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Apr/May 2019 Vol.12 No.5  
PP100007399

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# WORDS FROM THE EDITOR

According to the federal government's Budget report (2019–20), Australia is on track to meet its 2030 target to reduce emissions by 26 to 28% below 2005 levels. This was welcome news in April, along with the announcement of \$2 billion of funding over 15 years for the Climate Solutions Fund. The fund is basically similar to the Emissions Reduction Fund, which awards grants to eligible businesses and farmers working on projects that are designed to boost agricultural productivity, support jobs for Indigenous communities, improve biodiversity and water quality, and reduce greenhouse gas emissions.

It was interesting to note that the Snowy 2.0 project received the green light with \$1.4 billion over six years in equity funding being allocated. And plans for the fast rail are getting closer with a \$2 billion allocation from 2021–22 for the delivery of fast rail from Melbourne to Geelong. Support for feasibility studies into microgrids for regional and remote communities was also noted in the report.

With the Australian Ozwater event fast approaching, this issue is packed full of water-focused articles, including an opinion on drinking recycled water, details on new technology that could help repurpose desalination waste and a water quality application using smart 'plug-and-play' technology.

As the demand for sugar is declining, we also explore how sugarcane is being reinvented to effectively produce biofuels and bioplastics. Sugarcane is ideally suited to renewable energy applications because it's fast-growing with abundant biomass. So this scientific research has potential to sustain the sugar industry into the future.

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**Subscriptions**

For unregistered readers price on application.

Printed and bound by SOS Print+Media

Print Post Approved PP 10007399  
ISSN No. 1834-917X

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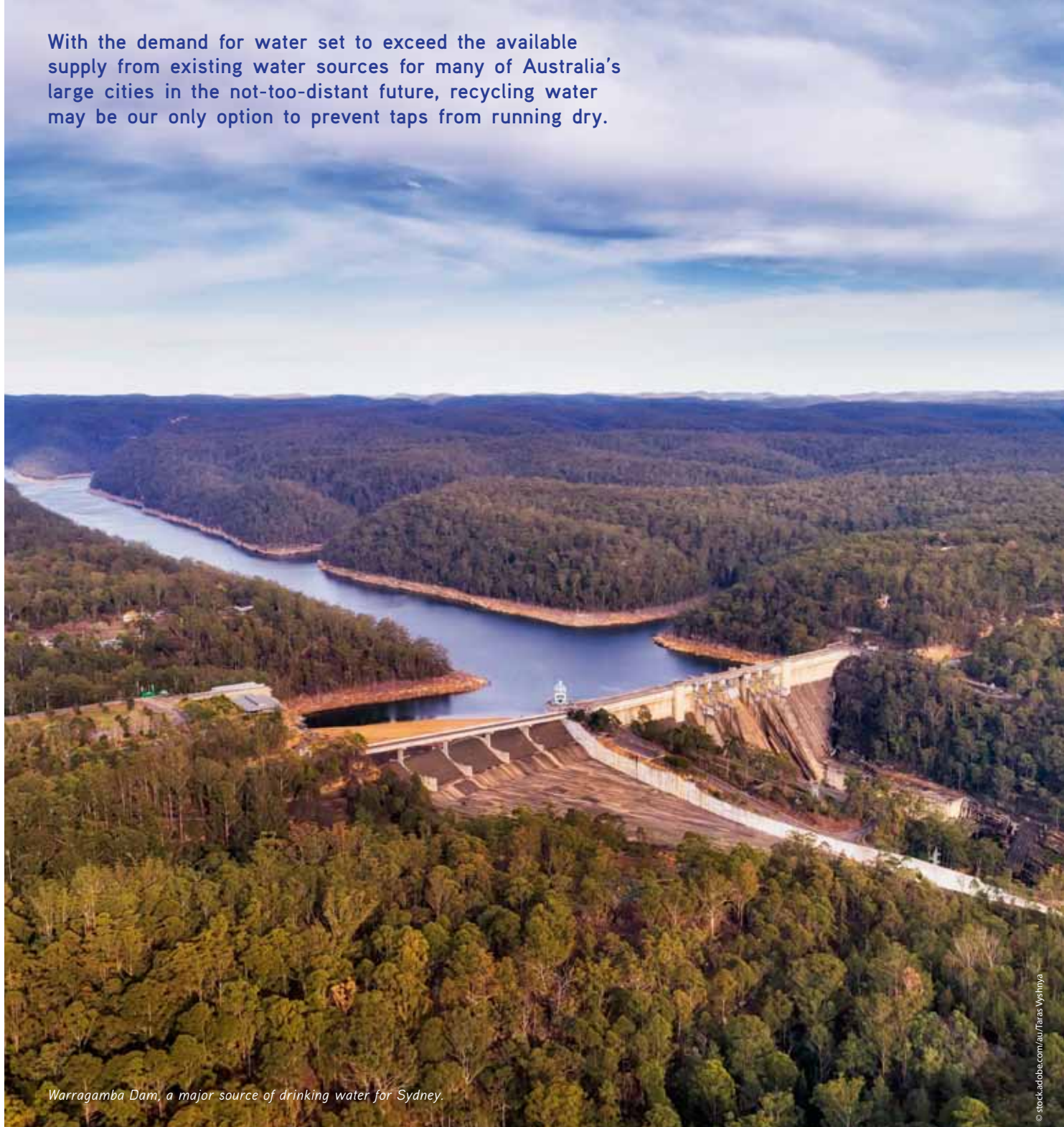
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# What's amiss with drinking treated sewage?

Andrew Miley\*

With the demand for water set to exceed the available supply from existing water sources for many of Australia's large cities in the not-too-distant future, recycling water may be our only option to prevent taps from running dry.



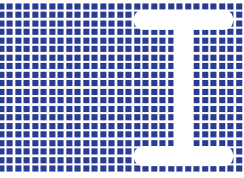
*Warragamba Dam, a major source of drinking water for Sydney.*

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As the world gets hotter, drier and more crowded, recycling wastewater into drinking water may be our only salvation if we hope to become more resilient to water scarcity.



In 2006 the people of Toowoomba voted against a \$68 million wastewater recycling scheme that would have supplied their homes with drinking water sourced from treated, recycled wastewater. As a result, the Queensland Government built a pipeline costing \$187 million between Wivenhoe Dam and Toowoomba — nearly \$120 million more than the proposed wastewater recycling project would have cost.

Toowoomba's residents rejected the proposal because they found the thought of drinking recycled wastewater too hard to stomach. Understandably, many people think the same, fearing that, despite treatment, recycled sewage water may still be contaminated with waterborne diseases such as cholera and other harmful pathogens. But are these fears justified, or are they unfounded?

### Drinking water treatment process

The water that comes out of your tap now has already been specially treated to make it safe to drink. Water harvested in a surface catchment can potentially contain animal waste and urine, dead animals and other organic debris, as well as dissolved contaminants such as heavy metals, pesticides and pathogens that can be harmful to our health if consumed. It may be affected by agriculture or other industries further upstream, natural minerals (eg, arsenic) found in soils in the watershed, weather conditions such as heavy rainfall or droughts, as well as natural events such as bushfires or algal blooms. The type of treatment method employed by a treatment plant will vary depending on the quality of the water entering the plant.

### Recycling wastewater for re-use

#### *Direct re-use of treated wastewater*

In Australia, treated wastewater is already re-used directly for many purposes, including irrigation of crops, lawns and vegies, fighting fires, washing cars, flushing toilets and even doing laundry. It is usually supplied via a separate water line, for example in Sydney the pipes and taps distributing recycled

wastewater are purple to differentiate them from the normal water supply. Of course this water has not undergone further treatment so it is not suitable for drinking.

With declining rainfall, Perth now relies on rivers and dams for just 10% of its water, with the balance coming from groundwater extraction, also affected by declining rainfall and desalination, which is expensive. Perth currently recycles about 10% of its sewage, using the recycled wastewater to replenish its groundwater supplies. Before replenishment this water is further treated to drinking-water standards then recharged into underground aquifers, which act as additional, natural filters until the water is extracted for use. Water-stressed Perth is now considering recycling all its sewage to further supplement its future water supply. Groundwater replenishment doesn't depend on rainfall and can potentially recycle high volumes of water naturally and sustainably to help address Perth's water scarcity.

#### *Indirect re-use of treated wastewater*

While the thought of drinking recycled sewage sounds unsavoury, our water supply may already contain recycled sewage. In Sydney, recycled sewage is an inevitable component of the water supply. While the city may not actively recycle its own sewage into drinking water, several large towns further upstream discharge their treated wastewater effluent into rivers that feed into dams and reservoirs that provide the city with water. According to a 2016 audit of the Sydney drinking-water catchment, the communities of Bowral, Goulburn, Lithgow, Mittagong and Moss Vale (around 116,000 people) discharge their treated sewage into rivers that feed into Warragamba Dam.

Other Sydney residents obtain their drinking water from the North Richmond Water Filtration Plant, whose supply comes directly from the Hawkesbury-Nepean River. This river has several sewage discharge outlets flowing into it from wastewater treatment facilities further upstream, including St Marys Advanced Water Recycling Plant, one of the largest and more advanced sewage treatment

plants in Australia. According to a report in *The Conversation*, in the drier summer months, treated sewage can contribute as much as 32% to the Hawkesbury-Nepean River flow around North Richmond. Water extracted from the river is highly treated at the North Richmond water treatment plant to ensure water delivered to residents is of a high quality that meets the standards set in the Australian drinking-water guidelines.

As the population in towns further upstream grows, so too does the volume of treated sewage flowing into the river. With the population in Greater Sydney expected to gain an additional 1.74 million residents by 2036, with much of this growth occurring in the western parts of the city, the volume of treated sewage entering the Hawkesbury-Nepean River is certain to increase further still.

Sydney is already recycling treated wastewater originating from residents further upstream and Sydney's residents are living to tell the tale. Sydney is not the only city in Australia or the world whose residents are indirectly re-using treated wastewater. Anyone whose water supply lies downstream from a wastewater effluent discharge point will essentially be indirectly consuming recycled wastewater. The risk of contamination is minimal as this wastewater has been treated by the wastewater treatment process, diluted with fresh water in the river, and then treated again during the water treatment process to ensure that it meets standards set for drinking water.

So what's amiss with drinking sewage? Nothing. It is already happening here in Australia and has been for many years with no ill effects. As the world gets hotter, drier and more crowded, recycling wastewater into drinking water may be our only salvation if we hope to become more resilient to water scarcity.

*\*Andrew Miley, Director, Global Market Development, Hydroflux Group, is a water industry professional with over 25 years' experience in the industry.*

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Engineers at MIT have developed a new desalination approach that could improve process efficiency while converting concentrated brine waste into a useful chemical resource.

## Upcycling desalination waste

Currently, the world produces more than 100 billion litres a day of water from desalination, which leaves a similar volume of concentrated brine. Much of that is pumped back out to sea, and current regulations require costly outfall systems to ensure adequate dilution of the salts to prevent damage to marine ecosystems. Now, engineers at MIT say they have found a better way.

In a new study, they show that through a fairly simple process the waste material can be converted into useful chemicals — including ones that can make the desalination process itself more efficient.

The approach can be used to produce sodium hydroxide, among other products. Otherwise known as caustic soda, sodium hydroxide can be used to pretreat seawater going into the desalination plant. This changes the acidity of the water, which helps to prevent fouling of the membranes used to filter out the salty water — a major cause of interruptions and failures in typical reverse osmosis desalination plants.

The concept is described in the journal *Nature Catalysis* and in two other papers by MIT research scientist Amit Kumar, professor of mechanical engineering John. H. Lienhard V, and several others.

Kumar said the desalination industry itself uses quite a lot of sodium hydrox-

ide. “They’re buying it, spending money on it. So if you can make it in situ at the plant, that could be a big advantage.” The amount needed in the plants themselves is far less than the total that could be produced from the brine waste, so there is also potential for it to be a saleable product.

Sodium hydroxide is not the only product that can be made from the waste brine: another important chemical used by desalination plants and many other industrial processes is hydrochloric acid, which can also easily be made on site from the waste brine using established chemical processing methods.

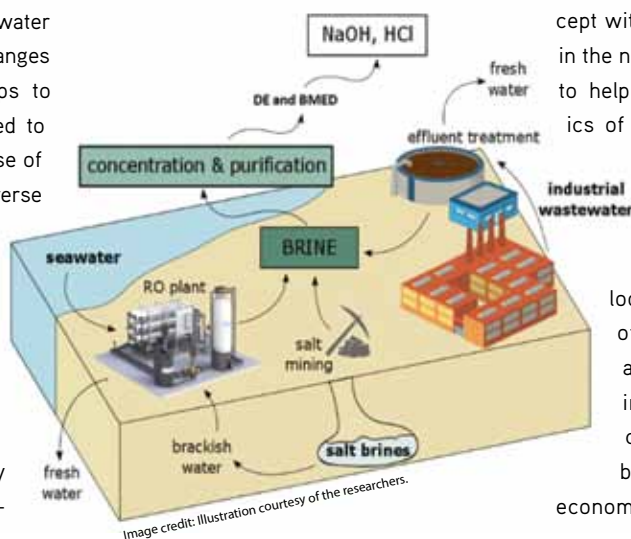
“Environmentally safe discharge of brine is manageable with current technology, but it’s much better to recover resources from the brine and reduce the amount of brine released,” Lienhard said.

The method of converting the brine into useful products uses well-known and standard chemical processes, including initial nanofiltration to remove undesirable compounds, followed by one or more electrodialysis stages to produce the desired end product. While the processes being suggested are not new, the researchers have analysed the potential for production of useful chemicals from brine and proposed a specific combination of products and chemical processes that could be turned into commercial operations.

“This very concentrated brine has to be handled carefully to protect life in the ocean, and it’s a resource waste, and it costs energy to pump it back out to sea,” so turning it into a useful commodity is a win-win, Kumar said.

The researchers have discussed the concept with companies that may be interested in the next step of building a prototype plant to help work out the real-world economics of the process. “One big challenge is cost — both electricity cost and equipment cost,” at this stage, Kumar said.

The team also continues to look at the possibility of extracting other, lower-concentration materials from the brine stream, he said, including various metals and other chemicals, which could make the brine processing an even more economically viable undertaking.





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# Sugarcoating renewable energy

## Could sugarcane be the fuel of the future?

Gene-editing sugarcane for use in renewable energy and bioplastics could help secure the industry's future.

Professor Robert Henry, Director of the Queensland Alliance for Agriculture and Food Innovation (QAAFI) at the University of Queensland, said sugarcane's reinvention as an 'energy cane' crop could sustain the industry in the face of falling global demand for sugar. "The industry must think beyond just producing sugar, to also producing electricity, biofuels for transportation and oils to replace traditional plastics," he said.

Working with a global team to sequence the sugarcane genome as part of a US Joint Genome Institute project, Prof Henry is conducting gene-editing experiments to tailor sugarcane to effectively produce biofuels and bioplastics. "It's about reinventing sugarcane as a crop with a wider range of end uses, and sugarcane is ideal

for renewables because it is fast-growing with abundant biomass," he said.

"Sugar is the last major cultivated plant to have its genome sequenced and we expect to see it fully decoded by 2020. Having sugar's genetic template will allow us to look at growing sugarcane as a biofuel and a source of 100% recyclable bioplastic, making it a substitute for petroleum in the production of countless items from cosmetics to car parts," he added.

Prof Henry's call to rethink sugarcane is supported by Cooperative Research Centre for Developing Northern Australia Chair Sheriden Morris. "Gene editing of the sugarcane genome will allow the sugar industry to explore adaptations that will reduce environmental impacts, especially on the Great Barrier Reef," Morris said. "It will help the industry to broaden the potential of a sugar crop to a wider range of uses.

Biofuels and bioplastics will be important to the long-term future of the industry."

Prof Henry, who has helped lead genomic breakthroughs in decoding the sugarcane genome, said the science was quickly developing to allow growers to tap into the commercial opportunities in renewables. "Australia's sugarcane growers are facing a falling sugar price — driven by declining world demand and increased competition in India and Brazil. The industry must look to the future."

QAAFI researchers supported by the US Joint BioEnergy Institute and Sugar Research Australia through an Australian Research Council Linkage grant are testing a range of sugarcane varieties to identify which types produce ethanol most effectively and efficiently. Researchers are also collaborating with the Indian Institute of Technology Delhi to investigate processes that break down sugarcane fibre to make bioplastics.

"Drink bottles made from sugarcane bioplastics are just one product on the agenda from this collaboration," Prof Henry said. "Economics is the key. Now that we understand more about the genetics of sugarcane, these sorts of products are becoming commercially realistic."



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## Smart tech optimising Hunter Water's network

Hunter Water is optimising water distribution throughout its network, contracting SUEZ to implement its Aquadvanced Energy solution.

Once implemented, the software will monitor and control pumps, control valves and water storage to supply real-time data on water consumption, forecasts and energy prices. This data will then be used to schedule and control water supply to meet consumer demand at the lowest price while meeting operational requirements.



According to SUEZ, the project will allow Hunter Water to reduce energy consumption, minimise its environmental footprint and deliver substantial ongoing electricity cost savings to customers.

Hunter Water Group Manager Ruben MacNeil said: "Hunter Water welcomes the partnership with SUEZ to deliver energy and

operational efficiencies across our network. This project is a great example of how we're embracing new and innovative solutions to deliver sustainable water services."

Servicing over half-a-million people in the Lower Hunter region, it is anticipated the project will provide operational benefits by improving water quality, extending the life of assets in the network and improving decision-making about operational and economic constraints. The outcome of this project will also help to contribute towards achieving the United Nations' Sustainable Development Goals.

SUEZ has implemented the energy solution at facilities in the UK, resulting in optimised drinking water, as well as reduced energy costs and greenhouse gas emissions. SUEZ General Manager Stuart Gowans is delighted to bring the Aquadvanced suite to Australia and said it typically reduces overall pumping energy bills by 10 to 15%.

The initiative builds on the successful trial of Aquadvanced Energy in the Hunter Water network in 2018, which tested the compatibility of the technology with Hunter Water's existing infrastructure. Implementation of this project has already started, with operations to begin in 2020.

Aquadvanced Energy is one of several solutions that form part of SUEZ's Aquadvanced suite, which will be discussed at OzWater'19 on 7-9 May 2019.

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## Grease-eating system solves US plant's FOG problems

A wastewater treatment plant has tackled a persistent problem with fat, oil and grease (FOG) products via installation of a grease digester. The FOG products were fouling the primary clarifier, inhibiting the settling of solids, and choking the scum pit and scum-pit transfer line to the pressroom and anaerobic digester.

The plant, located in central Pennsylvania, accepts waste grease from a local commercial confectionery food processor, as well as restaurants and businesses in the area. Originally, FOG products were accepted and blended with septage, but this fouled the screens and degritting system.

### Tackling grease

To solve the problems of handling grease, a simple grease digester was implemented. The system includes a 150,000 L in-ground tank, a separate grease-receiving area, a control room, pump room and storage area, and a Venturi Aerator to supply the required dissolved oxygen to support the breakdown of grease. To further break down grease, the tank is seeded with live-cultured grease-eating bacteria from an incubator.

The treatment process is designed to handle 38,000 L of grease each day, which is added to the 150,000 L in-ground tank. The minimum retention time in the tank is 72 hours, during which the contents of the



Image courtesy of Hydro Innovations

digester are aerated, pH is adjusted with a lime slurry and live bacteria are continuously dosed into the digester. Each day, 38,000 L of the treated grease are decanted from the digester to the adjacent headworks where they are blended into the plant's influent wastewater.

### The grease treatment process

Incoming grease is delivered by truck to an unloading station where the operator determines grease volume for billing purposes, ensuring the product is not mixed with sewage. A hose connects the tanker truck to the pipe stanchion quick-connect and begins offloading the grease, which flows directly into the digester where it is aerated and mixed. Lime is then added as a slurry and live bacteria are seeded from one of two biological activators (there are two units working on alternating 12-hour cycles). This pH-control process is important because, as

grease degrades into free fatty acids, the pH drops precipitously and could kill off the beneficial grease-eating bacteria. The newly received grease is mixed in with the 115,000 L already in the tank. The operator decants residual liquids of degraded grease upon arrival in the morning and slowly blends the treated and digested grease into the headworks during the high-volume, first-flush cycle of the day. A Gorman-Rupp pump pulls from the digester and discharges through a 6" Venturi Aerator,

which pulls in atmospheric air, mixes it with the pumped fluid, then sends the aerated fluid back into the digester.

Following the installation of the grease digester there have been no plugs or fouling at the plant. The influent biochemical oxygen demand from the grease has reduced significantly, the clarifier performs better and requires less cleaning from grease fouling, and odours have been reduced in the pressroom. Now that there is a legal grease disposal solution, even the collection system is cleaner and there has been no grease fouling of lift stations. Additionally, the gross revenue is anticipated to be approximately \$250,000 for the first year of operation on a capital project which was ~\$200K. This is less than a one-year payback.

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# Water utilities walk path to digitisation

Water utilities may be sceptical about embarking on expensive capital upgrades as part of a digital transformation journey. But there are inexpensive alternatives that allow water operators to move from reactive control to proactive management via digitisation of existing infrastructure.

New York Governor Andrew Cuomo recently made headlines when he announced the intention to invest \$2.5 billion in new clean-water projects as a first step to addressing what the governor sees as an \$80 billion need, in the state of New York, to upgrade water systems.

“Water utilities can sometimes be in a tricky situation when it comes to CAPEX requirements,” said Paul Banfield, Segment Director for the Water and Wastewater Segment, AVEVA. “Service levels are often a higher priority over making large profits, so long and expensive digital transformation projects can be hard to justify.”

Banfield said that while not every water utility has the same access to capital

funds as New York, they all share the same critical challenges — ageing infrastructure, unprecedented demand growth, increasing environmental pressures and a community demanding higher water-quality standards.

“If massive capital upgrades are beyond reach, there is an alternative approach that uses high-quality simulation and modelling of water networks,” said Banfield. “This is coupled with real-time information from existing sensors and SCADA systems, to give water network operators the tools they need to optimise their operations based on existing infrastructure investment.”

Banfield said AVEVA is seeing a shift in the water industry as digitalisation is getting cheaper, faster and more impressive than ever. “Every day we see examples from our colleagues around the world having suc-

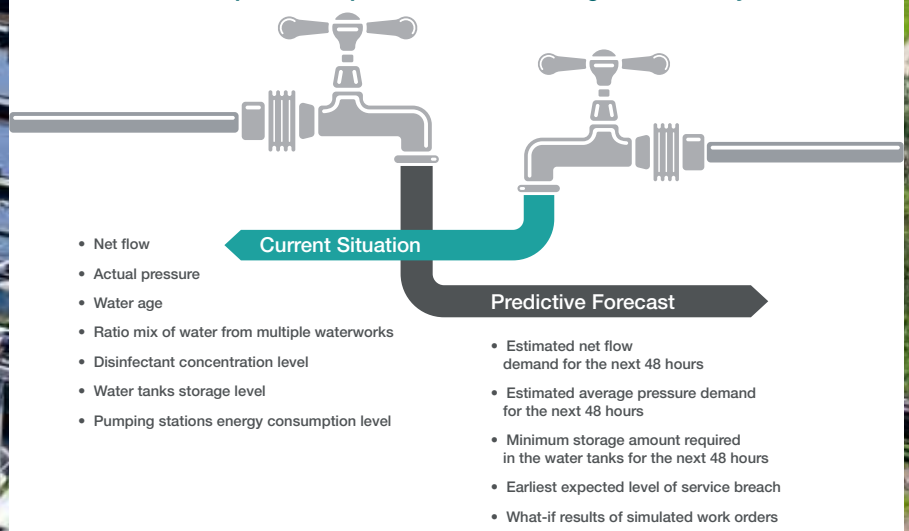
cessful conversations with water utilities. And the thing that all have in common is putting forward a project that delivers real value to the utilities.

“For example, opportunities for operators using water network simulation and optimisation include the ability to:

1. forecast the behaviour of the water network and predict the impact of planned and unplanned events with what-if scenarios;
2. trace water quality evolution through the network by predicting the spread of contaminants or additives system-wide based on sampling locations;
3. predict and locate leaks in the system quickly and respond with optimal tactics to minimise loss and customer impact; and



### Water Network Optimization provides real-time intelligence and analytics



4. reduce energy costs by optimising pump operation and reservoir levels based on fluctuating demand.”

According to Banfield, given the attractive return on investment metrics of these projects, water utilities around the world are already investing in them. “For example, a number of AVEVA customers in Scandinavia are leading the way in the use of water-network simulation and optimisation to reduce their operating costs while enhancing their ability to meet customer demands:

- The city of Oslo is modelling over 1550 km of water pipes in order to obtain a real-time overview of their water network.
- In Kalundborg, Denmark, the water operator is leveraging AVEVA’s Aquis Water Network Management solution to move

from a ‘hunch-based’ decision-making process to one based on facts presented in real time.

- VCS Denmark has done the same thing in Odense, where a 150-year-old water utility is now operating with a greater sense of security based on modelling and simulation results.
- In Ølgod, Denmark, Aquis is being used to predict the changing direction of flow in a ring-connected supply network and predict contaminant levels when a pollution event occurs.

“In every case, the water utility has benefited from greater visibility into the present and future behaviour of their network,” concluded Banfield.

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*Paul Banfield is the Water & Wastewater Segment Director for AVEVA in Australia and New Zealand. With more than 30 years’ experience around the use of technology and innovation in the water industry, he is focused on enabling water utilities to unlock the maximum value from their digital transformation journey. Before joining AVEVA, Paul held a number of commercial roles starting and managing regional subsidiaries, working with channel partners and leading direct sales teams working with numerous clients across the globe.*





## Boneo Water Recycling Plant gets a \$130m upgrade

South East Water has appointed the John Holland SUEZ Beca (JHSB) joint venture to undertake a major upgrade of its Boneo Water Recycling Plant (WRP) on Victoria's Mornington Peninsula, delivering a range of innovative treatment technologies designed to reduce energy consumption in the water recycling process. The \$130 million upgrade will be delivered through a design, build, operate and maintain contract, with JHSB operating the plant for 10 years to enable knowledge sharing and collaboration.



The upgrade will include the capture of biogas generated during the treatment process to power the plant's operations and implementation of the nitrite-shunt nutrient removal process, an emerging technology which significantly reduces the electricity required to treat the wastewater. Both technologies will assist in reducing South East Water's reliance on grid electricity in the treatment process, taking the utility one step closer to achieving its emissions reductions target of 45% by 2025.

The plant's upgrade will enable an additional 16,000 properties in the area to connect to South East Water's Peninsula ECO scheme, a reticulated pressure sewer network helping to replace septic tanks and mini treatment plants — a known cause of groundwater and waterway pollution on the southern peninsula. The upgrade will also support the large seasonal spikes in both sewage inflows — during the summer months, peak flows into the Boneo WRP increase by over 50% — and recycled water use, with local farmers relying on Class A water from the plant for irrigation during the summer months.

South East Water has engaged with a broad range of community and stakeholder groups throughout the planning process. This

includes a partnership with Melbourne Water and Mornington Peninsula Shire Council to revitalise a section of the Tootgarook Wetlands, adjacent to the plant, which is home to over 120 different bird species, some of which are threatened or endangered. Already more than 57,000 new plants have been planted.

"The Boneo Water Recycling Plant upgrade will support the continued growth of the Mornington Peninsula as a place to live, work and play, while helping to maintain its pristine environment," said Terri Benson, Managing Director at South East Water.

"It will also move us significantly closer to our emissions reduction targets and our commitment to customers to protect our environment."

It is expected that 160 new jobs and 10 new apprenticeships will be created for the design, build operation and maintenance of the plant. South East Water anticipates works to commence in March 2019.

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### PRESSURE FILTER VESSELS FOR WATER TREATMENT

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Glacier Filtration was part of the Cape Town Water Crisis response and delivered pressure filter vessels for a number of desalination plants and a wastewater re-use plant that were constructed to help alleviate the effects of this drought crisis. The projects were of a highly urgent nature and there was significant time pressure for these plants to be constructed and brought online — the specialised filter vessels were designed and delivered to South Africa in time.

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# Getting smart with 'plug-and-play' water quality monitoring

Kempsey Shire Council decided to update its time-consuming water quality monitoring with a smarter 'plug-and-play' solution for its water and wastewater services.

Located 350 km north of Sydney, Kempsey Shire Council uses monitoring stations to ensure water quality standards are being maintained. One such legacy system was equipped with sensors for measuring pH and chlorine. The sensors used reagents to establish measurements; however, it was becoming unreliable and required time-consuming upkeep.

Chlorine sensors are traditionally a high-maintenance monitoring solution, generally requiring a constant routine of replacing parts (membrane caps), upkeep of electrolytes, increased labour and equipment costs. Additionally, the presence of chloramines, either intentional or unintentional, can also have a strong influence on readings, creating errors in free chlorine analysis.

Of greatest concern for the council was the fall-off in accuracy and the need for frequent recalibration.

## The solution

The council compared a number of alternative systems and decided on the Bürkert Online Analysis System. The compact modular design has an integrated HMI display, input/output modules, a range of available sensor cubes including: pH, chlorine ( $\text{Cl}_2$ ) or chlorine dioxide ( $\text{ClO}_2$ ), conductivity, oxidation reduction potential (ORP/redox) and turbidity; as well as a cleaning system. All of which can be wall or panel mounted, or built into an existing cabinet, which is the solution the council used.

The solution reduced maintenance requirement, diminished drift or need to recalibrate, which were all regarded by the council as essential advantages for its



application. The zero effects from chloramines was an added bonus.

Bürkert's  $\text{Cl}_2$  and  $\text{ClO}_2$  sensor cubes contain a high-precision membrane covered amperometric sensor, but the difference is they are based on MEMS (microelectromechanical systems) technology. This microchip allows for precision measurements, with little to no drift as its readings are not influenced by chloramines. These cubes only require small samples for measurements and have a fast response time ( $t_{90}$ ) of <30s.

Once installed, the individual sensor modules or 'cubes' are essentially plug-and-play. It's a simple process to create alarm parameters for each sensor cube, ensuring that any anomaly in the process is identified quickly.

## The results

Greg Morrow, Instrument Technician at the South West Rocks plant of Kempsey Shire Council, commented: "We are very pleased with the new system. Since it was installed, there has been no need to recalibrate the chlorine or the pH sensor cubes. Their performance has been verified using portable laboratory

equipment (DPD1 photometer reference test) for free chlorine. Furthermore, the sensors' response time has been virtually instant, far exceeding the performance of the alternatives we looked at."

Bürkert's Online Analysis System communicates with existing control protocols and with personnel, both on and off site. Any deviation from the set criteria is notified immediately. This integration helps reduce time between a deviation from process parameters and remedial action required to correct the situation.

Tristan Nowland, an Instrument Technician for Kempsey Shire Council, added: "After 10 months in operation, the accuracy has been excellent; there's no drift in either the chlorine or the pH measurements. Additionally, the amperometric chlorine MEMS sensor chip isn't affected by chloramines, providing true chlorine analysis. Another major benefit is the cubes are not reagent-based, and so the maintenance requirement for this system is greatly reduced."

The performance and ease of installation of these systems has prompted the council to install the Bürkert Online Analysis System at several other reservoirs and water treatment plants.

These systems are designed to provide all the analysis data required for most applications — as well as acting as a data logger to provide necessary evidence for maintaining water quality standards.

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## UNCOOLED METHANE GAS DETECTION CAMERA

FLIR Systems has announced the FLIR GF77 Gas Find IR, a thermal camera for detecting methane. It is built around an uncooled, longwave infrared detector, making it an alternative to cooled cameras.

Based on the design of the FLIR T-Series camera platform, the lighter weight GF77 features an ergonomic design, a vibrant LCD touch screen and a viewfinder to make it easy to use in any lighting conditions. It is engineered specifically to detect methane in order to improve gas inspections and reduce the chance of false readings. It also offers FLIR's High Sensitivity Mode (HSM), which accentuates movement to make tiny gas plumes more visible to the user.

The product includes laser-assisted autofocus to help inspectors target leaks and one-touch contrast improvement that makes gases stand out clearly against the background. A rapid-response graphical user interface helps professionals increase efficiency by allowing them to organise job folders, record notes and add GPS location annotation on the camera.

The handheld camera offers inspection professionals the features they need to find potentially dangerous, invisible methane leaks at natural gas power plants, renewable energy production facilities, industrial plants and other locations along a natural gas supply chain. It is designed to empower the oil and gas industry to reduce emissions and ensure a safe work environment.

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# Smart design makes water work in Tongzhou District

The successful completion of a water infrastructure project in China will allow massive urban development to go ahead.

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**T**ongzhou District in south-east Beijing is marked for intense future urban development, being located at the end of China's Grand Canal and acting as an eastern gateway to the nation's capital. However, until the completion of significant water works, the region had experienced water shortages as a result of declining groundwater supplies. Planning teams anticipated that, to meet current and future water demand and supply continuous water to residents, Tongzhou Water Works would need to significantly increase capacity and reduce reliance on groundwater.

As part of the Beijing South-to-North Water Diversion Project, a ¥354 million (\$74.4 million) project was initiated to deliver 600,000 m<sup>3</sup> of water/day. Beijing Institute of Water was contracted by the Water Affairs Bureau of Tongzhou District to design the water facility and ancillary buildings. The project, serving

as an important infrastructure guarantee for future land development projects, needed to improve building energy efficiency, reduce construction costs and eliminate the impact on the surrounding environment, as specified by the Chinese Government.

## Collaborative design process

To tackle the design brief, the project team established a collaborative 3D design management platform using Bentley's ProjectWise and MicroStation software. This platform was used to centrally store and manage design information for 13 professions, as well as extract 2D construction drawings and engineering statistics. The 3D platform enabled the team to enforce production standards for the 26 engineers working on the design, securely share data and models, and minimise design errors while improving work efficiency.

The 2D construction drawing and engineering statistics completed during the 2D design phase took six months to implement, involving more than 50 engineers. However, the 3D design software allowed just 26 engineers to complete all 3D modelling, 2D drawings and engineering statistics work in 40 days, saving more than 50% of the design effort by automatically generating engineering statistics and increasing the accuracy of calculations.

## Environmental impact

Considering environmental impacts, the layout of the water purification structures and plant terrain was designed to reduce operational electricity consumption, achieving a 5% reduction. The heat-pump placement saved more

than 40% on cooling and heating costs. To take advantage of favourable sun exposure, the team was able to implement solar heating to reduce fossil-fuel energy usage by more than 45%. In addition, by placing a rain-catchment area on-site, the facility could collect and store 80% of rainwater for re-use.

## Meeting current and future demands for water

The final design achieved its objective, providing 62.9% of domestic water and production water supply to 900,000 people in a service area of 155 km<sup>2</sup>. This raised the regional water supply capacity to 2.8 times that of 2011 and increased the water supply safety coefficient to 1.3. Additionally, by replacing local surface water with diverted groundwater, the proportion of local, underground water supply fell from 74.2% in 2011 to 21.4%, resulting in an annual reduction of 4.77 million m<sup>3</sup> of groundwater exploitation.

Now that the facility has been completed and is operational, the city's subcentre and Tongzhou New Town will be incorporated into the south-to-north water supply zone to enhance the region's water quality, volume and pressure, reaching supply levels in line with the city centre. Water quality will reach, or even exceed, WHO and US EPA standards. The improvement in water conditions of the Tongzhou area will allow the government to relocate the city government to Tongzhou and make it a vital population hub in the future.

Bentley Systems Pty Ltd  
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3D design applications allowed designers to work in a collaborative management platform, improving design accuracy and efficiencies.



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## CASE STUDY - HYDROPOWER: FORCES FIRMLY UNDER CONTROL

Renewable energy from hydroelectric plants is an important part of the global energy transition. A high level of automation is required to operate hydroelectric plants economically. Among other things, WAGO solutions can be found in turbine controls that are connected to a higher-level SCADA system for monitoring and power station control.

### Advantages with WAGO's Telecontrol Solution:

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## DATA LOGGER WITH REMOTE DATA TRANSMISSION

The ARC-1 is the latest-generation data logger from KELLER, superseding the GSM-2 device. The unit remotely tracks pressure measurements and fill and water levels, and monitors limit values.

In the interests of compatibility, the ARC-1 incorporates the same functions as the GSM-2 but includes some new features including: ARC-1 communicates via the 3G or 4G

mobile network; Micro SIM card; system status information has been supplemented by a moisture sensor; integration of a real-time clock to improve accuracy.

At 48 mm in diameter, the ARC-1 can be easily placed into the top of a 2"-wide sounding tube, standard in the groundwater-measuring industry. Complete with energy-efficient electronics and a premium-quality lithium battery (3.9 V/32 Ah), the logger can transmit the results of 24 measurements every day.

DataManager software covers the key functions of a monitoring, collection, control and organisation. Third parties can access the measurement data by means of various export and internet functions for integration into their own data collection systems.

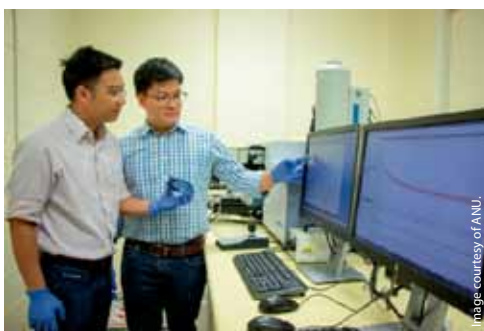
KELLER's Kolibri Cloud offers access to measurement data with a personal login and SSL encryption. Measurements can be displayed as graphs and the export function allows download of data as Excel or CSV files.

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## Skin cells hold key to solar tech revolution

Scientists at Australian National University (ANU) have made a series of breakthroughs that could revolutionise solar technology, making it more efficient and accessible. To date, most research in the field has focused on improving the body of solar cells; however, the ANU research has focused on the skin layer, 1000 times thinner than a human hair and used to conduct electricity and protect the cell.

Lead researcher Dr Hieu Nguyen explained that when hydrogen atoms are injected into the skin of a solar cell, rather than the cell body, the performance of the entire structure is boosted significantly. "Hydrogen is the lightest element in the periodic table but extremely powerful for healing 'wounds' in semiconductor materials," Dr Nguyen said. "Unfortunately, in nature, it [hydrogen] often exists in a molecular form (two atoms joined together). We got around this by placing another material with plenty of atomic hydrogen on top of the skin, then pushing the individual hydrogen atoms into the skin by simply heating the sample at 400°C."



Researchers initially discovered that the solar skin layer emits light with some very distinct qualities. They quickly realised that the presence of hydrogen atoms dramatically changed the characteristics of the light, information that can be used to understand what's going on inside the skin.

"Improving the skin layer is a critical step for achieving highly efficient solar cells," PhD candidate Thien Truong said. "These discoveries will definitely help produce more robust and more efficient silicon solar cells since we now know how to manipulate this hydrogen content inside the skin to have a better solar cell."

Funded by ARENA and the Australian Centre for Advanced Photovoltaics, the research is expected to lead to a replacement of traditional solar cell technology in the coming years. Dr Nguyen said this makes the team's discoveries very significant for both solar manufacturing and research laboratories worldwide.

The research papers are published in *ACS Applied Materials & Interfaces* and *ACS Applied Energy Materials*.



## BIOGAS DEHUMIDIFICATION SYSTEM

The Biogas Dehumidification System (BDS) from HRS Heat Exchangers removes water from biogas, protecting combined heat and power (CHP) engines from corrosion and cavitation. The system comes with a heat-recovery section, increasing the overall energy efficiency of an anaerobic digestion (AD) plant.

The BDS reduces biogas temperatures from around 40°C to approximately 5–7°C, condensing more than 90% of the water volume. It works via a chiller system, which supplies a coolant that is transferred to heat exchangers. Biogas flows on the product side of the exchanger, while the coolant flows on the service side.

More than half of the heat transfer duty is used to condense the water contained in the biogas, while the remainder is used to reduce the gas temperature. As it cools, the water separates from the gas, leaving a clean biogas that is suitable for use in CHP engines.

A heat recovery option is available, whereby the resulting cold biogas is then used to pre-cool any incoming biogas. This reduces the load on the final cooling heat exchanger, recovering as much as 20% of the energy needed for the process.

Suitable for AD plants of all sizes, the BDS comes skid mounted for easy access and freedom of movement and features an automatic control panel for full process control.

HRS Heat Exchangers Australia New Zealand  
[www.hrs-heatexchangers.com/au](http://www.hrs-heatexchangers.com/au)





## Hot CO<sub>2</sub> technology efficiently sterilises water



Technology developed by UNSW Canberra could provide an environmentally friendly, cost-effective method of sterilising water. Developed by UNSW Canberra researchers Dr Adrian Garrido Sanchis, Professor Richard Pashley and Australian National University Emeritus Professor Barry Ninham, the technique bubbles unpressurised carbon dioxide (CO<sub>2</sub>) through wastewater in a bubble column, effectively inactivating bacteria and viruses.

The technology is capable of sterilising water with hot CO<sub>2</sub>, which considerably reduces the energy requirements compared with boiling water, as heating gas is much more efficient than heating water. The method is also safer than chemical treatments such as chlorine.

Dr Sanchis first tried to inactivate viruses with a bubble column while

completing his PhD at UNSW Canberra. "The collision between the hot air bubbles and the viruses was the mechanism behind the inactivation," he said.

"Then I tried to improve the inactivation effect with different solutions, with air at different temperatures and finally with different hot gases. This proved that hot carbon dioxide inactivated virus[es] and bacteria faster than the other gases. Therefore, we decided to conduct a specific CO<sub>2</sub> pathogen inactivation study."

Dr Sanchis explained that current water disinfection technologies have several limitations. "This new technology could become a new sterilisation technology candidate able to compete with the existing ones," he said. "The fact that the process can use heated CO<sub>2</sub> gas instead of heated water, and the possibility of re-using exhaust

gas from combustion processes, makes the new process potentially more energy efficient."

Australian Pork Limited (APL) has previously funded research into the technology and is interested in supporting the next phase of the research towards commercialisation.

"APL funded the construction of a small pilot plant for pure water production from the condensation of the saturated gases from the bubble column," Dr Sanchis said. "This pilot plant was able to produce pure condensed water and also sterilise the piggery effluent, producing another output of sterilised water."

"Many waste disposal industries, like landfills, piggeries, wastewater treatment plants, biogas plants and coal power plants, emit large amounts of CO<sub>2</sub>. There is the potential for them to use these emissions in water treatment processes to sterilise water."

On 22 March, World Water Day, the United Nations shone a light on clean water availability. Today 2.1 billion people live without safe water at home and one in four primary schools has no drinking water service. The United Nations' 2030 Agenda for Sustainable Development includes a target to ensure available and sustainable management of water for all by 2030. New technology, including this water sterilisation method, could help achieve that goal.

## RECYCLED-RUBBER HORSE TRACK SURFACE

Equine Air is a horse track surface made from a mix of recycled tyre rubber. The product can be used for synthetic fibre tracks, sand tracks, mounting yards, horse walks and associated areas. The design allows the product to be placed over problematic ground conditions and is laid using conventional paving equipment. The product can also be applied as a single layer directly on a prepared track base.

The paving product is free-draining, with an ability to drain the surface in a short time after a rainfall event. The bound-rubber surface provides a cushioning effect, providing less concussive riding forces, lowering the potential for injuries to horses. Initial rider feedback confirms that there is less concussive force felt than on traditional surfaces, describing the result as a less 'jarring' ride.

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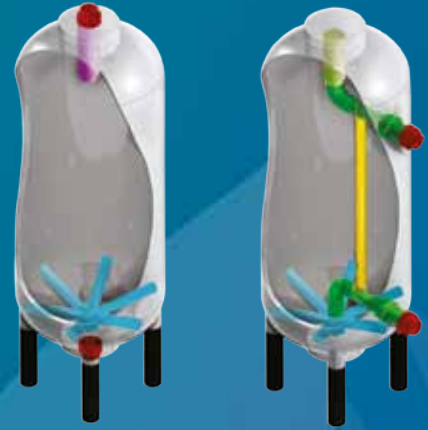


# PRESSURE VESSELS FOR THE WATER TREATMENT INDUSTRY



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## **SUPERIOR EQUIPMENT - INTELLIGENT SOLUTIONS**





## Recycled plastics and glass pave the road ahead in the ACT

Downer and Roads ACT have partnered with Close the Loop, a resource recovery and recycling company based in Melbourne, to repurpose soft plastics and glass to make asphalt.

Setting a new benchmark in sustainability, roads built at Gungahlin and Casey in the ACT will divert plastic from approximately 619,000 plastic bags and packaging items, and the equivalent of 123,000 glass bottles from landfill. In addition to soft plastics and glass, toner from approximately 15,100 used printer cartridges and more than 210 tonnes of recycled asphalt have been repurposed to create close to 1000 tonnes of road surface material.

The recycled asphalt has been used to resurface the roundabout on Gundaroo Drive between Pallin Street and Hollingsworth Street in Gungahlin. Downer Executive General Manager of Road Services Dante Cremasco said, "The milestone event demonstrated the importance of partnerships with other thought leaders to create economic, social and environmental value for products that would more than likely end up in landfill, stockpiled or as a pollutant in our natural environments.



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"Together with Roads ACT and our partners, we have proven that with thought leadership and the tenacity to make a positive difference, we have set a new benchmark in the Territory when it comes to sustainability by creating new avenues to recycle and repurpose waste materials into new streams of use. It's all about pulling products, not pushing waste," Cremasco said.

"Further to the direct sustainability benefits, this cost-competitive road

product called Reconophalt has enhanced properties of improved strength and resistance to deformation making the road last longer and allowing it to better handle heavy vehicle traffic," Cremasco added.

Downer partnered closely with Close the Loop to tailor waste products to a road surface application. Close the Loop Australia General Manager Nerida Mortlock commented, "This superior asphalt product demonstrates the many benefits of the circular economy. Our collaborative partnerships with Downer and others have enabled us to design, develop and manufacture sustainable new products using valuable waste materials destined for landfill.

"Reconophalt also provides a practical use for waste soft plastic — one of Australia's most significant problematic waste streams. While steps have been taken to minimise single-use plastic bags, soft plastic is still prevalent in everything from bread and produce bags to pallet wrapping. The innovative asphalt product re-uses this plastic to create not just a new product, but a superior product," Mortlock added.



## Research to save millions of tonnes of glass from landfill



A new process turning waste glass into every day products could save tens of millions of tonnes of glass from going to landfill every year.

University of Queensland (UQ) PhD candidate Rhys Pirie and Professor Damien Batstone have developed a method to extract liquid silicate from waste glass, which can be used to make thousands of products, from concrete sealers and fertilisers to detergents and toothpaste.

"We estimate the process is more than 50% cheaper than conventional ways of producing silicate," Pirie said. "It requires less energy, raw materials and capital, and that's before you consider the reduced social and economic costs compared to landfilling material."

Co-funded by the Cotton Research and Development Corporation and Department of Agriculture and Water Resources, UQ's method leaves behind little waste, with nearly all of the glass being turned into saleable products.

Pirie began exploring the possibilities of glass recycling after speaking with Professor Batstone, a specialist in converting waste into high-value products, from UQ's Advanced Water Management Centre.

Pirie commented, "The transition towards circular economies is a movement which is gaining momentum and something I've always been interested in. My PhD has highlighted how we need to make use of both the raw materials in 'waste' streams and the energy embodied in them during manufacture."

For the remainder of his PhD, Pirie is looking at ways in which waste glass could also be used to create a low-cost silicon-based additive to increase fertiliser efficiency.

UniQuest, UQ's commercialisation company, has filed a patent covering the process and is now seeking commercial partners.





## Young researcher awarded to propel methane-reduction study



Image courtesy of SA Water

Sarah received the prestigious Water Research Australia (WaterRA) Nancy Millis Memorial PhD Scholarship at the industry association's annual international Research and Innovation Gala Dinner, which provides \$25,000 in project funding and travel support. The award is given in memory of the late Emeritus Professor Nancy Millis, a pioneer for Australian women in science, and recognises students who have demonstrated exceptional qualities and a passion for research.

"The experience and insight I will gain, along with the motivation of achieving this award, will help me to develop as a researcher and make a positive contribution to the water industry," Aucote said.

A young South Australian will investigate how to improve the operation of wastewater sludge-drying lagoons by reducing their methane emissions. The research will be conducted at SA Water's laboratory based in Adelaide's CBD. Management of human waste and its impact on the environment is a critical international issue and it is hoped that results from the study will have a positive impact on the wastewater industry globally.

Conducting her PhD research with SA Water and the University of Queensland, Sarah Aucote (pictured above) said promoting the activity of natural microorganisms that consume methane may reduce emissions and help contribute to climate change mitigation efforts.

"Sludge-drying lagoons are commonly used around the world to treat wastewater sludge and form biosolids for agricultural application such as fertiliser, but they've recently been shown to contribute to the carbon footprint of wastewater treatment plants," she explained.

"As a young researcher, it's incredibly satisfying to work on such a fantastic project that I believe will be beneficial not only to SA Water, but to other water utilities around the world."

"I'm extremely thankful to WaterRA for the award, and appreciative of the opportunities my supervisors have provided me throughout the project — the continual guidance and support they have offered has been integral to my development."

Aucote's passion for research has seen her flourish at SA Water, and her recent achievement builds on the Student Water Prize she received at the 2018 Australian Water Awards for her Honours project through Flinders University.

Aucote is supervised by SA Water Lead Scientist Environment and Wastewater Dr Ben van den Akker, alongside Professor Zhiguo Yuan AM and Dr Shihu Hu of the Advanced Water Management Centre at the University of Queensland.

Dr van den Akker said, "Her desire and commitment to helping improve the water industry through research is second to none, and we're so proud [that] her efforts and qualities have been recognised through this terrific accolade. The win was a significant achievement and reflects her individual brilliance and initiative, and it will further inspire her to keep contributing to the betterment of the water industry."

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## Wastewater treatment system mimics ecosystem



A wastewater treatment system developed by John Todd Ecological Design (JTED) mimics the processes of a natural ecosystem via a self-contained network of natural ecological systems that support microorganisms that eat toxic waste.

Most wastewater treatment systems involve some form of biological process to break down waste, usually requiring chemical intervention to complete the process. The JTED Eco-Machine system features constructed wetlands with interacting organisms, biological processes and sand filtration to purify water without the use of chemicals.

The Eco-Machine wastewater treatment system was recently certified under the Living Building Challenge, achieving a Waste Petal for the installation at the Omega Centre for Sustainable Living in Rhinebeck, New York, by virtue of its ability to transform wastewater into non-potable water and valuable humus. To be certified under the Challenge, projects must meet a series of performance requirements including net zero energy, waste and water over a minimum of 12 months of continuous occupancy. The Omega Centre itself was recently certified under the Living Building Challenge criteria for compliance as 'Living'.

The wastewater treatment system employed at Rhinebeck mimics processes of the natural world, using a combination of microorganisms, algae, plants, gravel and sand filtration to clean wastewater and return clean, drinkable water to the aquifer. The process involves collecting and storing wastewater from toilets, sinks, basins and showers, which is then fed to microscopic algae, fungi, bacteria, plants and snails. Following this, wastewater flows to constructed wetlands where microorganisms and native plants reduce biochemical oxygen demand, remove odorous gases, continue the denitrification process and harvest nutrients such as phosphorous.

From the wetlands, wastewater moves to internal aerated lagoons where plants, fungi, algae, snails and other microorganisms convert ammonia into nitrates and toxins into harmless base elements. Wastewater then moves from these lagoons to an outdoor recirculating sand filter to meet advanced wastewater standards. The water can then be dispersed to groundwater or used for irrigation, toilet flushing and recharging of the aquifer.

**Tony Edye & Associates**  
[www.tonyedye.com.au](http://www.tonyedye.com.au)



Images courtesy of John Todd Ecological Design.





## Transfer station to divert 70% of waste from landfill

Member for Bass Jordan Crugnale has opened a new waste transfer station in Pakenham, Melbourne. The Future Recycling facility has been fully refurbished in partnership with Sustainability Victoria and the Victorian State Government as part of the \$35 million Resource Recovery Infrastructure Fund.

The transfer station will provide the local community and businesses with a better option for disposing of their waste and has also created 10 full-time jobs, with more in the pipeline as the business expands.

The site will attract commercial and public customers and will be supported by bin hire, metal recycling, scrap metal and resource recovery services. The traffic flow in the site is well planned, as all deliveries are directed by waste stream to aid recovery and ensure efficiency.

At the new \$4.5 million transfer station, material is sorted manually to recover the maximum re-usable and recyclable content and, according to Future Recycling, will divert at least 70% of the waste delivered to the site away from landfill. This will include up



*Jordan Crugnale MP, Member for Bass, learning how clean concrete and brick material is separated in preparation for road base rock crushing at the inert processing plant.* Image courtesy of Future Recycling.

to 100,000 tonnes of builders' waste, general waste, green waste and recyclables such as cardboard, car batteries and metals, including whitegoods and electronics.

In her opening speech, Crugnale stated, "The Resource Recovery Infrastructure Fund program has awarded \$15.1 million to support 47 projects so far. Our government will continue backing businesses like Future Recycling to improve the collection, sorting and reprocessing of recycled materials across Victoria."

The investment includes the latest waste management equipment such as Sennebogen machinery and a brand new, computerised public weighbridge, which records the volume and type of waste, along with the client's details.

Future Recycling Managing Director Tyrone Landsman explained, "Our aim is to extract as much recyclable material as possible from waste streams to avoid landfill.

**Future Recycling**

[www.futurerecycling.com.au](http://www.futurerecycling.com.au)

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# Algae cleans up wastewater in rural communities

Flinders University researchers have confirmed that an improved wastewater system, using algae to accelerate the breakdown of effluent, presents Australian rural communities with a more environmentally and economically efficient solution.

**P**rofessor Howard Fallowfield, Professor in Environmental Health at Flinders University, has led research for the past 10 years into the use of high-rate algal pond systems (HRAP) for treating wastewater in South Australian rural communities. In 2016, the treatment system was accepted by the SA Department of Health Wastewater Management Group as an alternative to existing passive lagoon systems for use in South Australia.

Prof Fallowfield said the recent report on this research — Performance of a high rate algal pond treating septic tank effluent from a community wastewater management scheme in rural South Australia, by Neil Buchanan, Paul Young, Nancy Cromar and Howard Fallowfield (DOI: 10.1016/j.algal.2018.08.036) — confirms that the new HRAP system is smaller, faster and more effective at treating wastewater and creates the potential to reclaim more water for beneficial use.

“This system has the potential to dramatically increase the availability of water for re-use in rural communities,” Professor Fallowfield said. “These sustainable, low-energy systems are cost effective to run, and the capital cost of construction is also about 40% of the previous system for effluent-only schemes, and marginally higher for blackwater schemes.”

The study catalogues extensive testing of a HRAP system in a side-by-side trial with a conventional system at Loxton-Waikerie District Council’s Kingston-on-Murray site.

“The study demonstrated that high-rate algal ponds are a viable alternative to waste stabilisation ponds for the treatment of wastewater in rural South Australian communities and elsewhere,” said Prof Fallowfield.

“While a conventional system requires 66 days to treat the wastewater, HRAPs can perform a similar level of treatment in 5–10 days. Its ability to remove pathogens is equal to, or better than, existing wastewater systems.”

He added that by providing more reclaimed water to irrigate local woodlots, the new system is a winner, both environmentally and economically.

The study evaluated the performance of the HRAP over two years when fed 12 cubic metres a day of either treated effluent from on-site septic tanks, or a facultative pond further treating the

septic tank effluent from the local community of 300 people. It showed that, generally, wastewater treatment and biomass production was improved when the HRAP was fed septic tank effluent.

- Wastewater from septic tanks was treated more effectively than from a facultative pond.
- 90% BOD5 was removed, mean biomass production was 31.7 g m<sup>-1</sup> day<sup>-1</sup>, and only nitrogen removal was influenced by pond depth.
- *E. coli* disinfection was acceptable when operated at 0.32 m depth and at four-day retention time.

The composition of the incoming wastewater affected the treatment performance; the stronger septic tank effluent was better treated and produced more algal biomass for subsequent exploitation than facultative pond effluent.

Centralised treatment systems are commonly installed in non-sewered (mostly rural) areas, generally where disposal of effluent by on-site systems is made difficult by space constraints, poor soil absorption, failed soak-ages or other issues that create a potential public health issue, with Prof Fallowfield issuing the warning that “if you are close to the Murray, where there are sandy soils, there is also the potential to contaminate the river and groundwater”.

He points to the substantial reduction in size compared to conventional systems as being a clear reason why the new HRAP system is particularly beneficial to non-sewered rural communities.

Flinders University  
www.flinders.edu.au



Professor Howard Fallowfield with Dr Harriet Whitley.





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# Farmers continue to embrace solar

*Dr Georgina Davis, Advisor Resources, Queensland Farmers' Federation*



Electricity prices are never far from the headlines.

**E**lectricity prices for Queensland's intensive agricultural sector are now unsustainable, particularly for a heavily trade-exposed sector where energy, water and the climate are so inextricably connected. Climate change is continuing to affect water availability and put new stresses on not only cropping systems but also energy systems (particularly in constrained areas).

Future energy costs, reliability and sustainability (particularly given the changing climate patterns moving towards increasing frequency and the duration of drought and other extreme weather conditions) are a major concern to farmers.

Some Queensland farmers have been on the receiving end of electricity cost increases of more than 200% in 10 years, while CPI has increased by just 24% over the same period. And there is increased pricing uncertainty into the future with the final design of future tariffs post June 2020 still unknown; as the next Regulatory Revenue Proposal process, which determines the revenue allowance for Energy Queensland (Ergon Energy and Energex)

under the National Electricity Rule (NER) and accompanying Tariff Strategy Statement continues, coupled with increasing uncertainty of generation costs across the National Electricity Market (NEM) and recent moves to 'Big Stick' energy retailers.

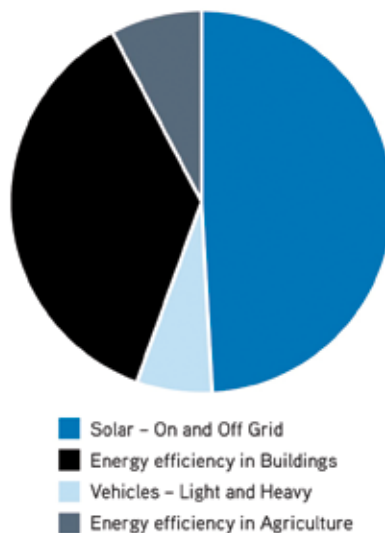
Many farmers have taken the initiative to manage unsustainable electricity prices, offset unavoidable peak demand charges (often due to crop or animal

welfare needs, particularly on hot days, or mandatory water licence access terms and conditions) and sought to decarbonise the 'energy mix' by adopting a range of technological solutions to improve energy efficiencies and ultimately drive on-farm productivity.

One area of available funding for farmers is the Clean Energy Finance Corporation (CEFC), which is responsible for investing \$10 billion in clean energy projects on behalf of the Australian Government to assist lowering Australia's carbon emissions by investing in renewable energy, energy efficiency and low emissions technologies.

Just over three years of CEFC data provided to Queensland Farmers' Federation outlined CEFC loans to agribusinesses for more than 1000 projects valued at \$220 million.

The 2015–2018 data revealed just under \$110 million was invested in more than 400 on-grid and 20 off-grid solar power projects, while Australian farmers were also committing to improving energy efficiency in their buildings, with almost 37% of the loan total invested in just under 200 projects to improve farm buildings and production systems.



*Agribusiness technologies financed through \$220 million in CEFC loans*





**\$110 million was invested in more than 400 on-grid and 20 off-grid solar power projects, while Australian farmers were also committing to improving energy efficiency in their buildings.**

In reality, the extent of agricultural investment will be many times higher as these figures are only based on CEFC-financed loans and do not include the projects where farmers have purchased renewable or energy efficiency technologies outright or sought funding elsewhere. But they do demonstrate some important trends in investment and the areas in which farmers are seeking loan assistance to make clean-energy improvements to their operations.

The agricultural sector is continuing to make significant investments in clean energy to decarbonise the economy. This is expected to continue in Queensland with the extension of the state government funded and Queensland Farmers' Federation led Energy Savers Program. With electricity price uncertainty

in the future, options are available for farmers interested in financing energy efficiency and renewable energy (see <https://www.qff.org.au/wp-content/uploads/2016/11/Energy-Savers-Fact-Sheet-1.pdf>).

Australian farmers are among the cleanest and greenest in the world and should be congratulated for their commitment to sustainable and productive farming. The water-energy-climate nexus will need various solutions, but efforts to drive efficiency in both energy and water end uses will increase Queensland's intensive agricultural sectors' resilience and help them manage the rising liabilities from climate and carbon-related exposure, including increasing electricity costs, rising environmental compliance and the increasing scrutiny of customers and investors.



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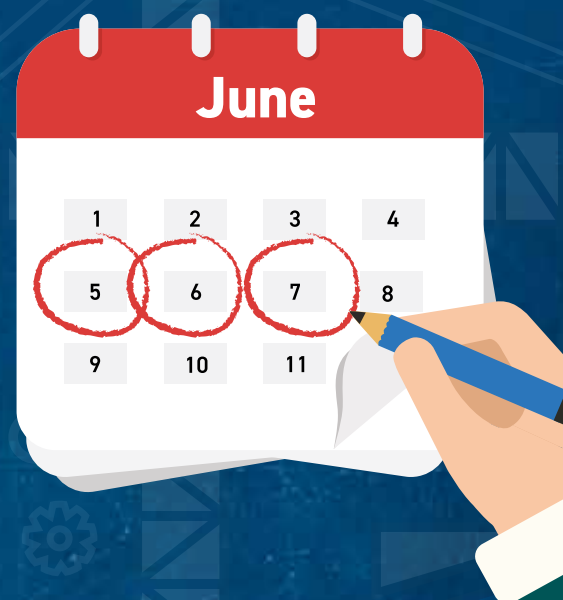
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Today, our business combines many services, solutions, products and applications to suit each client's needs. We continually pivot to keep pace with rapidly evolving technology, markets, regulations and climate conditions. We recognised the need to become more agile and that is why we integrated the Hydramet and TRILITY businesses into a single TRILITY entity.

We made this change with the market in mind, and with the aim to provide a complete offering. TRILITY is committed to be a 'partner of choice' in the delivery of water, wastewater and environmental services. Today our combined services consist

of; asset finance, project design and construction, operations and maintenance, modular solutions, spare parts supply, and servicing — all delivered by an integrated team, under a single brand.

This integration provides access to an extensive range of technical and operational expertise across a broad geographic spread. We manage numerous water infrastructure assets across Australia and New Zealand using best practice management systems and processes. We use the latest technology to design, build, install and operate modular water and wastewater treatment solutions. TRILITY specifically tailors solutions to meet the various water treatment challenges faced by the water sector today.

It was important to TRILITY to build our business around our strengths. We are front-line operators and service technicians supported by a dedicated group of water quality professionals. Together we deliver safe and efficient water and wastewater services, with a vision to be the most respected in our field.

Our solutions and services are built on our heritage and our expertise, a dedication to do it right, and a passionate commitment to provide our services effectively, efficiently, safely and responsibly. Our competitive advantage lies within our specialised teams, as well as our relationships with local subcontractors, consultants and suppliers. We work alongside our clients, as partners, to optimise facilities, processes and performance — creating value through the full water and wastewater cycle, enhancing competitiveness and protecting the environment.

TRILITY Managing Director, Francois Gouws says, "We do this with pride and with only one purpose in mind and that is; to serve our clients and the communities in which we operate."



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## Wetland sends phosphorous levels south

Water monitoring in the Cox Creek Catchment in the Adelaide Hills has revealed up to an 80% reduction in phosphorous levels over the last decade. The positive results are credited to an important project by SA Water to improve the quality of inflows to Mount Bold Reservoir.

With high levels of nutrients like phosphorous previously flowing from farming properties upstream, down the small catchment and into the Onkaparinga River, in 2006 crews constructed a natural wetland at the Woodhouse Activity Centre and a separate sedimentation basin at the nearby Brookes Bridge.

SA Water's Manager of Catchments, Wastewater and Environmental Science, Jacqueline Frizenschaf, said the initiative traps and removes large amounts of sediment from the creek before it flows into metropolitan Adelaide's largest drinking-water storage.

"Monitoring the balance of nutrients in our waterways is an important step in maintaining the taste and odour of our water, with phosphorus in particular a potential driver of algae which leads to extra work for our water treatment plant operators," Frizenschaf said.



Image credit: ©Tom Roschi Photography

"The end result has proved to be one of the most significant catchment measures of its kind in the Mount Lofty Ranges, with around one to two tonnes of phosphorous removed each year from the water course.

"Having a functioning natural environment is critical to the health of our water catchments, which help ensure the water quality in our reservoirs is safely and cost-effectively maintained for our customers," she continued.

The proactive initiative was a collaboration between SA Water, the Environmental Protection Authority, Scouts SA, the Adelaide and Mount Lofty Ranges Natural Resources Management Board and the wider Piccadilly Valley community.

The General Manager of the Woodhouse Activity Centre, James Sellers, said SA Water's efforts had made a significant impact on improving the facility's natural outlook.

"Having a native ecosystem on our property has become an extremely important educational feature where school groups, scouts and the wider community can study water birds and other aquatic wildlife thriving in their natural surroundings," he said.

"This is now a highly valued and tranquil natural area for the Mount Lofty Ranges, and we look forward to working with SA Water on this site well into the future."

**SA Water**

[www.sawater.com.au](http://www.sawater.com.au)

## Investigation underway to reduce steel manufacture emissions



CO2CRC has been awarded funding to conduct important research into reducing greenhouse gas emissions in steel production. The year-long study has been made possible by a grant from the NSW Department of Planning and Environment (Coal Innovation NSW Fund).

The project will explore pathways for reducing greenhouse gas emissions in steel production, including carbon capture from major emission sources and geological sequestration. Importantly, emerging technologies for emissions reduction at BlueScope Steel's facility in Port Kembla NSW will be explored.

A major component of the study involves investigation of options to use a steel plant waste stream, converting carbon monoxide that would otherwise be flared and emitted as CO<sub>2</sub>, into a value-added product.

The project has strong support from BlueScope Steel, which will be supplying relevant information for this study from its Port Kembla steelworks.

CO2CRC CEO David Byers commented, "An exciting aspect of this research is that it will examine how to capture greenhouse gas emissions and turn them into something useful. One option to be investigated includes using biochemical processes to convert a waste stream into ethanol, a valuable transport fuel.

"Developing a deeper understanding of these innovative technologies will help steel manufacturers select technologies that can dramatically reduce emissions in a commercially viable manner," he said.



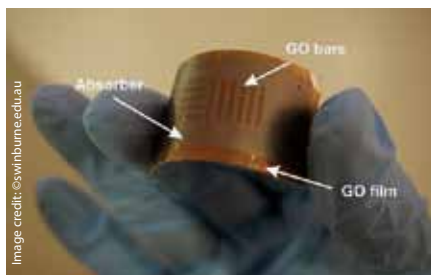


# Ultrathin graphene film offers new concept for solar energy

A collaborative team of researchers from Swinburne University of Technology, the University of Sydney and Australian National University has developed a solar-absorbing ultrathin film that has potential in solar-thermal energy harvesting. The 90 nm material is 1000 times finer than a human hair and can rapidly heat to temperatures as high as 160°C under natural sunlight in an open environment.

The research team has developed a 2.5 x 5 cm working prototype to demonstrate the photothermal performance of the graphene-based metamaterial absorber and has proposed a scalable manufacturing strategy to fabricate the graphene-based absorber at low cost.

"Our cost-effective and scalable graphene absorber is promising for integrated, large-scale applications that require polarisation-independent, angle-insensitive and broad-bandwidth absorption, such as energy harvesting, thermal emitters, optical interconnects,



photodetectors and optical modulators," explained lead author Dr Han Lin, Senior Research Fellow at Swinburne's Centre for Micro-Photonics.

The technology has the potential to lead to 'invisible cloaking technology' via the development of large-scale thin films enclosing objects to be hidden. It is hoped that the new graphene-based material will also open new avenues in thermophotovoltaics (the direct conversion of heat to electricity), solar seawater desalination, infrared lighting and heating, optical components, modulators and interconnects for communication devices, photodetectors and colourful display.

"This is among many graphene innovations in our group," said Professor Baohua Jia, Research Leader of Nanophotonic Solar Technology at Swinburne's Centre for Micro-Photonics. "In this work, the reduced graphene oxide layer and grating structures were coated with a solution and fabricated by a laser nanofabrication method, respectively, which are both scalable and low cost."

Co-author Dr Keng-Te Lin added, "Fabrication on a flexible substrate and the robustness stemming from graphene make it suitable for industrial use."

Professor Martijn de Sterke, Director of the Institute of Photonics and Optical Science, said, "We have essentially developed a new class of optical material, the properties of which can be tuned for multiple uses."

The research, published in *Nature Photonics*, has been funded by an Australian Research Council Discovery Project grant.

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### **Protecting and Enhancing the City's Green Spaces Through Increased Recycled Water Use**

Kevin Page,  
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### **The Water Resource Challenges for Two Indigenous Communities in Australia and the Pacific**

Russell Beatty,  
Hydrology and  
Risk Consulting

### **Planet, People, Prosperity: Tracking our Journey Towards Sustainability**

Grace Rose-Miller,  
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### **Lessons from the First Victorian Water Sector Climate Change Adaptation Action Plan**

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at The University of  
Queensland

### **Beyond Goal 6: Driving Sustainability at Melbourne Water Through the UN Sustainable Development Goals**

Tim Rowan,  
Melbourne Water


### **Developing a Sustainable Water Future for the Torres Strait Islands**

Priyani Madan, Arup  
and Tom Day,  
Torres Strait Islands  
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Doug van Gelder,  
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# The blow by blow on blowers



Ahead of Ozwater'19, Kaeser advises how to select the right blower for a wastewater treatment plant.

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**D**espite being high consumers of energy, blowers are a key component of wastewater treatment plants (WWTPs). Selecting the right blower is critical.

Blowers have several fundamental purposes, including agitation, aeration, filter backwashing and methane capture, all of which come at a cost: blowers are estimated to consume upwards of 60% of a WWTP's power consumption.

Kaeser Compressors have outlined key differences in blower design to address what factors should be considered when selecting an appropriate blower.

## Splitting solutions

Typically designed to operate for 20–30 years, WWTPs are built for expected future increased capacity to account for growing communities, meaning that specified blowers are usually oversized for the plant in the first 10–15 years. This creates unnecessary cost to the operator and is not ideal for the longevity of the blower. To avoid this problem, a splitting solution using multiple blowers to vary flow load as the plant expands or decreases is beneficial.

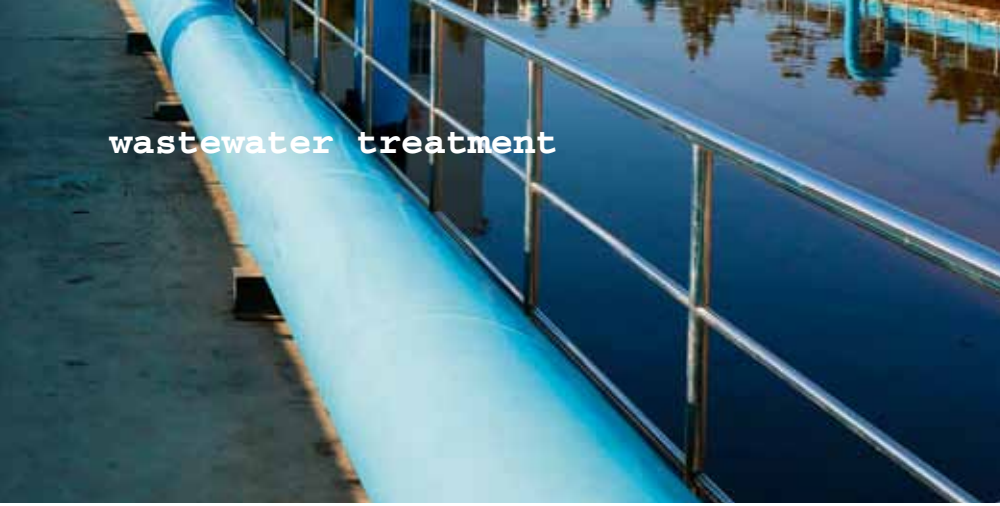
## Dynamic vs positive displacement

Blowers can be divided into two groups: dynamic or positive displacement (PD)

machines. Dynamic machines work by accelerating air to high velocities and include centrifugal and high-speed turbo devices. These blowers are generally more complex, can produce large amounts of flow and can offer high efficiency ratings, but they have limited ranges of control.

PD machines, including lobe and screw blowers, work by trapping volumes of air at the inlet port, subsequently pushing air out of the discharge port. These devices tend to be simpler than dynamic machines, offering a proportionally wider control range, are less expensive to purchase and provide greater start/stop capabilities. Historically, the lobe compressors offer lower efficiency ratings and





lower flow capacities than the larger centrifugal machines; however, this is changing with the introduction of modern screw-type designs.

### Lobe-style blowers

Low investment cost, versatility in application and adaptive pressure capabilities are some of the key advantages of lobe-style blowers. This type of device will only operate at the pressure the system requires and can be turned on and off frequently.

Lobe-style blower packages work well in most WWTP applications. In the case of screw-type machines and high-efficiency turbo designs, the cost of energy will in many cases determine the product that will deliver the best payback on investment. This is especially the case for applications like filter backwashing and digesters, where minimal usage (filter backwashing) and fluctuating fluid depths (digesters) will extend the payback period. In these situations lobe-type

machines provide sufficient performance at a reduced investment.

### Screw-style blowers

Although the package component requirements of a screw blower will differ between manufacturers, they are generally the same as the lobe design. The main difference is the operating speeds of the screw. With the same air-end size, a screw blower typically runs at twice the speed of a compressor with a lobe design. This changes the design requirements for the drive system, posing an additional challenge for oil-side seals. For the drives this means faster speed motors and greater drive ratios or a gear drive transmission system. Due to splash lubrication, additional care is needed to cool, seal and capture the oil mist generated by such high speeds. This ultimately makes the machine more complex compared with the simplistic lobe-type design.

The process of internal compression, characteristic of a screw design, creates a 20–30% gain over PD designs. This number will depend on the operating pressures and speed control range. In addition to gains in design, screw machines perform better at lower speeds. Comparing the specific performance curves of both designs, the screw blower offers close to a flat line, whereas the lobe type has a severe 'ski-ramp' effect at the lower end. While turbo compressors may offer a slight advantage at one design point, their turndown is limited and their curve is u-shaped.

Screw-design blowers are best suited for steady operating pressures with many running hours. For this reason they are a good fit for aeration basins that require air at all times and where the fluid depth doesn't fluctuate excessively. Integrating these blowers into the control system via IIoT allows more advanced machine control and preventive maintenance efforts.

Kaeser will showcase their compressed air management system and rotary screw compressors at Ozwater'19, 7–9 May 2019, Melbourne, Vic.

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The water meter has been granted the MID certificate (Measuring Instruments Directive), complying with the highest level of metrological standards, and is ready for commercial water accounting in the European Union.

AMS Instrumentation & Calibration is currently applying for approval to market the device in Australia.

AMS Instrumentation & Calibration Pty Ltd  
[www.ams-ic.com.au](http://www.ams-ic.com.au)





## WATER TREATMENT TECHNOLOGY

Infinite Water has announced third-party validation and endorsement of its Hydroxon technology for the treatment of drinking water to World Health Organization (WHO) and Australian Drinking Water Guidelines (ADWG) standards. The Global Water Institute of UNSW conducted rigorous validation and testing while independent analysis was undertaken by SA Water, which operates National Association of Testing Authorities accredited laboratories.

Hydroxon is a technology based on the oxidation of biological processes within the human body, making the process efficient. It is said to decontaminate and disinfect water while using less energy and fewer chemicals than conventional water treatment systems, which often rely on energy-intensive UV light, ozone

injection and membrane filtration or the use of chlorine.

The core technology is in the category of non-ozone based catalytic advanced oxidation (CAO), where hydroxyl radicals, which are highly reactive and the strongest oxidants that can be applied in water, are produced. These hydroxyl radicals can virtually oxidise any compound present in the water matrix.

A Hydroxon treatment plant is a decentralised solution that is modular and scalable. The plant can be containerised or skid-mounted, making it particularly relevant for the provision of potable water in remote and regional communities, and for tertiary treatment when repurposing wastewater.

The third-party testing and analysis confirms the high performance of the process for pathogen removal, achieving complete disinfection exceeding WHO and ADWG requirements for bacteria, viruses and protozoa without producing harmful disinfection by-products. In the case of viruses, the removal is close to 10,000 times greater than the designated standard.

The successful validation and testing shows the system can be used for a broad range of drinking water applications. Its integrated design and small footprint mean the technology can treat highly contaminated water to the most demanding drinking water standards simply and efficiently.

Infinite Water  
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# Evaporating at low temperature

Examining the benefits of low-temperature evaporation in reducing wastewater volume

Matt Hale



When treating wastewater, sludge and digestate, it can often be beneficial to also reduce the volume of material or increase the solids content. Mechanical dewatering via a centrifuge or belt press to separate solids and liquids is standard for the water treatment and anaerobic digestion sectors — but what if you want to further reduce the water content of the remaining liquid fraction?

**T**he two main reasons to remove or reduce water from effluent and waste are either to reduce the volume of material in order to cut storage, handling and disposal costs or to produce materials with distinct properties (such as liquid and solid fractions of digestate), which can then be stored and used in the most appropriate way. Traditionally, there have been two ways to achieve this: drying and evaporation.

## Drying vs evaporation

Drying usually requires large quantities of heat and energy, is costly and inefficient, and is unsuitable for materials with high water content. Conventional evaporation techniques require temperatures in excess of 100°C, which are usually achieved by boiling water or steam. However, due to the low temperatures used in wastewater treatment and aerobic digestion, such energy is not usually available without additional fuel inputs, making evaporation a high-energy option.

However, for many types of effluent, low-temperature evaporation can be a very energy-efficient method to remove water. Where process temperatures are 85–90°C, low-temperature evaporation combines the use of a vacuum to reduce the boiling point of the liquid to be removed, together with traditional high-temperature evaporators, based on heat-exchanger technology. Where the temperature of the effluent or digestate falls below the necessary temperature, increases can often be obtained via heat exchangers, utilising surplus heat from heaters and combined heat and power (CHP) engines.

## Heat exchangers

Heat exchangers are capable of recovering heat from other sources, such as the heat left from the CHP engine or from pasteurisation.





Using this as the basis for an evaporation system can improve overall process efficiency. Additionally, using a vacuum in the system to reduce the boiling point reduces the amount of energy required even further.

Combining systems into a multiple-effect evaporator allows larger quantities of water to be removed using the same initial heat input. Each evaporator is held at a lower pressure than the previous one: because the boiling temperature of water decreases as pressure decreases, the vapour boiled off in one vessel can be used to heat the next — only the first vessel requires an external source of heat, which can be taken from another process elsewhere or generated specifically for the purpose.

### Selecting the right heat exchanger

The type of heat exchanger used will depend on the nature of the products being treated. For materials with low or medium viscosities, such as wastewater and effluent with



**For many types of effluent, low-temperature evaporation can be a very energy-efficient method to remove water.**

low concentrations of organic solids, using the HRS K Series as an evaporator module provides high heat-transfer rates with good resistance to fouling. For more challenging and viscous materials, such as thicker effluents, digestate and solids with higher dry-matter concentrations, the HRS Unicus Series contains a self-cleaning scraper mechanism which reduces fouling and maintains heat transfer rates and therefore operational efficiency.

While both the K Series and Unicus Series are commonly used in the type of multi-effect evaporation system described above, both heat exchanger models can be used in other types of evaporator, such as mechanical vapour recompression (MVR) or thermal vapour recompression (TVR) systems, depending on the needs of the

product or application. In MVR set-ups, the evaporated steam is sent to a compressor (where it increases in pressure and temperature) and used as the thermal energy source in the evaporation process. Only electrical energy (for driving the compressor) is used in this case. In TVR set-ups, boiler steam can be mixed with evaporated steam in a thermo-compressor, leading to considerable energy savings.

The ultimate use of HRS heat exchangers for low-temperature evaporation can be found in the HRS Digestate Concentration System (DCS), which uses multiple evaporation effects to increase the solids in liquid digestate three- to four-fold.

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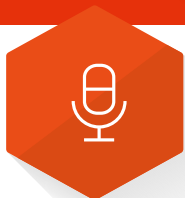
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# Can our solar farms weather the storm?

Assessing damage risk to solar panels in extreme weather conditions, such as high winds and tropical cyclones, is vital to protecting the nation's investment in renewable energy.

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Commercial property insurer FM Global has urged the Australian Government and power-generation and insurance industries to standardise resilience testing of solar panels.

Sun Metals Corporation (SMC), collaborating with the James Cook University Cyclone Testing Station and FM Global, has completed wind-tunnel and structural static testing of ground-mounted solar panels in Australia to understand the risk of high-wind and cyclone damage to solar farms.

The testing project was designed to reveal areas of exposure at SMC's recently installed \$200 million Townsville solar farm, claimed to be the largest solar farm in Australia. The Sun Metals Solar Farm is a huge facility incorporating more than 1.3 million solar panels. The 124 MW solar power station supplies the equivalent of around one-third of the electricity powering the Sun Metals zinc refinery, located approximately 15 km south of Townsville.

Static testing of the ground-mounted solar panels was conducted by James Cook University's Cyclone Testing Station in collaboration with RCR Tomlinson, the installer of the solar farm. Wind-tunnel tests were performed by CPP consultants. Static testing is a first step to initiate the evaluation and should be conducted along with comprehensive dynamic load calculations yet to be considered.

Sun Metals and its solar installer, RCR Tomlinson, worked with James Cook Univer-

sity's cyclone-testing station for wind-tunnel and structural static testing of ground-mounted solar panels so it could withstand winds of up to 200 km/h.

Lee said Sun Metals was happy to make its solar panels more sturdy given that Townsville is often hit by tropical storms. "Townsville is hit by cyclones pretty regularly. I'll be honest with you, when we first got there it looked like a million flat-screen TVs in a huge paddock and when you held onto one of the panels, it looked pretty flimsy," he said.

"When we looked at the risks, we didn't think it would withstand a cyclone. But the testing showed it could."

Australia's appetite for renewable energy projects, including large-scale solar, has propelled the nation towards its 2020 Renewable Energy Target. With increased uptake of solar, the potential for equipment failures to cause major disruption and multimillion-dollar losses for consumers and businesses has also risen. The Queensland region experiences an average of 4.7 tropical cyclones per year, yet despite this, standardised resilience testing of solar panels does not exist.

An article published in *Nature Geoscience* commented that greenhouse warming may cause the globally averaged intensity of tropical cyclones to shift towards stronger storms, with intensity increases of 2–11% by 2100. Warmer ocean temperatures may also affect the longevity of severe storms. This highlights the importance of standardised assessment to ensure solar installations

are able to weather increasingly violent winds and storms.

SMC Chief Financial Officer and Director Kathy Danaher said, "We recognised we were building our solar farm in a cyclone-prone area and made sure we designed all aspects of the build with the risks in mind. We reached out to FM Global to ensure our farm was as safe as possible and we are pleased that our solar panels performed strongly."

FM Global advocates for wind-resilience testing to be required under national regulations. The insurer promotes wind design and testing guidance for wind-resistant systems across its branches worldwide.

FM Global Operations Manager Lynette Schultheis commented, "Australia is a global leader in renewable energy and we're seeing the largest growth of large-scale solar projects in the north of the country. This area also happens to have the highest exposure to cyclonic winds."

"It's imperative for both solar users and key players in the power generation industry to understand and mitigate the risks these solar farms face. FM Global hopes the government and insurance industry will get on board to standardise the resilience testing of solar panels and futureproof our country's renewable energy investments."

Australia's pipeline of large-scale solar projects has leapt to 35 GW, joining an existing 564 MW of large-scale solar connected to the grid.

FM Global  
www.fmglobal.com.au



# One step closer to aluminium-ion batteries

Scientists from the US, Australia and South Korea have demonstrated a strategy for designing active materials for rechargeable aluminium-ion batteries that could be used in future for renewable energy storage.

While lithium-ion batteries have enjoyed remarkable success powering mobile electronic devices, in renewable energy applications they are fraught by limited cycle life, safety concerns and relatively high costs. Aluminium-ion batteries have thus been seen as ideal contenders for this space, given aluminium is the third most abundant element in the Earth’s crust behind oxygen and silicon. It also has the one of the highest theoretical volumetric capacities on account of its multiple redox states.

“Developing batteries using aluminium has received a lot of expectation for delivering high energy to price ratios,” said Dr Dong Jun Kim, formerly of Northwestern University and now based at UNSW. But up until now, finding appropriate host electrodes for insertion of complex aluminium ions had been a fundamental challenge.

“We found a novel way to design rechargeable aluminium

batteries by employing a redox-active macrocyclic compound as the active material,” Dr Kim said. In other words, he and his team managed to use a large organic chemical compound as the part of the battery that stores energy, something that previously had researchers stumped.

“We believe the research discussed in the article opens up a new approach to designing aluminium-ion batteries that could be of interest to scientists investigating next-generation electrochemical energy storage,” Dr Kim said.

Dr Kim said the results of the study, published in the journal *Nature Energy*, showed “promising battery performances”; however, he stressed that it is early days and improvement will be required in every aspect of the technology. He will

therefore continue to research aluminium-ion batteries while examining the potential of using other elements.

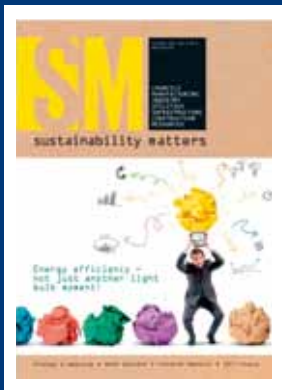
“I look forward to further research on utilising redox-active organic molecules for multivalent-ion intercalation batteries such as aluminium, magnesium, zinc and calcium,” Dr Kim said.



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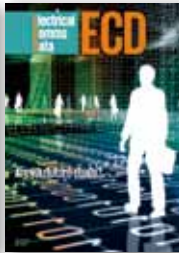
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Key to its high cost-efficiency is the POD system, an electronic controller that allows the fan to be regulated from low flow requirements right through to more than double the duty point of a traditional vane axial fan. With the use of the MAC System RFID trackers, it constantly remains aware what items of underground mining equipment are moving into the heading, so the POD controller will automatically adjust the air volumetric flow required to provide sufficient air volume to disperse the gases and ventilate the area.

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## New national conference for cleantech sector



**29–31 May 2019**

**The Events Centre, Sunshine Coast, Qld.**

**[www.nctce.com.au](http://www.nctce.com.au)**

The National Clean Technologies Conference & Exhibition (NCTCE) is a new, Australian-focused event that will encompass clean technology growth areas including energy, waste, water, the built environment and transport. The two-day conference will bring together key industry stakeholders to drive growth, innovation and investment in the sector.

The theme of 'Creating Connections: Building Business' presents a unique platform for producers, stakeholders and commercial end users of clean technology to come together. The program will focus on commercialisation, creating effective business clusters, the potential of the circular economy, innovation case studies and success stories, investment/funding channels, innovation and trends. It is hoped that the event will become *the* place for the cleantech industry to collaborate, be educated, be inspired, find opportunity and most importantly, do business.

Conference attendees will: hear from international and national leaders from the cleantech industry with real-world experience; discover new technology in waste, water, energy, transport and the built environment; explore how to create healthy, resilient and sustainable places and spaces for people to live and work; find out how regional Australia can take advantage of the rapidly growing cleantech

sector; and learn about commercialising and deploying new cleantech innovation, and develop successful partnerships.

With over 250 delegates, 40 exhibitors and 55 speakers, the program includes local study tours, workshops and two full days of conference sessions.

### **Speakers include:**

**Arron Wood, Deputy Lord Mayor of Melbourne.**

**Bianca Dragomir, European Cluster Manager of the Year. Clusters, SME and Cleantech Entrepreneurship Expert.**

**Barry Du Bois, Master Builder, Interior Designer, TV Presenter, Sustainability Advocate.**

**Cleve Schupp, Head of Marketing and Direct Sales for APAC and EMEA, Energy Products, Tesla.**

**Rory Martin, Sustainability Manager, Frasers Property Australia.**

**Jimmy Khoo, Singapore District Cooling/Singapore Power Group.**

**Jorge Chapa, Head of Market Transformation, Green Building Council of Australia.**

**ARC Laureate Professor Veena Sahajwalla, UNSW.**

**Professor Timothy Beatley, Department of Urban and Environmental Planning, School of Architecture at the University of Virginia, USA.**

**Angela Cooney, Sustainable Solutions Manager at Veolia.**

The conference will be held on 29–31 May 2019 at The Events Centre, Sunshine Coast, Qld. Registrations are open. For further information visit [www.nctce.com.au](http://www.nctce.com.au).

## New focus for Renewable Cities Australia 2019

**What: Renewable Cities Australia 2019**

**When: 13–14 June 2019**

**Where: International Convention Centre Sydney (ICC Sydney)**

**Web: [renewablecities.com.au](http://renewablecities.com.au)**

Renewable Cities Australia (RCA) has announced 'renewable' as the focus for this year's event, revealing exciting key changes to its program. The 2019 conference and associated exhibition will feature products, services and projects helping to decarbonise our economy through efficiency and automation. Renewable-generation technologies and energy providers will also be showcased, with a particular focus on large-scale power purchase agreements.

Entering its fourth year co-located with the Australian Energy Storage Conference and Exhibition, RCA will now be a free-to-attend two-day event featuring new industry association partners. The newly formed Business Renewables Centre Australia is the principal partner for the 1-day Renewable Cities Forum, while the Electric Vehicle Council and Hydrogen Mobility Australia have partnered to create a 1-day Zero Emissions Transport Workshop.

Local councils and city government will still be important visitors at the conference. Because cities and towns cannot obtain 100% renewable energy without participation from the commercial sector, which has seen a dramatic increase in renewable uptake, the 2019 RCA Forum will be designed to deliver benefit to these commercial organisations, as well as the cities and councils that have attended the event for the past three years.





## Hunter region gets green underfoot



Crushed glass sand and recycled plastic strips have been used in a footpath construction project in the Hunter region, trialling environmentally sustainable materials. Lake Macquarie City Council crews poured the 'greencrete' along a 30 m stretch of footpath on Steel Street, Redhead, with plans to monitor its performance and condition over the coming months.

The council's trial of crushed glass sand in civil works projects kicked off in June 2018, with tonnes of the material used in underground drainage pits. Council Manager of Asset Management Helen Plummer said the use of greencrete in the Redhead works was a Hunter first. She explained that 50% of the fine aggregate used in greencrete was crushed glass sand rather than natural sand, with the mix also containing thin polypropylene strips made

from 100% recycled plastic to help reinforce the material and replace the steel mesh traditionally used in concrete.

"These Australian-made materials close the loop on recycling, providing a practical end use for glass and plastic collected from kerbside recycling bins," Plummer said. "Greencrete supplier Redicrete conducted extensive testing on the concrete prior to it being poured and it is a case of so far so good. But we will continue to monitor the footpath in coming

months to see how it holds up to everyday wear and tear, and whether it cracks or wears differently to normal concrete."

More than 5000 tonnes of glass is collected from Lake Macquarie homes for recycling every year. A portion of this is sent to a processing plant on the Central Coast, where the glass is washed and crushed into a fine, smooth substance similar in appearance and performance to natural sand.

"Council is committed to exploring new and innovative ways to create a more livable, sustainable and environmentally friendly city," Plummer said.

The footpath construction project is part of council's asset management program, which identified more than 700 m of new footpath to be installed in Redhead in the 2018-19 financial year.

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# Coal reversal

## Researchers turn CO<sub>2</sub> back into coal

Gosia Kaszubska

Researchers have used liquid metals to turn carbon dioxide back into solid coal, in a breakthrough that could transform our approach to carbon capture and storage.

**T**he research team led by RMIT University in Melbourne has developed a new technique that can efficiently convert CO<sub>2</sub> from a gas into solid particles of carbon. Current technologies for carbon capture and storage focus on compressing CO<sub>2</sub> into a liquid form, transporting it to a suitable site where it is then injected underground. Implementation of this strategy has been hampered by engineering challenges, issues around economic viability and environmental concerns about possible leaks from the storage sites.

RMIT researcher and Australian Research Council (ARC) DECRA Fellow Dr Torben Daeneke said converting CO<sub>2</sub> into a solid could be a more sustainable approach. "While we can't literally turn back time, turning carbon dioxide back into coal and burying it back in the ground is a bit like rewinding the emissions clock," Daeneke said. "To date, CO<sub>2</sub> has only been converted into a solid at extremely high temperatures, making it industrially unviable. By using liquid metals as a catalyst, we've shown it's possible to turn the gas back into carbon at room temperature, in a process that's efficient and

scalable. While more research needs to be done, it's a crucial first step to delivering solid storage of carbon."

Published in the journal *Nature Communications*, the research offers an alternative pathway for safely and permanently removing the greenhouse gas from our atmosphere.

### How carbon conversion works

Dr Dorna Esrafilzadeh, lead author and Vice-Chancellor Research Fellow at RMIT's School of Engineering, developed the electrochemical technique to capture and convert atmospheric CO<sub>2</sub> to storable solid carbon.

To convert CO<sub>2</sub>, the researchers designed a liquid metal catalyst with specific surface properties that made it extremely efficient at conducting electricity while chemically activating the surface. The carbon dioxide is dissolved in a beaker filled with an electrolyte liquid and a small amount of the liquid metal, which is then charged with an electrical current. The CO<sub>2</sub> slowly converts into solid flakes of carbon, which are naturally detached from the liquid metal surface, allowing the continuous production of carbonaceous solid.

Dr Esrafilzadeh said the carbon produced could also be used as an electrode. "A side

benefit of the process is that the carbon can hold electrical charge, becoming a supercapacitor, so it could potentially be used as a component in future vehicles," Esrafilzadeh said. "The process also produces synthetic fuel as a by-product, which could also have industrial applications."

The research was conducted at RMIT's MicroNano Research Facility and the RMIT Microscopy and Microanalysis Facility, with lead investigator, Honorary RMIT and ARC Laureate Fellow Professor Kourosh Kalantar-Zadeh (now UNSW). The research is supported by the ARC Centre for Future Low-Energy Electronics Technologies (FLEET) and the ARC Centre of Excellence for Electromaterials Science (ACES).

The global collaboration involved researchers from Germany (University of Münster), China (Nanjing University of Aeronautics and Astronautics), the US (North Carolina State University) and Australia (UNSW, University of Wollongong, Monash University, QUT).

To view the research paper, visit [www.nature.com/articles/s41467-019-08824-8](http://www.nature.com/articles/s41467-019-08824-8).

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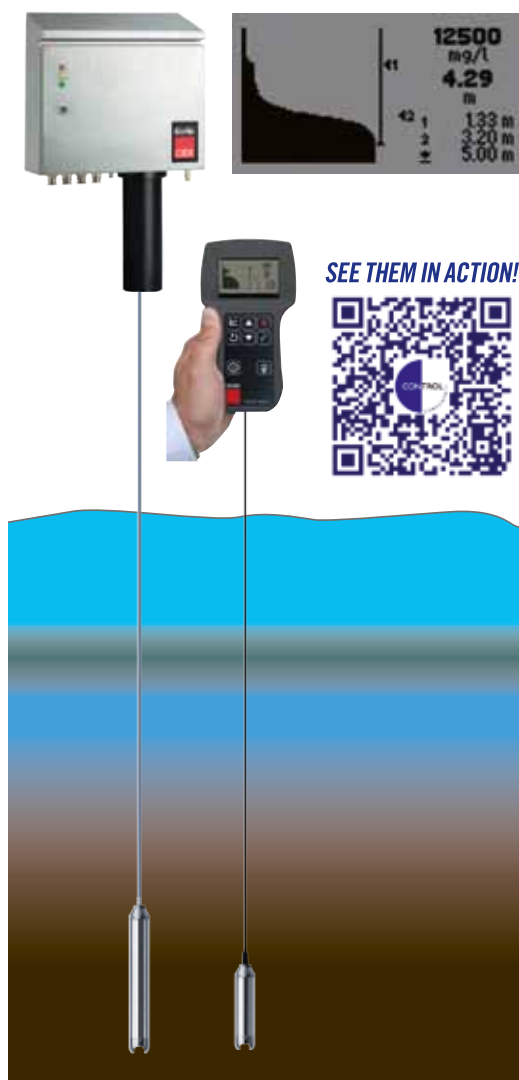


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