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Jun/Jul 2019 Vol.12 No.6
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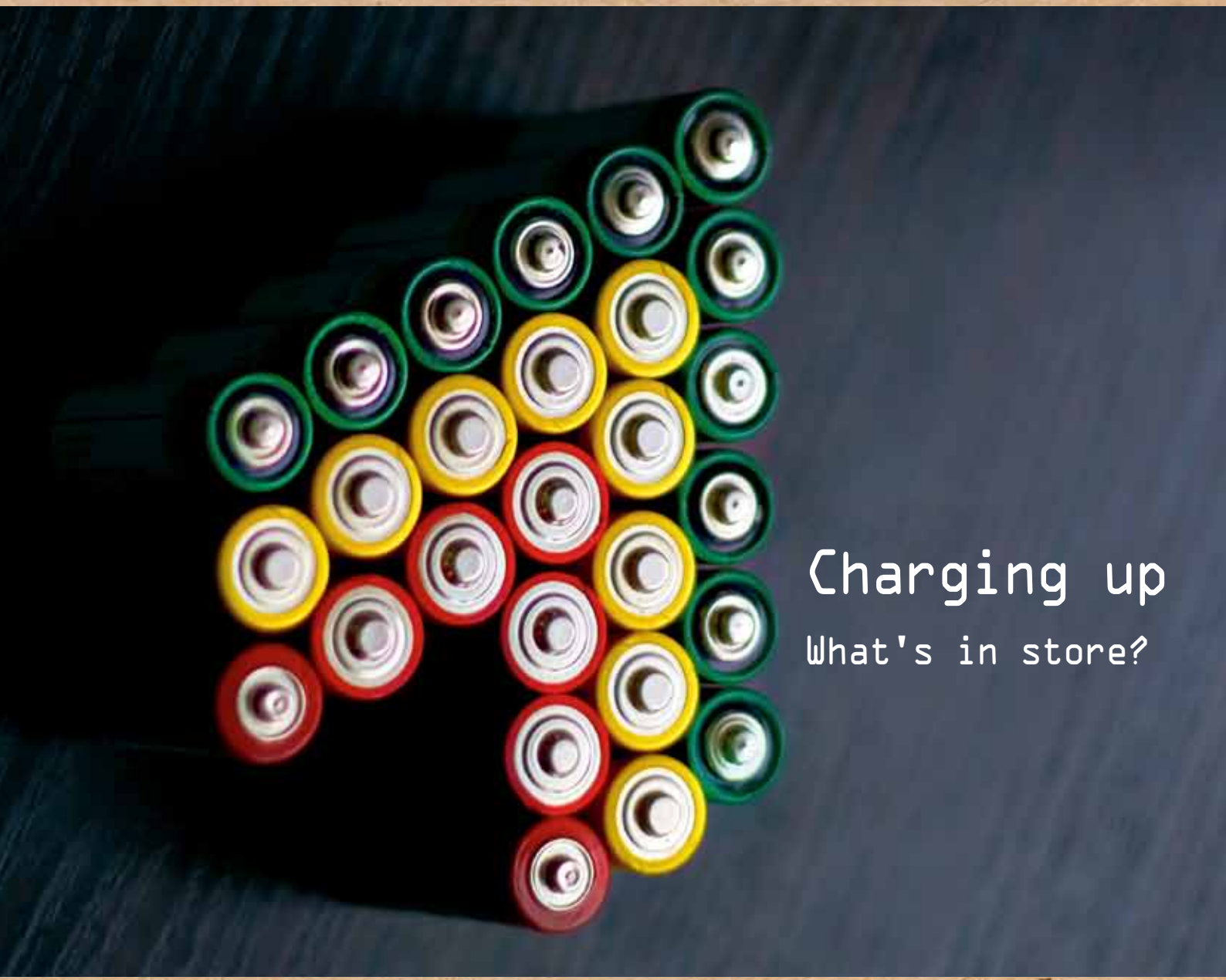

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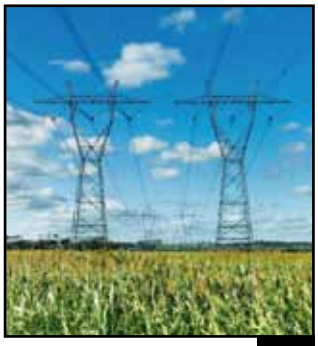

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WORDS FROM THE EDITOR

As dam levels fall to around 50% in Greater Sydney, the city has been forced into water restrictions for the first time in more than a decade. Even though it doesn't look like drought conditions in the city, the restrictions remind us all of how quickly climate variation can make an impact and that, even with loads of infrastructure, we still rely on the drips and drops from the sky.

Water authorities around Australia haven't been sitting on their laurels, as they continue to look for new ways of improving water treatment and increasing the use of recycled water. One such example is the South East Water biosolids project in Victoria. In partnership with the University of New South Wales, the research project hopes to drive change with the use of biosolids and recycled water. The project won one of the latest AWA National Awards and more details about this project are available on page 6.

With the recent federal election now decided, most of you will know that Sussan Ley is now Minister for the Environment. Angus Taylor will continue as Minister for Energy, with the addition of emissions reduction to his portfolio, to focus on the government's goal of lowering power bills and meeting the nation's 2030 emissions targets.

As more and more large-scale renewable energy projects are set up to meet our current targets, the need for storage becomes ever more important for the viability of this intermittent source of energy. The process of firming the business case for wind-plus-storage using a systems engineering approach is discussed further on page 8. The Future Battery Industries CRC is also working on developing storage solutions to improve our energy security — see page 12.

Enjoy the read!

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connecting industry

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Supercharging soil

"Optimising the use of biosolids will result in high-value products that can enhance agricultural productivity and soil health.

A trial in Victoria is investigating new ways to use biosolids, the by-product of the wastewater treatment process.

Biosolids provide farmers with a nutrient-rich fertiliser to maintain soils and stimulate plant growth, thus increasing agricultural productivity. Water organisations have used liquid biosolids in Australia since 1998, but all applications so far have been limited to New South Wales. The current method for producing biosolids in Victoria involves a long treatment process to ensure the product meets treatment grade T1 — the only type of biosolids deemed safe for unrestricted use as fertiliser on farms. This process involves storing the product for a minimum of three years before use.

In partnership with the University of Newcastle and supported by the Soil Cooperative Research Centre (Soil CRC), researchers from South East Water are studying the effects of soil-injected liquid biosolids on soil structure, fertility and function at their Longwarry Water Recycling Plant in Modella, Victoria.

Approved by EPA Victoria via its research, development and demonstration pathway, the trial has already recorded a bumper crop of summer forage sorghum following the liquid injection of biosolids under dryland conditions.

Soil CRC CEO Dr Michael Crawford believes the project is vital: "In addition to addressing an important issue for the water sector, it provides scientists and farmers with an understanding of how the addition of organic matter and nutrients to the subsoil can improve soil productivity and, ultimately, farmer profitability.

"The Soil CRC provides the opportunity for effective collaboration between industry and science as well as a pathway to adoption of new soil management technologies by farmers," Dr Crawford said.

University of Newcastle environmental remediation researcher and one of the project investigators, Dr Balaji Seshadri, said optimising the use of biosolids will result in high-value products that can enhance agricultural productivity and soil health.

"Delivering nutrients and organic matter in biosolids to the root zone via liquid injection is one novel approach we're exploring through this joint trial that will ultimately benefit Australia's farming community," Dr Seshadri said.

South East Water's Senior Research and Planning Scientist Dr Aravind Surapaneni said, "We hope to prove that using biosolids in liquid form (known as T2 or T3 treatment grade) is appropriate for use on agricultural crops. This would permit time and cost efficiencies through bypassing conventional drying and stockpiling processes.

"By undertaking this trial we can assess the impact of using T3-grade liquid biosolids on crops, as well as identifying any potential risks of using this by-product," he said.

If successful, the project may influence EPA guidelines on liquid injection of T3-grade biosolids in Victoria. To celebrate the success of the project so far, South East Water hosted a biosolids field day with more than 100 industry professionals and researchers at the plant.

South East Water had another recent cause for celebration after being declared the winner of the Research Innovation category at this year's AWA National Awards held in May. Dr Surapaneni accepted the award for the project to drive industry change on the use of biosolids and recycled water based on research.

"At South East Water, we've long recognised the role of research in driving industry improvements and greater customer value," Surapaneni said.

"Using rigorous research methodology and expertise, together with collaboration with industry and stakeholders, our project team was able to deliver regulatory changes that significantly reduced storage requirements for biosolids and recycled water from three years to one year and from 25 days to 18 days respectively," he added.

Water authorities around Australia have already adopted results of this research, which has translated into millions of dollars in savings, improved efficiencies at treatment plants and increased recycled water availability to customers.

Biosolids field day at Longwarry hosted by South East Water.

Sindhu Shankar* of Frazer-Nash Consultancy discusses how a systems engineering approach can help manage complexities and firm up business cases for wind-plus-storage.

Firming up the business case

A systems approach to wind-plus-storage solutions

The Clean Energy Council's Clean Energy Australia Report 2018 highlighted that wind power accounted for 7.1% of Australia's total electricity generation and 33.5% of its total renewable energy generation. As more and more large-scale energy projects are set up, the requirements for establishing a wind farm are no longer as simple as 'build in a windy location and connect to the grid'.

Developers' business cases need to consider a large number of interrelated and interdependent factors, beyond simply the local weather conditions. These factors are constantly shifting and evolving and range from complex and changing policies and regulations to asset considerations such as firming options and generator performance standards, financial issues such as investment justification and energy market participation, and environmental concerns taking into account local communities and ecosystems, to name just a few.

Perhaps one of the most complex challenges facing wind farm developers is in their consideration of firming options.

Firming can help wind power companies to address the inherent challenges of intermittent generation, to meet fast frequency response requirements and to manage the risks associated with exposure to 'causer pays' — whereby the party causing generation and frequency loads deviation is responsible for the resulting costs. By ensuring firm capacity, renewable generation companies can remain viable in a competitive generation sector.

Considering firming options

Firming options can include economic and contractual as well as physical options. AGL Energy's Wind Product Firming Unit (WPFU), an example of a derivative product, allows

WHAT IS WIND FIRMING?

There are challenges to delivering electricity from wind generating as its variable and intermittent supply may not correlate with demand. These changes in output make it more difficult to manage the power system and transmission networks, and challenge the economic viability of the developments themselves.

Firming uses an additional energy source or storage to provide a backup for the intermittent generation of wind. Firm capacity is the capacity from these sources and/or storage, which will be guaranteed to be available when needed.

wind generators to enter into forward swap contracts with them, to guarantee supply in the future when wind assets are generating less energy than forecast. Other capacity firming solutions are physical: for example, geographically distributed wind farms, wind plus solar or wind plus battery/storage. These firming options deliver benefits to both network operators and wind power generators. The networks gain certainty that power will be available when it is needed, while operators can capitalise on increased and more reliable income.

Whilst firming helps address the challenge of intermittent wind, it introduces its own complexities. Developers will need to consider which capacity firming option best suits their needs. Economically, they will need to examine firming costs, and the selected option will change — potentially raising the true cost of their wind projects. In trading terms, wind farms need to identify how valuable their megawatts are, and the best time and price to bid their capacity and charge/discharge their storage systems. Whether considering firming options and costs, the technical complexities or the economics of generating revenue, it's essential that all the interwoven issues are assessed. So how do we manage these complexities to present a sound business case for wind projects?

Managing complexities using systems engineering

Systems engineering is an interdisciplinary approach that can be used to manage the complexities of modern-day wind projects, helping to enable the successful realisation of complex systems. In practice, the systems engineering approach follows the processes shown in the V-diagram in Figure 1 (over page) definition of the organisation's goals, objectives and operational needs; deriving and analysing the requirements to meet these needs; and system design as per the defined requirements. The system is developed and integrated as documented in the design; testing and evaluation takes place to demonstrate requirements have been met; then the delivery of the system that meets its intended purpose. The systems engineering approach can be repeated throughout the operation and maintenance phase for the life of the system.

In the context of a renewable project, the systems engineering approach begins by capturing the developer's operational needs, goals and objectives. Of course, each wind system developer has different goals, which will influence the way they intend to operate their system. For wind firming, this might be to demonstrate the benefits of co-locating wind and solar, showing proof of concept that the complementary resources are optimised; or they may wish to use battery storage to firm their wind supply, allowing them to enter into energy supply contracts or to 'time shift' their output, capitalising on price fluctuations. Establishing these goals and objectives is essential, as they drive how the system is to be structured and crystallise the requirements that need to be met.

Once the organisational goals have been identified, the next phase of the systems engineering approach is to define the requirements and system specifications needed to achieve the identified goals. Requirements definition and analysis can be difficult for a complex system that has many interrelationships and interdependencies. Picturing the overall system of systems often helps with the requirements definition phase.

Picturing the system

Systems engineering offers an excellent approach to structuring the requirements definition, system design, integration, testing and delivery processes, but it can often be hard for users to picture a complex system in its entirety and be sure that all interrelationships and interfaces between the systems and subsystems have been covered. At Frazer-Nash, we use a tool which allows an approach known as model-based systems engineering (MBSE), which enables us to

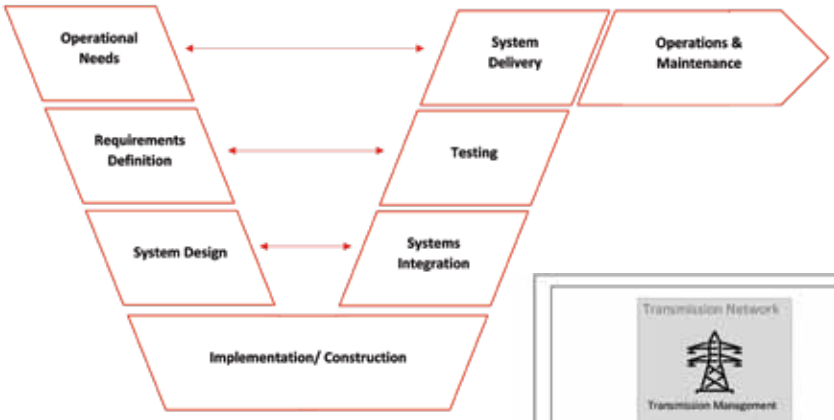

Figure 1: The systems engineering V-diagram.

present the structure and behaviour of a system visually, capturing and describing its interrelationships and interdependencies in a logical way, organising the logic of the organisational structure and business processes and facilitating the flow of information.

For example, at the development stage of a wind farm, developers will have a number of concerns, including regulatory compliance, governmental and council approvals, financial approvals, technical design, physical construction, revenue modelling and contract set-up. In the operational phase, the elements that owners and operators need to consider evolve — from the challenges of ongoing operations and maintenance to asset management, in-service updates, continued revenue generation, and ultimately decommissioning and disposal. MBSE can be used to define all of these complex functions, organisations, systems, drivers, business processes and requirements, and can illustrate how these elements interact with one another. It enables wind developers to view their systems architecture at increasing levels of detail. A functional layer (Figure 2) can show primary functions, organisations and their interrelationships; a systems layer can detail the systems used to realise organisational goals and the required information and data interactions; and a business process layer can show the depth of detail of critical business processes, considering roles, systems and key decision points.

Delivering power to the wind sector

For wind energy companies, there is power in understanding the level of detail presented

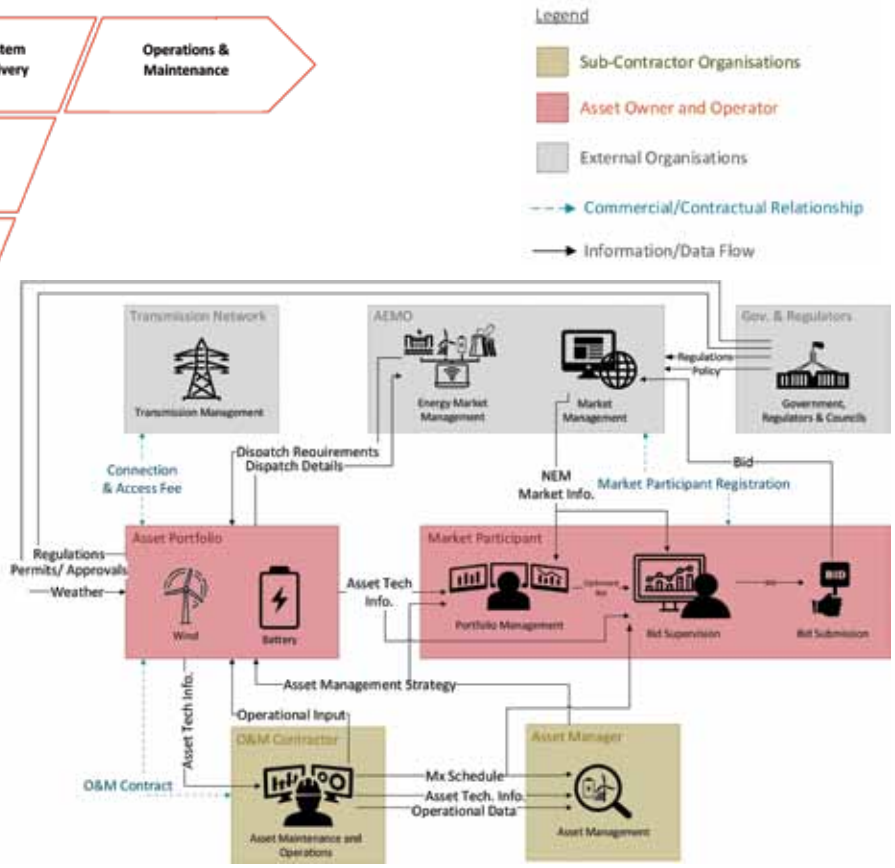

Figure 2: High-level functional/organisational layer of a wind farm project.

in system architectures down to the level of detail in critical business process definition. Requirements naturally fall out of business processes, and these requirements are essential for specifying the system and interfaces to be developed or procured, as well as for detailing the roles, organisations, facilities, processes and procedures that are required. In addition, this detailed definition enables work packages to be planned, contract requirements to be written and core system elements to be identified, and helps support workforce planning.

These requirements can be carried forward through the life of the project, allowing in-service changes to be undertaken more easily. With the overall 'system of systems' defined, even if a new asset needs to be added or new systems procured after some years, a systems engineering approach and MBSE can deliver understanding of the requirements for change and the impacts of change on the overall system.

So what does all of this mean to new and existing renewables projects? It means that a systems engineering approach is a valuable tool that can help you keep pace and make sure your organisation has the right strategies to meet the challenges of a rapidly evolving energy world, where more and more responsibilities are being placed on owner/operators.

**Sindhu Shankar is an experienced systems engineer who has recently transitioned to the energy and resources sector, having worked in the Australian defence aviation industry for over nine years. In Frazer-Nash Consultancy's Systems Safety and Assurance Group, Sindhu has successfully applied her strong systems engineering skills to new clean energy development projects, focusing on the integration of battery technology into the National Energy Market (NEM). Sindhu has led the technical development of a system architecture illustrating the functional structure and interrelationships of a battery asset within the broader Australian energy sector environment, and requirements to define market participation processes, as well as operations and maintenance activities.*

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Battery industry

gets future focused

The announcement of the Future Battery Industries Cooperative Research Centre will see researchers from Queensland University of Technology leading research to help propel Australia's battery industry.

The Future Battery Industries Cooperative Research Centre (FBI CRC) is a research initiative striving to secure Australia's position in the global battery value chain, an area that is currently undergoing rapid transformation. The industry-focused research partnership will involve 58 industry, government and research partners, with $25 million in funding from the federal government and more than $110 million from the research centre's partners.

The centre will address industry-identified gaps in the industry's value chain, focusing on three research programs: battery industry development; the processing of minerals; metals and materials for batteries as well as the development of a new battery storage system.

Based at Curtin University, the FBI CRC will fund 40 PhD students. Professor Peter Talbot (pictured) from Queensland University of Technology's (QUT's) Institute for Future Environments, who last year produced Australia's first lithium-ion battery at QUT's pilot plant precinct at Banyo, will lead research into battery materials and storage system development.

The QUT Power Engineering Group will be involved in activities around developing batteries into the grid and connecting to remote communities and industries. QUT will also contribute relevant research expertise in business innovation, industry transformation and socioeconomic research.

Prof Talbot said battery technology was vital, giving the example of a $2000 smartphone that was just a brick without a battery or an electric car that could not leave the driveway without an energy storage system. He commented that Australia has the resources and skills to produce the 'whole picture' of battery technology.

"A battery industry for Australia can go from mining, to usage and even to export," he said. "Battery technologies give you energy security. Storage capability allows you to call on renewable energy any time of the day or night.

"The CRC will be looking at doing it all in Australia — mine it, value add it, produce the components, make the batteries as I've shown in the example at QUT with our plant, put together the storage packs and then integrate it all with the power companies. It's about a whole industry," Prof Talbot said.

FBI CRC Chair Tim Shanahan said the consortium had a six-year plan to address industry-identified gaps in the battery industry's value chain.

"Given Australia's abundant resources of battery minerals and world-class resources sector, the potential to promote the nation's premium-quality, ethically sourced and safe battery minerals and metals through forensic-accredited and traceable sources will also be investigated, paving the way for Australia to position itself as a global leader in the international battery value chain," Shanahan said.

Australia is the world's largest miner of lithium. Exports of lithium have risen from $117 million in 2012 to $780 million in 2017 and are expected to rise to $1.1 billion by next year.

Nathan Cammerman, Executive Director of Queensland-based company Multicom Resources, said the research centre "sends a clear signal to our international partners, and the broader global market, that when it comes to raw material supply, battery technology development and its subsequent manufacture and deployment, Australia is clearly open for business".

Aussie tech digitises carbon credits in Silicon Valley

Australian tech company Power Ledger has partnered with Silicon Valley Power (SVP) to trial its carbon credit reporting tool C6 at an electric vehicle (EV) charging station in Santa Clara, California.

The trial linked Power Ledger's blockchain-enabled platform to a 370 kW solar system and 49 EV charging stations at the six-storey parking station. Energy production and use was tracked to help SVP earn carbon credits under the Low Carbon Fuel Standard (LCFS). Administered by the California Air Resources Board, the LCFS enables EV fleet owners or EV charging network operators to sell credits to fossil fuel refiners and producers. To date, these data have been collected and managed manually in spreadsheets; however, Power Ledger's platform will automate this reporting process to make credit claiming more efficient.

At the Santa Clara site, EV charging transactions were digitally recorded as smart contracts on the blockchain platform, generating a digitised LCFS certificate containing a cryptographic hash of real-time data sent to SVP's wallet, thus enabling the company to monetise its EV charging infrastructure.

Power Ledger Chairman Dr Jemma Green said, "This has been a pioneering project. Power Ledger and Silicon Valley Power have established a template for a blockchain-enabled solution for the measurement, reporting and verification of carbon credits, replacing a manual collection process that could often take months to validate. In the future, this could mean electric vehicle owners could make money out of their cars.

"Power Ledger and Silicon Valley Power have demonstrated a potential use case for creating a secondary market with digital exchange for tokenising and trading LCFS credits," she said.

"Blockchain technology creates a decentralised marketplace, enabling a more efficient and transparent method for exchanging assets, including carbon credits," Dr Green continued.

Power Ledger and SVP are now in discussions regarding commercial deployment of the system.

Power Ledger
web.powerledger.io

Electrifying Australia's vehicle network

Although national sales figures for EVs are currently low, the automotive industry is expecting a spike in sales over the next 5–10 years. This prediction is supported by an increase in EV-focused news in the media, the rise in EV enquiry and choice, and the expansion of national infrastructure.

A Kantar TNS study commissioned by Nissan Australia in 2018 found that two in three Australians (63%) believe that the move to EVs is inevitable, with a third of consumers (29%) already considering buying an EV. The study also revealed that almost two-thirds (62%) of Australians are more open to an electric (or other alternative fuel) vehicle than they were five years ago, with half saying that EVs are cool and trendy.

Highlighting the support for EVs within the community and their significant sales potential, an Australian Institute report revealed that most Australians want state and federal governments to implement policies that will encourage more EVs on our roads, including support via rebates and increased infrastructure.

In April, Schneider Electric partnered with JET Charge to supply Nissan Australia's electric vehicle (EV) charging equipment. The collaboration precedes the August release of the new Nissan LEAF and will see Schneider Electric and JET Charge installing charging stations at 89 Nissan dealerships.

Internal Nissan global research shows that most LEAF owners approach the recharging of their vehicle's battery in the same way as their mobile phone — by recharging overnight at home. In addition to fitting out Nissan dealerships with charging facilities, JET Charge will also be able to install Schneider Electric's at-home charging solutions for LEAF owners.

Nissan Australia Managing Director Stephen Lester said, "The new Nissan LEAF has the ability to transform the way we drive and live. The increase in power and particularly torque make this vehicle a lot of fun to drive, surprising many who get to experience it. In fact, electrified vehicles will represent a third of Nissan volume in Australia during our mid-term plan.

"By introducing more electric alternatives on several of our key models, we will make mass market electrification a reality. I have no doubt electric vehicles will be a success here, and sooner than many think, and Nissan is planning for this now to ensure we meet the future needs of the buyer."

JET Charge CEO Tim Washington said, "Working with Schneider Electric to provide reliable, world-class charging technology enables us to install the best charging solutions for Australian consumers.

"Driven by increasing charging infrastructure and car model availabilities, the Australian electric vehicle industry is soon to leapfrog over other markets, and is already well ahead of other markets. Partnering with leading car and technology manufacturers will enable us to accelerate this growth further, and set Australian EV uptake soaring," he said.

Farokh Ghadially, Vice President of Power Products and Solutions at Schneider Electric, said, "The automotive industry has been electrified with possibilities this year, with new vehicles, greater charging solutions and innovative technology setting the path for enthusiastic customers across Australia. Working with JET Charge and Nissan at the leading edge of EV design and solutions, we are proud that our technology is bringing EV charging solutions to more Australians than ever."

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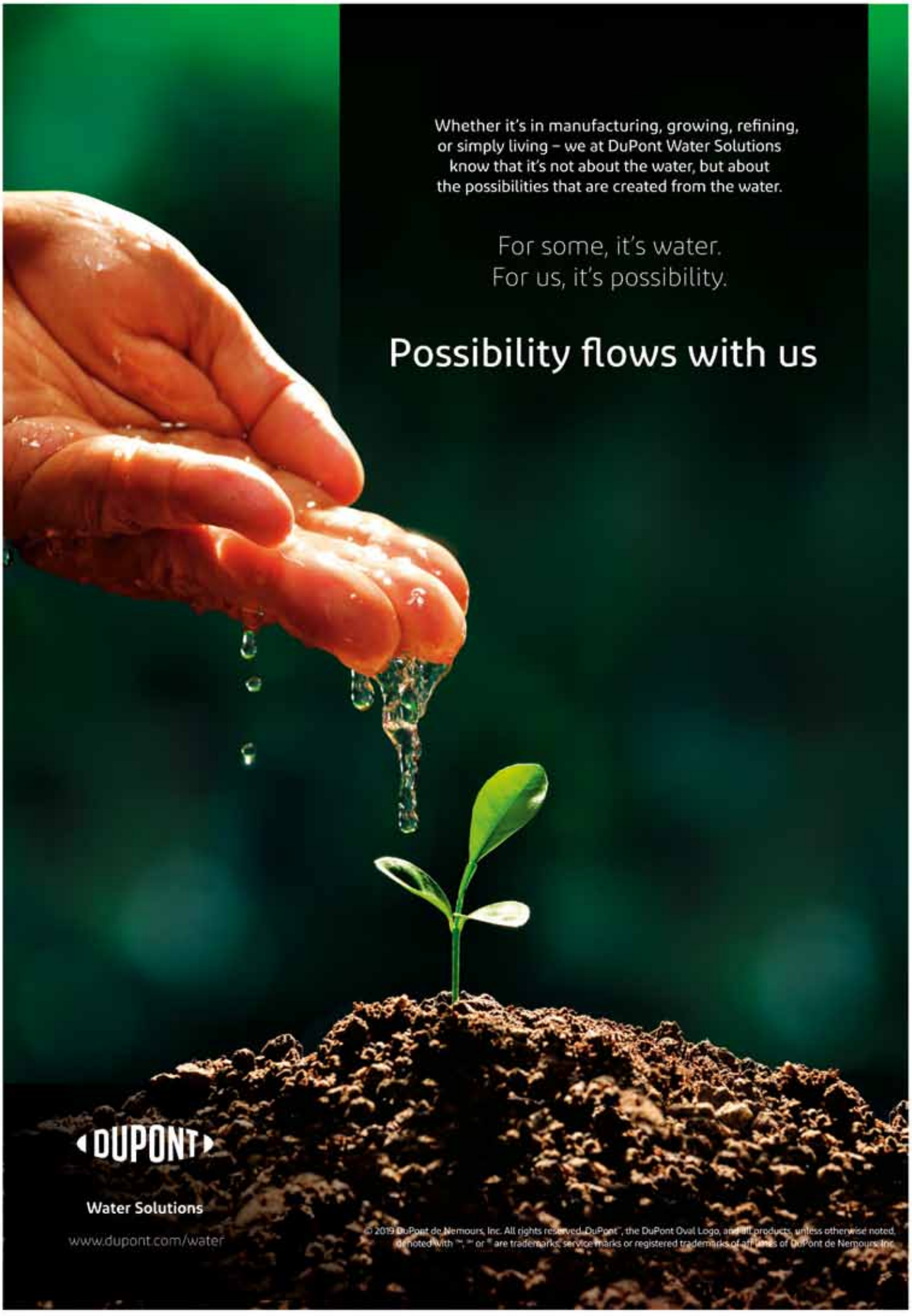


Could flying cars be the answer to sustainable mobility?

The dream of many of us growing up was to one day fly to work just like George Jetson in the 1960s animated sitcom *The Jetsons*. Could a miraculous flying car, which transforms into a briefcase at the end of the trip, be close to reality?

Sorry to disappoint but a new study of the environmental sustainability impacts of flying cars finds that they wouldn't be suitable for a Jetsons-style short commute. However, they could play a niche role in sustainable mobility for longer trips and could be especially valuable in congested cities, or in places where there are geographical constraints, as part of a ride-share taxi service.

Electric vertical takeoff and landing aircraft or VTOLs combine the convenience of vertical takeoff and landing like a helicopter with the efficient aerodynamic flight of an airplane. The study from University of Michigan's Center for Sustainable Systems and Ford Motor Co. revealed that several companies around the world are developing VTOL prototypes, and they could be greener than you think.

"To me, it was very surprising to see that VTOLs were competitive with regard to energy use and greenhouse gas emissions in certain scenarios," said Gregory Keoleian, senior author of the study and director of the Center for Sustainable Systems at U-M's School for Environment and Sustainability.

"VTOLs with full occupancy could outperform ground-based cars for trips from San Francisco to San Jose or from Detroit to Cleveland, for example," he said.

Published in *Nature Communications*, the U-M-Ford study is one of the first comprehensive sustainability assessments of VTOLs. It looked at the energy use, greenhouse gas emissions and time savings of VTOLs compared to ground-based passenger cars. Although VTOLs produce zero emissions during flight, their batteries require electricity generated at power plants.

> **Flying cars would be especially valuable in congested cities, or in places where there are geographical constraints, as part of a ride-share taxi service.**

The researchers found that for trips of 100 km, a fully loaded VTOL carrying a pilot and three passengers had lower greenhouse gas emissions than ground-based cars with an average vehicle occupancy of 1.54. Emissions tied to the VTOL were 52% lower than petrol vehicles and 6% lower than battery-electric vehicles.

Akshat Kasliwal, first author of the study and a graduate student at the U-M School for Environment and Sustainability, said the findings can help guide the sustainable deployment of an emerging mobility system prior to its commercialisation.

"With these VTOLs, there is an opportunity to mutually align the sustainability and business cases," Kasliwal said. "Not only is high passenger occupancy better for emissions, it also favours the economics of flying cars. Further, consumers could be incentivised to share trips, given the significant time savings from flying versus driving."

In the coming decades, the global transportation sector faces the challenge of meeting the growing demand for convenient passenger mobility while reducing congestion, improving safety and mitigating climate change.

Electric vehicles and automated driving may contribute to some of those goals but are limited by congestion on existing roadways. VTOLs could potentially overcome some of those limitations by enabling piloted taxi services or other urban and regional aerial travel services.

Several aerospace corporations and start-up companies — Airbus, Boeing, Joby Aviation and Lilium, for example — and agencies such as NASA have developed VTOL prototypes. One critical efficiency enabler for these aircraft is distributed electric propulsion, or DEP, which involves the use of several small, electrically driven propulsors.

The U-M and Ford researchers used publicly available information from these sources and others to create a physics-based model that computes energy use and greenhouse gas emissions for electric VTOLs.

"Our model represents general trends in the VTOL space and uses parameters from multiple studies and aircraft designs to specify weight, lift-to-drag ratio and battery-specific energy," said Noah Furbush, study co-author and a master's student at the U-M College of Engineering.

"In addition, we conducted sensitivity analyses to explore the bounds of these parameters, alongside other factors such as grid carbon intensity and wind speed," said Furbush, who is also a member of the U-M football team.

The researchers analysed primary energy use and greenhouse gas emissions during the five phases of VTOL flight: takeoff hover, climb, cruise, descent and landing hover. These aircraft use a lot of energy during takeoff and climb but are relatively efficient during cruise phase, travelling at 240 km/h. As a result, VTOLs are most energy efficient on long trips, when the cruise phase dominates the total flight miles.

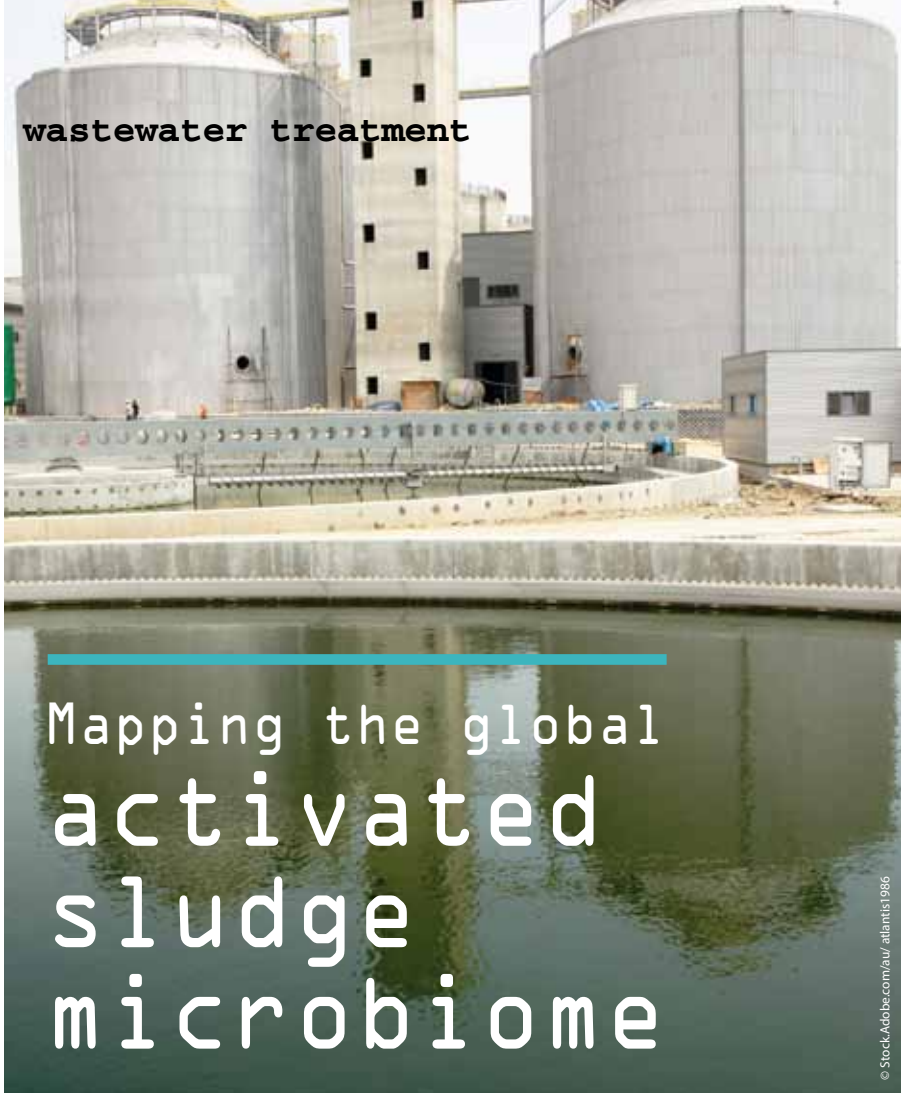
But for shorter trips — anything less than 35 km — single-occupant internal-combustion-engine vehicles used less energy and produced fewer greenhouse gas emissions than single-occupant VTOLs. That's an important consideration because the average ground-based vehicle commute is only about 17 km.

"As a result, the trips where VTOLs are more sustainable than gasoline cars only make up a small fraction of total annual vehicle-miles travelled on the ground," said study co-author Jim Gawron, a graduate student at the U-M School for Environment and Sustainability and the Ross School of Business. "Consequently, VTOLs will be limited in their contribution and role in a sustainable mobility system."

Not surprisingly, the VTOL completed the base-case trip of 100 km much faster than ground-based vehicles. A point-to-point VTOL flight path, coupled with higher speeds, resulted in time savings of about 80% relative to ground-based vehicles.

"Electrification of aircraft, in general, is expected to fundamentally change the aerospace industry in the near future," Furbush said.

The study's authors note that many other questions need to be addressed to assess the viability of VTOLs, including cost, noise and societal and consumer acceptance.



Mapping the global activated sludge microbiome

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Despite activated sludge being the predominant biological wastewater treatment technology in the world, the global activated sludge microbiome has remained unmapped, until now...

Developed over a century ago, activated sludge is a sewage and industrial wastewater treatment process involving aeration and a floc composed of biological microorganisms such as bacteria and protozoa. When mixed with wastewater, the microorganisms consume the biodegradable organic material and clump to form a solid mass that can be separated from the treated water.

Developing a comprehensive understanding of the biodiversity of the activated sludge microbiome in relationship to treatment performance is deemed critical to advancing and optimising wastewater treatment technology and re-use systems. Enhancing these systems via microbiome engineering will be critical to global health and sustaining a world population predicted to reach 10 billion by 2050.

In response to the knowledge gap relating to activated sludge components at different treatment plants, an interdisciplinary global study was led by researchers at the University of Oklahoma (OU). The research involved the collection and analysis of hundreds of samples from municipal wastewater treatment plants across the world, resulting in an expansion of our understanding of global activated sludge microbiomes.

As part of the initiative, in May 2014 the Global Water Microbiome Consortium (GWMC) was established to promote international collaboration and communication on global water and wastewater microbiome studies. Consisting of researchers from 23 countries, around 70 research groups from different universities and organisations have taken part in the GWMC. The aim of GWMC initiatives is to provide a system-level mechanistic understanding of the diversity, distribution, succession and stability of global water and wastewater microbiomes using high throughput metagenomic technologies.

Professor Jizhong Zhou, Director of the Institute for Environmental Genomics at OU, explained that, "Different from several other global initiatives using a bottom-up approach to solicit microbial samples, the consortium used [a] top-down sampling strategy to target the microbiomes of activated sludge processes in municipal wastewater treatment plants that represent a vital element of the infrastructure for modern urban societies. The campaign involved 111 investigators who sampled 269 wastewater treatment plants in 86 cities in 23 countries on six continents," he said.

As a result of the global initiative, around 1200 activated sludge samples have been collected and analysed, with results published in *Nature Microbiology*.

What makes this study novel?

The global study of activated sludge microbiomes:

- is the first comprehensive, coordinated effort to examine the global diversity and biogeography of the activated sludge microbiome;
- documents a highly diverse activated microbiome, containing up to one billion microbial phylotypes comprising novel species;
- identifies the core global taxa of activated sludge microbial communities that are linked to activated sludge performance;
- reveals that the activated sludge microbiome is distinct from microbiomes in other habitats;
- provides an understanding of the mechanisms driving the composition and functions of activated sludge communities.

Bruce Rittmann, Director of the Biodesign Institutes' Swette Center for Environmental Biotechnology at Arizona State University, said, "This unprecedented global sampling effort [has] yielded new insight into the microbiology of activated sludge.

"Despite giant geographic differences, the microbial communities of activated sludge have a core of about 28 bacterial strains, which reflects the powerful and unique ecological selection of the activated sludge process."

Lisa Alvarez-Cohen, Fred and Claire Sauer Professor of Environmental Engineering at the University of California, Berkeley, also commented on the research project: "This expansive study is the first time that a systematic study of the hugely beneficial microbial communities involved in the biological treatment of daily wastewaters from communities around the world have been studied to understand their fundamental structure and function has been undertaken. It represents an important development in understanding and maintaining these crucial microbial communities," she said.

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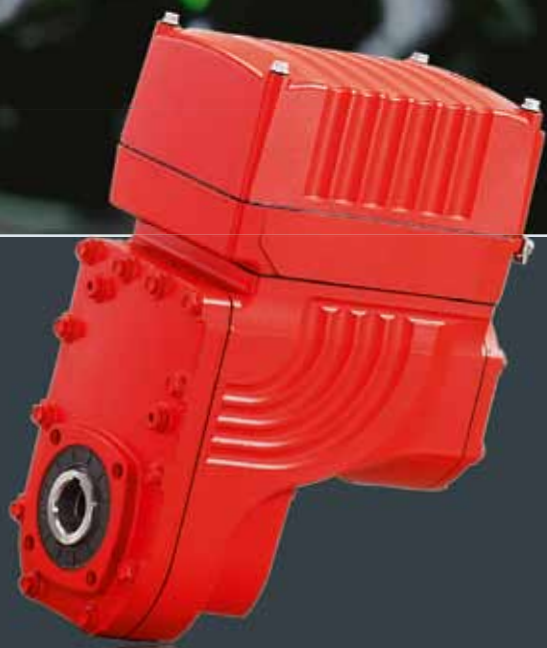

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Why sustainability in industry is the key

As we move towards the future, sustainability in construction is becoming increasingly important. With a growing world population, increased urbanisation and the effects of climate change being felt throughout the world, the demand for sustainable buildings is gaining momentum.

Based on data and studies of key global markets, it's clear that construction companies making smart decisions now — focusing on innovation, end-user benefits and sustainability — will reap the most rewards down the track.

"The successful construction companies of the future will be the ones that meet customer demands, ease consumer pain points and deliver enhanced social, economic and environmental value," said Matthew Mackey, National Director of Cost and Commercial Management at Arcadis.

"Technological advancements in building information modelling and data analytics can help companies design and construct innovative buildings. These intelligent spaces will help generate the technologies of the future and better meet the needs of their users."

Constructing and operating buildings has a significant impact on the environment in terms of water and energy use, carbon emissions and waste. International efforts to combat the effects of climate change and to conserve natural resources are creating a higher demand for more sustainable buildings with features that will reduce negative impacts on the environment.

"As the number of sustainable solutions continues to grow, the construction industry has a chance to reduce its impact on the environment. With smart planning and decision-making, developers and construction companies will be able to position themselves as industry leading and gain a distinct advantage over their competitors," Mackey said.

A key issue that construction companies must overcome is the belief that adopting new, sustainable methodologies will cost them more financially. While this may be the case initially, in the long run, significant savings can be made by reducing waste, increasing efficiency and promoting innovative new products.

"At the moment, the cost of sustainable products and resources is on the higher end due to a number of factors, including a lack of market competition, skills shortages, and increasing energy and labour costs. However, once market demand and competition increase, costs will reduce," Mackey explained.

The cost of building in 100 cities

To highlight the cost of building in different parts of the world, Arcadis has released its International Construction Costs 2019 report, which provides clients with the relative costs of building around the globe, as well as market highlights and recommendations for success. The report, based on industry-leading market knowledge and datasets, details the relative cost of construction in 100 of the world's leading cities.

Arcadis developed the index based on a survey of construction costs, review of market conditions and professional judgement from global experts. The index incorporates local specification data used to meet building functions and market needs. As a result, the index is a comparison of the relative costs of delivering similar asset types in each city.

According to the report, the index range for the ten most expensive cities has narrowed this year, with the average index value falling by 3% compared with 2018. This is due to a combination of currency and inflationary effects, resulting in cities shifting closer together in comparative costs for construction.

Multiple factors influence a city's position on the International Construction Costs Index. To begin with, some cities are more or less expensive than others. Part of this is what economists call the cost of living in a city, which is the price of goods and services such as food, taxes, health care and housing. The cost of living also influences the cost of labour, which has a significant impact on the cost of a construction project.

The overall productivity of the construction industry as a whole also affects costs. In parts of the world where productivity is higher,

the construction to long-term success

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the relative costs of completing a project will be lower. The cost of construction materials is another prominent factor, but with more materials being sourced globally, prices are less location dependent.

A city's position on the index will also be influenced by expectations relating to quality, complexity and functionality within each city. For high-quality, complex projects with sophisticated specifications, construction costs will typically be higher.

"Combining market knowledge with in-depth data on the world's construction markets and the use of digital tools can support smart decision-making. This allows greater predictability of outcomes, removes waste and generates value, not only now but also over the entire asset lifecycle. This is how developers and construction companies can gain a competitive edge," Mackey said.

Studies suggest that organisations that have leveraged existing and emerging technologies have pulled ahead of competitors. For the construction industry, now is the time to embrace technological advancements to boost productivity and cut costs in order to overcome global economic headwinds.

If construction companies want to grow and prosper in the future, it's imperative that all sectors of the supply chain focus on sustainability and respond to the needs of stakeholders promptly and effectively. Companies failing to do this will reduce their economic viability over time and may fall by the wayside.

The impact of consumers

Consumers are beginning to demand responsible approaches to design and construction, making choices based on how retailers and service providers impact on the environment. Everything from what products are made from to whether the packaging is recyclable to how companies dispose of their waste is currently under the microscope.

"Consumer voices are the one thing that will make construction organisations stop and take notice. If people truly want to make a difference they need to think about the products they are choosing, as what they buy and how they buy it can have a huge impact on all aspects of sustainable development," Mackey stated.

"Consumers will have a more positive image of companies that support social and environmental issues. People are not only assessing their own individual impact on their environment but also the way business owners are supporting the environment. At the end of the day, end users are going to make value choices and business owners will have no choice but to follow the market," he continued.

To be effective, suppliers, clients and end users need to consider sustainability at every stage of a building's life cycle — from design to construction, to operation and demolition. Simple changes, such as better waste management, use of low-flow plumbing fixtures, energy-efficient lighting and sourcing materials locally to reduce greenhouse gas emissions, are beginning to have a positive impact on the environment.

Community pressure will go a long way towards ensuring that sustainability in the construction industry remains an important and relevant topic. By raising awareness and lobbying the government to stay on top of this issue, consumers will help expedite action for reform agendas.

Eventually, increased regulation of carbon emissions and waste will force the construction industry to embrace sustainability and improve its processes. Right now, all levels of government are working hard to implement sustainable reform.

Sustainability in the construction industry is still in the early stages of development. Looking ahead, market conditions will present challenges and opportunities for construction clients. However, it's important to remember that sustainable buildings will not only allow us to use resources more efficiently, but will also improve the health and wellbeing of end users, and most importantly, reduce our impact on the environment.

Arcadis Pty Ltd

www.arcadis.com

Solving industrial wastewater challenges

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Wastewater management across mining, farming, construction and other industries is a challenging problem that can threaten vital waterways, with adverse health and environmental impacts. Ongoing technical innovation is needed to help factories and farms move towards more sustainable wastewater practices.

For example, the recent fish kills in the Darling River near Menindee[1] highlight the impact high-nutrient run-off from farms can have when river flows drop due to drought and water management practices. Blue-green algal blooms can quickly form, which deplete the dissolved oxygen and release toxins.

Treating wastewater from industries and farms has a dual potential benefit. Treated water can be recycled to help cut down industries' fresh water use, and the waste load in wastewater can be converted to biogas and used to produce electricity.

Anaerobic digestion is a natural process that converts organic matter present in wastewater sludge into biogas for electricity, as well as significantly reducing the contaminant load in treated water.

Anaerobic treatment with biogas production is a realistic solution for industrial sites and farms with concentrated wastewater management issues aiming to work sustainability philosophies into their wastewater management strategies.

Treating wastewater with anaerobic processes to produce biogas energy can significantly reduce pollution, and help industries recycle water and cut costs that would otherwise go towards electricity and energy demands. Increasingly, industrial sites are investing in on-site anaerobic cogeneration plants to treat wastewater.

For example, Calix has been involved in improving the performance of three biogas plants connected to palm oil plants in Thailand, converting the wastewater into up to 25% more biogas energy that the palm oil mill then uses to power its operations. This is a major opportunity for sustainable progress in Southeast Asia, which is home to more than 780 palm oil mills.

Calix has also worked with a Southwest Victorian piggery to reduce hydrogen sulfide (H_2S or 'rotten egg gas') from pig waste biogas, and to improve biogas production. Animal waste contributes significantly to groundwater pollution as a result of seepage, and traditional forms of concentrated animal farming often see significant quantities of wastewater find its way into external environments.

The Calix ACTI-Mag helps make anaerobic biogas plant work much more efficiently, which reduces groundwater pollution, generates potentially re-usable industrial water, and delivers a financial return on investment through sustainable power production.

Industrial sites that take up smart, sustainable wastewater practices and waste-to-energy technology aren't just saving money — they're saving water, local environments and communities.

[1]https://www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills

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Recovering resources from the ashes

One man's global mission for a better resource recovery industry

Danish innovator and entrepreneur Ejvind Pedersen is a prominent figure in the global industry supplying resources to the automotive sector, turning incineration bottom ash (IBA) into pure metal fractions of raw-material quality. He works with STEINERT to make his vision of closed-loop production a reality.

As a young man, Pedersen left his home in Copenhagen to join a company in the resource industry with factories throughout South America. After many years living in Venezuela, Bolivia, Columbia and Peru as a technical manager for six plants (including the building of two aluminium smelters to melt used beverage cans), Pedersen and his family returned to Denmark.

The young Pedersen was not proud of what the South American industries were doing to the environment and its people during his time there. He set out to find a high-end resource recovery solution, focusing on metal processing and re-usability to reduce the industry's carbon footprint and the impact of hazardous waste.

In 1989, Pedersen built a plant for melting cans in Denmark, investing €8 million, but the fall of the Berlin wall meant cheap metal overstocked the market and three years later he went bankrupt.

"I lost everything," he said.

Restarting from scratch

In 2002 Pedersen started over to establish Scanmetals. His persistence and determination led him back to success.

"STEINERT was there to help when I needed a solution. They rented me their X-ray (XRT) sorting machine to produce clean aluminium products," Pedersen recalled.

This was the beginning of Pedersen's financial independence, which gave him the opportunity to expand his idea throughout Europe. Today, because of Pedersen's success, there are many different sorting plants in existence that upcycle IBA into primary resources.

Reducing dependency on primary metals

Pedersen said that six years ago no-one believed in the potential of small particles in IBA. "We produce four truckloads of aluminium every day. One can imagine that the resource-hungry industry is waiting for it!" he exclaimed.

The biggest incinerator in Copenhagen produces about 240,000 tons of IBA per year. "We see that approximately 20% of the waste that goes into an incinerator ends up as bottom ash. Within this bottom ash, 2% is metal — pieces that range from 1–100 mm." At the incinerator, eddy-current

Scanmetals CEO Ejvind Pedersen with his companion, Tiger.

Zorba recovered from incineration bottom ash.

separation can lift the value in the bottom ash from 2% up to 50–60%. This treated IBA is available on the market for around €1000 per ton. "This means we pay €2000 for 1 ton of metal. The small pieces are important to me," Pederson said.

Closed-loop production with accurate separation and sorting technology

Pedersen's focus is on aluminium and the high-end quality metals acquired from secondary smelters. He explained that his investment in STEINERT technology allows for the accurate removal and reduction of free heavy metals and aluminium alloys. The process starts with a non-ferrous metal separator to recover zorba (a mix of non-ferrous metals such as aluminium, copper, zinc and brass) from the IBA, followed by an induction sorting system that extracts stainless steel.

STEINERT's sensor sorting and magnetic separation technology services the mining, scrap and waste-recycling industries. The STEINERT XSS T (X-ray transmission) produces very clean aluminium (99.9% pure) by sorting out heavy metals and high-alloyed aluminium. The STEINERT KSS FLI XF (X-ray fluorescence) separates heavy metals into copper, brass, zinc and precious metals, achieving heavy metal products with more than 97% purity.

Customers such as aluminium smelters produce almost 100% of their beverage cans from Scanmetals' recovered aluminium. Here, the closed-loop approach gets real. Historically, beverage-can producers had to use pure, new aluminium sourced from mines. Now, Scanmetals' customers are so satisfied with the quality of the company's recovered resources that they no longer need to buy primary aluminium from the mines. As an added bonus, recovered aluminium can be recycled up to 10 times without losing its quality. This closed-loop system means that companies can improve their sustainability record by using high-quality secondary raw material.

Delivering just in time

Not only is material quality a key component to success, but resource delivery time — 'just in time' — also plays a role. Reliable machinery is crucial for material recovery success. Pedersen has tailored his business in accordance to his customers' needs and market demands to ensure efficient delivery of resources.

Winning success

Accepting his 2018 'Innovation' award for EY Entrepreneur of the Year, Pedersen was acknowledged for his contribution to the industry via impressive business growth rates, innovative strength and social commitment. He called on others to create jobs that will save resources.

STEINERT Australia Pty Ltd
www.steinert.com.au

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The Series 629HLP differential pressure transmitters are suitable for measuring overpressure, underpressure and differential pressure in compatible gases and liquids with 1% accuracy. Dual pressure sensors convert pressure changes into a standard 4–20 mA or 0–10 VDC output signal.

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For more information: http://www.dwyer-inst.com.au/Product/Pressure/DifferentialPressure/Transmitters/Series629HLP.

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www.dwyer-inst.com.au

WASTEWATER ANALYSER

The Thermo Scientific Orion 7070iX Total Residual Oxidant (TRO) analyser is designed to measure low ppb chlorine concentrations in treated wastewater in line with stringent regulatory requirements.

Providing high sensitivity for low-level chlorine measurements down to 1 ppb with 1 ppb resolution, the system is designed to give users the confidence that chlorine concentrations in water discharged into natural water sources do not exceed the safety threshold or pose a threat to marine life. The analyser also enables full range measurements up to 15 ppm.

Compared to the conventional DPD (N,N-Diethyl-1,4-Phenylenediamine Sulfate) colorimetric method, the iodometric electrode technology does not suffer from turbidity or colour interferences, which can have a negative impact on result accuracy and precision.

The analyser is also capable of operating autonomously for long periods of time with minimal instrument drift (<5% for >180 days without calibration) eliminating the need for routine maintenance. At the same time, the system's self-cleaning capability prevents chemical and biological fouling of the measurement cell and sensor, minimising downtime and facilitating continuous testing.

Thermo Fisher Scientific
www.thermofisher.com.au

MAGNETIC FLOW METER

The FPI Mag magnetic flow meter is suitable for capital or maintenance projects, retrofits and sites never before metered. The unique combination of accuracy, ease of installation and total cost savings makes the FPI Mag a good choice for a wide range of municipal and industrial applications.

The flow meter meets or exceeds industry standards of 0.5% accuracy with third-party testing verification. The multi-electrode design and unique operating principle deliver high accuracy.

Available in battery- or solar-powered options for forward flow sensors, the flow meter can be installed in remote applications without access to power. Additionally, the new Smart Output feature allows the FPI Mag to connect to AMI/AMR systems through an encoded digital output.

The insertion design of the flow meter allows for easy, hot-tap installation, without interrupting service, dewatering lines, cutting pipe, welding flanges or inconveniencing customers.

Savings of up to 45% on installation and the total cost of ownership can be achieved because there is no need for heavy equipment or added manpower required during a typical full bore, flanged meter installation.

The FPI Mag has a single-piece design with no moving parts. The multi-electrode water flow sensor contains nothing to wear or break and is generally immune to clogging by sand, grit or other debris. It is available with forward flow only or bidirectional measurement for line sizes from 4–138″.

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Control Components

Goodbye batteries, hello brick building

A technology involving a modified construction crane, an electric motor and 35-tonne bricks is providing long-duration energy storage. Energy Vault is a long-term power storage that aims to address the problem of integrating intermittent energy sources, such as solar and wind, with the national grid.

Explaining the technology, Energy Vault Chief Commercial Officer Merrick Kerr said, "The Energy Vault system takes the simple principles of pumped hydro but, instead of using water, we use low-cost 35-tonne bricks.

Energy Vault Chief Commercial Officer Merrick Kerr

"When you want to store the energy, you simply use a modified construction crane and an electric motor to lift 35-tonne bricks from a low position to build a tall, free-standing tower. The energy is then stored as potential energy in the elevation gain of the bricks. "When you want the power back, you simply lower the bricks back to their low position and the motor that was used to lift them now becomes a generator," he explained.

Kerr said that Energy Vault's primary purpose is to provide a long-term storage solution that helps expand the capacity of the grid.

"[Energy Vault] is designed to provide long-duration storage; it was designed to allow a much greater quantum of intermittent renewable resources to be attached to a grid, and to provide the potential for off-grid, mini-grid and micro-grid solutions that can be run on 100% renewable energy," he said.

"Our technology can respond in milliseconds and ramps at over 33% per second, so it can provide the ancillary services currently provided by chemical batteries. If you require long-duration and short-duration [storage], then you can dispense with the chemical batteries and just use our solution."

Australia has ample solar and wind resources, but as sustainable energy companies accelerate efforts to harness them, it has become apparent that the current grid is not well suited to intermittent energy sources.

Kerr commented that, "We have a levelised cost of storage that in good sun areas allows us to combine with PV and deliver very close to 24 by 7 by 365 solar energy for less than the cost of diesel generation. We believe our technology offers an excellent opportunity for Australia to accelerate its wind and solar program again, and this time without the negative impacts on the grid."

As an added bonus, the bricks used by Energy Vault are made out of waste materials that would otherwise go to landfill, such as bottom ash from coal plants, mine tailings and contaminated soil. Kerr said, "In these circumstances we get a real win-win as you clean up an environmental problem and provide much-needed energy storage."

Energy Vault's storage technology was discussed at the Australian Energy Storage Conference & Exhibition 2019 held in June at the International Convention Centre in Sydney.

Energy Vault
https://energyvault.ch/

WI-FI ACCELEROMETER

The Beanair Wilow AX-3D is an ultra-low-power Wi-Fi accelerometer with built-in data logger, equipped with a MQTT communication protocol. The sensor is encased in a lightweight, waterproof, aluminium casing with IP67 protection. The tiny Radome Omni antenna enables wireless transmission with a maximum range of 200 m.

The Wilow device is suitable for use in a range of structural health monitoring, condition monitoring and other industrial monitoring applications due to its robustness and reliability to operate in harsh environments. The combination of a high-performing accelerometer and a 24-bit delta-sigma analog-to-digital converter also generates very few undesirable noises.

The Wilow AX-3D vibration sensor is also equipped with a smart shock-detection feature that triggers both data logging and device wake-up once the vibration level reaches a shock threshold.

The Wilow AX-3D also offers the Store and Forward+ lossless data transmission system. When network disruption occurs, data are stored in a Wi-Fi access point or Wi-Fi receiver and then retransmitted to the system on the next transmission cycle when the network is restored.

Wilow devices are designed with a smart energy-management system to allow power supply from an internal lithium-polymer rechargeable battery or external USB, and a solar panel.

By using Wilow sensors for monitoring, users can benefit from lower installation costs and reduced on-site cable complexity.

Key features include: measurement range: ±2 g and ±10 g and data storage: up to 5 million data points.

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CASE STUDY - WATER RESOURCE MANAGEMENT: INTELLIGENTLY NETWORKING MEASUREMENT VALUES

Using the right measurements – it always goes back to that when you are optimizing processes. It often sounds so easy, but it is usually anything but. Using the right measurements means: determining the data that are actually relevant for the process analysis, evaluating the data using suitable mathematical models, and bringing it into a targeted context. If this succeeds, then measures can be derived in the end that have the potential to sustainably increase the efficiency of the process.
In wastewater treatment, data is primarily recorded in the sanitary sewer network or at wastewater treatment plants. Using WAGO RTUs you can develop a solution that links data from geographically distant stations into a network in a comparatively easy way.

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From concrete jungle to eco-sponge

Asserting the value of sustainable drainage

*Andrew Harrison**

Management of water is a major challenge for modern societies — and one that the average person tends to take for granted until they're knee-deep, or the tap runs dry or dirty. That's when the mud will fly in the direction of designers, developers, authorities and regulators who haven't moved towards ensuring sustainable infrastructure and water management. When it comes to reputation, mud tends to stick.

With climate projections predicting more intense and frequent weather events such as floods, droughts and heatwaves, and with regulators and authorities delivering increasing environmental penalties, every development must factor sustainability and resilience into its water and drainage design or face increasing costs.

Over recent decades, knowledge of sustainable drainage systems (SuDS) or water-sensitive urban design (WSUD) methods and techniques has matured, and many examples around the world have demonstrated great success and benefits for the environment and communities. These environmental and social benefits are very real, and are certainly valued by communities and regulators, but they can be hard to quantify in monetary terms except by considering the costs of remediating the alternative scenarios, such as dealing with pollution or cleaning up flood damage.

For designers and developers, the slow rate of adoption of sustainable solutions is likely due to a combination of factors, including preferences for the familiar, a perception of higher costs of construction compared to traditional approaches, and a lack of comprehensive understanding of interactions in a wider catchment.

The good news is that sustainable drainage features can be easily integrated into urban development without undue excess cost. Even at a very small scale, sustainable drainage can provide significant benefits in terms of water quantity, water quality, amenity and biodiversity.

Defining sustainable urban drainage solutions

In essence, sustainable drainage is about coping with the quantity of water (such as how to handle large volumes of rainfall and stormwater to avoid flooding) as well as preserving or improving the quality of water (such as by filtering pollutants and contaminants out of stormwater before it returns to waterways).

Urban development replaces natural 'soft' surfaces with artificial and non-absorbent 'hard' surfaces. This means that rainfall and run-off can no longer soak into the ground and instead need to be captured and transferred away. Traditional drainage systems do little to prevent the run-off mixing with sediment and other pollutants, so adequate water treatment is needed for urban run-off, and that comes at significant cost.

Sustainable drainage alternatives allow integration of more 'soft' surfaces which can act as sponges and filters. This restores some of the natural elements of the water cycle. Water is able to be stored or slowed, which helps prevent flooding and promotes absorption. The permeable surfaces and vegetation also provide a series of simple treatment stages to maintain or improve water quality, including filtration, insect and microbial activities, and UV radiation.

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Sustainable road drainage involves greater use of swales and permeable paving, alone or in combination. For buildings, sustainable drainage practices move beyond the traditional methods of diverting water from roofs and driveways into the underground stormwater system, and embrace features such as green roofs and rain gardens which reduce the speed and quantity of run-off and provide natural filtration for better water quality. Swales can be combined with these features to collect the drainage from individual buildings.

Many of these features can be integrated into developments at comparable construction and maintenance costs to traditional approaches.

Counting the benefits

By increasing vegetation, sustainable drainage approaches not only ensure better water filtration and water retention, they also promote groundwater recharge by slowing the water flow and allowing percolation into the underground strata. More vegetation also means a greener urban environment, with habitats for plant, animal and insect life, space for recreation, and a more pleasant and appealing landscape for human habitation. Green roofs combine these biodiversity and amenity benefits, as well as helping to regulate building temperatures by insulating during the winter and absorbing heat during the summer.

But what does this mean to a developer in monetary terms, or in the short term? Can these amenity and environmental benefits be advantageous to the bottom line?

For developers, it is possible that development footprints could potentially be extended by counting elements such as green roofs, rain gardens, swales and permeable paving as significant portions of a development's requirements for open-space amenity as well as flood storage. Development levies from local and regional authorities could be reduced if those authorities were to benefit from the reduced costs of water treatment and flood remediation. Strong environmental credentials for both developers and developments will appeal to increasingly socially and environmentally conscious consumers.

Driving the agenda

For these benefits to be realised, everyone must do their part to understand and increasingly apply sustainable drainage approaches. In some jurisdictions, more widespread implementation could be driven by support and direction from governing bodies to embed sustainable approaches into mandatory requirements. Similarly, local and regional authorities can move the agenda forward with the development of catchment-wide sustainable drainage master plans and quantification of the cost-effectiveness of these plans. An incentive program that returns cost savings to developers who incorporate sustainable drainage features is another opportunity to promote change.

Designers who begin to allow for integration of sustainable drainage features at the earliest stages of design, without increasing construction costs or significantly impacting on the density of the development, will further demonstrate the advantages of sustainable approaches.

Exploring our options in the face of changing climate conditions is the responsible choice. Taking the time to understand and promote the benefits of sustainable drainage solutions and educate others about those benefits is a first step. Once everyone involved in regulation, planning, design, construction and property development fully recognises the ongoing benefits, we are far more likely to see wider incorporation of sustainable drainage and the greening and softening of our concrete jungles. It won't be very long before our communities simply expect it.

Andrew Harrison is Golder's Design Group Leader for South Australia and Victoria. Managing a team of 40 engineers and CADD technicians with significant experience in the design and construction supervision of sediment and surface water management infrastructure, Andrew is a Chartered Professional Engineer (Civil, Environmental and Leadership & Management) and a Project Management Professional with 20 years' experience in water, tailings and waste management projects in Australia, Africa, Southeast Asia, the United Kingdom and Ireland. Andrew also has presented on the topic of sustainable drainage at the 10th International Water Sensitive Urban Design Conference and the 9th International Urban Design Conference.

Golder Associates Pty Ltd

www.golder.com.au

Solar cells given a caffeine boost

A collaborative team of researchers from UCLA and Solargiga Energy in China have discovered that caffeine can increase the efficiency of perovskite solar cells, enhancing their thermal stability and ability to convert light to electricity.

The research, published in the journal *Joule*, may enable the cost-effective renewable energy technology to compete on the market with silicon solar cells.

The idea began as a joke over morning coffee, with PhD candidates Jingjing Xue and Rui Wang from the Department of Materials Science and Engineering at UCLA discussing perovskite solar cells. They wondered if coffee would boost solar cell energy and improve performance as it did for them.

The team was keen to discover if caffeine, an alkaloid compound containing molecular structures, would interact with the precursors of perovskite materials — compounds with a particular crystal structure that form the light-harvesting layer in a class of solar cells.

The researchers added caffeine to the perovskite layer of 40 solar cells, using infrared spectroscopy to determine if the caffeine had successfully bonded with the material.

Further infrared spectroscopy tests revealed that the carbonyl groups in caffeine interacted with lead ions in the layer to create a 'molecular lock'. This interaction increased the minimum amount of energy required for the perovskite film to react, boosting the solar cell efficiency from 17% to over 20%. The molecular lock continued to occur when the material was heated, which could help prevent heat from breaking down the layer.

"We were surprised by the results," Wang said. "During our first try incorporating caffeine, our perovskite solar cells already reached almost the highest efficiency we achieved in the paper."

But while caffeine appears to significantly improve the performance of cells that utilise perovskite to absorb sunlight, the researchers do not think it will be useful for other types of solar cells. The unique molecular structure of caffeine only allows it to interact with perovskite precursors, which may give this solar cell variety an edge on the market.

Perovskite solar cells already have the advantage of being cheaper and more flexible than their silicon counterparts. They are also easier to manufacture — perovskite cells can be fabricated from solution-based precursors as opposed to solid crystal ingots. With further research, Wang believes caffeine may facilitate large-scale production of perovskite solar cells.

"Caffeine can help the perovskite achieve high crystallinity, low defects and good stability," he explained. "This means it can potentially play a role in the scalable production of perovskite solar cells."

To continue enhancing the efficiency and stability of the solar cells, the team plans to further investigate the chemical structure of the caffeine-incorporated perovskite material and to identify the best protective materials for perovskites.

HIGH-RESOLUTION DIGITAL MANOMETER

Bestech Australia offers the high-resolution digital manometer from Keller — LEO 5 — designed for reliable monitoring of pressure peak in the water industry. The LEO 5 achieves this by combining the notable features of Keller's products, LEO Record and LEX 1 digital pressure gauges.

The LEO 5 digital pressure gauge features an IP66-rated stainless steel enclosure with a large backlit LCD. This robust housing contains contemporary micro-controller electronics and capacitive touch controls that are operated through the environmentally sealed safety glass front panel.

With two available measurement modes, Standard and Peak, the LEO 5 offers versatility for measurements in a wide range of applications. It can measure up to 5000 samples/s when operated in Peak mode to capture sudden hikes in pressure. The data are sampled with 16-bit resolution.

The Keller LEO 5 allows easy connection to the PC via USB interface. This allows data to be recorded in real time so that operators can quickly spot abnormalities, if present. An optional Bluetooth interface is available for measurements in inaccessible areas. Future developments of Keller LEO 5 include the integration of LoRa technology for Internet of Things applications.

Key features include: pressure ranges 0–1000 bar, 0.05% standard accuracy and a large 5-digit display.

Bestech Australia Pty Ltd
www.bestech.com.au

ULTRASONIC WATER METER

The QALCOSONIC F1 (IP65) ultrasonic water meter by AXIOMA Metering measures cold and hot water consumption in a residential, commercial or industrial setting.

The device has been granted a German Cooling Approval Certificate by the German National Metrology Institute (PTB), meaning that, in the EU, the water meter can be used for heating and cooling energy accounting.

The unit uses an M-Bus communication protocol and is equipped with an 8-digit LCD, with special symbols to display parameters, measurement units and operation modes. The following information can be displayed on the device: integral and instantaneous measured parameters; archived data and set-day data; device configuration information; and programmable LCD display parameters.

Product features include a nominal flow rate per 100 m^3/h and a dynamic range up to Q3/Q1 = R 250/400. Communication modules include M-Bus, CL, WM-Bus 868 MHz, Modbus RS485, MiniBus, LORA and Bacnet.

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

PET RECYCLING PROCESS

VACUNITE technology brings together EREMA's VACUREMA bottle-to-bottle process with vacuum-supported solid state polycondensation (SSP) from Polymetrix. All thermal process steps take place in a nitrogen atmosphere, largely eliminating flake and pellet discolouration and removing additives which could lead to undesired reactions in the melt. The end result is rPET pellets which are said to exceed all existing food-contact requirements.

The vacuum support cleans the nitrogen, which means it can be returned to the previous processing stage and nitrogen consumption is reduced as a result. Any remaining dust particles are removed from the pellets before filling to avoid preform contamination.

Depending on machine type, 50–60 m^2 of floor space is sufficient for the SSP part. The height and substructure have less impact on the dimensions of the plant building compared to other SSPs, according to the company, with lower maintenance as a result. The energy consumption for the entire production process, from the flake to the final pellets, amounts to 0.35 kWh/kg.

CEMAC technologies
cemactech.com

Taking Mackay Council's smart water initiative to next level

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Mackay Regional Council CEO Craig Doyle and Managing Director of Taggle Systems John Quinn.

A commercialisation deal has been struck between Mackay Regional Council and Taggle Systems, an Australian technology company specialising in smart water metering and smart water sensing. The deal gives Taggle Systems the rights to the council's locally developed smart water application, MiWater.

Developed in Mackay on behalf of the council by local IT company Tyeware, the MiWater suite of software emerged as part of council's smart water initiative designed to use smart water meters and other sensors to identify leaks, engage with consumers and reduce water consumption in the region. With software development commencing in 2014, MiWater is now used by more than 110,000 homes and businesses.

The MiWater application includes the myH2o website used by more than 14,000 Mackay residents to keep track of their daily water consumption, which has been instrumental in helping the region conserve water resources. The reduction in water demand has had a meaningful effect on the cost of water in Mackay, allowing council to defer the cost of a new water treatment plant for at least 10 years, with the savings passed on to residents.

In 2018, the MiWater software helped identify and notify Mackay consumers of 35,000 water leaks and Australia-wide has helped identify leaks totalling 6 billion litres of water.

Taggle will continue to support the software for council and other existing customers while further developing the software and expanding its commercial use in Australia and across the world.

Mackay Regional Council CEO Craig Doyle said he was extremely proud of council's water services team for developing a program that allowed businesses to better manage their water consumption. "The MiWater program identifies high consumption and water leaks in the network and relays this information to businesses and residents to help them conserve water and operate more efficiently," Doyle said. "We look forward to seeing Taggle Systems take our home-grown innovation to the world."

Taggle Systems Managing Director John Quinn said the deal was an exciting milestone. "Mackay has done a brilliant job of developing and commercialising MiWater and we look forward to furthering its success, both in Australia and worldwide," he said.

"Taggle Systems plans to continue to expand the capability of the MiWater software to collect and analyse more types of data, and help utilities plan and monitor their assets, improve their operations and help them engage with households and businesses about their water consumption," Quinn said.

Taggle Systems will continue to work with Tyeware on the future development of MiWater and is already planning to demonstrate an internationalised version of the application at the American Water Works Association conference in Denver, Colorado, in June 2019.

Taggle Systems Pty Ltd
www.taggle.com.au

Sustainable groundwater exploration

A collaborative team of water engineers has developed a new technique to investigate and manage groundwater resources. The passive exploration method allows for more sustainable groundwater analysis at lower cost compared with current techniques.

In an article to be published in *Reviews of Geophysics*, the research team from UNSW Sydney, Karlsruhe Institute of Technology (KIT) in Germany and Deakin University details how changes in groundwater levels caused by the effects of Earth and atmospheric tides can be measured via monitoring boreholes.

Dr Gabriel Rau, an engineering geologist at KIT affiliated with UNSW's Connected Waters Initiative (CWI) Research Centre, described the new method as paradigm shifting.

"We can use the impact of Earth and atmospheric tides on commonly acquired atmospheric and groundwater pressure to obtain unprecedented knowledge of subsurface properties at low cost," he said.

"Similar to tides in the ocean, the groundwater level is affected by tidal forces squeezing the porous rocks in the subsurface and causing measurable pressure changes."

Dr Rau explained that current testing methods require active pumping of water from a specially designed water-extraction well and observing the water level response in other wells in the vicinity. This strategy is expensive and only provides a result for a particular location. A crew of two to three people managing the drill rig to pump water out is also needed, with the process taking a few days up to several months.

"The properties of groundwater reservoirs — also known as aquifers — vary greatly in space, and it is much too expensive and intrusive to build extraction wells everywhere," he said.

"The new method, on the other hand, involves using tidal information embedded in water levels from monitoring boreholes. It is a passive technique and simpler to conduct than the current practices of pump and aquifer testing."

The passive approach requires only a small hole to be drilled, then an automated water pressure data logger is placed in the hole for a month, which produces the same results.

Co-author Timothy McMillan, from the UNSW CWI Research Centre and School of Minerals and Energy Resources Engineering, said, "An added advantage of our new approach lies in the fact that we can re-analyse decades of existing water level data to calculate subsurface properties that change over time."

The global increase in groundwater extraction is linked to falling water tables, ground surface subsidence, water quality degradation and reduction of stream baseflow. It is hoped that knowledge of the impact of Earth and atmospheric tides on groundwater can be used to forecast the effect of climate variability on groundwater resources.

Melbourne plant takes composting to the next level

The launch of a waste treatment plant in Melbourne heralds industrial-scale composting facilities for the city. The plant will be using technology to slash greenhouse gas emissions and reduce the volume of waste going to landfill.


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Sacyr established the mechanical and biological treatment plant for municipal organic waste in Dandenong South through its subsidiaries Sacyr Industrial and Sacyr Environment. The indoor facility will upscale the process of composting to an industrial level and will be used by councils in south-east Melbourne to recycle green garden and food waste, servicing a population of 1.2 million. With a maximum capacity of 120,000 tonnes of waste per year, the plant will treat the organic waste obtained from eight metropolitan councils to produce up to 50,000 tonnes of quality compost per annum.

The plant's processing technology consists of a bespoke mechanical–biological treatment system that combines the mechanical treatment system developed by German company Stadler and the biological and air treatment systems developed by Dutch company Waste Treatment Technologies. These technologies, as well as use of ventilation spigots and leachate collection systems, represent innovative processes in Australia's waste management system.

With the plant in operation, more than 65,000 tons of CO_2 per year will cease to be released into the atmosphere and the emissions generated by landfill waste will be reduced by 85%, the equivalent of removing 13,900 cars from circulation.

Composting food scraps diverts organic waste from landfill, reduces methane emissions that would otherwise be released in landfill and results in a product that can be used in crop production. In addition, the compost produced has good commercial value due to the aerobic tunnel fermentation process and aerobic maturation in the warehouse, resulting in a product that complies with the most demanding standards within the industry and with the rigorous Australian quality standard AS4454.

Victorian water industry commits to renewable future

Barwon Water is cementing its commitment to renewable energy via two major solar projects at its Black Rock Water Reclamation Plant and Wurdee Boluc Water Treatment Plant in Victoria.

The addition of 5544 solar panels at the Black Rock Water Reclamation Plant's solar farm will triple the plant's solar capacity from one to three megawatts, generating enough energy to meet 35% of the operation's energy requirements. The project will also incorporate a battery storage system to slash the plant's greenhouse gas emissions and keep customers' bills low.

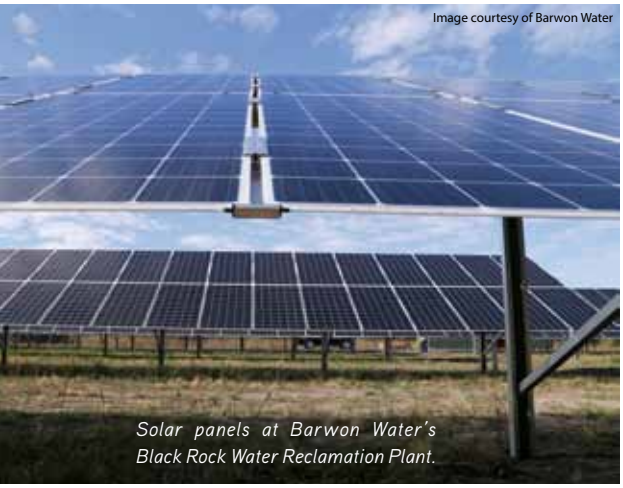


Image courtesy of Barwon Water

Solar panels at Barwon Water's Black Rock Water Reclamation Plant.

A separate project will install a 300 kW solar array at the Wurdee Boluc Water Treatment Plant, featuring a 200 kW battery to store solar energy.

Barwon Water Managing Director Tracey Slatter said the two projects will dramatically reduce energy consumption, helping the company achieve its goal of using 100% renewable electricity by 2025.

"Reducing our energy use drives down our operating costs, which helps us keep downward pressure on water bills," Slatter said.

"Treating sewage and water is an energy-intensive process, resulting in Barwon Water being one of the main greenhouse gas emitters in our region. Our Black Rock Water Reclamation Plant in Connewarre, which treats the majority of our region's sewage, uses about 33,000 kWh a day, about seven times more energy than an average household uses in a whole year.

"As a significant greenhouse gas emitter, we're committed to developing more sustainable practices, and we're doing that by investing in renewable energy to become more self-sufficient and limit our impact on the environment."

Slatter emphasised the importance of investment in renewable energy to cut emissions, as businesses such as Barwon Water depend on a stable climate to deliver safe, reliable and affordable water.

Both solar projects are expected to be complete by mid-2019.

Barwon Water
www.barwonwater.vic.gov.au

PFAS CONTAMINATION TREATMENT

Pumps United has engineered a treatment process that is designed to remediate per- and polyfluoroalkyl substances (PFAS) contamination and deliver clean water that is reported to exceed human drinking standards by approximately 500 times.

The treatment system is claimed to remove PFAS and precursors to levels of PFOS < 0.0002 ug/L and perfluorooctanoic acid < 19 ug/L, which exceed existing Australian benchmarks. Once removed, PFAS are chemically bonded to dry filters and media, then incinerated, minimising transport and storage risks and halting the progression of PFAS permeation.

The solid waste stream produced from the method is claimed to be 80 times less than current conventional PFAS treatments. The system operates from a compact footprint of two shipping containers, relative to conventional systems that currently require up to a thousand square metres to treat similar contaminant volumes.

Pumps United is also trialling 'soil washing' as efforts in site remediation accelerate, and is undergoing research and development in underground 'water glass' barriers to prevent migration of contaminated liquid into already treated areas — building containment zones that allow for holistic site remediation.

Pumps United
www.pumpsunited.com.au

THREE-PHASE GRID-TIE INVERTER

The SelectSun, from Selectronic, is a three-phase grid-tie inverter and the result of a technology partnership with European manufacturer REFU Elektronic. Available in 20 and 40 kW models, the system uses UltraEta 5 level topology for high energy yields, as well as integrated monitoring via the REFUlog portal.

The product provides high performance in harsh outdoor environments, operating at maximum power in 40°C ambient temperature due to its natural convection cooling design feature and IP65 rating. It is a flexible solution that can be used in applications from rooftop PV to solar farms, or even as a true off-grid solution when combined with the SP PRO multimode inverter for energy storage. The low-maintenance, lightweight design (38 kg for the 20 kW model) also allows for easy installation.

Selectronic Australia Pty Ltd
www.selectronic.com.au

Breaking down plastics

How a new discovery could revolutionise plastics recycling

Researchers have designed a recyclable plastic that can be broken down to molecular constituents and then rebuilt, without compromising performance or quality. The new plastic marks a step towards a circular plastic future.

Despite our best efforts, very few plastics can be successfully recycled. In addition to many different types of plastic being used to make disposable materials and packaging, plastics contain additives such as dyes, fillers and flame retardants that make recycling challenging. Even the most recyclable plastic, PET (polyethylene terephthalate), is only recycled at a rate of 20–30%, with the rest typically going to incinerators or landfills.

However, a team of researchers at the US Department of Energy's (DOE) Lawrence Berkeley National Laboratory (Berkeley Lab) has designed a next-generation plastic that, like Lego, can be broken down into molecules then reassembled into a different shape, texture and colour again and again, without compromising quality. The new material, called polydiketoenamine or PDK, was reported in the journal *Nature Chemistry*.

"Most plastics were never made to be recycled," said lead author Peter Christensen, a postdoctoral researcher at Berkeley Lab's Molecular Foundry. "But we have discovered a new way to assemble plastics that takes recycling into consideration from a molecular perspective."

All plastics are made up of large molecules called polymers, which are composed of repeating units of shorter carbon-containing compounds called monomers. According to the researchers, the problem with many plastics is that the chemicals added to make them useful — such as fillers that make a plastic tough or plasticisers that make a plastic flexible — are tightly bound to the monomers and stay in the plastic even after it's been processed at a recycling plant.

During processing, plastics with different chemical compositions are mixed together and ground into bits. When this blend of plastics is melted to make a new material, it's hard to predict which properties it will inherit from the original plastics. This situation has prevented plastic from becoming a 'circular' material whose original monomers

can be recovered for re-use for as long as possible or upcycled to make a new, higher quality product.

Brett Helms, team leader and staff scientist at Berkeley Lab's Molecular Foundry, explained that when a re-usable shopping bag made with recycled plastic gets threadbare, it can't be upcycled or even recycled to make a new product. Once the bag has reached its end of life it's either incinerated to make heat, electricity or fuel, or ends up in a landfill.

"Circular plastics and plastics upcycling are grand challenges," he said. "We've already seen the impact of plastic waste leaking into our aquatic ecosystems and this trend is likely to be exacerbated by the increasing amounts of plastics being manufactured and the downstream pressure it places on our municipal recycling infrastructure."

Recycling plastic one monomer at a time

The researchers' aim is to divert plastics from landfills and the oceans by incentivising the recovery and re-use of plastics, which could be possible with polymers formed from PDKs.

"With PDKs, the immutable bonds of conventional plastics are replaced with reversible bonds that allow the plastic to be recycled more effectively," Helms said.

Unlike conventional plastics, the monomers of PDK plastic could be recovered and freed from any compounded additives simply by dunking the material in a highly acidic solution. The acid helps to break the bonds between the monomers and separate them from the chemical additives that give plastic its look and feel.

"We're interested in the chemistry that redirects plastic life cycles from linear to circular," said Helms. "We see an opportunity to make a difference for where there are no recycling options." That includes adhesives, phone cases, watch bands, shoes, computer cables and hard thermosets that are created by moulding hot plastic material.

The researchers first discovered the exciting circular property of PDK-based plastics when Christensen was applying various acids to glassware used to make PDK adhesives and noticed that the adhesive's composition had changed. Curious as to how the adhesive might have been transformed, Christensen analysed the sample's molecular structure with an NMR (nuclear magnetic resonance) spectroscopy instrument. "To our surprise, they were the original monomers," Helms said.

After testing various formulations at the Molecular Foundry, the team demonstrated that not only does acid break down PDK polymers into monomers, but the process also allows the monomers to be separated from entwined additives.

Next, the researchers proved that the recovered PDK monomers can be remade into polymers, and those recycled polymers can form new plastic materials without inheriting the colour or other features of the original material — so that broken black watchband you threw away could find new life as a computer keyboard if it's made with PDK plastic. The plastic could also be upcycled by adding additional features, such as flexibility.

Moving towards a circular plastic future

The researchers believe that their new recyclable plastic could be a good alternative to many non-recyclable plastics in use today.

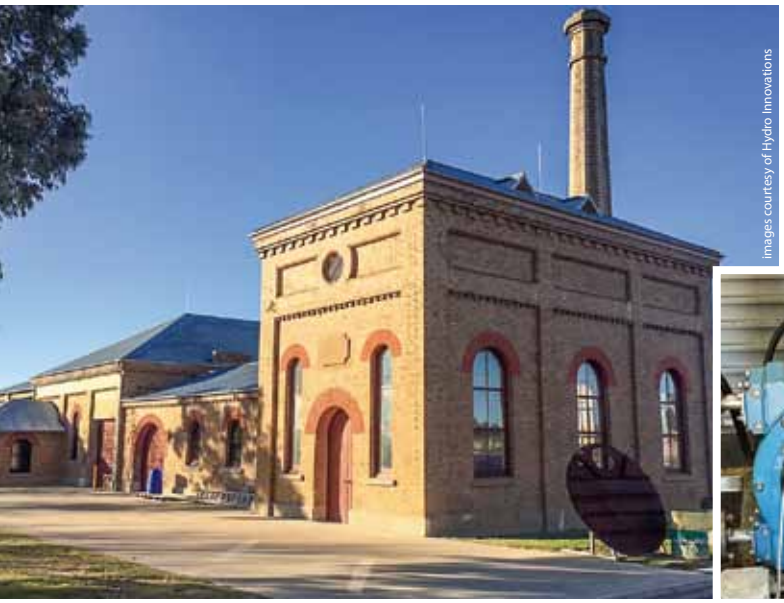
"We're at a critical point where we need to think about the infrastructure needed to modernise recycling facilities for future waste sorting and processing," said Helms. "If these facilities were designed to recycle or upcycle PDK and related plastics, then we would be able to more effectively divert plastic from landfills and the oceans. This is an exciting time to start thinking about how to design both materials and recycling facilities to enable circular plastics," he continued.

The researchers plan to develop PDK plastics with a wide range of thermal and mechanical properties for applications as diverse as textiles, 3D printing and foams. In addition, they are looking to expand the formulations by incorporating plant-based materials and other sustainable sources.

Hose changing is mess-free with new pump

Before July 2018, Bathurst Water Filtration Plant operated two peristaltic pumps to transfer carbon slurry as part of the plant's treatment process. Slurry is abrasive, meaning that the hoses had to be replaced once or twice each year.

The supervisor of the treatment plant, David Cashen, explained that the mess caused by the hose changes was a huge problem. Due to the 'shoe-on-hose' design, when changing out a hose, the pump casing had to be filled with lubricating fluid. In the event of a hose failure, a messy mix of carbon slurry and lubricating oil covered the inside and outside of the pump, creating a mammoth and unwanted clean-up job.



images courtesy of Hydro Innovations

Cashen said that hose replacements and the consequential clean-up would often take days. In addition to the mess, Cashen had to incur the cost of the lubrication fluid to replace a hose each time, on top of the cost of the hose itself.

While attending the Water Industry Operations Conference & Exhibition in 2018, Cashen was introduced to the Ragazzini Rotho Peristaltic Pump at the Hydro Innovations stand and was convinced he had found the solution to his messy hose-changing issues.

The Ragazzini Rotho Peristaltic Pump features a 'roller on bearings' design that eliminates the need for lubricating oil and reduces friction, resulting in extended hose life. The automatic retractable roller system allows for easy maintenance and hose changeover, and takes the pressure off hoses during pump rest periods.

Another appealing feature is the simplification of hose changeouts, with no hose lubricating oil required, meaning no mess or potential contamination in the event of a hose failure. Seven different hoses are available, operating at 1 L/hour up to 180,000 L/hour, with operating pressures up to 15 bar.

Two Ragazzini MS0 pumps were supplied, with one fitted at the plant immediately to assess performance. This pump has been operating since July 2018, running continuously for up to 20 hours per day in the hotter periods. At a recent inspection in April 2019, there was no hose failure or need to change out the original hose.

Hydro Innovations
www.hydroinnovations.com.au

EPA shifts to digital waste tracking

The Victorian Environment Protection Authority (EPA) has pledged $5.5 million for a new system to electronically track industrial waste. The production, movement and receipt of chemical waste will be digitally recorded using GPS, enabling the EPA to track waste more quickly and accurately than the current paper certificate system.

Sparked by a Victorian state government crackdown on the illegal storage of hazardous material, the move will see the EPA phase out paper certificates by 1 July 2019, ensuring all certificates are recorded electronically.

Minister for Energy, Environment and Climate Change Lily D'Ambrosio said, "We're implementing these new measures to crack down on the illegal storage of hazardous waste and increase safety for the community.

"Moving to a fully electronic GPS tracking system will mean we know when and where these chemicals are being moved and stored — so we can identify potentially illegal activity and catch these criminals in the act," she continued.

The EPA currently uses a combination of electronic and paper waste transport certificates — with up to 100,000 paper certificates received each year.

EPA CEO Dr Cathy Wilkinson explained, "The introduction of a fully electronic waste transport certificate system will enable EPA to better track the movement of waste by providing improved quality data, helping us to detect potential risks and intervene earlier."

An integrated waste tracking tool, with improved data analytics and reporting, will also be developed over the next 12 months to deliver insights on sector activity and trends, as well as highlight potential illegal activity.

This best-practice tracking system is due to be finalised by March 2020 to allow the industry a three-month transition period before the new Environment Protection Act legislation comes into effect on 1 July 2020. The new legislation will introduce modern surveillance devices, tougher penalties and a greater focus on industry responsibility and proactively managing risks to human health and the environment.

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THERMAL MASS FLOW METER FOR BIOGAS PROCESSES

The ST51A Biogas Flow Meter, from Fluid Components International (FCI), is designed specifically for dirty, potentially hazardous biogas processes, making it suitable for engineers responsible for biogas production involving industrial organic waste and municipal wastewater treatment. It provides system operators with repeatable mass flow measurement to facilitate system control, log gas production data and provide mandated safety and environmental reporting information.

To survive in biogas processes, the meter comes with rugged 316 stainless steel body construction and Hastelloy-C22 thermal sensors. It features a no-moving-parts, non-clogging design, which eliminates the need for constant cleaning under wet, dirty biogas conditions. The meter comes with full global Division 1, Zone 1, Ex safety approvals.

The meter's electronics are housed in a durable NEMA 4X, IP67 dust/water ingress protected and rugged, all-metal (aluminium or 316L stainless steel) enclosure with dual conduit ports in either NPT or M20 threading. The transmitter can be integrally mounted with the flow element (probe) or can be remote mounted for installation flexibility. The instrument comes standard with dual 4–20 mA, NAMUR NE43 compliant outputs and a 500 Hz pulse output.

The product adds digital communications via the HART 7 protocol. It provides plant staff with digital data on flow rate and temperature parameters, the instrument's health, fault diagnostics and asset management info. It also features the capability to make field configuration changes if needed by using standard HART portable communicators.

The flow meter is available in multiple probe lengths for installation into pipe diameters from 263 to 610 mm. It is easily connected into the pipe via a 1/2″ or 3/4″ NPT compression fitting. Its insertion-style design requires only a simple, single point tap into the process piping that requires minimal technician time.

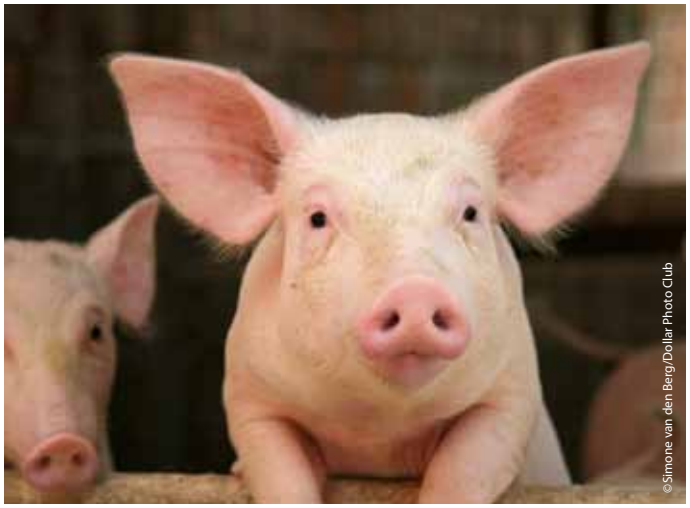
The flow meter utilises constant power thermal dispersion mass flow technology, which employs a slightly heated sensor that provides a subtle drying effect on condensating moisture to make it effective in moist biogas applications. Built-in temperature compensation circuitry provides correct readings under variable climate conditions — cold winters and hot summers.

The meter operates over a wide measurement range of 0.08 to 122 MPS with 100:1 turndown. The instrument's standard accuracy is ±2% reading, ±0.5% full scale, with an optional configuration to provide higher accuracy to ±1% reading, ±0.5% full scale.

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

Evaporation project manages manure

Livestock waste management is a problem facing the global farming industry. Although manure has the potential to harm the environment and contribute to climate change, manures and slurries represent a valuable resource that can return valuable crop nutrients to farmland. Cost-effective and integrated solutions are needed to address the problem.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Up to 90% of pig and cattle slurry is water, meaning that water content reduction is an effective way to reduce overall volume. As well as reducing storage requirements, the method can reduce potential odours and gaseous emissions during application.

A European project coordinated by HRS Heat Exchangers Sales and Product Development Director Arnold Kleijn looked at how to improve practices for pig producers in Spain, many of whom were reliant on off-site treatment plants to reduce slurry and manure volumes. With transport costs accounting for 60% of the total processing cost, a better alternative was sought.

The project, completed in 2013, cut treatment costs by 40%, sped up the treatment process, reduced energy consumption by 25%, cut slurry volumes by 60% and created potential revenue streams for farmers via nutrients and biogas.

Another aim of the project was to devise a small-scale solution for use on farms. The HRS Heat Exchangers engineering team, using their experience with evaporation and concentration systems, devised a system for direct use on manures and slurries or, in the case of on-farm biogas plants, on the digestate which remains after the anaerobic digestion process.

Arnold Kleijn explained, "The thermal energy needed for evaporation can often be obtained from nearby combined heat and power plants at little or no cost. One of the keys to success was improving the scraping action in the evaporator and preventing the concentrated manure from sticking to the surfaces. This increased heat transfer rates two- to threefold, increasing efficiency and speeding up the evaporation process. By combining the various technologies, we reduced slurry volume by up to 60%, resulting in less storage requirements and fewer tanker journeys."

As part of the EfficientHeat consortium, HRS Heat Exchangers has continued to develop technology to improve the efficiency of the evaporative system and make it a practical solution for use on farms. Unicus Series scraped-surface heat exchanger technology is used for evaporation and acid dosing reduces volatile ammonia in the process. This strategy reduces odours and creates ammonium sulfate, which is useful as a crop fertiliser.

HRS Heat Exchangers Australia New Zealand
www.hrs-heatexchangers.com/au/

DIGITAL SYSTEM OPTIMISES WATER EFFICIENCY IN MINING INDUSTRY

A procedure to optimise water consumption in the mining industry has been developed by researchers at the Helmholtz Institute Freiberg for Resource Technology (HIF) in Germany. Mineral ore extraction requires immense quantities of water; the new digital system developed at HIF aims to optimise the extraction process by improving efficiency and reducing freshwater consumption.

The procedure digitalises real-time monitoring and process simulation, enabling water to be recycled without incurring losses during the ore enrichment process. The procedure was initially tested in the extraction of the mineral fluorite, which is enriched in a flotation process that typically consumes up to 4000 L of water per extracted ton.


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A potential problem of using recycled water is that it contains chemical substances that may hamper the hydrophobisation of the fluorite. The researchers tested and observed the digitised control of mineral beneficiation in the laboratory, transferring their findings to the HSC Sim simulation software, which manages water recycling without compromising efficiency.

Additional process optimisations are planned, which may reduce water consumption to as low as 1000 L per ton.

FLOATING EVAPORATOR

The E46 Floating Evaporator is designed to increase the natural evaporation rate by at least 10–12 times the speed of nature. It includes the option of a weather station so operation can be automated — depending on environmental conditions.

The evaporator works by pumping water through specially designed and patented nozzles that use the Venturi Principle to draw air into the water stream to produce water droplets, which evaporate more readily. The nozzles' unique design minimises drift of contaminated water droplets outside the perimeter of the pond.

The evaporator has four HDPE UV stabilised pontoons and a stainless steel lifting frame. Each nozzle is also made from HDPE to cope with hazardous ambient and corrosive liquids.

Commonly used in desalination plants, mining operations and decontamination applications, the unit is modular so multiple units can be used in the same pond to achieve rapid evaporation.

Tecpro Australia
www.tecpro.com.au

WATER-ACTIVATED FUEL CELLS

HydraCell, a fuel cell technology developed by Hydra Light, can generate its own power when activated by dipping in water.

When dipped in water, the moistened, salt-impregnated bridge material allows a reaction to start between the magnesium core and the oxygen in the air, initiating an electrochemical reaction and releasing electrons. The electrons are collected by the proprietary carbon membrane cathode and converted into usable DC power. HydraCells are claimed to maintain full power output for the entire life of the cell, unlike conventional batteries that slowly diminish in power.

When kept properly sealed and dry, the fuel cells can be stored for 25 years or more. They are activated to full capacity simply by dipping in water for 15 s to hydrate the bridge material. Once activated, the cells will operate continuously under load, requiring only periodic rehydration.

Potential applications include: emergency preparation, disaster relief, NGO and aid agencies, off-grid communities, lifestyle and outdoor enthusiasts, and the security, military, automotive and marine sectors.

The technology is suited to remote communities or areas with intermittent traditional power sources. The HydraCell generates power to replace disposable batteries, kerosene or candles, and generates USB power to charge phones and power USB devices.

Hydra Light
global.hydracellpower.com/

The secrets of sewage sludge flow

The behaviour of sewage sludge flow may hold the key to optimising the thermal treatment of wastewater and could boost production of biogas, according to research conducted at RMIT University.

Tracking sludge flow during the thermal treatment process could help engineers improve treatment plant designs and boost biogas production. The research findings demonstrate that sludge flow can be used as a tool to gauge how quickly organic matter is dissolving at high temperatures, with scope to monitor process performance online.

Traditional methods of assessing the performance of thermal treatment require time-consuming sampling and chemical analysis. But rheology calculations — which measure and detail how liquids flow — can be done online in real time.

The study, published in *Water Research*, found a correlation between how sludge dissolves and changes in its flow behaviour, indicating it may be possible to monitor thermal treatment performance simply by tracking the flow.

Lead investigator and Associate Professor Nicky Eshtiaghi from the School of Engineering said that correctly estimating the rheological parameters of sludge is critical to efficient process design.

"Our technique enables engineers and plant operators to conveniently obtain these parameters without having to perform the measurements at high temperatures themselves," Eshtiaghi said.

"We hope the research encourages more serious consideration of flow behaviour in optimising and designing high-pressure and high-temperature sludge-handling processes."

The equations used in the study are based on direct measurement of sludge at conditions that mimic real-world thermal treatment processes. The new technique can measure flow behaviour without destroying the samples, often a big challenge during data collection of concentrated sludge.

Thicker sludge, more biogas

The study showed that varying the thickness of sludge has little impact on the effectiveness of thermal treatment. This means plant operators could increase biogas production downstream by increasing the solid content of sludge during initial treatment processes.

"Thicker sludge can be beneficial for both optimising efficiency overall and for producing more biogas," Eshtiaghi said.

"With our discovery that the thickness of sludge makes no difference, this research gives plant operators more flexibility in designing processes that can better exploit the renewable energy potential of wastewater sludge treatment."

Eshtiaghi, a member of the Water: Effective Technologies and Tools Research Centre at RMIT, said the research could enable more efficient design and troubleshooting of pumps, mixers and heat exchangers in the sludge treatment process.

The study, with lead author and PhD researcher Kevin Hii, is published in *Water Research* (DOI: 10.1016/j.watres.2019.03.039).

RMIT University
www.rmit.edu.au

WASTE RECYCLING PRE-SHREDDERS

Metso has expanded its waste recycling product range with the launch of its M&J K-series pre-shredders. The M&J K160 and M&J K210 models for stationary and mobile plants are based on a powerful drive system, patented knife design and an open cutting table. These features allow for continuous use at a high run rate even with hard and abrasive materials.

The pre-shredders can handle a wide range of different materials, delivering a stable and homogenous output suitable for refuse-derived fuel production. Customers can achieve a throughput of up to 28 tons/h. The multi-edged shaft is fitted with a patented knife system and smart engineering to reduce operating costs.

Features include: bidirectional shredding system (both synchronous and asynchronous) with two shafts; knife design reduces the risk of wrapping on the shafts, resulting in less bridging and fewer cleaning stops; modularity ensures that only relevant components need to be maintained; open cutting table design means operators do not need to pre-sort waste being loaded into the shredder; and robust construction with easy access for maintenance.

Metso Australia Limited
www.metso.com

CONTINUOUS GAS ANALYSER

Emerson presents the Rosemount CT4400 Continuous Gas Analyzer, a purpose-built quantum cascade laser (QCL) and tunable diode laser (TDL) analyser designed to help plants reduce ownership costs and report emissions accurately. The analyser measures standard components such as nitric oxide, nitrogen dioxide, sulfur dioxide, carbon monoxide, carbon dioxide and oxygen.

Optimised for cold and dry applications running at ambient pressure, the analyser offers the benefits of QCL/TDL technology, including high sensitivity, accuracy, improved stability and low-drift performance in a configuration that allows fast, easy integration into existing plant infrastructure.

Because the system can hold up to four laser modules, it can measure up to seven application-specific gas components simultaneously, providing flexibility in continuous emissions monitoring systems applications.

The Rosemount CT4400 employs Emerson's QCL technology, which detects gas molecules in near- and mid-infrared wavelengths. The system employs a patented laser chirp technique that enables detection of individual gas species, free from the cross-interference effects of other gas components in the stream, making the measurement highly accurate and stable down to sub-ppm concentrations.

Emerson Automation Solutions
www.emerson.com/au/automation

DRY-TYPE DIGITAL TRANSFORMER

ABB has launched a dry-type (oil-free) digital transformer, the ABB Ability TXpert Dry. The product incorporates digital capability within the company's dry-type transformers.

Transformers typically use oil for cooling and insulation but dry-type transformers are designed to work without oil, where the core and the coil are cooled by air and non-flammable solid insulation material. This makes them safer, as the flammability element of oil is eradicated, and also more environmentally friendly. Such transformers are suited to high-risk applications like offshore as well as densely populated areas and sensitive ecosystems.

Due to its dry-type design, digitalisation and little or zero maintenance, the ABB transformer offers safety and data security, with plenty of uptime and optimised operations. Smart sensors collect data and combine them into powerful analytics, enabling key functionality such as power quality monitoring, self-supervision and lifecycle assessment.

ABB Australia Pty Ltd
www.abbaustralia.com.au

Timor-Leste adopts Aussie tech to go plastics neutral

Timor-Leste may become the world's first plastics-neutral country after signing an agreement with Mura Technology for the development of a US$40 million chemical recycling plant that will help to establish a circular economy for plastic waste in the country.

Mura will help establish the plant via a new not-for-profit organisation, RESPECT (Recycling. Environment. Social. Plastic. Empowerment. Community. Timor), at no cost to the people of Timor-Leste. All financial surpluses from the plant will be returned to support community initiatives and develop livelihoods for waste collectors.

Licella Cat-HTR plastic

© The University of Sydney

Developed in Australia by University of Sydney Professor Thomas Maschmeyer and Licella Holdings CEO Dr Len Humphreys, the breakthrough technology, known as Catalytic Hydrothermal Reactor (or Cat-HTR), uses water under high temperature and pressure to chemically recycle waste plastic (including plastic currently deemed non-recyclable) back into oil. This synthetic oil can be used to produce new plastic, fuels and chemicals, reducing waste and creating new sources of revenue.

With global plastic production exceeding 300 million tonnes each year, the Cat-HTR technology provides a solution to avoid plastic waste ending up in the ocean, soil, incinerators and landfill.

Dr Humphreys explained that "Cat-HTR is much better equipped to handle plastic waste than the current systems in place as it converts all types of plastic waste into high-value products in only 20 minutes."

The government of Timor-Leste welcomed the partnership with Mura to help deal with the estimated 70 tonnes of plastic waste generated in the country each day. Just one Cat-HTR plant has the potential to convert Timor-Leste's entire plastic waste stream into valuable petrochemicals, which can enable operations to be self-sustaining. It could also establish Timor-Leste as the first plastic-neutral country in the world. This means that no used plastics will enter the environment as waste but will instead be recycled into new products.

Timor-Leste's Secretary of State for the Environment, Demetrio do Amaral de Carvalho, said: "This is an exciting collaboration for us. Not only will it make a big difference in plastic waste reduction and reduce harm to our cherished marine life, but Timor-Leste can be an example to the rest of the world about what this technology can achieve and the benefits it will have for the planet."

Licella Holdings

https://www.licella.com.au/

Researchers closer to affordable green hydrogen

As Australia ramps up its renewable sources of energy, the ability to produce affordable 'green' hydrogen remains a challenge.

Hydrogen is a flexible resource for storing and recovering excess generated energy, especially from intermittent renewable sources. Electrolytic water splitting is currently considered to be the most feasible method for the industrial production of green hydrogen fuel.

A study published in *Nature Catalysis* has identified a variation on water-splitting technology that could provide stability and affordability to green hydrogen production.

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Lead author Dr Alexandr Simonov from the Monash School of Chemistry explained that renewable energy requires an efficient carrier that will allow energy to be delivered throughout Australia and exported.

"In a practical context this requires robust electromaterials — catalysts, which can accelerate two half-reactions of the water-splitting process — the hydrogen evolution and the oxygen evolution reactions," he said.

"Our research team has introduced an intrinsically stable, 'self-healing' catalytic system based on Earth-abundant elements to promote the water electrolysis process in a strongly acidic environment and elevated temperatures.

"The catalyst demonstrates the state-of-the-art activity, and most importantly, exhibits unparalleled stability under a wide range of aggressive, technologically relevant conditions of water splitting," Dr Simonov explained. He commented that the stability and low cost of the catalytic system could make it a suitable option for use in the industrial production of green hydrogen fuel.

Professor Doug MacFarlane, study co-author and ARC Laureate Fellow at the Monash School of Chemistry, said the investigation of water oxidation electrocatalysts is a core theme within the Australian Centre for Electromaterials Science. He emphasised that the rapidly developing national renewable energy sector makes the research critically important.

"This work represents a breakthrough that will bring inexpensive generation of green hydrogen from renewables much closer to reality. It is an important development that will further establish Australia's role as a global powerhouse in the generation and export of renewables."

Solar system to power SA Water

SA Water has contracted South Australian company Enerven to deploy solar power and energy storage across around 70 of its sites.

The investment in more than 500,000 solar panels is expected to deliver a return on investment in 6 years and help SA Water reach its goal of achieving zero net electricity costs from 2020. Minister for Environment and Water David Speirs said the project is expected to support around 250 jobs during construction and will include Aboriginal business engagement, apprentice training and opportunity for the supply chain within the state.

"The scale and complexity of this landmark program will deliver opportunities for local businesses across a range of sectors, drawing on South Australian excellence in everything from civil works through to security services, engineering and project management, to high-tech system automation," said Minister Speirs.

SA Water Chief Executive Roch Cheroux (right) and Senior Manager Procurement Nicola Murphy inspect solar PV construction at Glenelg

image courtesy of SA Water

SA Water Chief Executive Roch Cheroux said neutralising operating costs like electricity, which reached $62 million in 2017–18, will help deliver low and stable prices for customers. "Our bigger picture is a zero cost energy future, where we regain control over one of our single largest operational expenses," he said.

Enerven is expected to mobilise to the first group of sites, including large facilities like the Bolivar Wastewater Treatment Plant and Morgan Water Treatment Plant, in the first half of this year. General Manager Richard Amato said SA Water's energy initiative is an exciting example of South Australia leading the transition to a renewable energy future. "We're relishing the opportunity to be part of a world-class program like this," Amato said.

A local subcontractor set to play a key role in the delivery of the new energy infrastructure is Tonsley-based SAGE Automation, which will deliver control and monitoring systems. Following an initial $10 million investment in December 2017, the construction of 6 MW of solar at SA Water's Glenelg, Hope Valley and Christies Beach facilities is nearing completion and will connect to the National Electricity Market in coming months.

SA Water

www.sawater.com.au

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www.WFMedia.com.au/subscribe

ROTARY SCREW COMPRESSOR WITH INTEGRATED COMPRESSED AIR DRYER

Kaeser has launched the FSG series of its dry-running rotary screw compressor with integrated heat of compression (i.HOC) rotary dryer. It provides an oil-free compressed air solution for sensitive applications that require flow rates up to 50.20 m^3/min and efficient compressed air drying.

The integrated rotary dryer for screw compressors provides a steady supply of oil-free compressed air, with pressure dewpoints of up to -30°C. With its i.HOC, the desiccant dryer uses 100% of the available hot compressed air from the second compression stage to directly regenerate its desiccant.

For particularly sensitive compressed air applications, Kaeser has an optional pressure dewpoint regulation system. If cooling conditions deteriorate, the dewpoint regulation system registers the resulting pressure dewpoint increase and boosts the dryer's regeneration potential accordingly.

In addition to the i.HOC, the water-cooled FSG features an efficient integrated heat recovery system, which helps to use the available compression heat twice: once in the i.HOC to dry the compressed air and again via the integrated heat recovery to heat process or hot water up to 90°C. An automatic, fail-safe cooling system protects the compressor — and thus the compressed air supply — from excessively high water temperatures.

Kaeser Compressors Australia
www.kaeser.com.au

SMALL-SENSOR AIR MONITORING SYSTEM

The AQMesh air quality monitor uses small-sensor technology to measure a wide range of particulate matter and different gases in the air to parts per billion.

Gases measured include NO, NO_2, NO_X, O_3, CO, SO_2, H_2S and CO_2. The small-sensor system has undergone thousands of hours of real-world trials and placements in more than 30 countries, including the city-wide air quality monitoring project Breathe London, launched in January 2019.

AQMesh air monitoring units are portable and can be used in isolation or to complement more expensive, fixed-reference air quality monitoring stations to provide comprehensive pollution readings in particular areas.

The pods feature wireless power options, mobile network communication, cloud-based processing and secure online access.

Ecotech is the distributor for AQMesh in Australia.

Ecotech Pty Ltd
www.ecotech.com.au

REAL-TIME WATER QUALITY MONITOR

Eco Detection water quality monitoring technology uses capillary zone electrophoresis to separate ions (nitrate, nitrite, ammonium and phosphate) for real-time detection of water contaminants.

The patented sensing technology monitors fresh water quality, agricultural run-off and key contaminants (dissolved nitrogen, phosphates, sulfate and heavy metals) so that informed decisions can be made to improve fresh water environments. Data is transmitted in real time, providing an end-to-end data collection service for industry, governments and organisations.

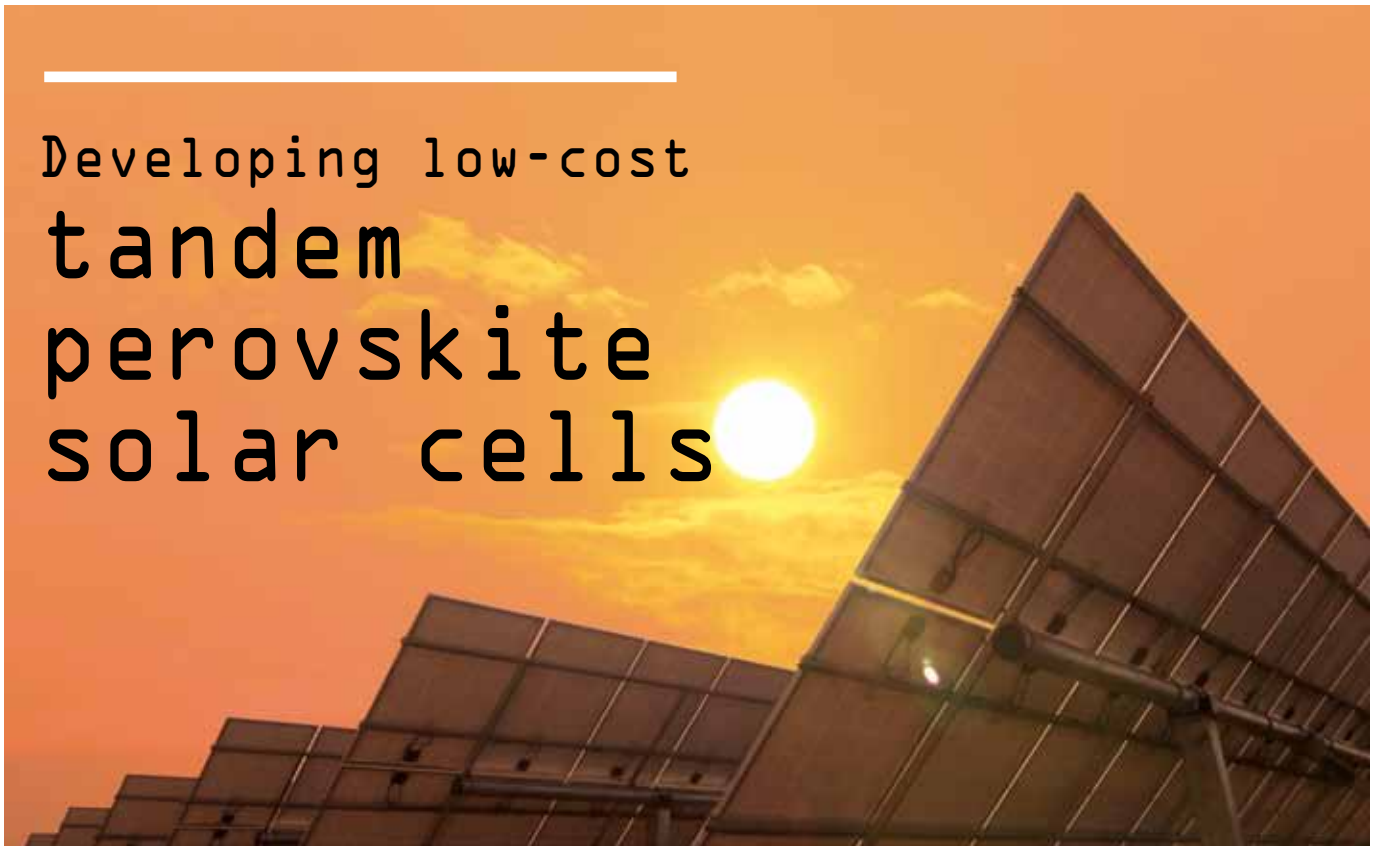
The sensors can detect changes at concentration levels down to parts per billion as they happen.

Other features include: replaces time-consuming manual monitoring; high-performance sensors conduct a real-time, laboratory-quality test at the water source; results are delivered wirelessly every hour; testing can be triggered remotely or set to a predetermined time; allows for immediate response to key weather events; and captures irregular events such as dumping, overflows and spikes.

The technology is designed to operate on battery, solar or mains power.

Eco Detection
ecodetection.com

Developing low-cost tandem perovskite solar cells



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Research is underway at the University of Toledo to create a high-efficiency, low-cost material that can harness solar energy.

Working in collaboration with the US Department of Energy's National Renewable Energy Lab, University of Toledo Professor of Physics Dr Yanfa Yan has reported a significant breakthrough in the chemical formula and process to make the new material, known as tandem perovskite solar cells.

The research, published in the journal *Science*, outlines how the photovoltaics team is fine-tuning a mix of lead and tin to advance the technology closer to its maximum efficiency. Efforts have so far brought the efficiency of the new solar cell to about 23% compared with silicon solar panels on the market today, which have an efficiency rating of around 18%.

Using a chemical compound called guanidinium thiocyanate, the research team has improved the structural and optoelectronic properties of the lead–tin-mixed perovskite films.

Dr Yan's team identified the ideal properties of perovskites about five years ago. He has since focused on producing an all-perovskite tandem solar cell that brings together two different solar cells to increase the total electrical power generated by using two different parts of the sun's spectrum.

"We are producing higher-efficiency, lower-cost solar cells that show great promise to help solve the world energy crisis," Dr Yan said.

"The meaningful work will help protect our planet for our children and future generations. We have a problem consuming most of the fossil energies right now, and our collaborative team is focused on refining our innovative way to clean up the mess," he continued.

"Our … research is ongoing to make cheaper and more efficient solar cells that could rival and even outperform the prevailing silicon photovoltaic technology," said Dr Zhaoning Song, study co-author and Research Assistant Professor at The University of Toledo Department of Physics and Astronomy.

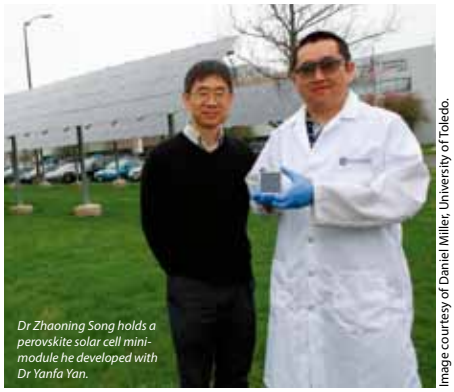
"Our tandem solar cells, with two layers of perovskites, deliver high-power conversion efficiency and have the potential to bring down production costs of solar panels, which is an important advance in photovoltaics," he added.

While Dr Yan's team has improved the quality of the materials and the process to manufacture them at a low cost, more progress needs to be made.

"The material cost is low and the fabrication cost is low, but the lifetime of the material is still an unknown," Song said. "We need to continue to increase efficiency and stability."

The research team also wants to work with the solar industry to ensure that solar panels made from the new material can be recycled so they don't have a negative impact on the environment.

Dr Yan envisions the technology will be ready to debut in full-sized solar panels in the consumer market in the near future. Currently, silicon is the solar-cell material of choice for converting the sunlight into electrical energy, but perovskites are considered the future of solar cells, as their easily synthesised distinctive structure makes them perfect for enabling low-cost, efficient photovoltaics.



Dr Zhaoning Song holds a perovskite solar cell mini-module he developed with Dr Yanfa Yan.

Image courtesy of Daniel Miller, University of Toledo.

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