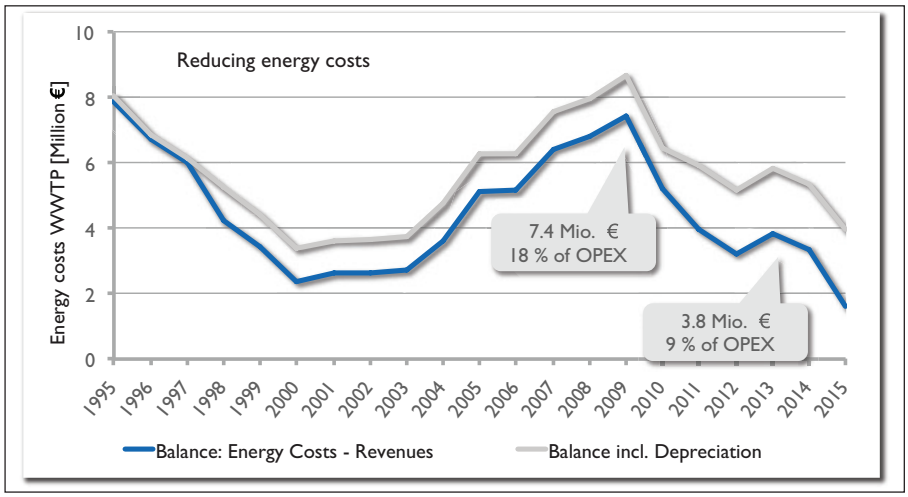
Nevertheless, the utility installed three wind turbines with an overall rated power of 8 MW. With their hub height of 140 m and rotor diameter of more than 100 m they are now part of the seaport skyline.

Even though wind power is not an obviously reliable source, the yearly balance of energy consumption and production today reveals a remarkable energy surplus.

THE SURPLUS: FEEDING DIGESTER GAS INTO THE NATURAL GAS GRID

The amount of digester gas production was significantly increased by co-fermentation of various types of biological wastes.

This was initially also intensified regarding the revenues from this business and became more and more important for reducing the energy



demand and costs. Since it became clear that the gas production would soon exceed the usage capacities, Hamburg Wasser had to decide about the right technology for extending these capacities.

The simple way – increase of electricity generation – was obviously not the best, since there was no use for the extra heat. Even the electricity self-sufficiency was already in sight. The solution was not to use the gas for self provision, but to sell it to the natural gas grid.

Due to the different contents and qualities of digester and natural gas, a plant for upgrading the digester gas has been installed – one of the first plants using that technology, running on digester gas. The main task is to remove carbon dioxide from the raw digester gas, which is done by an amine scrubbing process. This treatment was chosen, because it requires heat as auxiliary energy for regeneration of the amine suspension.

Heat demand again can be covered from the sludge incineration in a very efficient and economic way. The whole plant is constructed in a modular container based unit and turned out to be a very reliable system. It can be controlled very flexibly and is therefore also used to control the digester gas usage according to the actual electricity demand of the WWTP.

WIN WIN

From 1995 onwards, the electricity consumption has been reduced from more than 100 GWh p.a. to less than 79 GWh p.a. At the same time, the renewable electricity generation increased to more than 80 GWh p.a. Both trends will continue in the future as further projects are under construction. At the final stage the electricity production will exceed consumption by 15%. Concerning heat supply, a continuous surplus of almost 10% has already been achieved since 2010.

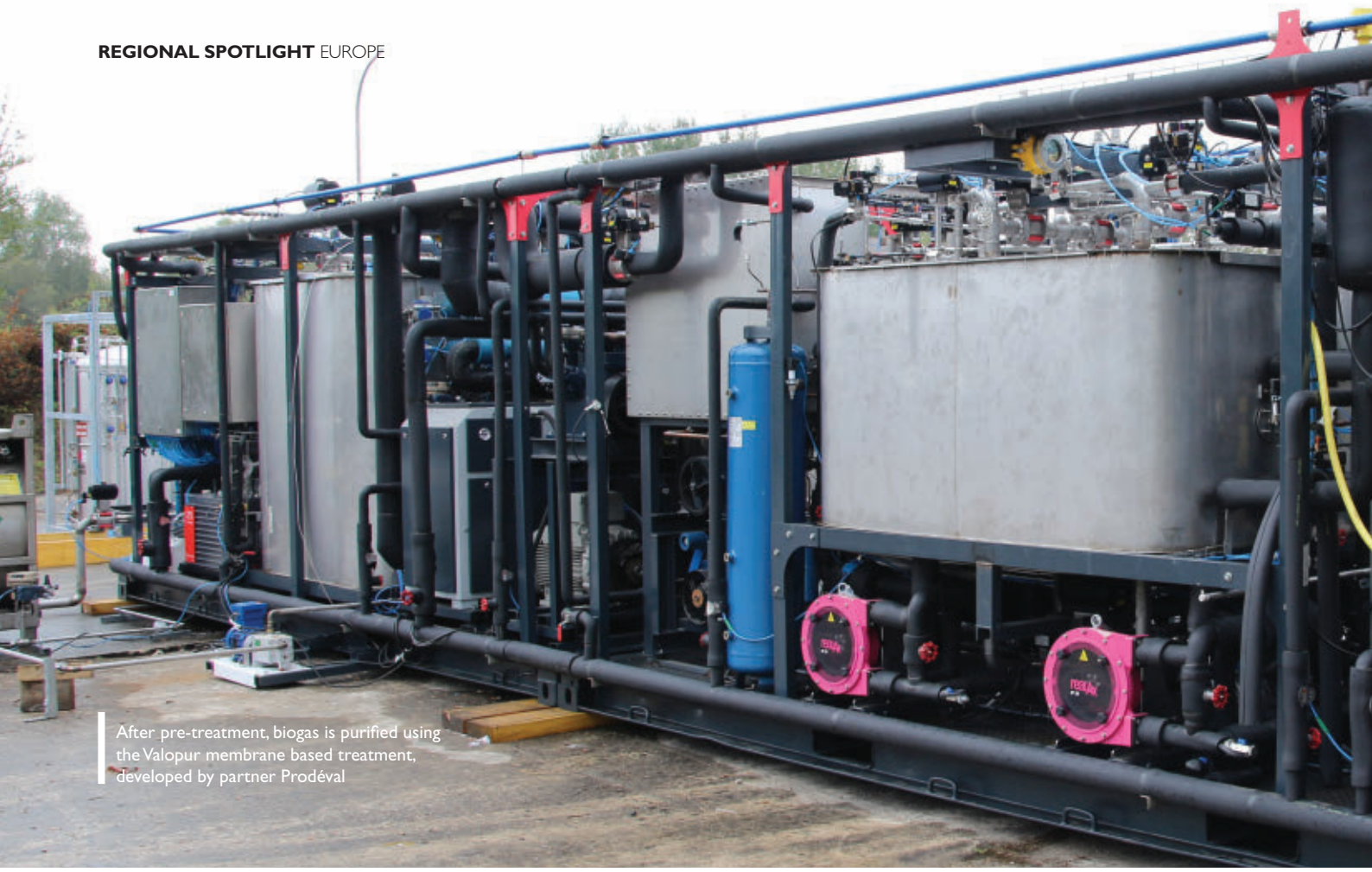
Every single project, of course, has to pass a thorough payback analysis. If technical approaches are failing in this aspect, they are reassessed when changing frame conditions, giving reasons to expect a positive result. Thus the savings of energy costs exceed by far the operation and capital expenditures of the implemented projects. The overall balance of energy procurement expenditures, revenues from energy sale, operation and capital costs of energy production will decrease from €8.7 million in 2009 to about €4 million in 2015 – and that almost without any public subsidies.

Another economic aspect is almost as important: energy costs have become predictable now and almost independent from volatile energy prices. Since 2007, the electricity price continuously increased by 65% - almost 10% p.a!

At the same time energy costs for the WWTP decreased by 30% and are on a constant level for three years now, since they are more and more dominated by capital costs, not by energy markets.

After all, the energy concept has come to an ecological and economic success, which already stimulated similar strategies in other German cities and attracts worldwide attention – and we are still moving forward.

Author's note: Lueder Garleff is in the energy management team at Hamburg Wasser. More information on the utility can be found at: www.hamburgwasser.de



After pre-treatment, biogas is purified using the Valopur membrane based treatment, developed by partner Prodéval

VA VA VOOM LIQUEFIED BIOGAS FROM WASTEWATER ACCELERATES IN FRANCE

French water treatment company Suez Environnement has developed an innovative new process that converts wastewater into liquefied biogas (LBG) using membrane based technology. So, how exactly does the technology work? What is the biomethane used for? And what are the potential uses of the BioGNVAL system in industrial applications? *Andrew Williams reports.*

In recent years, there has been a growing recognition that biogas, a natural by-product of the anaerobic digestion of organic matter can be used to produce biomethane, a potentially abundant source of renewable energy. Following compression or liquefaction, biomethane can be pumped directly into the natural gas grid and used as a non-polluting fuel source for a variety of vehicles.

However, in some countries, the use of biomethane is limited - either because the domestic natural gas grid does not have enough capacity or because grid connections are located too far from production facilities - meaning that the resource is sometimes not exploited to its full potential.

In an effort to help in remedying this situation, SUEZ environnement has devised a new purification technology, known as BioGNVAL, which recovers some 40% of the available biogas that cannot be injected into the natural gas network, and converts it into a storable fuel that be transported over long-distances by lorries.

The development of CNG solutions for transport, through the 'blue corridor project' in Europe, will create a need for more LBG solutions, says Coursan

"In France, we can inject biomethane into [the] natural gas grid, but for many projects the grid won't have enough capacity or will be too far from the producer. So, the produc[tion] of LBG is a solution to valorise biomethane directly into biofuel or energy for industrial [applications] that are not connected to the natural gas grid," says Pierre Coursan, marketing manager - biogas and energy efficiency at SUEZ environnement.

MEMBRANE TREATMENT

In June 2014, the first membrane treatment demonstration unit producing biomethane using biogas from sludge digestion was installed - and is still currently operated - by the company at the Arvéa wastewater treatment plant in La Roche-sur-Foron, France.

The novel solution has also been under testing since December 2014 in Valenton, France at the Seine Amont wastewater treatment plant owned by the SIAAP (the Interdepartmental wastewater authority for the Greater Paris area).

After pre-treatment, the biogas is purified using the Valopur membrane based treatment technique, developed by SUEZ environnement 's partner Prodéval, which Coursan describes as a "simple, robust and open-ended process" that creates biomethane capable of being injected directly into the natural gas network - and which has also been successfully tested as a biofuel for a car.

Following this stage, the BioGNVAL

solution is used to treat any surplus biomethane that cannot be pumped into the grid. As Coursan explains, the solution works by purifying the biogas and liquefying it "using cryogenic technology to reduce its volume by 1,000".

Coursan adds: "Membrane technology is very simple to use and very compact. It is also very robust. The system is modular [and] we can add membranes if necessary if flow rate grows. We tested the capacity of the membranes to adapt themselves to flow rate fluctuations and the results are good - the efficiency on methane is constant at 99.5%."

UNFAVOURABLE TARIFF SYSTEM

For Coursan, the key advantage of the technology, which was developed by SUEZ environnement as part of a partnership with EReIE - an organisation specialising in the use of mixed refrigerant systems to produce clean energy - and supported by the French Environment and Energy Management Agency (ADEME) as part of its Investments for the Future programme, is the "unique system of refrigeration to purify the biogas and to liquefy the biomethane".

"The system is also easier to manage than classical systems which use two or three technologies to do the same thing," he adds.

Biogas also benefits from the fact that it is a durable and easily stored resource that is relatively methane-rich, and which is readily available as a by-product of existing infrastructural facilities, particularly at sewage treatment and other anaerobic digestion plants.

Even so, Coursan admits that, in common with many renewable energy technologies, the BioGNVAL solution would still benefit from continued public sector backing and more favourable tariff systems - and he regrets that the policy landscape in France is no longer as supportive as it once was.

"As for every renewable energy, LBG needs ... specific help from administration[s] to be developed. For example, there was a special tariff for biomethane injected into the natural gas grid or for electricity produced from biogas, which no longer exists in France," he says.

BIOGAS TREATMENT UNIT

In September 2014, construction work began on another biogas treatment unit that will use the new technology, at the Strasbourg-La Wantzenau wastewater treatment plant, also in France.

According to Coursan, SUEZ environnement has signed a fifteen year agreement with Lyonnaise des Eaux and Réseau Gaz Distribution Services, under which biomethane produced at the facility will be injected into the city's natural gas network.

"As part of the Strasbourg project ... which is supported by the European Union's Life+ programme ... biomethane will be injected into the natural gas grid. We chose a membrane technology. Works are in progress and we would be able to inject in June [2015]," he adds.

SUEZ environnement has also recently won another fifteen-year contract - this time from the Greater Grenoble (France)-Alpes Métropole urban authority - to work alongside Gaz Electricité de Grenoble to build and operate a unit that will recover the excess biogas produced at the local Aquapole wastewater treatment plant and converting it into biomethane using the Prodéval membrane technology - before injecting the biomethane into the natural gas network. After the Strasbourg facility, the wastewater treatment plant at Grenoble will be only the second in France that is capable of injecting biomethane from sludge methanisation into the natural gas network.

A key feature of the Grenoble project is an innovative financial model, whereby Grenoble-Alpes Métropole receives a royalty from the income generated by the sale of the biomethane.

According to Coursan, the project will also facilitate the "local recovery" of part of the biomethane produced at the plant, which will be used to supply green fuel for urban transport - helping to create what he describes as "a sustainable local energy model".

Looking ahead, Coursan is also confident that there are a number of potential future commercial markets and applications for the BioGNVAL

STRONG GROWTH IN THE EUROPEAN BIOGAS SECTOR

Late last year, the European Biogas Association (EBA) published its annual Biogas Report. It revealed that current electrical and thermal energy production from biogas across Europe is roughly the same as the annual consumption of all the households in Belgium and Slovenia combined - equating to the output of some 15 coal power plants with an average capacity of 500 MWel.

Analysis of the data collected for the latest EBA report also confirms a continued upward trajectory - finding evidence for a strong increase in biogas production across Europe, as well as in the total number of biogas plants over the reporting period. In all, some 760 new plants opened in 2013 alone and annual biogas production across the continent is now 92.315 GWh/year.

In another encouraging development, the report also finds that, in common with biogas sector at large, the biomethane industry continues to experience strong growth - with a total of 282 plants across Europe, equating to a combined production of some 1.375 billion m^3, currently in operation across the continent.

For the EBA, this rapid growth is at least partly due to what it describes as an increasing variety of "utilisation possibilities" - in particular, a massive rise in the number of biomethane filling stations, which more than doubled in 2013, in the process helping to increase the share of biomethane used in transport to "10% of the total produced biomethane in Europe".

"The most successful countries are indeed the largest producers at the moment - Germany, Italy, Switzerland, France, the Czech Republic and the UK," says EBA President, Dr. Jan Stambasky.

The EBA also earmarks the Scandinavian countries as key growth areas that continue to enjoy a steady rise. One particularly solid performer in the Nordic region is Finland, where the levels of biogas consumed in the transport sector has increased by 168% - making it the "dominant growth factor" for biogas across the nation.

Just across the Gulf of Finland, Estonia is also showing signs of strong growth - and the country is expected to establish a new investment support programme for biomethane plant constructions very soon. The EBA also reports that schemes to upgrade biogas plants by converting them to biomethane and grid injection facilities is now rising 'in most of the biomethane producing countries,' - including France, but also Austria, Germany, the Netherlands and Sweden.

Biogas is durable and is an easily stored resource that is relatively methane-rich, available as a by-product of existing infrastructure facilities, particularly at wastewater treatment and other anaerobic digestion plants

solution. One key growth area is likely to be the use of liquid biomethane in long distance transport by truck.

Since its establishment in May 2014 the EU-backed LNG Blue Corridors project has supported the installation of five dedicated LNG refuelling stations across the continent - the SGA Station in Sweden and the GOLD Station in Portugal, as well as the Gas Natural Fenosa in Spain, the ENI Station in Italy and the Drive System in Belgium.

"Whenever it is possible to inject biomethane directly into the natural gas grid, we can use simple technological solutions such as membranes or others," says Coursan. "However, with the development of CNG solutions for transport, for example through the 'blue corridor project' in Europe, we will need more and more LBG solutions."

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CLOSING THE NUTRIENT CYCLE

Circular Economy Thinking for Phosphorus Recovery

Commercialisation of nutrient recovery technologies are progressing across Europe, with a contract signed earlier this year to recycle phosphorus from 60,000 tons of sewage sludge ash. This article looks at progress and options from other companies against market barriers such as raw material prices and legal frameworks.

By Dr. Christian Kabbe

To sustain good agricultural harvests, about one million tons (907,185 tonnes) of mineral phosphorus have to be imported into Europe annually. However, the potential to recover and recycle this essential resource remains untapped or, in the case of sewage sludge, is currently inefficiently used.

In the recent years various technical alternatives to the traditional but disputed application of sludge in agriculture have been developed to recover the nutrients. User friendly solutions have already made their way to full-scale or at least pilot-scale application.

Yet, it is not enough to just recover nutrients. To achieve real recycling, the gap between recovery and return of phosphorus into the nutrient cycle needs to be closed. The supply side needs to match with the requirements of the demand side and the regulative framework.

PHOSPHORUS RECOVERY

For the implementation to market, new technologies need to be proven capable and feasible. Today, three main routes for phosphorus recovery are discussed and partly demonstrated. As shown in figure 1 and given the fact that most of the phosphorus entering a wastewater treatment plant (WWTP) ends up in the sludge, three principle and complementary routes for closing the phosphorus cycle by recovery from the wastewater stream appear to be reasonable.

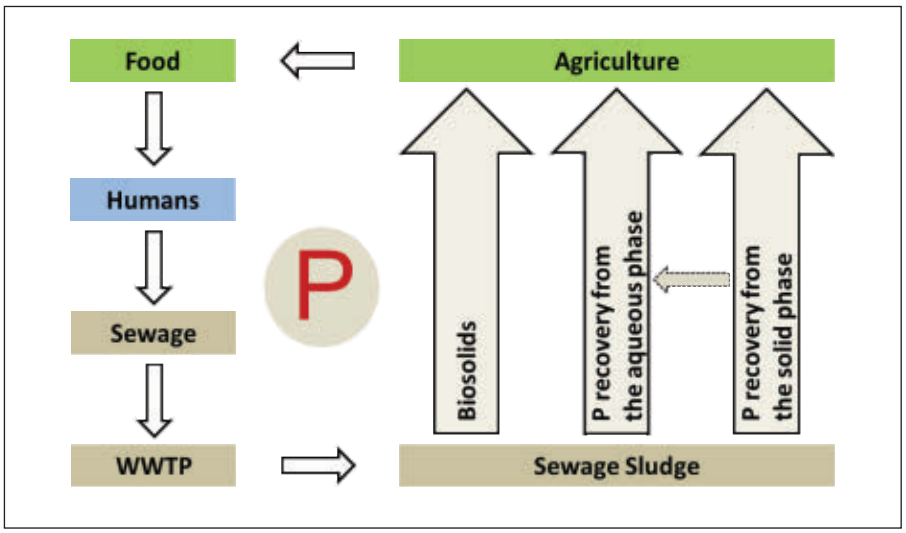

Figure 1: The three principle pillars for P recovery from the wastewater stream

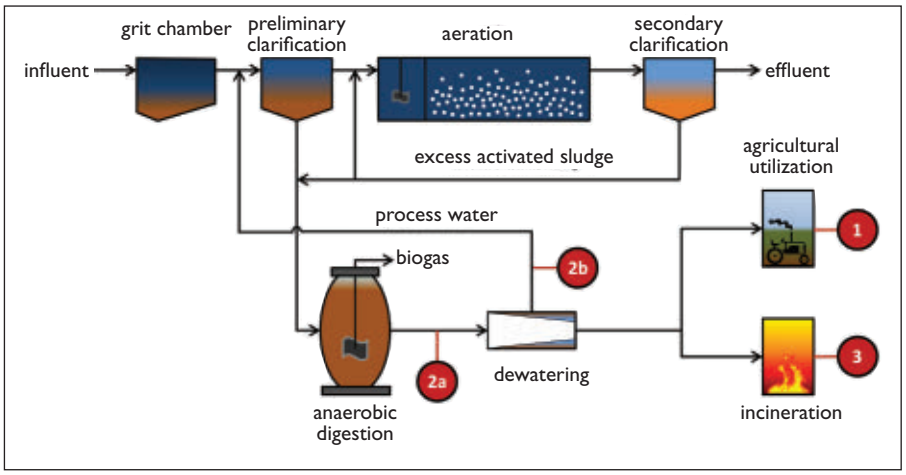

Figure 2: Hotspots for phosphorus (P) recovery from the wastewater stream (in centralised sanitation systems) Source: (Kabbe, 2013) Legend: 1 – direct sludge (biosolids) application in agriculture; 2a – P recovery from aqueous sludge phase prior to dewatering; 2b – P recovery from sludge liquor after dewatering; 3 – P recovery from mono-incineration ash.

Meanwhile, figure 2 illustrates the hot spots for phosphorus recovery from wastewater. Direct application of stabilised sewage sludge or so-called biosolids on arable land is the traditional path to valorise the contained nutrients in agriculture, as long as they can be taken up by the roots of the crops.

The UK and several European countries favor this solution and it will remain one of the pillars for phosphorus recycling on international scale. To make this path as safe as possible, harmful substances within the wastewater treatment scheme should be replaced by harmless alternatives. Current monitoring routines hardly reflect the chemical constitution of a heterogeneous matrix like sewage sludge.

Depending on wastewater treatment infrastructure, phosphorus can be technically recovered from the aqueous phase of the sludge prior or subsequent to the sludge dewatering process. If sludge is incinerated in mono-incineration plants, the resulting ash contains the highest available concentrate of phosphorus within the wastewater stream. But, due to the very limited plant-availability of the nutrient within the ash, further treatment is obligatory.

STRUVITE RECOVERY

Struvite (magnesium ammonium phosphate) tends to be a favored approach and is the final step of many phosphorus recovery technologies. It can provide a slow-release fertiliser with excellent plant-availability of the nutrients phosphorus, nitrogen and magnesium. It is even considered a suitable mineral fertiliser for organic farming.

Prior to dewatering, by crystallising struvite directly after the digestion within the sludge, the efficiency of the

sludge dewatering can be increased dramatically. In large WWTPs like Berlin Wassmannsdorf (operated by utility Berliner Wasserbetriebe) this kind of optimisation after installation of an AirPrex® unit led to substantial reduction of operational costs for the WWTP summing up to several hundred thousand Euros per year, even without selling the struvite.

These benefits are mainly achieved by reduced disposal costs due to improved dewatering of sludge, lower polymer demand and lower maintenance costs (scaling in pipes and abrasion in centrifuges) and a reduced return load in the sludge liquor. Every process optimisation has the potential to increase the overall energy efficiency.

One proven option to enhance the yield of struvite is a combination with thermal (for example, using technology from Norwegian firm, Cambi AS) or chemical (i.e. PONDUS, Germany) hydrolysis for disintegration of excess activated sludge.

Besides improved biogas production in the subsequent digester, also insoluble or hardly soluble polyphosphates are transformed into soluble ortho-phosphate available for struvite crystallisation in the sludge water. Both combinations will be implemented in full-scale in the coming months and years in the cities of Brunswick, Uelzen, Salzgitter and others in Germany.

HEAVY METALS AND IMPURITIES

Recovered struvite within the sludge might include more impurities than the material crystallised from the process water after dewatering.

But, in the end, both qualities are already certified safe fertilisers (i.e. Berliner Pflanze or Crystal Green from Canadian firm, Ostara). Every plant operator needs to choose the option that fits the most to his expectations, needs and infrastructure.

Operational benefits are of course a strong argument, especially when the feasibility of the technology is independent from the sales price for the obtained recycling product. Unfortunately, most of these technologies are limited to WWTPs with enhanced biological phosphorus removal (EBPR) followed by digestion.

If the phosphorus is removed from the wastewater by precipitation in form of hardly soluble iron or aluminum salts, which is the case for most of the existing wastewater treatment plants, direct struvite crystallisation is not feasible. The phosphorus needs to be remobilised first, normally done by hard chemical treatment like acid leaching at low pH value.

The challenge within this approach is the separation of the simultaneously remobilised heavy metals from the phosphorus and the post-treatment or disposal of the contaminated acid solutions. The higher the targeted phosphorus yield, the higher the chemicals consumption and collateral impact on the WWTP and the environment. So, high phosphorus recovery rates (>70%) can only be achieved at high cost.

A very promising and green alternative is being developed by the German company Budenheim. Here, only applying carbon dioxide as solving agent that is internally recycled and then plant-available and marketable dicalcium phosphate is precipitated.

Recovery rates above 50% have been demonstrated in medium scale and are now to be replicated and increased in pilot scale in the cities of Mainz and Itzehoe. The co-incineration of the phosphorus degraded sludge solids in

cement kilns opens the door for zero waste scenarios.

INCINERATION OPTIONS

When the sludge is about to be incinerated in mono-incinerators, several options for phosphorus recovery can be applied. Currently, only a part of the sludge is incinerated without dilution. With a lack of ash treatment facilities and interim storage capacities, most of the phosphorus in these ashes is lost.

If legal requirements will enter into force as currently being discussed in Germany, the future of thermal treatment of sewage sludge must include phosphorus recovery. Co-incineration means dilution of the phosphorus content and will therefore be restricted, unless the phosphorus has been removed before.

If sludge is incinerated in a mono-incineration plant (Figure 2, number 3) a high phosphorus concentrate can be produced from waste streams. The phosphorus content in municipal sewage sludge ashes (SSA) ranges between 2% and 12% in Germany. But, due to very limited plant availability of the nutrient within most of the ashes, further treatment is needed before it can be fully used as a resource.

The reality is that with a lack of ash treatment facilities and interim storage capacities, most of the phosphorus in the ash is lost today. Looking at existing infrastructure, it looks promising if we partly substitute phosphate rock in commercial fertiliser production.

European fertiliser companies have already started to test the substitution potential of sewage sludge ash and other secondary sources, even on a large scale. However, the application is limited due to legal barriers for the integration of waste material and specific requirements from the operator's perspective. Desirable high phosphorus content in the ashes, iron and chlorine also turn out to be a limiting factors among others here.

COMMERCIAL PROGRESS

Comparable to that scenario is the wet chemical extraction and ion-exchange purification of low-grade phosphate rock and other raw materials developed by Belgium company, EcoPhos. This allows the production of high-grade phosphates.

Two facilities are currently in preparation: one demonstration plant in Varna, Bulgaria followed by a full-scale facility in Dunkerque, France. EcoPhos had just signed a contract in February 2015 with SNB and HVC, both Dutch mono-incinerators, to recycle phosphorus from 60,000 tons of sewage sludge ash. A similar route is intended by the German company Remondis Aqua with its TetraPhos technology, yielding high-grade phosphoric acid.

The first pilot unit is currently assembled in Hamburg and said to be quickly followed by a full-scale plant (20,000 to 25,000 tons ash/a) on the same site.

Looking at the Mephrec (metallurgical phosphorus recycling) process developed by German company Ingitec, thermal valorization and phosphorus recovery in one single step are not mutually exclusive. A pilot project is currently in preparation in the city of Nuremberg, Germany. If a municipality or region decides for a new mono-incineration, the integrated solution of mono-incinerator and ASH DEC recovery module provided by Outotec might be an elegant option as well.

OUTLOOK

A focus should be put on bringing existing and feasible technologies to the market and not to increase the spectrum of technologies. The current legal framework and the low prices for raw materials have to be considered as market barriers.

At current price levels for phosphate rock and other raw materials, only legal requirements are likely to boost a wide-spread implementation of phosphorus recovery and recycling from the wastewater stream. Ideas for creating a level playing field for fertilisers have to materialise. This is regardless of whether they are made from fossil or secondary sources.

Otherwise, recovery and recycling technology will not be implemented in Europe if it is not providing benefits to its operators under current conditions. There is a lot of know-how waiting to be shared with huge potential to be creatively transformed into innovation. Think forward, act circular!

Dr. Christian Kabbe is from the Berlin Centre of Competence for Water, Germany. Email: Christian.kabbe@kompetenz.wasser.de.

▲ Greek water protests

GREECE'S WATER PRIVATISATION BATTLE

Surprising to many, Greece is endowed with abundant water resources of 58 billion cubic meters per year. Yet, like its finances, mismanagement has left the country's 230 different municipal utilities in need of help. Government plans to privatise two of Athens' largest water companies didn't go according to plan but at what price for international involvement in the country?

By Jeremy Josephs

Edit the famous song title from the film Grease and you have Greece Lightning. This seems an entirely appropriate analogy for the thunderbolt which has befallen the Greek economy in recent years. Unsurprisingly, this has impacted heavily on each and every aspect of the country's water sector. The country battles against the odds to keep up with the requirements of the European Framework Directive while the topic of water privatisation has been part of an impassioned and ongoing national debate.

So much so that in virtually every institution, from the EU to the OECD and the IMF there is now incessant and anguished discussion about the possible ramifications of what is referred to as Grexit - a Greek withdrawal from the Eurozone monetary union.

While ancient Greece is seen as the seminal civilisation that provided the very foundation of modern Western culture, there is considerably less unanimity as to why it entered into decline in the first place. A recent study published in Scientific journal PLOS ONE argues that it was a 300-year drought that caused the demise of several eastern Mediterranean civilizations and cultures, including ancient Greece, some 3,200 years ago.

Modern day Greece continues to be plagued by severe and regular water shortages, especially on the Greek islands, some of which are supplied by tanker ships or have turned to desalination for water supply. Ironically, the country is in fact endowed with abundant water resources of 58 billion cubic meters per year, of which the country uses just 12%.

Speaking exclusively to WWi magazine, Spyros Kouvelis, Greece's former deputy minister for foreign affairs and current member of the Mediterranean Action Plan of the United Nations Environment Programme, says: "That's because of Greece's particular geography. So when it comes to droughts it depends on which part of the country you are talking about. To simplify matters you can divide Greece with a line through the center.

"While the north is rich in water resources as you move towards eastern Greece and the Aegean, well, precipitation falls dramatically. As for our islands - well, obviously you have a lot of tourism which means everyone requiring water when there happens to be no rainfall at all. So the basic situation is not complicated

▲ Spyros Kouvelis says a 20 year plan is needed for water

- we don't have the water where and when we require it."

Following Wall Street's implosion in 2008 Greece became the epicenter of Europe's debt crisis, oten classed as a weak link in the Eurozone, requiring multiple bailouts.

Mismanagement, unsurprisingly, has been reflected in the country's water sector - not so much in Athens and Thessaloniki, where the two semi-private utilities EYDAP and EYATH are in charge of water supply and sanitation, but in the country's no less than 230 different municipal utilities. The Kallikratis plan for local government reform was designed to merge these smaller municipalities and utilities into larger units. But since the program was presented by the previous socialist Papandreou cabinet rather than the new left-leaning and ruling Syriza party, the plan is now officially "under review".

PRIVATISATION PROBLEMS

The battles relating to the merging of Greece's utilities pale into insignificance when compared to the issue of water privatisation. The government's plan was to privatise both EYDAP and EYATH - the previous government announced that it would reduce its share in the two companies to 51% as part of a broader Hellenic Privatisation Program.

The Greek parliament went further still - arguing that the companies should be sold off in their entirety. Despite early interest from France's Suez Environnement and Israel's Mekorot, there was what could be considered a major political earthquake with the Coalition of the Radical Left (Syriza) being elected as the largest party in the Hellenic Parliament and with its young and charismatic chairman, Alexis Tsipras, being sworn in as Prime Minister of Greece.

Tsipras's message was quite clear: austerity and privatisation were at the very top of his 'no' list. The Irish anti-water charges campaign became 'inspirational' to the people of Greece, according to Maria Karagianni, a member of Syriza's youth wing, who was closely involved in the three yearlong running anti-privatisation campaign which culminated in a referendum in May 2014 in which the people voted overwhelming "Okh'I" – no in Greek.

Greece's highest constitutional court, the Council of State, took the unprecedented step of blocking the proposed privatisation of the country's biggest water utility (Athens Water) on the grounds that the sale could put public health at risk. Both Suez Environnement and Mekerot were expectantly unavailable for comment on the issue.

TARGETING AGRICULTURE

Kouvelis adds: "The key issue, in my view, is that we need a full restructuring of how agriculture is carried out in Greece."

"To free up water with a view to doing better and more sustainable things. For example we need improved irrigation technologies. Water cannons irrigating maize in the middle of the day - 40% evaporates and doesn't even reach the crops - whilst at the same the EU continues to subsidize crops like cotton which are not at all sustainable. It's crazy.

"The key here is to make sure that you have appropriate water management in the long-term because we have 16,000 kms of coast line with tourism and cities developing apace. This means that you have to have not a five-year but a 20-year plan - really looking ahead into the future with a view to developing the accompanying infrastructure appropriately."

Kouvelis adds: "Broadly speaking we have to take on board the notion that water is part of the renewable energy source of Greece - especially in terms of the smaller hydro power stations that can and need to be developed as much as possible."

RUSSIAN INVESTMENT

Water privatisation might be off of the Greek agenda, for the moment at least. But there are other developments in the Mediterranean. For as the Greek government appears to be tiring of European demands to get its financial act together, so its leaders have been looking towards Moscow rather than Brussels. But everything comes with a price. Russia may well be prepared to throw some money towards Greece but at what price?

Why, nothing less than "particular Greek assets". While one Russian source failed to specify what these might be, it is rumored that Moscow might well have its eyes set on the Greek gas company DEPA, the train operator TrainOSE - not to mention the sea ports of Athens and Thessaloniki alike.

In such a swift and fast moving situation it's of course impossible to predict what the outcome is likely to be. For what is happening in the water sector is clearly intimately bound up with what is happening higher up the economic and political chains. What is clear is that nothing is likely to happen at a lightning pace. And certainly not Greece Lightning.

▲ Breaking away: what impact could a Grexit - Greece's withdrawal from the Eurozone - have on its water supply?

Jeremy Josephs is freelance contributor for WWi magazine. Email: tomf@pennwell.com

▲ View of Delhi from Jama Masjid,

INTEGRATED APPROACH
THE KEY TO INDIA BEATING URBAN WATER STRESS?

About 30% of people in India live in cities that are expected to double in population by 2050. With a growing economy and changing lifestyles the pressure on already strained water resources is increasing. The government has shown an interest in Integrated Urban Water Management (IUWM) as a new framework and approach for the nation.

By François Brikkés

Most cities in India are water stressed, with no city having 24/7 water supply. According to the Ministry of Urban Development (MoUD), 182 cities require immediate attention in regards to proper water and wastewater management. According to official statistics, the coverage of sanitation has increased but resource sustainability and slippages are very common in that coverage.

Moreover, in cities with more than one million people, the official water supply after 35% loss in leakages is just 125 litres/day per capita which is considerably lower than the demand of 210 litres/day per capita. Infrastructure development and regulations have not kept pace with population growth and urbanisation and as a result wastewater management has become a major challenge.

Government has made significant efforts to reduce surface water pollution but they remain jeopardised by the lack of wastewater treatment. An estimated 160 million latrines and septic tanks contribute to 80% of the pollution of the national surface waters.

There is also major groundwater exploitation in urban India as many towns and cities depend on groundwater for their supply.

Reform is needed which reduces non-revenue water, groundwater exploitation, considers waste as a resource, and looks at the water cycle in a holistic way.

▲ Khajuraho, India, Girls pumping from water from communal pump

ENTHUSIASM FOR IUWM

During India Water Week in January 2015, GWP – in collaboration with GWP India and WAPCOS Limited – held a one day training on Integrated Urban Water Management (IUWM). The objective was to introduce IUWM as an approach, in particular for India. The workshop saw high enthusiasm from the representatives of government, different institutions and partner organizations (ICLEI, Taru Research, Development Alternatives, Centre for Science and Environment (CSE)).

During the training an interest was expressed by Dr. Amarjith Singh (Secretary to the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR)) to develop a programme on IUWM for India that includes awareness raising and capacity building activities.

Dr. Singh said: "Considering India's vast challenges and needs, a new framework and approach is required for efficient water management and IUWM provides this framework."

POTENTIAL SOLUTION FOR INDIA

So why is IUWM right for India? The IUWM approach is a paradigm shift for urban water management. It is not a prescriptive model but a process that invites existing cities and emerging ones to adjust their current planning and management practices, given their own priorities, in a hydrological, environmental and socio-economic context. It is based on the following key concepts:

- Participation of key stakeholders coming from the public, private and social sectors representing different socio-economic activities that have an interest in water in urban areas. There can be many stakeholders involved but an agreement needs to be reached with the representatives of local government who remain the main convener. Not all have the same role and responsibility, but all need to be aware and contribute.

The participation of stakeholders is needed in order to: break 'silos' between different sectors and activities; reach a common understanding and vision of challenges and activities; understand and balance interests and needs of different stakeholders; strengthen cooperation, sustainability and ownership; and induce behavior change and realistic demand management.

- Urban water security through a holistic approach implies managing water resources and its waste in a new integrated way, with a focus on: considering the whole urban water cycle as one system within the watershed; aiming for water security through diversity and optimum use of all potential sources of water and matching water quality with purpose of use; aiming for a better utilisation of natural systems for water and wastewater treatment; considering storm water/rainwater catchment systems as a potential source; better managing use of water, effluents and water demand and hygiene behavior; strengthening leakage management and maintenance; strengthening resilience of urban water systems that are facing drought or floods.
- Wastewater is a resource that can be used productively. Grey water can be reused for irrigation, urban agriculture and industrial processes, treated or untreated depending on the purpose of its use and its legislation; nutrients in wastewater (grey and black) can be used for energy production and fertiliser production.
- Optimum infrastructure design implies the following key points: technology selection for water supply, wastewater treatment and sanitation is based on a multi-criteria decision support system to analyse a wide range of indicators; such indicators include water quality, economic condition of households, size of population, access to advanced technologies and skilled manpower, availability of land, institutional set up and more; and this includes green infrastructure and low cost and energy efficient options, natural systems and innovative technologies
- Effective water governance with an IUWM perspective encompasses many aspects with the main following key elements: adopting a new mind set, a holistic and cross sectoral approach linking urban water management with overall urban planning; adjusting some of the policy and legislation concerning the use of water and reuse of waste water; analysing aspects of centralised and decentralised management; assessing the economic and financial impact of adopting an IUWM approach; building the capacity of technical and managerial staff; and sharing information with the public and users.

LOOKING FORWARD

The urban water management situation in India is dire and there is a lot of scope and opportunity for GWP and its local partners to carry out activities that can make a significant difference. The good news is that there is strong political will in the country to improve water management. Already the government has initiated a few programmes, like 100 smart cities, the National Mission to Clean Ganga and the Total Sanitation Programme.

François Brikké is senior network officer, Global Water Partnership. He has 25 years experience in the water sector, including at UNICEF, the World Bank and IRC.

UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR HELPS NOTTINGHAM WWTP RUN ON BIOGAS

A three-stage biological sewage treatment process is approaching final commissioning at Nottingham's Stoke Bardolph wastewater treatment works. Severn Trent Water (STW) design– build subcontractor NMCNomenca worked with Dutch company Paques BV to introduce three suitable and complementary technologies to the site in a first for the UK. The combined use of Paques' PHOSPAQ, BIOPAQ UASBplus and ANAMMOX processes has made it possible to: effectively remove phosphorus, recover a phosphate fertiliser, generate biogas and deliver efficient ammonia removal at the site. STW expects to make an annual saving of some £70,000 per year by reducing maintenance costs incurred by struvite damage to plant equipment. The BIOPAQ reactor for the trade waste converts organic compounds into mainly methane biogas anaerobically. The gas is used for the combined heat and power engines onsite and produces approximately 3 MWh/day, contributing 7% to this energy-neutral site's total gas output. www.nomenca.co.uk

SCREW COMPRESSOR FOR SLUDGE AGITATION

Gardner Denver has launched its new Robuschi Robox Screw compressor and blower package for the wastewater treatment industry. Available in high (up to 2.5 bar) and low pressure (1 bar) configurations, it includes a RSW compressor and oxidation-resistant coating on the rotor shafts.Wide-diameter shafts are designed help to reduce the deformation caused by internal and external loads. The unit provides the maximum airflow, up to 10,500 m^3/h. It features a traditional belt drive in place of a gear overdrive and for applications with a reduced thermal speed, uses a simplified lubrication system. www.robuschi.it

SUBMERSIBLE MIXER USED IN VIRGINIA, US

World Water Works has used a Landia submersible mixer as part of the implementation of its DEMON treatment system at the York River Treatment Plant in Seaford, Virginia. The first operating implementation of DEMON technology in North America, the system runs a two-step, single stage process. The two types of bacteria used are ammonia oxidising bacteria (AOB) and anaerobic ammonium oxidising bacteria (anammox). Designed to agitate, homogenise and suspend solids, Landia's submersible mixer model POP-I is used to mix granulated sludge for the HRSD implementation of the DEMON process. www.WorldWaterWorks.com

SLUDGE CAKE LOADING SILOS DELIVERED TO SOUTHERN WATER, UK

BioEnergy and bulk materials handling specialist Saxlund International has secured contracts from Barhale Trant Utilities to design and supply sludge cake truck loading silos for Southern Waterwaste treatment plant (WWTP) near Southampton. The projects include the construction of raised storage silos, each with a capacity of 240 m^3. The flat bottomed silos will incorporate Saxlund's sliding frame technology to ensure consistent discharge of material as well as screw conveyors and integrated control systems. www.saxlund.co.uk

GRP OVERFLOW FOR COMBINED SEWERS

In cooperation with the CVUT University Prague under the direction of Jaroslav Pollert PhD and in compliance with the EU Water Framework Directive 2000/60/EC, HOBAS developed a GRP overflow system for combined sewers. The CSO Chamber separates suspended solids from wastewater and directs them to the WWTP, while the cleaned part of the water is led into the receiving water course. The system is based on a design which has been verified by means of a mathematical CFD (Computational Fluid Dynamics) and a physical model. Through this basic model, flow analyses for various flow rates and dimensions can be simulated. Each HOBAS CSO Chamber is individually designed and optimised.
www.hobas.com

GRINDING, MILLING AND CUTTING EQUIPMENT UPGRADE FOR PIPE ROBOT

ID-TEC has launched its fifth piece of equipment for the Sewer Rehabilitation SERIES base robot, that can grind, mill and cut. The equipment has a 7" stroke and a 6,000 Watt, water driven, piston motor for cutting tough materials. ID-TEC developed the twist-and-lock mechanism as a base for the multifunctional robot allowing different equipment to be attached. The robot is able to: do CCTV inspections, remove roots and other blockades, reinstate laterals and do grinding, milling and cutting operations in 7" and larger relined pipelines.
www.id-tec.nl/usa/

WOLEEBEE CREEK PIPELINE PROJECT USES AUMA ACTUATORS

Electric automation company AUMA's devices were selected for the 120 km Woleebee Creek to Glebe Weir water pipeline in Queensland, Australia owned by Sun Water. The pipeline is designed to transport up to 36,500 megalitres of treated coal seam gas (CSG) water per year for use by industrial and irrigation customers. AUMA SAR actuators with intelligent AC actuator controls and GS part turn gearboxes were selected for both the Woleebee Creek pumping station and Glebe Weir structure. The actuators are installed as control devices on VAG plunger valves. Key features include enhanced accuracy for modulating duty. www.auma.com

YORKSHIRE WATER TRIALS NEW SEWER PIPE LINING TECHNOLOGY

UK utility Yorkshire Water has undertaken a trial of Nu Flow's Nu Drain cured-in-place pipe (CIPP) liner, which has only just become available to UK utilities but has already been applied widely across North America. The pilot trials were undertaken on drains at four domestic properties in Leeds, Hull and Barnsley in November and December 2014 and involved both clay and pitch-fibre pipes. Yorkshire is carrying out further trials with a view to rolling Nu Flow out across its entire network. Due diligence has been carried out on using the technology further. www.nufloweurope.com

STEAM-CURED PIPE LINER

Trelleborg's pipe seals operation has launched its newest range of liner solutions for trenchless pipe rehabilitation. The company's main-to-house (MtH) packer innovation as well as its cured in place pipe (CIPP) liner with a silicone coating; the DrainPlusLiner 2.0. The company said the liner is "extremely soft and flexible" and its coating is highly resistant to heat. This development in temperature resistance of the coating means that the liner can now be steam cured.
Suitable for pipes and sewers from DN 70 to DN 250, the DrainPlusLiner 2.0 is applicable for vertical and horizontal pipe lines. The liner only requires low pressure during installation and curing. www.trelleborg.com/Pipe-Seals

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CALENDAR OF EVENTS

A selection of events related to the water and wastewater industry in 2015 can be found here. For a full list, visit: www.wwinternational.com and click on the Events tab at the top of the page.

May 10-14, 2015
Euro Med 2015
Palermo, Italy
http://www.edsoc.com/

May 12-14, 2015
Oz Water '15
Adelaide, Australia
www.ozwater.org

May 17-19, 2015
New Horizons for Desalination
Santa Marghertia, Portofino, Italy
http://idadesal.org/new-horizons-for-desalination/

May 18-21, 2015
IWA Nutrient Removal and Recovery 2015: Moving innovation into practice
Gdansk, Poland
www.nrr2015.org

June 7-11, 2015
AWWA ACE'15
Anaheim, CA
www.awwa.org/conferences-education/

June 8, 2015
Water and Energy 2015
Washington, DC
www.awwa.org/conferences-education/

June 10-12, 2015
Aquatech China
Shanghai, China
www.aquatechtrade.com/china

August 11 -13, 2015
Aquatech India
New Delhi, India
www.aquatechtrade.com/india/

August 23-28, 2015
World Water Week
Stockholm, Sweden
www.worldwaterweek.org

August 30 – September 4, 2015
IDA 2015 World Congress
San Diego, California, US
http://wc.idadesal.org/

September 03-05, 2015
Istanbul Water Expo
Istanbul, Turkey
www.istanbulwaterexpo.com

September 15-18, 2015
IFAT Environmetnal Technology Forum Africa
Johannesburg, South Africa
www.ifatforum-africa.com

September 26, 2015
WEFTEC 2015
Chicago, IL
www.weftec.org

October 4-6, 2015
POWER-Gen Middle East
Abu Dhabi, UAE
http://www.powergenmiddleeast.com

October 18-22, 2015
Water and Development Congress & Exhibition
Jordan
http://www.iwa-network.org/WDCE2015/

November 3-5, 2015
Aquatech Amsterdam
Amsterdam, The Netherlands
http://www.aquatechtrade.com

November 3-6, 2015
The Year in Infrastructure 2015 Conference
London, UK
http://bit.ly/1RceeID

December 8-10, 2015
POWER-GEN 2015
Las Vegas, Nevada
www.power-gen.com

December 15-17, 2015
NGWA Groundwater Expo
Las Vegas, Nevada
http://groundwaterexpo.com/

"Always look two steps ahead!"

Amadio Caprari
The Founder

ANNIVERSARY
1945 - 2015

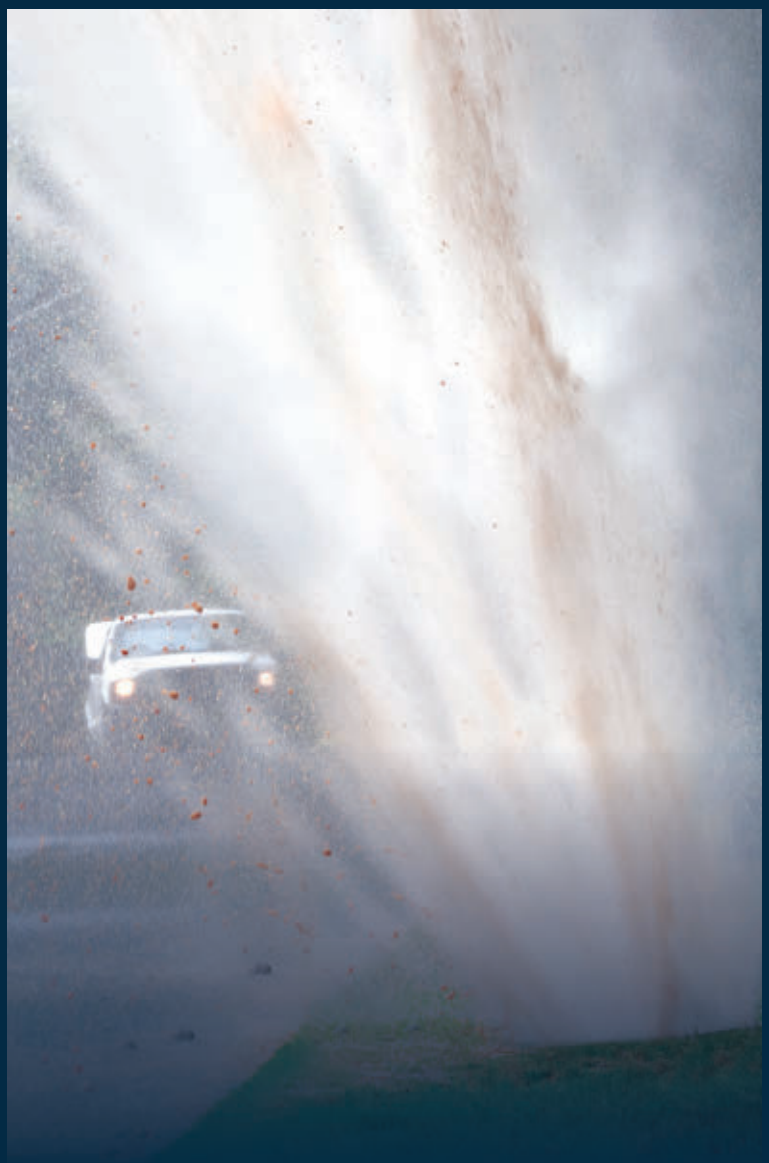
70 YEARS IN THE INTEGRATED WATER CYCLE

"Seven decades of continuous, single-minded work, in search of value-effective solutions dedicated to the world of Water, as industrial organization with international culture. By keeping a watchful eye on the requirements of changing markets, we have evolved to serve them at best.

For us, this anniversary is just a satisfying stage in a journey, that we will continue with all our customary drive, passion and enthusiasm."

caprari

Energy costs out of control? Bentley helps you fight back.



Reduce energy costs from pumping and water loss

Up to 4 percent of all electricity produced is consumed by water utilities – and energy costs can reach as much as 40 percent of total operating costs.* Reducing energy costs is a clear priority, and Bentley software will help you do that now – for pump scheduling, optimization, and water loss.

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To learn how to reduce energy costs, visit:
www.bentley.com/Reduce-Energy