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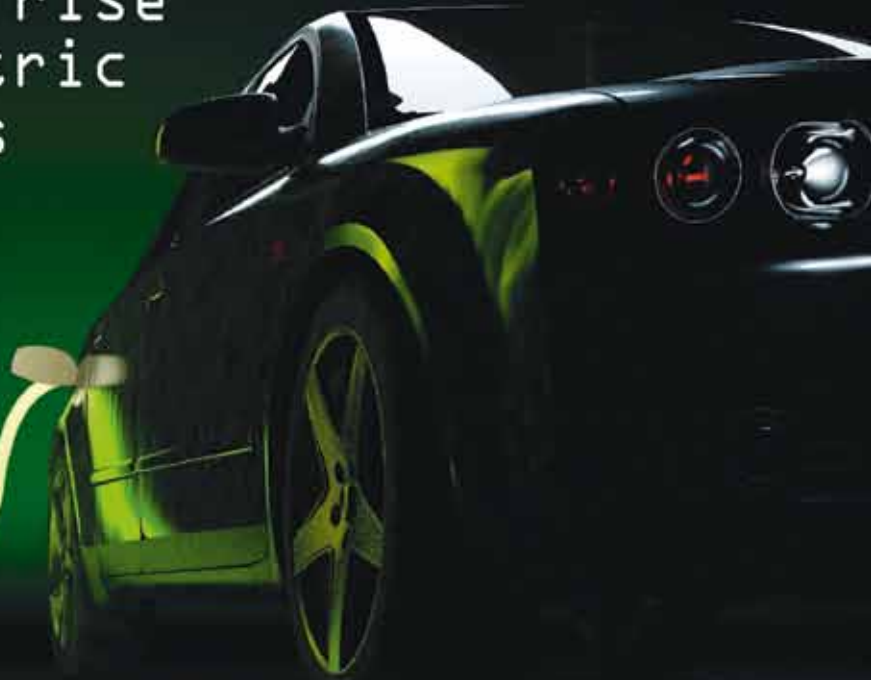
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CONTENTS

- 12 Case studies
- 24 Products & services



10

6
Can Australia charge forward with wheel benefits?

Electric vehicles

10
Lithium-ion batteries could be charged five times faster

Battery technology

14
Creating new business from wastewater

Industrial wastewater

16
'Nature-based solutions' key to water management: UN report

Water quality



16



26

18
Combining the use of engineered and natural plants in activated sludge systems

Wastewater treatment

26
Bacteria breathe easy with 'passive aeration'

Energy-efficient wastewater treatment technology

28
Compressed air audit reveals

potential savings in excess of \$300,000

30
Stations with stars

Sustainable construction

42
Fuel cells produced from recycled carbon fibres

Resource recovery

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France and the United Kingdom have planned to end the sale of new diesel and petrol cars by 2040. Across the ditch, New Zealand has a target to increase the number of electric vehicles (EVs) to 64,000 on the road by 2021. And nearly every car manufacturer, including prestige cars such as Lamborghini, has made or is making an EV model. Even the newly wed royals, Prince Harry and Meghan Markle, made a swish move at their wedding in an E-Type Jaguar which had been retrofitted with electric power.

But Australia is a laggard when it comes to the uptake of EVs. Why? It seems along with a decided lack of political action, it may also be related to the inconvenience of charging and the current high upfront costs of purchasing an EV. However, this is set to change.

Rising petrol prices in Australia are helping to build the economic case for EVs, which have running costs a third of petrol costs. And the implementation of Queensland's Electric Super Highway, with fast charging stations initially available for use at no cost, demonstrates how longer car trips are possible with an EV. Also, many car manufacturers have indicated that more economic EV models are on their way.

Together with the added environmental benefits of EVs, with 3.8 tonnes of greenhouse gas emissions saved annually (for each car driving over 15,000 km per year if 100% solar charged), it seems that the growth of the EV market could be unstoppable.

Find out more about the growth of EVs in this issue as well as details about industrial wastewater, resource recovery and energy-efficient solutions.

Carolyn Jackson

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Can Australia charge forward with wheel benefits?

Laetitia Odini, Solutions Marketing Manager – Small & Mid-size buildings at Schneider Electric, Sydney

The wheel benefits of a battery-powered future are available if Australia charges electrically forward, otherwise we may be left spluttering.

While the governments of Western Europe, New Zealand, China and India have been getting on with implementing mobility programs to encourage electric vehicle (EV) uptake and infrastructure building, the Australian Government has been sitting on its hands.

Uptake of electric vehicles in Australia has been slow and recently stalled. Over the last five years only around 6000 electric vehicles have been sold nationally. This does not match what has been happening globally.

Just recently the head of the Australian arm of Jaguar Land Rover called on the Australian Government to become more involved or risk putting the nation even further behind the global race and missing a major economic and environmental opportunity. This is an echo of recent calls by the Electric Vehicle Council, Tesla and the head of BMW Australia.





... it's safe to say the global EV market has become somewhat of a global phenomenon, except in Australia.



But this isn't just a call by car makers. In early 2016 a collection of companies and city governments submitted to the federal government a plan called 'The Path Forward for Electric Vehicles in Australia'. The group included the NRMA, Jet Charge, AGL Energy, Adelaide City Council, City of Sydney and ClimateWorks Australia. They recommended a series of measures to increase demand, supply and support for EVs in Australia, with the short-term goal of kickstarting a national electric revolution.

There are many factors holding EV sales back including cost of vehicle (no tax or government fee incentives); lack of models (poor sales keep providers away); and anxiety about range of travel (charging infrastructure). All of these factors could be addressed with a national policy of support. International experience demonstrates that policy is critical for encouraging EV uptake.

What is strange about this spluttering in EV support is that it does not match the historical support provided by governments for renewable energy or solar panels. Australia now has the highest penetration of residential solar in the world with three million homes powered.

This solar penetration has contributed to the radical change in the nation's energy system with the acceleration of renewables, microgrids, the prosumer movement, commercial renewable power

purchase agreements and digital smart grid management. A transformation of the energy infrastructure is decentralising energy production and distribution. This is delivering a reliable, accessible and sustainable suite of choices for businesses and consumers.

What occurred in energy was that various local and state governments, businesses and households grew tired of waiting for the national government to take an informed leadership role and got on with investing in generation and residential infrastructure. However, inaction on policy and grid management meant that volatility entered the pricing market and the political arena. What is concerning onlookers now is that they can see this type of imbroglia repeating itself for electric vehicles unless there is a national strategy.

It's been almost a decade since the world was introduced to a new generation of highway-ready, battery-powered electric vehicles. At the time, the striking look, sporty performance and controversial silence of these high-level EVs made one very loud statement: lithium-ion battery cells could drive us to the future.

Over the years that followed, investment in the development of battery technology resulted in reductions in their cost by as much as two-thirds since 2010. Given the battery accounts for roughly 40% of the cost of an electric vehicle, these savings

electric vehicles



The 'Path Forward For Electric Vehicles in Australia' recommends encouraging the sale and increased availability of EVs through the introduction of light vehicle CO₂ emission standards because Australia is one of the few developed countries without such standards.

were passed on to consumers making a cheaper end product, and making EVs more viable in the eyes of many consumers.

Today, global plug-in electric vehicle sales have soared well past three million units, and it's safe to say the global EV market has become somewhat of a global phenomenon, except in Australia.

But batteries only drive the car if charged. Perceptions around the availability of public charging infrastructure can be crucial to EV acceptance. There is a view that most EVs will be charged at home or at the workplace, but that widespread infrastructure is needed to mitigate range anxiety about purchasing.

Close to home, the New Zealand Government, in May 2016, then a conservative liberal one, released its Electric Vehicles Program with a statement that said: "It's clear that electric vehicles are the future." It covered a range of measures including the target to increase the number of electric vehicles to 64,000 on the road by 2021.

The government stated that they would "tackle and remove barriers that have until now prevented households and business from choosing electric. Current barriers include the limited selection of models

available, a lack of widespread public charging infrastructure and lack of awareness about electric vehicles."

The program has reduced government charges and taxes for EVs, undertaken bulk purchase of EVs, funded a nationwide information program, funded projects, allowed EVs to drive in priority lanes and facilitated the coordination of the rollout of charging infrastructure.

There have been a number of minor incentives and tokens of support for electric vehicles enacted at state levels in Australia, but they are piecemeal and low level compared to the significant initial cost of purchasing an EV.

The Path Forward For Electric Vehicles in Australia recommends encouraging the sale and increased availability of EVs through the introduction of light vehicle CO₂ emission standards because Australia is one of the few developed countries without such standards. Emission standards require that manufacturers must meet an average level of CO₂ emissions across their entire fleet, incentivising manufacturers to focus on low and zero-emission vehicles. But while people may then say Australia no longer has a car manufacturing industry, the issue becomes

one of the dumping of low-emission cars into the Australian market.

The report claims Australia "runs the risk of becoming the dumping ground for low-specification models and falling further behind international peers, resulting in relatively higher fuel costs for motorists and businesses".

However, I think the key issue is that the focus cannot just be on the EV itself. Infrastructure is critical. If through new incentives such as lower charges and taxes or emission standards there is increased adoption of EVs, there will be an increased strain on the infrastructure.

Accordingly, the Path Forward report calls for a national deployment strategy to make sure these needs will be met — not only by developing public infrastructure in places like commuter parking lots but also by incentivising residential developments, commercial locations and parking facilities to provide charging spots for EVs.

Schneider Electric, a global manufacturer of EV chargers, has been working closely with the forward-looking City of Adelaide and Queensland Government on the provision of charging infrastructure. It has developed a range of wall-mounted chargers suitable for public locations, homes and businesses, and these have been used in the Adelaide and Queensland projects.

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Laetitia Odini, Solutions Marketing Manager – Small & Mid-size buildings at Schneider Electric, Sydney



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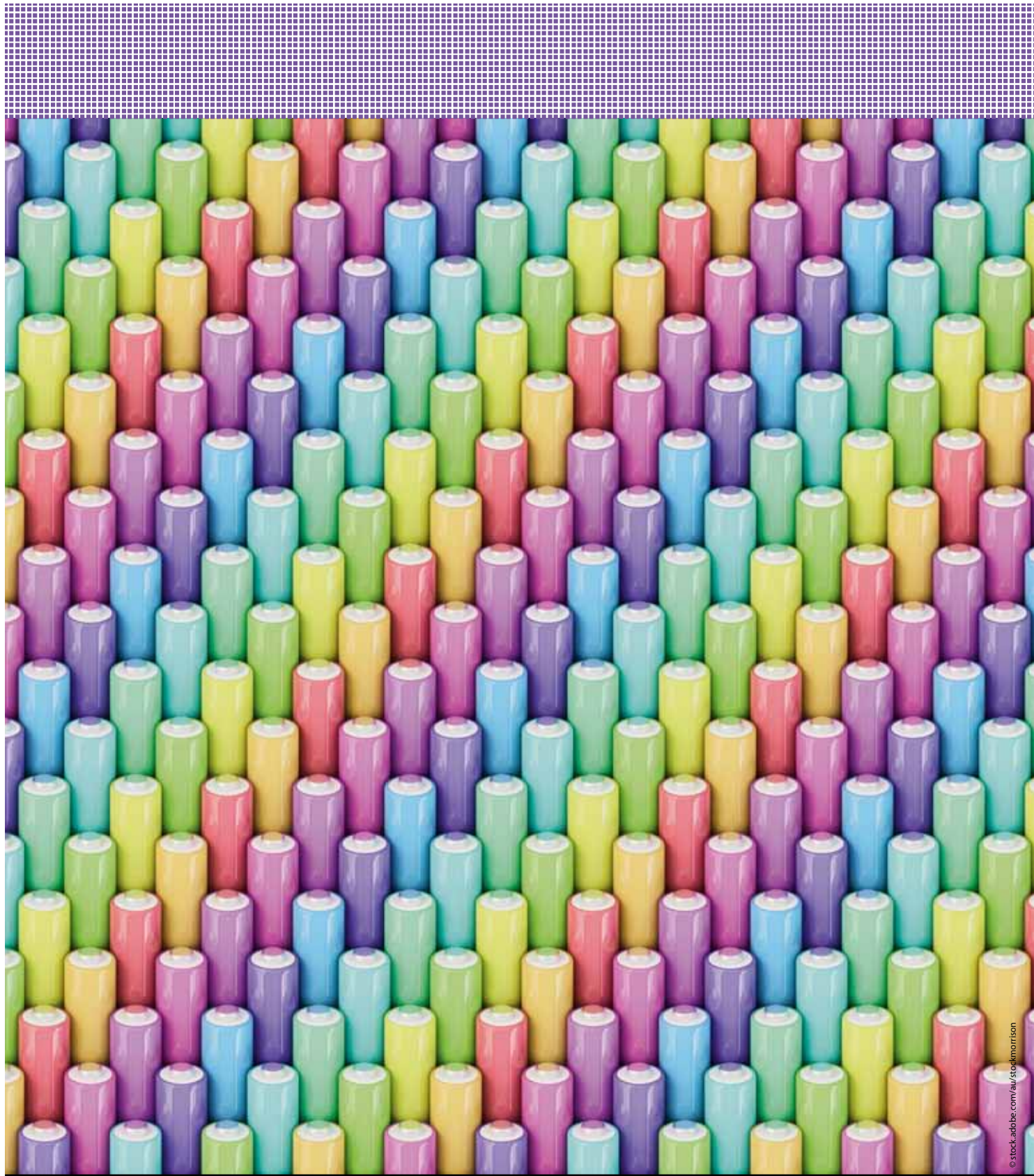
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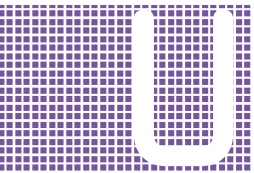
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Lithium-ion batteries could be charged five times faster





Faster charging as always comes at the expense of overall battery life, but many consumers would welcome the ability to charge a vehicle battery quickly when short journey times are required and then to switch to standard charge periods at other times.



UK researchers have developed a precise test of lithium-ion batteries' internal temperatures and their electrodes' potentials, and found that the batteries can be safely charged much faster than the current recommended charging limits.

If a battery becomes overheated, it risks severe damage — particularly to its electrolyte — and can even lead to dangerous situations where the electrolyte breaks down to form gases that are both flammable and cause significant pressure build-up. Overcharging of the anode can lead to so much lithium electroplating that it forms metallic dendrites and eventually pierces the separator, causing an internal short circuit with the cathode and, subsequently, catastrophic failure.

In order to avoid this, manufacturers stipulate a maximum charging rate or intensity for batteries based on what they think are the crucial temperature and potential levels to avoid. However, internal temperature testing (and gaining data on each electrode's potential) in a battery has previously proved either impossible or impractical without significantly affecting the batteries' performance.

As a result of this, manufacturers have had to rely on a limited, external instrumentation which is unable to provide precise readings. This has led them to assign very conservative limits on maximum charging speed or intensity to ensure the battery isn't damaged and doesn't suffer catastrophic failure.

Now, researchers at the University of Warwick have developed a range of methods that allow direct, highly precise internal temperature and 'per-electrode' status monitoring of lithium-ion batteries of various formats and destination. The technology works in situ during a battery's normal operation without impeding its performance, provides more precise

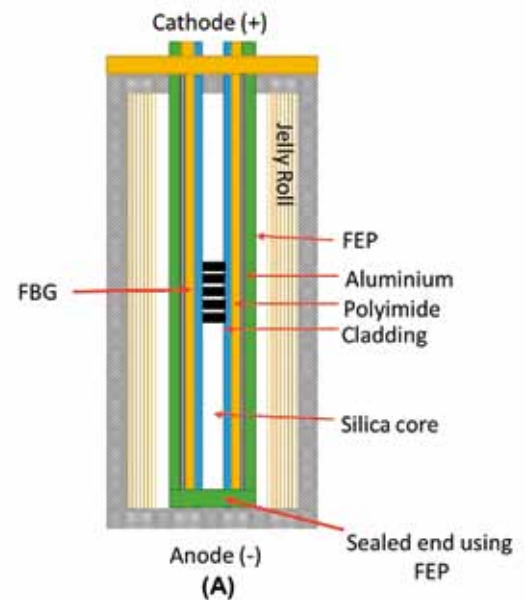
data than external sensing methods and has been tested on commercially available automotive-class batteries.

The technology employs miniature reference electrodes and Fibre Bragg gratings (FBG) threaded through bespoke strain protection layer. An outer skin of fluorinated ethylene propylene (FEP) was applied over the fibre, adding chemical protection from the corrosive electrolyte. The result is a device that can have direct contact with all the key parts of the battery and withstand electrical, chemical and mechanical stress inflicted during the batteries' operation while still enabling precise temperature and potential readings.

"This method gave us a novel instrumentation design for use on commercial 18650 cells that minimises the adverse and previously unavoidable alterations to the cell geometry," said Associate Professor Rohit Bhagat, a co-author on the study. "The device included an in situ reference electrode coupled with an optical fibre temperature sensor. We are confident that similar techniques can also be developed for use in pouch cells."

Writing in the journal *Electrochimica Acta*, the team from the Warwick Manufacturing Group (WMG) revealed that current commercially available lithium batteries could be charged at least five times faster than the recommended maximum rates of charge. Their technology is expected to enable advances in battery materials science, flexible battery charging rates, and thermal and electrical engineering of new battery materials/technology, and it has the potential to help the design of energy storage systems for high-performance applications such as motor racing and grid balancing.

"This could bring huge benefits to areas such as motor racing, which would gain obvious benefits from being able to push the performance limits, but it also creates massive opportunities for consumers and



A lithium battery temperature sensor. Image credit: WMG, University of Warwick.

energy storage providers," said Dr Tazdin Amietszajew, who led the research.

"Faster charging as always comes at the expense of overall battery life, but many consumers would welcome the ability to charge a vehicle battery quickly when short journey times are required and then to switch to standard charge periods at other times. Having that flexibility in charging strategies might even, further down the line, help consumers benefit from financial incentives from power companies seeking to balance grid supplies using vehicles connected to the grid."

Dr Amietszajew stated that the technology is ready to apply now to commercial batteries, though the researchers would need to ensure that these vehicles' battery management systems are able to accommodate variable charging rates. The WMG team have also conducted further research on the subject of battery sensing, according to Associate Professor Bhagat, who says they hope to publish their work on other innovative approaches within the next year.

Electric water taxi tested on Lake Geneva



A futuristic, zero-emission new design of water taxi, called SeaBubbles, was recently demonstrated on Lake Geneva in Switzerland.

The vehicle represents a milestone in the development of new forms of transportation that do not impact the environment or place any burden on urban infrastructure. It is set to be equipped with the ABB Ability Marine Advisory System known as OCTOPUS – a software solution that helps vessel operators gather and analyse all relevant data to optimise water travel.

SeaBubbles was founded by Alain Thébault, who conceived the idea, and Anders Bringdal. They brought together a team in France with skills in hydrodynamic design, finalising a design in 2016 for a five-person SeaBubbles water taxi.

Designed to operate in a no-wake zone, the SeaBubbles rises after a few metres and reaches a speed of 11–15 km/h on four skids. This reduces water drag by 40% and increases efficiency, allowing speeds of up to a potential 46 km/h.

The development of the demonstration craft was supported by the Geneva cantonal authorities and the Department of Energy,

Transport and Agriculture (DETA), represented by State Councilors Luc Barthassat and Pierre Maudet, drawing on technology from ABB. Further trials will continue in the months ahead, including the deployment of the OCTOPUS. The system will enable ABB to provide real-time data to the SeaBubbles control centre, covering virtually every aspect of the vessel's operating status.

ABB Australia Pty Ltd
www.abbaustralia.com.au

Converting diesel trucks into EVs in NZ

Waste Management NZ has opened New Zealand's first workshop dedicated to converting diesel trucks into electric vehicles, as part of its plan to convert 20 of its national truck fleet in the next two years. The workshop is also open to other companies looking to transform their vehicles into EVs.

The New Zealand Government's Low Emission Vehicles Contestable Fund, administered by the Energy Efficiency and Conservation Authority (EECA), contributed NZ\$500,000 in 2017 to help build the workshop and convert the first two trucks as part of its commitment to EV development. The first conversion is almost completed and the truck will be used to collect waste from Auckland Hospital.

The workshop was opened by Waste Management Managing Director Tom Nickels, who described the opening as a major step forward for both the company and electric vehicles in New Zealand.

"Our investment in the EV workshop will create a knowledge centre for EV



conversion in New Zealand and will help us move towards our long-term goal of a fleet of fully electric vehicles," he said.

"Our conversion partner EMOSS in the Netherlands has provided the kitsets and knowledge for our team to start completing conversions here in Auckland. We are also looking forward to helping other New Zealand businesses convert their fleets for a more sustainable future."

Waste Management announced its move towards a fleet of electric vehicles in September 2016. Since then the company

has launched the Southern Hemisphere's first sideloader electric truck for residential wheelie bin waste collections, which has started work on Christchurch streets, with another sideloader electric truck soon to be in operation in Auckland.

This is in addition to the electric box body truck, which started work in Auckland in November 2016, and the 20+ electric cars that Waste Management has added to its light fleet during this time.

"Our move towards electric vehicles reflects our place in a circular economy, where our vehicles can be 'powered by waste'," said Nickels. "Through our modern, sustainable landfill and energy parks we generate renewable electricity from the gas we capture from the decomposition of waste that we collect."

Up to 95% of gas emissions are captured through this process, putting enough power back into the national grid to power over 18,000 homes nationally.

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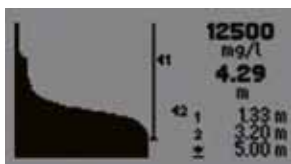
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Creating new business from wastewater



Michael Romer, Business Development Manager, Calix

Traditional wastewater treatment plants can suffer from a range of maintenance and operational issues arising from the corrosive and potentially septic nature of the materials being processed. However, there are alternative options that can reduce or even eliminate these issues, leading to a reduction in maintenance costs and improvement in odour.

Furthermore, with the right levels of alkalinity, it's possible to use wastewater sludge as a powerful source of renewable energy. This could be an answer to the energy and environmental needs of the future, acting as a viable alternative to coal-based power generation. It can also provide water authorities with a new revenue stream, since wastewater treatment and biogas energy production can happen simultaneously.

Biogas is created through a process of anaerobic digestion, which can convert organic matter such as that found in wastewater sludge into biogas. To do this effectively, it's essential to manage alkalinity and control the pH levels of the material.

This is because, as the material's pH gets too high, approximately half of the dissolved hydrogen sulphide (H_2S) already present in the material is released

to the air. When that happens, the odour release can become unbearable and even toxic to workers, and, as the hydrogen sulphide converts into sulphuric acid, it can significantly corrode assets such as wastewater pipes. The easiest and most cost-effective way to reduce hydrogen sulphide generation is to maintain the pH at optimum levels by dosing an alkali to the wastewater stream.

Municipal wastewater usually contains a good amount of alkalinity to support the biological conversion of organic waste. However, in some cases, the addition of an alkali is needed to maintain optimum bacterial growth conditions. Furthermore, it's essential to reduce the production of hydrogen sulphide, which is the gas that causes the 'rotten egg' odour.

Improving the performance of wastewater treatment could help increase the amount of wastewater biogas production.

Calix Limited
www.calix.com.au

Case study: Victorian piggery improves wastewater treatment

Calix recently helped a Victorian piggery generate significantly more biogas and power while reducing hydrogen sulphide, avoiding the use of a chemical scrubber, reducing retention time, reducing blockages from struvite and reducing sodium hydroxide consumption.

Owned and operated by the same family since 1970, the piggery started producing electricity from the effluent it produced in 1991 when the family invested \$2 million in an anaerobic cogeneration plant. As the price of electricity continued to rise, the piggery owners wanted to improve its electricity production directly from the anaerobic cogeneration plant.

To do this, it was established that the piggery needed a way to more effectively manage alkalinity.

Calix conducted a trial of its ACTI-Mag product versus hydrated lime powder, 25% caustic soda and standard magnesium hydroxide. For the same alkalinity dose, ACTI-Mag resulted in 300% more biogas generation in lab tests. And, in contrast to caustic soda or lime, the product is safe to handle, non-corrosive, safe for the environment and doesn't add to salinity. It also improves sodium absorption ratio (SAR) value in soils.

As a result of field trials, the piggery was able to increase biogas volume by 20% and power generation by 23.5%. The trial also showed that the average daily effluent soluble phosphate levels decreased by almost 40%. H_2S reduced by 70%, significantly reducing the unpleasant odour. System blockages due to solid crystal formation called struvite were eliminated during the trial, although they had previously formed on a regular basis.

Importantly, the piggery was able to achieve an increase in earnings of \$68,000 per year from increased power generation due to the improved treatment of its wastewater. This has contributed to the economic performance of the business while helping the environment. Australia currently only converts 0.1% of sewage biogas to electricity; with better wastewater treatment performance, this could be increased substantially. The Victorian piggery has proven that it's not only possible to do so but that it can also improve economic performance at the same time.



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'Nature-based solutions' key to water management: UN report

Nature-based solutions can play an important role in improving the supply and quality of water and reducing the impact of natural disasters, according to the 2018 edition of the United Nations World Water Development Report.

Presented at the 8th World Water Forum by UNESCO Director-General Audrey Azoulay and UN-Water Chair Gilbert Houngbo, the study argues that reservoirs, irrigation canals and water treatment plants are not the only water management instruments at our disposal.

In 1986, the State of Rajasthan (India) experienced one of the worst droughts in its history. Over the following years, an NGO worked alongside local communities to set up water harvesting structures and regenerate soils and forests in the region. This led to a 30% increase in forest cover, groundwater levels rose by several metres and cropland productivity improved.

These measures are examples of the nature-based solutions (NBS) advocated by the latest edition of the report, 'Nature-based Solutions for Water'. It recognises water not as an isolated element, but as an integral part of a complex natural process that involves evaporation, precipitation and the absorption of water through the soil. The presence and extent of vegetation cover across grasslands, wetlands and forests influences the water cycle and can be the focus for actions to improve the quantity and quality of available water.

"We need new solutions in managing water resources so as to meet emerging challenges to water security caused by population growth and climate change," said Azoulay. "If we do nothing, some

5 billion people will be living in areas with poor access to water by 2050. This report proposes solutions that are based on nature to manage water better. This is a major task all of us need to accomplish together responsibly so as to avoid water-related conflicts."

"For too long, the world has turned first to human-built, or 'grey', infrastructure to improve water management," Houngbo said in the foreword of the report. "In so doing, it has often brushed aside traditional and Indigenous knowledge that embraces greener approaches. Three years into the 2030 Agenda for Sustainable Development, it is time for us to re-examine nature-based solutions (NBS) to help achieve water management objectives."



Focusing on 'environmental engineering'

So-called 'green' infrastructure, as opposed to traditional 'grey' infrastructure, focuses on preserving the functions of ecosystems, both natural and built, and environmental engineering rather than civil engineering to improve the management of water resources. This has multiple applications in agriculture, the greatest consumer of water by far. Green infrastructure can help reduce pressures on land use while limiting pollution, soil erosion and water requirements by contributing to the development of more effective and economic irrigation systems, for example.

Thus, the System of Rice Intensification, originally introduced in Madagascar, helps restore the hydrological and ecological functioning of soils rather than using new crop varieties or chemical products. It enables savings of 25 to 50% in water requirements and 80 to 90% in seeds while raising paddy output by 25 to 50%, depending on the region in which it is implemented.

It is estimated that agricultural production could be increased by about 20% worldwide if greener water management practices were used. One study cited by the report reviewed agricultural development projects in 57 low-income countries and found that using water



For too long, the world has turned first to human-built, or 'grey', infrastructure to improve water management. In so doing, it has often brushed aside traditional and Indigenous knowledge that embraces greener approaches.

more efficiently, combined with reductions in the use of pesticides and improvements in soil cover, increased average crop yields by 79%.

Green solutions have also shown great potential in urban areas. While vegetated walls and roof gardens are perhaps the most recognisable examples, others include measures to recycle and harvest water, water retention hollows to recharge groundwater and the protection of watersheds that supply urban areas. New York City has been protecting its three largest watersheds since the late 1990s. Disposing of the largest unfiltered water supply in the USA, the city now saves more than US\$300 million yearly on water treatment and maintenance costs.

Faced with an ever-increasing demand for water, countries and municipalities are showing a growing interest in green solutions. China, for example, recently initiated a project called 'Sponge City' to improve water availability in urban settlements. By 2020, it will build 16 pilot Sponge Cities across the country. The goal is to recycle 70% of rainwater through greater soil permeation, retention and storage, water purification and the restoration of adjacent wetlands.

The importance of wetlands

Wetlands only cover about 2.6% of the planet but play a disproportionately large role in hydrology. They directly impact water quality by filtering toxic substances from pesticides, industrial and mining discharges.

There is evidence that wetlands alone can remove 20 to 60% of metals in water and trap 80 to 90% of sediment from runoff. Some countries have even created wetlands to treat industrial wastewater, at least partially. Over recent years, Ukraine, for example, has been experimenting with artificial wetlands to filter some pharmaceutical products from wastewater.

However, ecosystems alone cannot perform to totality of water treatment func-

tions. They cannot filter out all types toxic substances discharged into the water and their capacity has limits. There are tipping points beyond which the negative impacts of contaminant loading on an ecosystem become irreversible, hence the need to recognise thresholds and manage ecosystems accordingly.

Mitigating risks from natural disasters

Wetlands also act as natural barriers that soak up and capture rainwater, limiting soil erosion and the impacts of certain natural disasters such as floods. With climate change, experts predict that there will be an increase in the frequency and intensity of natural disasters.

Some countries have already started taking precautions. For example, Chile announced measures to protect its coastal wetlands after the tsunami of 2010. The State of Louisiana (USA) created the Coastal Protection and Restoration Authority following Hurricane Katrina (2005), whose devastating impact was magnified by the degradation of wetlands in the Mississippi Delta.

Nevertheless, the use of nature-based solutions remains marginal and almost all investments are still channelled to grey infrastructure projects. Yet, to satisfy the ever-growing demand for water, green infrastructure appears to be a promising solution complementing traditional approaches. The authors of the report therefore call for greater balance between the two, especially given that nature-based solutions are best aligned with the Sustainable Development Goals adopted by the United Nations in 2015.

Coordinated by the World Water Assessment Programme of UNESCO, the United Nations World Water Development Report is the fruit of collaboration between the 31 United Nations entities and 39 international partners that comprise UN-Water. Its publication coincided with World Water Day, celebrated every year on 22 March.



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Combining the use of engineered and natural plants in activated sludge systems



Integrated Fixed Film Activated Sludge Plants (IFAS) rely on the use of a media on which a biofilm is grown, which results in a compact footprint as a majority of the biomass is fixed to a high surface area as opposed to being suspended.

A recent development of this process by Organica Water has been to combine naturally occurring plants with engineered media. To put it simply, a botanical garden is placed on top of the IFAS reactors, with the plant roots penetrating into the reactors.

The interaction of enzymes and various organic acids from the plant roots to the bio-media creates a diverse biology, leading to increased process stability, less sludge production and lower energy demand when

compared to conventional activated sludge plants. And the sewage treatment plant looks like a botanical garden.

Large-scale installations in Europe have been in operation for 10+ years.

Background

Bio-film technology in wastewater treatment has been available since the 1970s, available as moving bed biofilm reactor (MBBR) systems or integrated fixed film activated sludge processes (IFAS). In general the bulk of the developments in this field relates to increased surface area, scouring and bio-film growth.

Generally the media used in either MBBR or IFAS is a non-metallic surface. Both systems provide benefits such as reduced reactor size, high total available biomass inventory, high tolerance against biomass washout during storm events and simultaneous nitrification-denitrification within the biofilm layer.

Organica's Food Chain Reactor (FCR) combines the use of naturally occurring plants, such as bulrushes, marsh reeds, together with an IFAS-based process. A greenhouse is typically used to house the process, resulting in an aesthetically pleas-



ing treatment system. For warmer climates, a shaded structure is used.

Discussion

Pilot work for the FCR process was conducted in 2001, and was mostly based on the use of plants, to provide a high surface area for biomass growth. Full-scale wastewater treatment plants were then constructed for 2000 and 5000EP systems, based on sequencing batch process.

Over the next eight years, the process was refined to enable the use of the technology in larger scale wastewater treatment plants,

and to improve energy efficiency and with lower biomass yield.

The combined use of the natural plants and engineered media meant that there was no limit on size for the FCR process.

Reactor configuration

The sequential batch process was then configured to a continuous multistage cascade process. Similar to MLE, an anoxic zone with internal recycle from the last stage was incorporated as part of the nitrogen removal loop.

Observations from operating sites

The multistage cascade FCR was observed

to provide a number of operational benefits. What was found in the pilot scale has been verified in full-scale installations that have been in operation for several years.

Key observations include:

- Independent development of biomass and ecology within each stage
- A significant increase in the diversity of biomass speciation due to the interaction of the natural plants and biomass
- Very high total biomass inventory, due to the biofilm growth
- Very high observed sludge retention time (SRT)
- Reduce Biomass Yield, due to a predatory effect and higher SRT
- A low MLSS in the water phase of 300 mg/L
- Increased alpha factor within the aeration system, due to the lower free MLSS
- Relatively free odour
- No need to return activated sludge (RAS) in process design

The lower free MLSS means that the phase separation step post FCR can be designed with a lower loading. Rather than using secondary clarifiers, phase separation can occur in a horizontal disc filter which has a tenth of the footprint as compared to a conventional clarifier.

In addition, the lower MLSS results in a higher diffuser alpha factor, meaning that less air is required to deliver to process oxygen need. This results in a lower energy demand.

wastewater treatment

Diversity of biomass speciation results in adaptive ecologies forming in each FCR stage. As opposed to 300 to 400 species commonly present in activated sludge plants, the FCR exhibits up to 3000. This diversity creates a very stable process, which is tolerant to shock loads, and in the last stage, the presence of eukaryotes results in the consumption of decayed bacteria.

Operating data from several facilities has demonstrated the robustness of the FCR systems, as well as consistent effluent quality. The discharge quality that can be achieved can be designed to match any conventional activated or MBR process.

The total observed biomass within the FCR system is typically 16,000 mg/L, which is three to four times conventional systems. Although MBR systems exhibit similar high MLSS, the energy demand associated with FCR is significantly less due to simplified secondary clarification phase.

Aesthetics

The FCR can be housed within a greenhouse structure, or provided with a shading structure. The selection is generally based on minimum temperatures in the winter period. The end result is a wastewater treatment plant that resembles a garden or greenhouse facility, with low odour emissions and a very aesthetically pleasing look.

In some European installations, buffer zones around the treatment plant have been reduced from 350 m to 50 m, freeing up additional land for development and providing a net positive attitude from local communities.

Conclusion

The use of bio-film technology provides a number of advantages with regard to footprint and biomass inventory. The

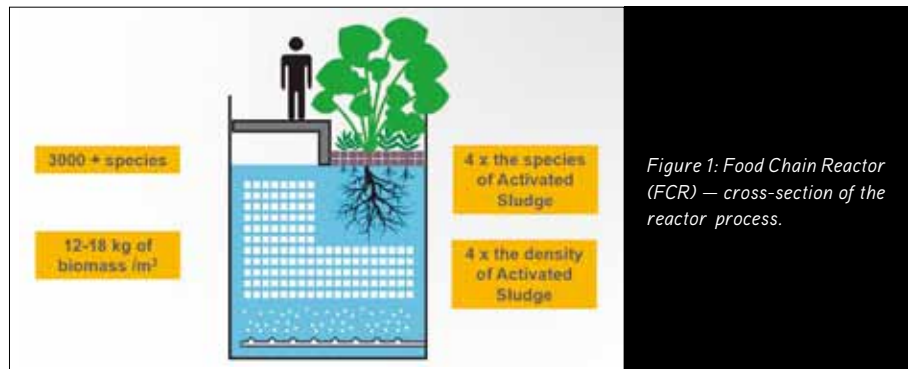


Figure 1: Food Chain Reactor (FCR) — cross-section of the reactor process.

results in a process which has been scaled up to full-size treatment facilities, that provides a number of capital and operational cost savings.

The natural plants do not actually treat the wastewater, but provide nutrients, organic acids and enzymes that create a highly diverse biology within the plant roots and IFAS modules. A much denser bio-film is created, when compared to other IFAS systems or MBBR processes.

With an observed total biomass concentration that is three times conventional systems, a reduced footprint of up to 65% can be achieved. Savings in energy demand and sludge disposal are two other key benefits of the process, particularly over MBR-based systems that exhibit similar space-saving features.

Full-scale installations as large as 80 MLD have demonstrated the technol-

ogy's application within the municipal and industrial wastewater field.

The aesthetically pleasing look of the Organica FCR has changed local community attitude towards wastewater treatment, and has provided a place for communities to interact with the process in a very positive way.

As rapid urban growth continues in many cities around the world, this technology has demonstrated its use as a decentralised facility that can be constructed in the middle of a dense urban landscape, to relieve load on existing sewer systems and enable water reclamation in these environments.

Hydroflux Epco is the exclusive Australian representative for Organica Water's Food Chain Reactor process.

Hydroflux Epco Pty Ltd

www.hydrofluxepco.com.au

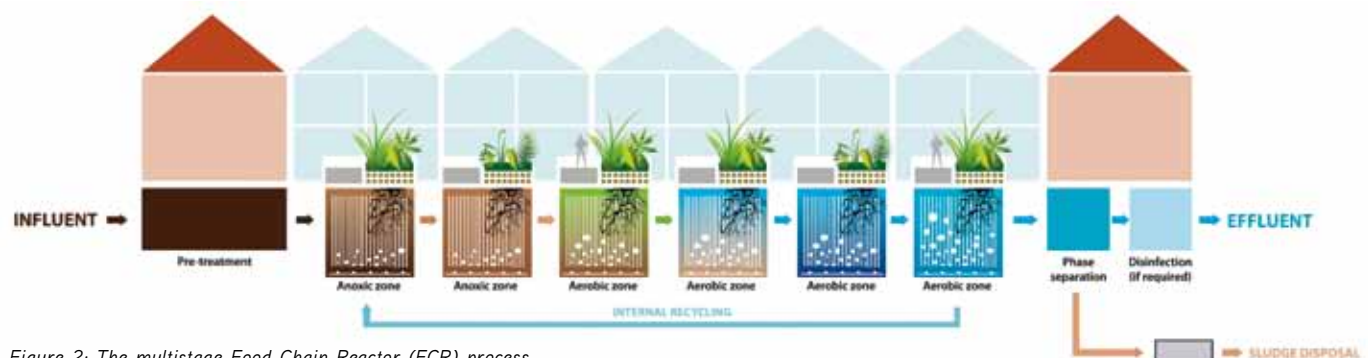


Figure 2: The multistage Food Chain Reactor (FCR) process.

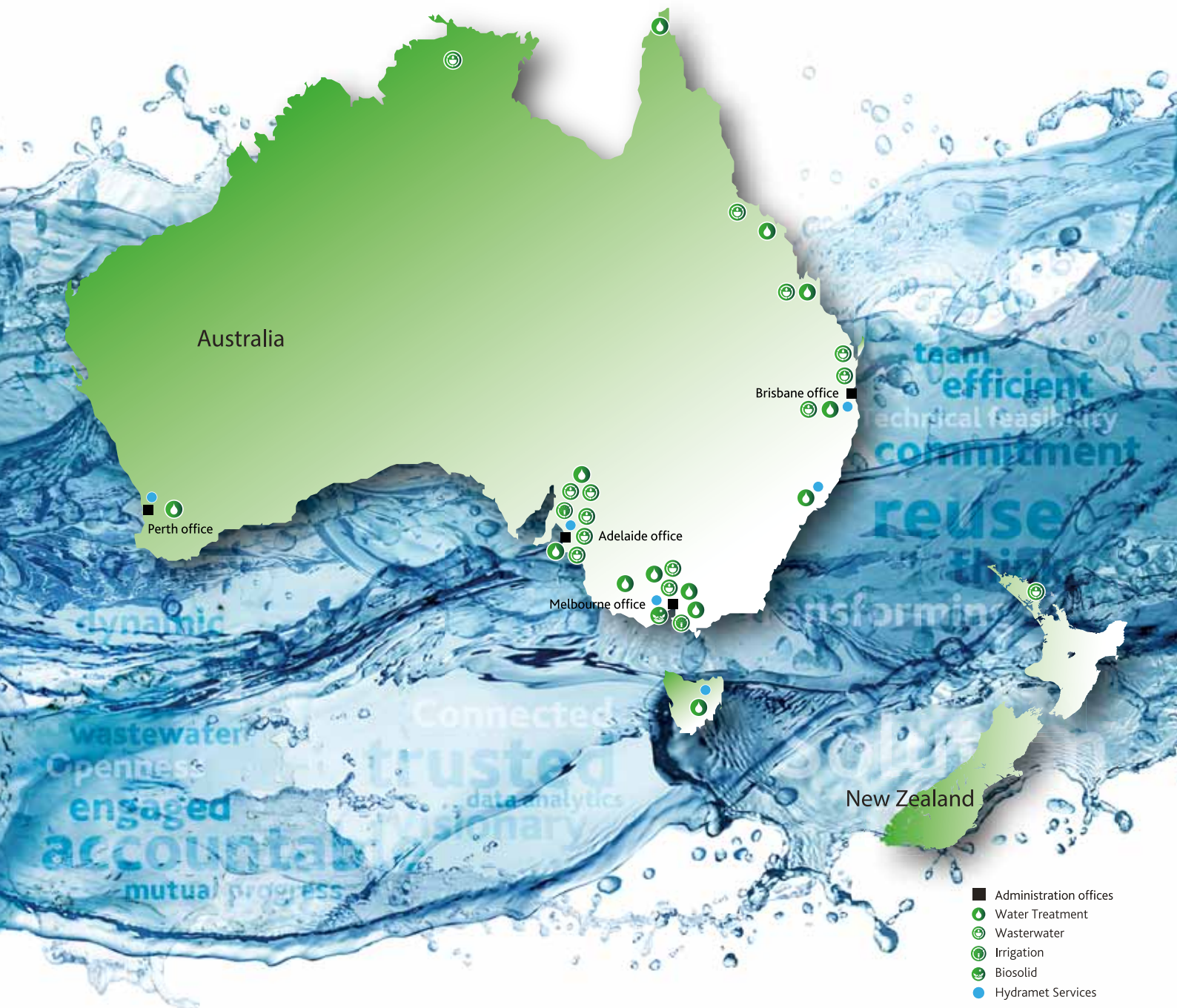


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Goulburn abattoir turns its waste into bioenergy



A Goulburn abattoir has teamed up with a Queensland energy provider to turn its waste into energy, thanks to the support of the Australian Renewable Energy Agency (ARENA).

On behalf of the Australian Government, ARENA last year provided \$2.1 million in funding to ReNu Energy to design, construct, own and operate a biogas facility at Southern Meats' existing abattoir facility. The abattoir processes sheep and lambs, using around 20,000 kWh of electricity every day.

"Disposing abattoir waste is a major environmental challenge, and processing and storing meat is an energy-intensive business," said Minister for the Energy and Environment Josh Frydenberg.

"That's why this project is win-win; it helps reduce the need to dispose of waste from the abattoir and it provides Southern Meats with a more affordable source of energy."

The \$5.75 million project consists of an anaerobic digestion process where the abattoir waste is treated in a covered lagoon to biologically break down the effluent to produce biogas. The lagoon acts like a giant bladder that can expand to hold biogas when energy demand is low, saving it to generate power when demand hits a peak. Simultaneously, this system disposes of waste from the abattoir and reduces methane emissions.

Biogas is treated and transferred to two 800 kW dual fuel generators to produce approximately 3800 MWh of electricity per year for use during the manufacturing process to reduce peak electricity consumption. The generators are able to supplement biogas with natural gas, allowing the plant to minimise use of electricity from the grid during peak usage and peak charge periods.

ARENA CEO Ivor Frischknecht said bioenergy represents a significant opportunity for the livestock processing sector to switch to renewable generation and reducing exposure to energy prices. "Bioenergy also has environmental benefits for being able to re-use the effluent rather than disposing of the waste," he noted.

"This project is a fantastic example of waste-to-energy generation, and we are very pleased to have the opportunity to work with an excellent counterparty such as Southern Meats," said ReNu Energy CEO Craig Ricato. "We also thank ARENA for its contribution to the project."

Fonterra manufacturing site to reduce water use by 70%

Dairy company Fonterra is constructing an advanced plant that is set to reduce the amount of groundwater extracted for its Darfield manufacturing site by around 70%.

Based on New Zealand's South Island, Darfield is already considered a world-leading facility, according to Fonterra. Now the company is investing \$11 million in new water processing technology for the site, which is expected to have a significant impact on its environmental footprint.

"Thanks to the new plant we'll save the equivalent of around 100 tanker loads of water every day," said Robert Spurway, head of Fonterra's global operations.

"As well as reducing water use, the new technology also decreases the amount of water the site discharges for irrigation. It's a win-win situation."

The new plant uses a reverse osmosis technique to purify the water extracted from cow's milk during the manufacturing process.



Fonterra's Darfield manufacturing site.

Water is passed through a membrane filtration system, which makes it drinkable and suitable for use in a range of on-site activities such as cooling, heating and cleaning.

The Darfield development aligns with Fonterra's six water commitments to help improve the quality of New Zealand's waterways:

1. Farm within regional environmental limits.
2. Encourage strong environmental farming practices.

3. Reduce water use and improve wastewater quality at manufacturing plants.
4. Build partnerships to improve waterway health.
5. Invest in science and innovation to find new solutions.
6. Make the products people value most.

"We're prioritising investment to reduce water consumption," said Spurway. "Last year we announced our 2020 target to reduce the amount of water we use across our 26 New Zealand manufacturing sites by 20%.

"The new plant will go a significant way toward helping us achieve our target, creating a manufacturing site that's more self-sufficient."

The new plant is expected to be up and running by October, in time for the 2018–2019 milk season.

Fonterra
www.fonterra.com



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ATEX CERTIFIED PORTABLE OXYGEN ANALYSERS

The portable galvanic electrochemical oxygen analyser range from Advanced Instruments Inc (All) now has ATEX approval for use in atmospheres containing acetylene and/or hydrogen. The certified instruments include the GPR-1000, GPR-1100 and GPR-2000 portable range and the GPR-1200 premium portable analyser, which are used to measure oxygen to ensure product quality or avoid potentially explosive atmospheres by detecting leaks.

Using All's galvanic oxygen sensors, the portable analysers are simple to use with low maintenance. The sensors have a life between 24 and 32 months, and replacing them is quick and easy to do.

The portables have an innovative design which is said to eliminate the waiting time between measurements, providing an instant purge and a fast response to changes in oxygen levels. The instruments also feature a sample bypass system that isolates the sensors from high concentrations of air and allows a quick recovery from an upset. They are convenient to use in the field, with a long battery life of up to 30 days on a single charge.

AMS Instrumentation & Calibration Pty Ltd
www.ams-ic.com.au

ELECTRIC REFUSE TRUCK

The Volvo Trucks Volvo FE Electric is designed for heavier city distribution and refuse transport operations with gross weights of up to 27 tonnes. The truck was developed together with Europe's refuse collection bodybuilder, Faun.

The truck will be offered in several variants for different types of transport assignment. For instance with Volvo's low-entry cab, which makes it easier to enter and exit the cab and gives the driver a commanding view of surrounding traffic.

The working environment improves too as a result of the low noise level and vibration-free operation. Battery capacity can be optimised to suit individual needs, and charging takes place either via the mains or via quick-charge stations.

Features include: two electric motors with 370 kW max power (260 kW cont. power) with a Volvo 2-speed transmission; lithium-ion batteries, 200–300 kWh and range up to 200 km; two charging systems are available and charging time varies from 1 to 10 h, depending on the system used.

Sales will commence in Europe in 2019.

Volvo Group Australia Pty Ltd
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DATA LOGGER

KELLER's GSM-2 data logger with remote data transmission unit has been upgraded and renamed ARC-1, the Autonomous Remote Data Collector. Providing a simple way of remotely tracking pressure measurements, fill and water levels and monitoring limit values, the ARC-1 incorporates the same functions as the GSM-2 but also includes some additional features.

The product communicates via the 3G mobile network, or 4G if required. Radio modules also allow the device to be located via the mobile network. It is supplied with a micro SIM card, or an e-SIM on request.

The system status information, including battery status and signal strength, has been supplemented by a moisture sensor. A real-time clock (RTC) has also been integrated into the data logger, which continues running autonomously when the battery is changed.

At 48 mm in diameter, the cylindrical data logger can simply be placed into the top of a 2"-wide sounding tube standard in the groundwater measuring industry. It can be installed in a matter of seconds.

The housing is designed to withstand condensation and temporary flooding. The sealed antenna is covered by a lockable protective cap made of robust plastic. This protects against theft and damage by people or wild animals when level measurements are being taken in the open countryside.

Complete with energy-efficient electronics and a lithium battery (3.9 V/32 Ah), the logger can transmit the results of 24 measurements every day by email, SMS or FTP for up to 10 years. At its fastest, it can make one measurement/min.

With two input voltages (0–5 V), two digital inputs, one bus interface (RS485) to operate up to five level sensors and an optional SDI12 interface for water analysis devices, the data logger is a universal data collection module for wide-area measurement networks.

The product is available as a tube or box, with all designs available in 3G, 4G or LoRa versions. An intrinsically safe version of the box can be supplied on request. Existing GSM-2 data loggers can also be upgraded if the existing 2G network at the measuring point is no longer available.

Bestech Australia Pty Ltd
www.bestech.com.au

FAST ELECTRIC VEHICLE CHARGER

ABB has launched its latest EV charging solution, the Terra High Power (Terra HP).

By operating at powers of up to 350 kW, the charger is said to add up to 200 km of range to an electric vehicle in 8 min. This makes it the fastest e-vehicle charger in the world, according to the company.

The charger is particularly suitable for use at highway rest stops and petrol stations.

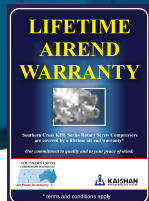
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Bacteria breathe easy with 'passive aeration'

Energy-efficient wastewater treatment technology

Murdoch University researchers have developed an energy-efficient process that they believe will revolutionise wastewater treatment by chopping the required electricity consumption in half.



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W

ith current wastewater treatment technology in Australia more than 100 years old, Murdoch's Dr Ralf Cord-Ruwisch believed the time is right

for a more energy-efficient approach. "At present, the majority of the electricity consumed by the nation's wastewater treatment plants is used to oxygenate wastewater as part of the treatment process," he explained.

Teaming up with Dr Liang Cheng and two PhD students, Dr Ralf Cord-Ruwisch designed a new system based around the naturally occurring bacteria that break down and process organic waste in water. He said gaining a deeper understanding of these bacteria was an important first step in developing the system.

"All the hard work of breaking down organic matter in wastewater is carried out by a range of live bacteria, which can be cultivated in a form we refer to as 'biofilm' during the treatment process," Dr Cord-Ruwisch said.

"Like humans, these living bacteria require oxygen to function and survive, and in traditional treatment plants, a lot of electricity is used in pumping air bubbles

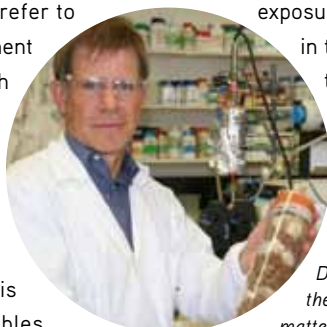
through the wastewater to allow this bacteria to 'breathe'.

"This is not a very energy-efficient process, as these air bubbles are only about 20% oxygen and the rest of it is nitrogen, which isn't required."

The research team believed there had to be a more efficient way of delivering oxygen to these water-dwelling bacteria than sending air bubbles to them through the wastewater. Dr Cord-Ruwisch noted, "As humans, we don't fill our lungs up with water and then pump air bubbles into them to receive oxygen; we simply breathe the air directly into our lungs. Why should the way the bacteria take in oxygen be any different?"

The new treatment plant design operates on the concept of 'passive aeration', whereby the water is drained from the treatment reactors, leaving the bacteria behind on a supported biofilm and exposing them directly to the open air for a period of time. This exposure allows the bacteria to take

in the required amount of oxygen to function, before they are re-submerged in the wastewater to absorb and store more pollutants.



Dr Ralf Cord-Ruwisch shows off the bacteria that break down organic matter in wastewater.

"This is similar to the way in which a whale floats on the surface of the water, taking in enough oxygen from the air into its lungs to sustain itself before it submerges," Dr Cord-Ruwisch said. The bacteria can then continue their work of removing organic carbon and nitrogen pollutants from the wastewater in a way that produces substantially fewer greenhouse gases and odours, and much less sludge.

Requiring less than half the electricity of a traditional wastewater treatment system to operate, and with a provisional patent on the process, the team has now formed a company that has aspirations to fabricate the processing plant on an industrial scale and is currently seeking partners to commercialise the technology. Dr Cord-Ruwisch noted that the technology is designed for municipal wastewater treatment, but could cover other wastewaters containing organic carbon and nitrogen compounds such as agricultural, food and fertiliser industries.

"Not only can we offer significant operational savings for water utility operators by reducing the volume of electricity required by at least 50%, but this new process could also dramatically lower the carbon footprint associated with treating our wastewater," Dr Cord-Ruwisch said.

Murdoch University
www.murdoch.edu.au

Air + solar power = clean drinking water

The Australian Renewable Energy Agency (ARENA) has announced an Australian-first trial of water systems that produce clean drinking water drawn directly from the air using solar power.

ARENA will provide \$420,000 in funding to US-based Zero Mass Water to deploy 150 of its solar-powered SOURCE drinking water systems across multiple locations in Australia. The \$821,500 total project will demonstrate the technology not yet seen in Australia — a product that produces clean, renewable drinking water extracted from the air using solar energy.

The SOURCE hydropanels are infrastructure-free, with no external electricity or water required for operation. Instead of filtering or distributing mains water, SOURCE produces pure water by harnessing the power of the sun and the moisture in the air.

The hydropanels can produce up to 5 L of clean drinking water on a typical day, depending on the climate. Each hydropanel produces enough water to displace over 20,000 plastic water bottles over 15 years.

The trial will see SOURCE rolled out in 150 sites across Australia, including Sydney, Adelaide and Perth as well as regional towns and remote communities. The hydropanels will also be trialled in a variety of locations, including airports, cafes, community centres, commercial buildings and sustainable properties.

The project is expected to reduce the reliance on plastic bottled water while also providing accessible clean drinking water to rural communities with limited access to clean drinking water or electricity, or during droughts. The pilot phase will also incorporate a third-party study to evaluate the environmental impacts of bottled water in Australia.

“Zero Mass Water’s project will create a product that offers a new application and market opportunity for the solar industry in Australia,” said ARENA CEO Ivor Frischknecht. “Using a combination of solar PV with solar thermal technology, SOURCE’s ability to create clean drinking water could be utilised to achieve positive solutions around water supply.

“The potential benefits of this technology to the environment are important. This pilot project can produce reliable drought-resistant water sources to remote communities while simultaneously reducing the amount of plastic bottles that end up in landfill.”

“We are thrilled to partner with ARENA and demonstrate our SOURCE hydropanel technology in Australia,” added Zero Mass Water’s founder and CEO, Cody Friesen.

“SOURCE hydropanels provide a renewable, infrastructure-free water solution to the driest inhabited continent on Earth.”

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Compressed air audit reveals potential savings in excess of \$300,000

Many industries around the world are waking up to the potential for savings in compressed air generation costs.

While compressed air generation is vital throughout the world to power production in major industries, it has become a constantly increasing cost factor due to rising energy prices. This is of particular concern for Australian industry dependent on keeping expense down to remain competitive.

As a result, air compressor manufacturers have been under pressure to provide more cost-efficient and high-performance products and services to offset growing energy costs. But upgrading or replacement of your compressed air plant is not the only answer to curtailing costs.

According to Mark Ferguson, CEO of Southern Cross Air Compressors Australia:

“A relatively low-cost, comprehensive air audit of your current system, particularly those that are over say five years old, can typically expose wasted energy opportunities of up to 50% including air leaks and system set-up faults.”

One major company with plants in Australia and New Zealand, guided by a policy of continuous improvement, plus a strong commitment towards minimising all adverse impacts on the environment, sought submissions from several compressed air specialists to conduct a full analysis of its compressed air supply system.

Southern Cross Compressors (Australia) was commissioned to undertake a comprehensive audit of the compressed air systems within its Victorian manufacturing plants. The brief was to identify opportunities for improvements in efficiency, reduce operating costs and at the same time further improve the company’s environmental footprint and sustainability.

By eliminating all leaks and other inefficiencies in the system, the audit demonstrated potential annual savings in excess of \$300,000 in wasted power over a number of its plants. The same air audit also demonstrated additional potential savings of around \$700,000 per annum through the installation of latest technology compressors and ancillary equipment.

The audit clearly identified common power wastage issues such as oversized compressors for specific applications, inefficient or non-existent sequencing

between multiple compressors, flow imbalance through air lines, incorrect pipe sizing causing pressure drop, incorrect pressure settings and undersized air receivers.

The review included a complete compressed air audit of both the supply and demand side at sites within Victoria. The supply-side audit involved reviewing the size of the compressors, the installation, filters, dryers and receivers, supply pipe sizes, pressure settings and the method of control. Critical ventilation and maintenance programs were also studied to allow recommendations to be made.

The demand side audit reviewed reticulation piping to point of use, air leaks, incorrect pressure settings, pressure drops and inappropriate uses.

Using the latest technology ultrasonic flow meter, Southern Cross technicians were able to determine the exact airflow and usage profile on each airline for each shift on all sites studied. With dramatically varying loads, profiles were then established to identify more suitable, cost-effective equipment to ultimately achieve maximum efficiency. Air leaks on the demand side were identified using an ultrasonic leak detector with every leak tagged, photographed and detailed in a report providing information on leak volumes, corresponding kilowatts wasted and annualised energy costs.

“Today, as part of the global Kaishan Group, we have the resources to identify and rectify energy wastage problems within a huge range of industry application,” said Ferguson. “Our knowledge and capability when applied to Australian industry has the potential to revolutionise the way we generate compressed air now and into the future.”

Matching the right system to each customer application is critical in meeting production requirements while minimising running costs.

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Stations with stars

Melbourne's reinvigorated train stations are receiving praise across the sustainability sector thanks to a range of initiatives saving time, money and the environment.

From self-sourcing energy using rooftop solar panels to implementing sustainable construction methods, all stations rebuilt under the Level Crossing Removal Project are subject to independent reviews.

The stations have been rated according to best-practice Green Building Council of Australia (GBCA) and Infrastructure Sustainability Council of Australia (ISCA) rating tools and scored in categories such as energy, waste and innovation.

The opening of Noble Park's elevated station in February represents the first of five new stations to be rebuilt under the Caulfield to Dandenong Project, with each station achieving five out of six

stars in the Green Star 'Design' review. This is in addition to the eight stations across the city — Bentleigh, Ormond, McKinnon, Gardiner, Heatherdale, Gini-fer, St Albans and Bayswater — already completed and 'As Built' certified under the GBCA.

In addition, ISCA awarded final 'As Built' scores of 63 (Excellent) and 80 (Leading) for the Level Crossing Removal Authority's first two packages of works, including perfect scores under the category of innovation.

Saving water during construction

Bayswater's new station received a 93.5 for its 'Design' submission — the highest

category score across Australia and New Zealand in 2016 — which included the use of a dewatering centrifuge, ultimately saving 5.6 megalitres of water and \$1 million in overall costs.

A dewatering centrifuge unit was introduced at the Bayswater Project to separate sediment and water excavated during construction of the project. This is claimed to be a first in the rail sector in Australia.

Considering the project was being delivered during short periods of intense construction work, the project didn't have the flexibility to wait for settlement of sediments in waste fluids under standard filtering practices.

The use of the dewatering centrifuge unit allowed clean water to be reclaimed

rapidly to be re-used for ongoing drilling or dust suppression works and provided an opportunity to re-use the separated dry soil as backfill at the site.

The unit was in operation for 76 days during construction of the Bayswater Project processing 2473 m³ of waste fluid, removing 452 m³ of solids from the waste fluid and generating 2024 m³ of processed clean fluid.

Sustainable benefits from this initiative included reducing water usage and waste, reducing traffic congestion to local roads by eliminating truck trips for off-site waste disposal and saving an estimated \$750,000 in waste disposal and water use costs.

With the dewatering centrifuge unit and many other initiatives introduced in

the design and construction phase, during its 17-month construction phase and 50-year operational life, the Bayswater Project will consume approximately 70% less drinking water than an average infrastructure project.

Recycling waste during construction

98.6% of waste generated from the demolition of St Albans and Ginifer Stations was recycled.

During the demolition/construction of St Albans and Ginifer stations, products which were collected for recycling include: brick, paper, concrete, asphalt, vegetation, timber, fill/soil, glass, plasterboard, plastic, metal/steel, cardboard, polystyrene, insulation and aluminium.

The project also:

- re-used 1380 m of existing steel rail track at Main Road North, to avoid wasting good steel that still has a useful lifespan;
- used a polymer-based Trinet drainage blanket instead of a conventional crushed rock drainage layer to deliver time and material savings, and avoid the need to excavate and dispose of an additional 300 mm of soil;
- consolidated the combined services trench from twin to a single trench using slotted reinforced plastic for track drainage. Using a lightweight product rather than concrete increased materials efficiency and allows for pipes to be lifted manually, improving safety in the worksite and reducing machinery requirements.

Sustainability rating tools

Sustainability rating tools rely heavily on documented evidence to prove that sustainability is embedded in a project.

Level Crossing Removal Authority CEO Kevin Devlin said the Authority was breaking new ground in a rail context, using the rating tools as a driver of continual improvement.

“By setting high benchmarks in sustainability, we are encouraging contractors to think outside the box and ensuring that our works are delivered with environmental and social impacts in mind,” he said.



Gardiner Station

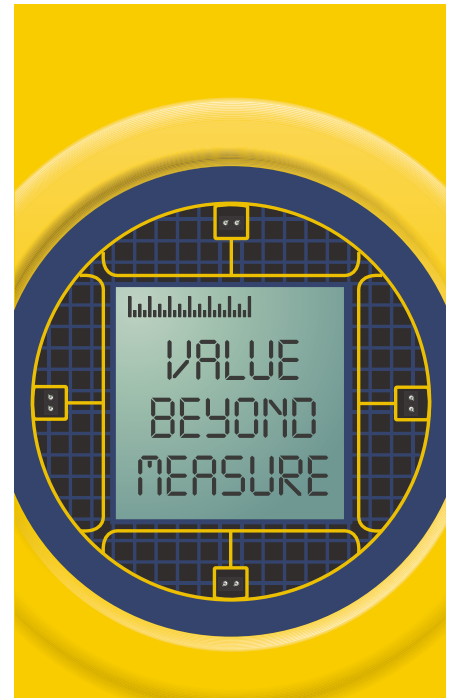


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Lithium-sulfur batteries made from paper biomass

Researchers at Rensselaer Polytechnic Institute are using cheap and abundant paper biomass to make rechargeable lithium-sulfur batteries, anticipated to be the next generation of battery.

Rechargeable lithium-ion batteries are currently the dominant battery technology. In recent years, however, much interest has grown around developing lithium-sulfur batteries, which can have more than double the energy of their lithium-ion counterparts of the same mass.

A rechargeable battery has two electrodes — a positive cathode and a negative anode. Placed in between the electrodes is a liquid electrolyte that serves as a medium for the chemical reactions that produce electric current.

In a lithium-sulfur battery the cathode is composed of a sulfur-carbon matrix, while a lithium metal oxide is used for the anode.

In its elemental form, sulfur is nonconductive — but when combined with carbon at elevated temperatures it becomes highly conductive, allowing it to be used in novel battery technologies. The challenge is that sulfur can easily dissolve into a battery's electrolyte, causing the electrodes on either side to deteriorate after only a few cycles.

Researchers have previously used different forms of carbon, such as nanotubes and complex carbon foams, to confine the sulfur

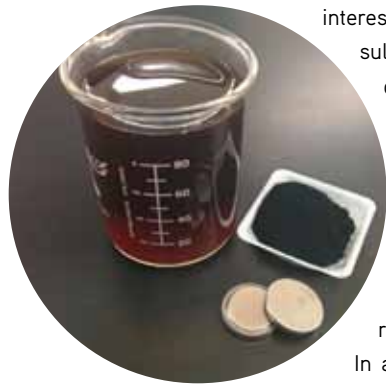
in place, but with limited success. Trevor Simmons, a Rensselaer research scientist who developed the technology with his colleagues at the Center for Future Energy Systems (CFES), said, "Our method provides a simple way to create an optimal sulfur-based cathode from a single raw material."

The material in question was lignosulfonate, a major by-product in the papermaking industry. This sulfonated carbon waste material is typically combusted on-site, releasing CO₂ into the atmosphere after sulfur has been captured for re-use.

The Rensselaer researchers partnered with paper mill Finch Paper, which provided the lignosulfonate. The dark, syrupy substance was dried and then heated to about 700°C in a quartz tube furnace.

The high heat drives off most of the sulfur gas but retains some of the sulfur as polysulfides (chains of sulfur atoms) that are embedded deep within an activated carbon matrix. The heating process is repeated until the right amount of sulfur is trapped in the carbon matrix. The material is then ground up and mixed with an inert polymer binder to create a cathode coating on aluminium foil.

The research team has so far created a lithium-sulfur battery prototype that is the size of a watch battery, which can cycle about 200 times. The next step is to scale up the prototype to increase the discharge rate and the battery's cycle life, with the ultimate goal of eventually powering big data centres and providing a cheaper energy-storage option for both microgrids and the traditional electric grid.



Cool airports using smart watering

A trial conducted by SA Water and Adelaide Airport has found the smart use of water to maintain soil moisture and cultivate green space can reduce average ambient temperatures by 3°C on warm days and potentially lower heat-influenced costs such as air conditioning and aircraft take-off.

The concept's creator, SA Water Manager of Environmental Opportunities Greg Ingleton (pictured), said the promising findings could help improve the livability of cities around the world — especially hot and dry places like Australia.

"By supporting green infrastructure and the intelligent use of water, we can cool urban areas and reduce the impact of heatwaves and climate change," he said.

"The extensive hard surfaces and cleared land around airports means they can often become heatsinks, which has impacts on both terminal and airside operations that need to be managed."

In its third year, the study focuses on sustainable outcomes, with recycled water irrigating four hectares of Lucerne 600 m south of the airport's runway, to also demonstrate the space can



Greg Ingleton at Adelaide Airport measuring temperatures from the tarmac.

produce revenue-generating food crops.

Between 12 and 15 mm of water is applied to the area up to three evenings a week, with more than 40 temperature and humidity sensors monitoring conditions in the irrigation area, and the persistence of cool air outside of the test zone.

"Jet engines work better in cooler, denser air, using less fuel during take-off and being better able to carry their optimal passenger and cargo loads."

There is also a threshold temperature above which some smaller domestic aircraft like the Airbus A330 and Boeing 737 simply cannot take off.

"Last year in Arizona, in the United States, 50 flights were cancelled in one day due to it being too hot for the planes to take off.

"We can reduce the risk of this happening at many airports in Australia and around the world, by employing irrigation to green buffer land around the runways," said Ingleton.

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VALVE ISLAND

The Bürkert Type 8647 AirLINE SP valve island has been designed to be compatible with the Siemens I/O system SIMATIC ET 200SP, enabling maximum system availability for pneumatic controllers.

The valve island was developed for use in the food and beverage, pharmaceuticals and cosmetics industries, as well as in water treatment systems.

To save space it can be mounted in the control cabinet together with different Siemens modules for controlling up to 64 valve functions. The valves are directly connected to the Siemens I/O system.

This enables fast and seamless integration both at the time of commissioning and later, during monitoring of operation.

The display of the number of switching cycles allows optimal preventive maintenance of the system to minimise wear and downtimes. Maximum system availability is achieved by means of the pneumatic valves in the supply channel: they are hot swap capable, so they can be replaced during operation.

The valve island features pressure sensors and an LCD, which displays detailed status information such as the position of the pilot and process valves directly at the device — both by means of icons and plain text. This enables fast detection and elimination of faults. The use of ring topology and the Media Redundancy Protocol (MRP) ensures continued operation of the system in the event that a communication client fails. This increases system availability.

The product has a crucial safety function: check valves in the exhaust duct. They ensure that pilot valves and actuators operate properly, by preventing pressures peaks. This eliminates the possibility of any mixing of different media.

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AERATION SYSTEMS

Venturi aeration systems, available through Hydro Innovations, are suitable for odour control, sludge digestion, wastewater aeration, lake destratification, septage treatment and many other applications.

The Venturi Aerator is a static device that is installed immediately downstream of a pump. The pumped fluid is forced into the aerator, where a specially designed and machined nozzle produces a venturi effect, enabling atmospheric air to be drawn into the system and mixed with the pumped fluid. The aerated fluid is then pumped back into the lagoon or basin the water was drawn from.

When used with self-priming pumps, the system can be mounted on the banks of lagoons. This is said to make them safer and easier to maintain than other systems. Hydro Innovations claims that by using a Venturi Aerator with a Gorman-Rupp self-priming pump, also avail-

able from the company, asset owners can transfer oxygen at a cheaper rate per kW employed than other forms of aeration.

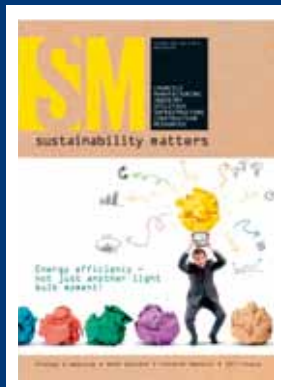
Other forms of aerator are mounted on pontoons and are tethered to banks via cables, whereas the Venturi Aerator system is mounted on lagoon banks, not in them. This makes this style of system safe and easy for operators to maintain. Operators don't have to drag floating units into banks or row out to them.

The aerators are available in 50, 75, 100 and 150 mm sizes, with fluid transfer rates from 5 through to 80 L/s with a single unit.

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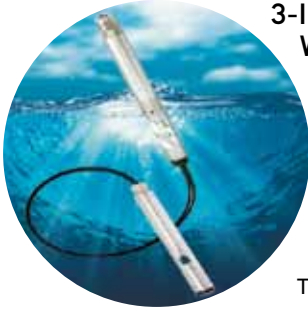


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3-IN-1 SUBMERSIBLE PROBES FOR QUALITY MONITORING IN WASTEWATER TREATMENT

Bestech Australia has introduced a highly integrated, complete pressure management solution for the water industry with the release of the CTD (conductivity, temperature, depth) versions of KELLER's high-precision DCX data loggers.

The DCX-22 AA-CTD is suitable for long-term monitoring of over 50,000 time-stamped measurements and is capable of reading level, conductivity and temperature data simultaneously. The water conductivity data can be used as an indicator of water purity, which is an important standard process measurement in the water and sewage industry.

With a robust 316L stainless steel housing, the measuring system is suitable for applications under harsh and corrosive conditions, such as performing observation tasks relating to localised water pollution. The battery-operated probe is capable of level measurement up to 200 m, with an optional GSM module for remote monitoring. The system also features two isolated absolute pressure sensors that compensate for ambient pressure, electrically or using software.

KELLER's Logger software is free of charge and is compatible with the recent Windows operating system. It enables the user to remotely configure logger instruments and download the measurement data. The software also has a user-friendly interface and allows the user to easily extract the required information in tabular or graphical form for data analysis.

Key features include: measurement capabilities up to 200 m (level), 0–200 mS/cm (conductivity) and -10 to 60°C (temperature); pressure measurement accuracy <0.0025% FS; eight years of battery life; and RS485 digital output.

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Rocla has introduced the First Defense High Capacity (HC) separator for effective stormwater treatment. The TSS capture device has been designed with flexibility in mind and to maximise available site space without compromising the treatment level.

With internal components designed to remove and retain gross debris, total suspended solids (TSS) and hydrocarbons, the device prevents pollutant washout at peak flows to ensure high efficiency. It is an adaptable online treatment system so it works easily with large pipes, multiple inlet pipes and inlet grates, and now also contains a high-capacity bypass for the conveyance of large peak flows.

There is a long flow path through the device that ensures extended residence time within the treatment chamber and enhances the pollutant settling. All higher flows bypass the treatment chamber to prevent turbulence and washout of any captured pollutants, protecting the surrounding environment.

The device has a retrofit installation that means stormwater treatment can be placed on, or tied into, an existing stormwater line. It is suitable for sites constrained by space, topography or draining profiles with limited slope and depth of cover. It is delivered to the site pre-assembled and ready for installation.

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Smart stormwater drains reduce risk of flooding



A collaboration between Downer, Fujitsu and EYEfi has successfully trialled a 'smart drains' solution that has the potential to significantly reduce the risk of flooding due to overflows from stormwater drains.

Piloted on Downer works for the Yarra Ranges Council in Victoria, the system uses a network of sonar and camera sensors to monitor water levels and potential flow rate within roadside stormwater drains, thus negating the need for manual inspections. It additionally provides real-time alerts to response and maintenance teams so blockages can be addressed before inundation occurs.

The Yarra Ranges Council faces a number of local flood management and drainage challenges, with over 4900 properties known to be at risk of flooding from waterways or underground drains. Adding to these challenges are long-term future pressures on the existing drainage system associated with urban consolidation and an increase in rainfall intensity, with approximately 7% of properties within the Yarra Ranges Council being prone to flooding.

The smart drains solution incorporates networked smart sensor, cloud technology and software developed by EYEfi to provide alerts for rising water every 15 minutes.

It provides a dashboard view of input from all sensors to provide management with a clear view of drain infrastructure to identify areas of focus.

"Many of our stormwater pits, especially those in flood-prone areas, could be checked daily or several times per day," said Yarra Ranges Mayor Len Cox. "This technology informs us quickly that there is a blockage so we can send someone there immediately and have it removed and cleaned before further flooding and complications arise. We are proud to be trialling this in the Yarra Ranges as an Australian first and, if the results are positive, we hope it can be adopted throughout the municipality."

The project came to fruition through a co-creation initiative in which Downer, Fujitsu and EYEfi invested in the development of the solution with a view to wider deployment to reduce the risk of flooding across Australia. The trial is currently exploring the potential of artificial intelligence, the IoT, cloud and security to innovate and minimise flooding events.

Simon Langdon, founder and CEO of EYEfi, said, "We are proud to be collaborating with Fujitsu and Downer to offer this world-first, end-to-end remote monitoring and intelligence gathering solution. This is an exciting adaptation of our Industrial IoT technology, as it solves several critical

problems for end users, which is imperative when considering investing in technology solutions. We're looking forward to the further deployment of the solution with Downer and Fujitsu's customers."

Jeff Sharp, group manager technology and innovation at Downer, added, "We had a concept that we believed would add value to our customers and provide a better service to their customers. We were excited to partner with EYEfi, Fujitsu and the Yarra Ranges Council to make this a reality. Downer is investing heavily in IoT solutions that we believe will drive better value for our customers and improve services, creating smarter cities."

Mike Foster, chief executive officer, Fujitsu Australia, concluded, "This is an excellent example of how co-creation combines the best thinking from different disciplines to solve a real-world problem and create a better outcome for the community. It is great to see that our investment in this collaboration with Downer and EYEfi has the potential to reduce the risk of flood damage as we explore opportunities to deploy the technology across Australia."

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Compressed air system for cardboard packaging facility

Oji Fibre Solutions opted for an energy-efficient Kaeser compressed air system for its new Green Star-rated corrugated cardboard packaging manufacturing facility in Yatala, Queensland. The company supplies corrugated cardboard packaging solutions to a range of industries, from fresh fruit and produce to meat, poultry, seafood, beverages and industrial manufacturing.

Complementing Oji's existing plants in Melbourne and Sydney, the Yatala site houses a 2.4 ha facility, enabling the company to better serve customers in Queensland, northern NSW and the Northern Territory. The facility operates to a Green Star rating system, with a number of initiatives that assist in reducing emissions — from daylight sensors and a lighting control system to a rainwater harvesting system.

The company also chose to invest in an energy-efficient compressed air system, which is key throughout the manufacturing process — from material handling to the conveyor systems, pre-feeders and corrugator. After considering a number of packages, Oji chose a Kaeser compressed air system consisting of a Kaeser CSD 85 series fixed speed rotary screw compressor, a CSD 125 SFC Sigma frequency controlled rotary screw compressor and a comprehensive compressed air treatment package.

All CSD series models include the low-speed Sigma Profile rotary screw compressor block. Equipped with flow-optimised rotors, this achieves power savings of up to 15% compared with conventional screw compressor block rotor profiles, according to the company. Efficiency is further maximised with the IE3 drive motor, which complies with and exceeds Australian GEMS regulations for three-phase electric motors.

The 1:1 drive design eliminates the transmission losses associated with gear or V-belt driven systems, as the motor directly drives the screw compressor block. The Sigma Control 2 compressor controller enables compressor performance to be matched to actual air demand, thereby allowing additional energy savings.



In order to meet the facility's fluctuating demands for compressed air, a frequency controlled rotary screw compressor was selected as part of the compressed air package. As the lead compressor, it is responsible for supplying the site's initial requirements for compressed air.

In any compressed air installation where a frequency controlled compressor is installed, this will be the compressor that operates longer than any other unit within the system. The Kaeser CSD SFC series models were built with efficiency in mind and are designed to avoid extreme high-speed operation, which saves energy and maximises service life.

Operating pressure can be consistently maintained with ± 0.1 bar. In turn, the consequent ability to reduce maximum system pressure also reduces energy costs. The relationship between pressure consistency and speed can be viewed directly on the Sigma Control 2 display.

The soft rise in motor starting current from zero to full load without current spikes leads to an almost unlimited motor starting frequency. The continuously variable acceleration and deceleration significantly reduces component stress.

All Kaeser SFC packages are equipped with Siemens frequency converters. They provide seamless communication between the SFC control cabinet and the compressor controller, thereby ensuring efficiency at all times.

The additional fixed-speed Kaeser CSD 85 series rotary screw compressor acts as the lag compressor. This means that it only starts up and produces compressed air when the demand exceeds that which the CSD 125 can produce alone. This ensures that the fixed-speed unit is not operating in a loaded state for extended periods of time. The result for Oji is optimum energy efficiency, by only producing the precise amount of compressed air required at any one time.

"We have been using Kaeser compressors for some time now on our other sites and they have proven to suit our application and be reliable and efficient in meeting our compressed air requirements," said Oji Engineering Manager Peter Henley. "We have also found that they are well suited to operating in the Australian climate."

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Fuel cells produced from recycled carbon fibres



The Fraunhofer ICT uses recycled, small chopped carbon fibres (top) to produce bipolar plates (bottom) for batteries and fuel cells. Image ©Fraunhofer ICT.

Carbon fibre reinforced plastics are gaining importance as components of aircraft — a trend which is increasing the need for sustainable recycling concepts. Now, researchers at Germany's Fraunhofer Institute for Chemical Technology ICT have developed technology that converts recycled carbon fibres into materials for batteries and fuel cells.

Modern wide-body aircraft today consist of over 50% carbon fibre reinforced plastics (CFRP). The material is installed, for example, over a large area in the wings or fuselage. With carbon fibres embedded in a plastic matrix, the composite is lighter than previously used materials, while still being very stable. Due to their lower weight, the aeroplanes require less fuel.

So what's the downside? As explained by Fraunhofer scientist Elisa Seiler, "The manufacturing and processing of the CFRP is currently very time-consuming. The demand for sustainable recycling concepts is therefore steadily increasing."

The amounts of CFRP recycling material are tremendous: for the Airbus 350, for

example, they add up to over 65 tons. "In addition to this, there are other relevant scrap quantities that already arise during production," added Seiler.

The Fraunhofer ICT has many years of experience in the development of technologies for fibre-reinforced plastics. Now, its scientists are recovering materials for batteries and fuel cells out of recycled carbon fibres. With the help of partners, it has been possible to use recovered carbon fibres to produce a prototype of a bipolar plate — on an industrial scale.

"Electric drives are now also a serious topic in the aviation industry," said Seiler. "Manufacturers can directly perform value-preserving recycling by transferring materials from one application to the next."

The carbon fibres are electrically conductive and are suitable as a substitute

for natural graphite, which also consists of carbon: a resource-critical raw material for the German economy that currently has to be imported from China at great expense.

Another advantage is that recycled CFRP can be used for additive manufacturing processes such as 3D printing — a trend that makes production processes more efficient and saves costs, according to Seiler. Aircraft manufacturers also have to comply with the EU requirements that up to 85% of the average weight of a used vehicle must be recycled. Furthermore, in Germany the landfilling of CFRP is prohibited, and waste incineration plants can refuse to accept the material.

The CFRP experts have developed a special process with which carbon fibres can be recovered from the plastic matrix. To do so, they use microwave radiation to burn the plastic matrix that surrounds the fibres. So that the fibres do not burn up at temperatures of up to 900°C, the combustion has to be performed without oxygen.

"In technical jargon, this is called pyrolytic decomposition," said Seiler. The use of microwave radiation is an energy-efficient process, as the whole oven no longer needs to be heated — just the component itself.

Next, the researchers embedded the recovered fibres in thermoplastic material. This composite material has similar properties to graphite and is suitable for the production of bipolar plates. As noted by Seiler, "Our prototype passed all the tests for conductivity, density and corrosion resistance perfectly."

The researchers have thus proven that it is feasible to use recycled CFRP fibres to produce bipolar plates for batteries and fuel cells. The next steps include the characterisation of the bipolar plates in the battery cell network and studies concerning the life cycle assessment.

"Then, we want to tune the technology so that we can manufacture bipolar plates from recycled CFRP in series — for example, with an aviation partner," said Seiler.

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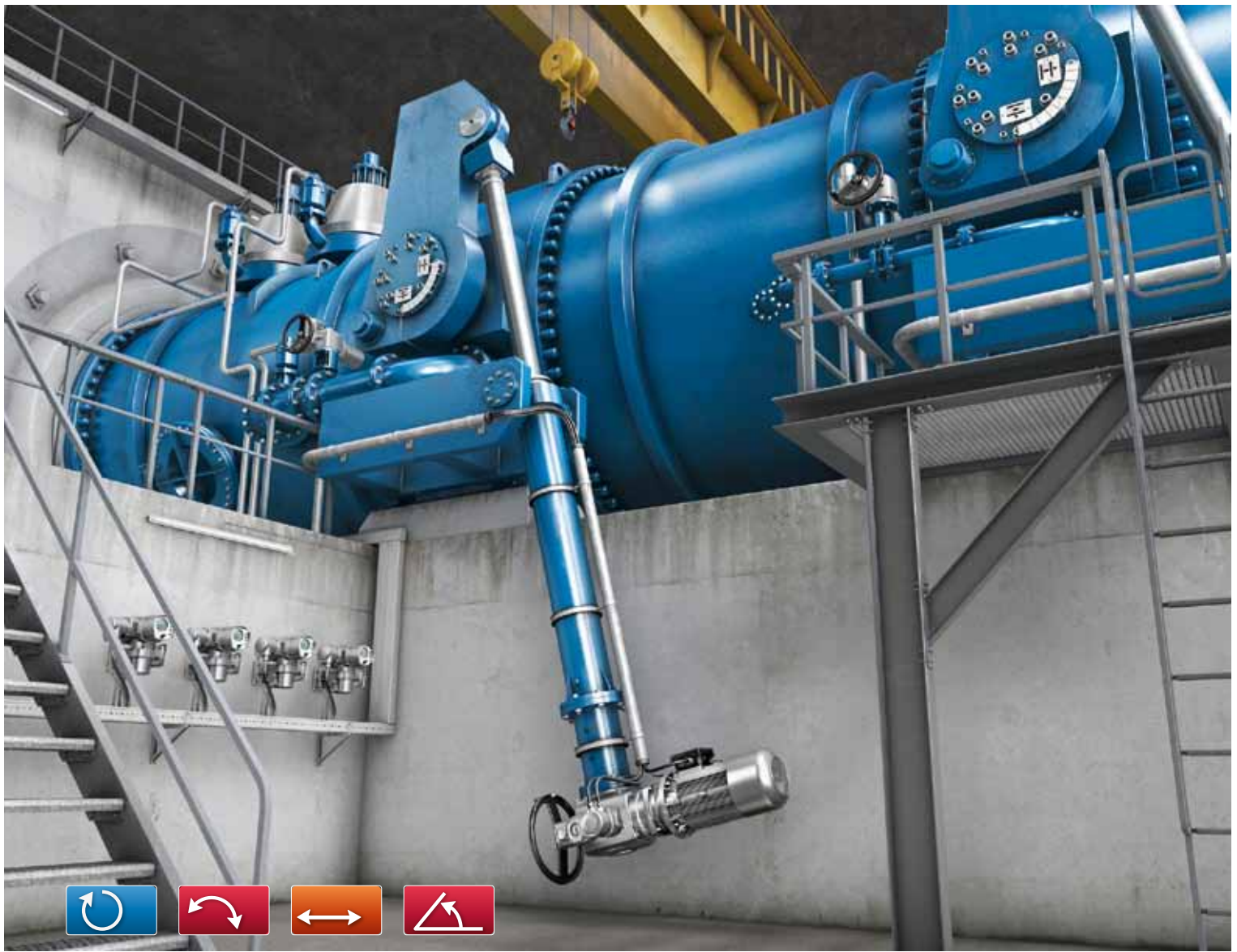
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