INTERNATIONAL

Wave-energy-driven CO2 reduction system

A team from King Abdullah University of Science and Technology (KAUST), Beijing Institute of Nanoenergy and Nanosystems, and Georgia Tech has developed a wave-energy-driven electrochemical CO_2 reduction system that converts ocean wave energy to chemical energy in the form of formic acid, a liquid fuel.

The system, described in an open-access paper in the RSC journal *Energy & Environmental Science*, mainly consists of a spherical spring-assisted triboelectric nanogenerator (TENG) to convert the mechanical energy of the wave to electrical energy; a power management circuit with a supercapacitor to temporarily store the harvested electrical energy; and a electrochemical setup to reduce carbon dioxide to formic acid.

The team optimized the charging process of the supercapacitor and the operation potential of the electrochemical cells to more effectively utilize the energy harvested from the nanogenerator and maximize the production of formic acid. Under simulated waves, the system can produce 2.798 µmol of formic acid per day via the wave energy harvested from a water's surface area of 0.04 m^2.

They also performed field tests in the Red Sea to demonstrate the practicality of such an electrochemical CO_2 reduction system. According to the field test results, the wave-energy-driven CO_2RR system can produce 0.325 µmol of formic acid per day at 18 knots wind speed. Finally, they present design guidelines for achieving a cost-effective, efficient, and large-scale wave-energy-driven CO_2 reduction system for liquid fuel production.

https://www.greencarcongress.com

AI used to detect ocean pollution

Intel has recently partnered with Accenture and the Sulubaaï Environmental Foundation to create an AI-driven data collection platform aimed at analyzing and protecting vulnerable marine habitats, habitats like coral reefs. A combination of climate change, pollution, and overfishing have been damaging the world's oceans, particularly coral reefs. Coral reefs around the world are experiencing mass die-offs and problems like coral bleaching. Scientists and conservationists are looking for ways to protect coral reefs and help them recover. Designing plans to support coral reefs requires data, and as Engadget reported, Intel has partnered with two environmental foundations to create the CORaiL platform. The purpose of CORaiL will be collecting information on coral reefs and other marine habitats, providing researchers with the data they need to determine what strategies could be effective at protecting vulnerable marine ecosystems. As Jason Michell, managing director of the Communications, Media, and Technology practice at Accenture explained in a blog post: "Artificial intelligence provides unprecedented opportunities to solve some of society's most vexing problems. Our ecosystem of corporate and social partners for this 'AI for social good' project proves that there is strength in numbers to make a positive environmental impact."

In May of last year, the team of researchers and engineers from the three organizations installed concrete structures along reefs found near the Philippines' Pangatalan Island. The concrete chunks contained sections of living coral capable of growing into new habitat for creatures inhabiting coral ecosystems. In addition, the researchers placed video cameras underwater near the structures so they could collect data on the coral and the surrounding environment. The cameras utilized an AI-driven video analytics system developed by Accenture, and the cameras enabled the researchers to gather data on the reefs through minimally invasive methods.

Accenture's AI video analytics system lets researchers collect real-time video data from the coral environments, without needing to be physically present in the water. While many divers collect footage of coral reefs, this incurs travel expenses and presents the possibility that the divers could interfere with wildlife in the area. The AI video platform does much of the data collection and analysis for the research teams, continually monitoring the environment for change, and letting researchers do analysis in more or less real-time.

Over the course of the past year, CORaiL has collected around 40,000 images for analysis, and the images are already helping researchers analyze how coral reefs change in response to shifting environmental conditions. Meanwhile, engineers from the cooperative effort are already working on the next generation of the CORaiL system. The next proptype will include a backup power supply and an optimized series of convolutional neural networks. New versions of CORaiL might be employed for tasks other than studying coral, such as studying how tropical fish migrate through cold waters or monitoring for violators of reef protection orders.

https://www.unite.ai

Solar device converts seawater to drinking water

An international team of scientists has developed a cheap way to provide fresh water to thirsty communities by making seawater drinkable without using electricity. So long as the sun is shining, they say, their device will produce enough high-quality potable water to cover a family's needs, at a cost of around $100. The scientists, from Massachusetts institute of Technology (MIT), U.S. and Shanghai Jiao Tong University, China, believe their brainwave offers a simple solution to thirsty islands and arid coastal areas which lack a reliable electricity supply but have access to seawater. It could even help to prevent some of the mass migrations expected with climate change.

The researchers report their work in the journal *Energy and Environmental Science*. Testing their prototype on a roof at the Massachusetts Institute of Technology, they produced more than 1.5 gallons of

fresh drinking water every hour for every square meter of solar collecting area. Their device is cube-shaped, with multiple layers of solar evaporators and condensers piled one on top of another, surmounted with a layer of transparent insulation. Essentially it is a multi-layer solar still, similar to those used for centuries to make strong liquor and used today in many applications.

A solar still uses flat panels to absorb heat which it then transfers to a layer of water, which begins to evaporate. The vapor condenses on the next panel and the water is collected, while the heat from the vapor condensation is passed to the layer above. Whenever vapor condenses on a surface, it releases heat; in typical condenser systems, that heat is simply lost to the environment. But in this multi-layer version the released heat flows to the next evaporating layer, recycling the solar heat and boosting overall efficiency.

The efficiency comes from using each of the multiple stages to remove salt from the sea water, with the heat released by the previous stage harnessed instead of wasted. In this way, the team's demonstration device achieved an overall efficiency of 385 percent in converting the energy of sunlight into evaporation. Although adding more layers increases the conversion efficiency of the system, each layer also adds cost and bulk. The team settled on a 10-stage system for their proof-of-concept device. It delivered pure water that exceeded city drinking water standards, at a rate of 5.78 liters per square meter (about 1.52 gallons per 11 square feet) of solar collecting area. This is more than twice as much as the record amount previously produced by any such passive solar-powered desalination system, Professor Wang says.

And a big advantage of the system is that it has a self-flushing mechanism which will clean out the accumulation of salt each night and return it to the sea. One possible way of using the system would be with floating panels on a body of saltwater. The panels could deliver constant fresh water through pipes to the shore so long as the sun was shining. Other systems could be designed to serve a single household, perhaps using a flat panel on a large shallow tank of seawater.

The team estimates that a system with a roughly one-square-meter solar collecting area could meet the daily drinking water needs of one person. In production, they think a system built to serve the needs of a family might be built for around $100.

https://www.ecowatch.com

ASIA-PACIFIC

AUSTRALIA

Breaking down marine microplastic pollution

Plastic waste that finds its way into oceans and rivers poses a global environmental threat with damaging health consequences for animals, humans, and ecosystems. Now, using tiny coil-shaped carbon-based magnets, researchers in Australia have developed a new approach to purging water sources of the microplastics that pollute them without harming nearby microorganisms. Their work appears July 31 in the journal *Matter*.

"Microplastics adsorb organic and metal contaminants as they travel through water and release these hazardous substances into aquatic organisms when eaten, causing them to accumulate all the way up the food chain" says senior author Shaobin Wang, a professor of chemical engineering at the University of Adelaide (Australia). "Carbon nanosprings are strong and stable enough to break these microplastics down into compounds that do not pose such a threat to the marine ecosystem."

To decompose the microplastics, the researchers had to generate short-lived chemicals called reactive oxygen species, which trigger chain reactions that chop the various long molecules that make up microplastics into tiny and harmless segments that dissolve in water. However, reactive oxygen species are often produced using heavy metals such as iron or cobalt, which are dangerous pollutants in their own right and thus unsuitable in an environmental context.

To get around this challenge, the researchers found a greener solution in the form of carbon nanotubes laced with nitrogen to help boost generation of reactive oxygen species. Shaped like springs, the carbon nanotube catalysts removed a significant fraction of microplastics in just eight hours while remaining stable themselves in the harsh oxidative conditions needed for microplastics breakdown. The coiled shape increases stability and maximises reactive surface area. As a bonus, by including a small amount of manganese, buried far from the surface of the nanotubes to prevent it from leaching into water, the minute springs became magnetic. "Having magnetic nanotubes is particularly exciting because this makes it easy to collect them from real wastewater streams for repeated use in environmental remediation," says Xiaoguang Duan, a chemical engineering research fellow at Adelaide who also co-led the project.

As no two microplastics are chemically quite the same, the researchers' next steps will center on ensuring that the nanosprings work on microplastics of different compositions, shapes and origins. They also intend to continue to rigorously confirm the non-toxicity of any chemical compounds occurring as intermediates or by-products during microplastics decomposition.

The researchers also say that those intermediates and byproducts could be harnessed as an energy source for microorganisms that the polluting plastics currently plague. "If plastic contaminants can be repurposed as food for algae growth, it will be a triumph for using biotechnology to solve environmental problems in ways that are both green and cost efficient," Wang says. This work was supported by the Australian Research Council, the National Natural Science Foundation of China, and the Science and Technology Program of Guangdong Province.

https://www.sciencedaily.com

Industrial underwater robots to help ocean discoveries

The remotely operated vehicles can be adapted to gather scientific data while being used to inspect and maintain offshore structures. A team of scientists have

published a paper urging for the oil and gas industry to think about how underwater robots -- otherwise commonly referred to as remotely operated vehicles (ROVs) -- could be adapted and used to help researchers gather scientific data about the marine ecosystem.

The team, led by Dianne McLean and Miles Parsons from the Australian Institute of Marine Science (AIMS), published the paper in the journal *Frontiers in Marine Science*, citing how "low-cost engineering and operational tweaks" to ROVs could be used to gather scientific information.

Some of the suggested tweaks included attaching additional cameras, audio transmitters and receivers, and sample collection devices to existing ROVs.

ROVs are typically used by the oil and gas industry to inspect and maintain offshore structures. But McLean believes they can be used, for instance, to collect water samples to analyse environmental DNA, make scientific discoveries, examine the impact structures have on the ocean, and understand how climate change is changing the ocean.

"Scientists have limited access to a lot of the deep oceans just because it is remote and costly to get out there that. The oil and gas industry is doing these surveys with ROVs routinely, we should work with them to get this information," she said, speaking to ZDNet. "Just being able to access some of the imageries these ROVs collect could really provide us with huge insights about marine life down there."

https://www.zdnet.com

CHINA

Supercapacitor to store ocean energy

The system features a supercapacitor to temporarily store the harvested energy and an electrochemical setup able to reduce carbon dioxide to formic acid. A scientific team from the City University of Hong Kong has developed a novel wave energy device that generates electricity while converting carbon dioxide into fuel. Researchers say the new lightweight device can capture ocean wave energy and convert it into formic acid, a liquid fuel.

The electrochemical carbon dioxide reduction system consists of three components – a spherical medusa-like nanogenerator that can convert the energy of the wave into electricity, a power management circuit with a supercapacitor to temporarily store the harvested energy and an electrochemical setup that can reduce carbon dioxide to formic acid.

The research behind this breakthrough highlights the role of the ocean wave energy as an abundant and relatively stable source of renewable energy, which would be highly desirable for the conversion of carbon dioxide to conveniently stored and transported liquid fuels. Professor He Jr-hau from the Department of Materials Science and Engineering said: "Unlike conventional wave energy converters based on electromagnetic generators, the lightweight device, which can float on water surface and causes minimal impact to marine life and the seafloor, is more cost-effective and able to survive storms.

A liquid fuel, in the form of formic acid, is favourable because it can be stored at room temperature and is relatively easy and safe to transport. More importantly, this technology can mitigate carbon dioxide, a major greenhouse gas, during the energy conversion process, and ultimately help combat climate change.

https://www.energylivenews.com

INDIA

Turbines to convert wave energy to electricity

The Indian Institute of Technology (IIT) Madras and National Institute of Ocean Technology (NIOT) researchers are working towards developing better turbines that can harness the power of ocean waves to generate electricity. Their most recent studies on turbine-chamber coupling have been published in the reputed peer-reviewed International Journal of Energy Research.

The research is being headed at IIT Madras by Abdus Samad, Associate Professor, Department of Ocean Engineering, who works towards extracting energy from the ocean waves. The work of Abdus Samad and his research team is aimed at meeting renewable energy and climate change objectives of the Government of India. Recent research by Abdus Samad's group at IIT Madras, in collaboration with National Institute of Ocean Technology (NIOT), is being funded by Ministry of Earth Sciences, Government of India, and focuses on improving the devices and machines used for wave energy harvesting.

The research team comprises of Aravind George, Suchithra Ravikular, R Ananthnarayan, and Abdus Samad from the Department of Ocean Engineering, IIT Madras. George is the first author of the paper, and he is now at the University of Melbourne, Australia, completing his PhD. On the other hand, the scientists, Prasad Dudhgaonkar, Biren Patnaik, and Purnima Jalihal are from NIOT. Jalihal is the head of Energy and Fresh Water group of NIOT.

The aerodynamic performance of the turbine plays a major role in the wave-to-wire conversion efficiency. The coupling between the hydrodynamic process of the wave energy absorption and the turbine's aerodynamic process is affected by the interplay between the pressure in the oscillating water column and the airflow rate through the turbine. This interplay is called the damping effect. The variability of waves induces varying turbine speed, which in turn affects damping. Abdus Samad and his team analyze the running characteristics of a turbine connected to an oscillatory airflow test rig and subjected to varying rotational speeds.

In their recently published paper, the team presents the variations of pressure drop and pressure coefficient along with damping characteristics of the test rig, based on acceleration and deceleration of the turbine. In effect, they present the characteristics of the turbine-chamber coupling. This work by Abdus Samad's team offers a good launchpad for future research in the area of wave power. Such future research would examine the power output of the turbine, the turbine mean efficiency, and the chamber efficiency to relate turbine?chamber coupling in greater detail, which would help in the design of more efficient wave energy harvesting devices.

The turbine is the heart of the wave energy system and a huge amount of research works are done through fluid dynamic analysis, experimental system development, design, and tests. To overcome the challenges coming on the way to develop from scratch to the ocean test took 7 years and more than two dozen of researcher's work on it. The turbines being developed are for the floating and fixed wave devices being developed at NIOT. The hydrodynamics, floating body dynamics, offshore-related aspects and integration of the turbine- generator module with the device are all being done by NIOT.

https://www.indiatoday.in

Hydrogen from sea-water

Researchers from the Indian Institute of Technology (IIT) Madras have developed a technology that can be used to generate hydrogen fuel from seawater, an advance that may contribute to a cleaner energy future. Using this technology, described in the journal *ACS Sustainable Chemistry & Engineering*, hydrogen can be produced on-demand at the point of use, and hence it need not to be stored. This overcomes the storage-related challenges associated with hydrogen as its highly inflammable and may cause an explosion, the researchers said.

The researchers noted that hydrogen is produced at a tunable rate without heat, electricity or sunlight. The starting materials are all eco-friendly. The process is amenable to all scales of production that is relevant for the hydrogen economy — hence sectors such as automotive, aviation etc. would benefit from this technology, they said. The researchers, including Tiju Thomas, Associate Professor at IIT Madras, said they are on the way to customise and design a proper hydrogen system for vehicles.

The technology is used to generate hydrogen from any source of water. However, as seawater covers two-thirds of the surface of the Earth, the researchers are keen on utilising it. The setup, the scientists said, can generate fuel production with the push of a button, which adds water from one compartment to the other.

The researchers noted that the commercial method requires a high temperature of about 1,000 degrees Celsius and nearly 25 bar pressure. However, the new process works at the room temperature, and atmospheric pressure which is 1 bar, they said.

https://www.firstpost.com

JAPAN

New biodegradable plastic in ocean water

Researchers from Osaka University have developed a new kind of plastic that can be used to make watertight containers that are also biodegradable in certain kinds of ocean water. The project was a joint effort from Osaka University and Nippon Shokuhin Kako Company, a Japanese agricultural giant that produces starch-based food products. The team extracted starch from cassava provided by Nippon Shokuhin Kako and combined it with cellulose taken from wood pulp.

The mixture was dissolved in a water solution and spread into a transparent sheet that's just 100 micrometers thick. The sheet was then heated to turn it into a solid plastic, according to a report in the *Asahi Shimbun*. The team says the resulting plastic is twice as strong as conventional plastic made from polyethylene, one of the main components in plastic bags.

To test its biodegradability, they placed samples of the new plastic in several different containers filled with seawater, each of which had varying levels of microorganisms in them. The team found that the plastic fully broke down within 30 days in the seawater sample with the highest concentration of microorganisms. In other containers with lesser amounts of microorganisms the plastic remained in tact after the 30 day observation period.

In comparison, a plastic bag in the ocean takes around 20 years to decompose, while plastic bottles can take as long as 450 years. The team from Osaka University hopes their new kind of plastic could cut down on the harm food containers and other plastic waste causes in the ocean.

https://www.dailymail.co.uk

EUROPE

UK

AI detects plastics in the oceans

An AI system has spotted plastic pollution in the sea by analyzing images from satellites orbiting the earth. The scientists behind the technique claim that it's the first time patches of plastics in coastal waters have been detected via satellites. The system studies images collected by the European Space Agency's Sentinel-2 satellites to spot debris floating in the world's oceans. These objects absorb and reflect light to produce a "spectral signature" in the data that contain clues about what they are.

Researchers from Plymouth Marine Laboratory in the UK then trained an algorithm to classify the different objects by spotting differences in their spectral signatures. They then ran the algorithm over images of seas surrounding Canada, Scotland, Ghana, and Vietnam. On average, the system differentiated between plastics and natural materials such as seaweed with 86% accuracy.

The team now plans to refine the technique to accurately detect floating patches in turbid coastal waters and large river waters. Eventually, they hope the method will be combined with drones to monitor plastic littering and support clean-up operations. But they add that the only way to clean up our polluted oceans is to dramatically reduce the amount of plastic we produce.

https://thenextweb.com

NORTH AMERICA

USA

Battery-free sensor for underwater exploration

MIT researchers have developed a battery-free underwater communication system that uses near-zero power to transmit sensor data. The system could be used to monitor sea temperatures to study climate change and track marine life over long periods — and even sample waters on distant planets. They are presenting the

system at the SIGCOMM conference this week, in a paper that has won the conference's "best paper" award.

The system makes use of two key phenomena. One, called the "piezoelectric effect," occurs when vibrations in certain materials generate an electrical charge. The other is "backscatter," a communication technique commonly used for RFID tags, that transmits data by reflecting modulated wireless signals off a tag and back to a reader.

In the researchers' system, a transmitter sends acoustic waves through water toward a piezoelectric sensor that has stored data. When the wave hits the sensor, the material vibrates and stores the resulting electrical charge. Then the sensor uses the stored energy to reflect a wave back to a receiver — or it doesn't reflect one at all. Alternating between reflection in that way corresponds to the bits in the transmitted data: For a reflected wave, the receiver decodes a 1; for no reflected wave, the receiver decodes a 0.

The researchers demonstrated their Piezo-Acoustic Backscatter System in an MIT pool, using it to collect water temperature and pressure measurements. The system was able to transmit 3 kilobits per second of accurate data from two sensors simultaneously at a distance of 10 meters between sensor and receiver.

The transmitter and receiver must have power but can be planted on ships or buoys, where batteries are easier to replace, or connected to outlets on land. One transmitter and one receiver can gather information from many sensors covering one area or many areas. Next, the researchers aim to demonstrate that the system can work at farther distances and communicate with more sensors simultaneously. They're also hoping to test if the system can transmit sound and low-resolution images. The work is sponsored, in part, by the U.S Office of Naval Research.

http://news.mit.edu

Faster-degrading plastic for cleaner seas

To address plastic pollution plaguing the world's seas and waterways, Cornell University chemists have developed a new polymer that can degrade by ultraviolet radiation, according to research published in the *Journal of the American Chemical Society*. "We have created a new plastic that has the mechanical properties required by commercial fishing gear. If it eventually gets lost in the aquatic environment, this material can degrade on a realistic time scale," said lead researcher Bryce Lipinski, a doctoral candidate in the laboratory of Geoff Coates, professor of chemistry and chemical biology at Cornell University. "This material could reduce persistent plastic accumulation in the environment."

Commercial fishing contributes to about half of all floating plastic waste that ends up in the oceans, Lipinski said. Fishing nets and ropes are primarily made from three kinds of polymers: isotactic polypropylene, high-density polyethylene, and nylon-6,6, none of which readily degrade. "While research of degradable plastics has received much attention in recent years," he said, "obtaining a material with the mechanical strength comparable to commercial plastic remains a difficult challenge."

Coates and his research team have spent the past 15 years developing this plastic called isotactic polypropylene oxide, or iPPO. While its original discovery was in 1949, the mechanical strength and photodegradation of this material was unknown before this recent work. The high isotacticity (enchainment regularity) and polymer chain length of their material makes it distinct from its historic predecessor and provides its mechanical strength. Lipinski noted that while iPPO is stable in ordinary use, it eventually breaks down when exposed to UV light. The change in the plastic's composition is evident in the laboratory, but "visually, it may not appear to have changed much during the process," he said.

The rate of degradation is light intensity-dependent, but under their laboratory conditions, he said, the polymer chain lengths degraded to a quarter of their original length after 30 days of exposure. Ultimately, Lipinski and other scientists want to leave no trace of the polymer in the environment. He notes there is literature precedent for the biodegradation of small chains of iPPO which could effectively make it disappear, but ongoing efforts aim to prove this.

This research was supported by the National Science Foundation's Center for Sustainable Polymers, the NSF-supported NMR Facility at Cornell, and the Cornell Center for Materials Research.

https://www.sciencedaily.com

Catalyst produces hydrogen from seawater

Researchers from the University of Houston have reported a significant breakthrough with a new oxygen evolution reaction catalyst that, combined with a hydrogen evolution reaction catalyst, achieved current densities capable of supporting industrial demands while requiring relatively low voltage to start seawater electrolysis. Researchers say the device, composed of inexpensive non-noble metal nitrides, manages to avoid many of the obstacles that have limited earlier attempts to inexpensively produce hydrogen or safe drinking water from seawater. The work is described in *Nature Communications*.

Zhifeng Ren, director of the Texas Center for Superconductivity at UH and a corresponding author for the paper, said a major obstacle has been the lack of a catalyst that can effectively split seawater to produce hydrogen without also setting free ions of sodium, chlorine, calcium and other components of seawater, which once freed can settle on the catalyst and render it inactive. Chlorine ions are especially problematic, in part because chlorine requires just slightly higher voltage to free than is needed to free hydrogen.

The researchers tested the catalysts with seawater drawn from Galveston Bay off the Texas coast. Ren, M.D. Anderson Chair Professor of physics at UH, said it also would work with wastewater, providing another source of hydrogen from water that is otherwise unusable without costly treatment. To address the challenges, the researchers designed and synthesized a three-dimensional core-shell oxygen evolution reaction catalyst using transition metal-nitride, with nanoparticles made

of a nickle-iron-nitride compound and nickle-molybdenum-nitride nanorods on porous nickle foam.

First author Luo Yu, a postdoctoral researcher at UH who is also affiliated with Central China Normal University, said the new oxygen evolution reaction catalyst was paired with a previously reported hydrogen evolution reaction catalyst of nickle-molybdenum-nitride nanorods.

The catalysts were integrated into a two-electrode alkaline electrolyzer, which can be powered by waste heat via a thermoelectric device or by an AA battery. Cell voltages required to produce a current density of 100 milliamperes per square centimeter (a measure of current density, or mA cm-2) ranged from 1.564 V to 1.581 V. The voltage is significant, Yu said, because while a voltage of at least 1.23 V is required to produce hydrogen, chlorine is produced at a voltage of 1.73 V, meaning the device had to be able to produce meaningful levels of current density with a voltage between the two levels.

https://www.sciencedaily.com

Energy from mixing of freshwater and seawater

Stanford researchers have developed an affordable, durable technology that could harness this so-called blue energy. The paper, recently published in American Chemical Society's *ACS Omega*, describes the battery and suggests using it to make coastal wastewater treatment plants energy-independent.

"Blue energy is an immense and untapped source of renewable energy," said study coauthor Kristian Dubrawski, a postdoctoral scholar in civil and environmental engineering at Stanford. "Our battery is a major step toward practically capturing that energy without membranes, moving parts or energy input." Dubrawski works in the lab of study co-author Craig Criddle, a professor of civil and environmental engineering known for interdisciplinary field projects of energy-efficient technologies. The idea of developing a battery that taps into salt gradients originated with study coauthors Yi Cui, a professor of materials science and engineering, and Mauro Pasta, a postdoctoral scholar in materials science and engineering at the time of the research. Applying that concept to coastal wastewater treatment plants was Criddle's twist, born of his long experience developing technologies for wastewater treatment.

The researchers tested a prototype of the battery, monitoring its energy production while flushing it with alternating hourly exchanges of wastewater effluent from the Palo Alto Regional Water Quality Control Plant and seawater collected nearby from Half Moon Bay. Over 180 cycles, battery materials maintained 97 percent effectiveness in capturing the salinity gradient energy.

The technology could work any place where fresh and saltwater intermix, but wastewater treatment plants offer a particularly valuable case study. Wastewater treatment is energy-intensive, accounting for about three percent of the total U.S. electrical load. The process -- essential to community health -- is also vulnerable to power grid shutdowns. Making wastewater treatment plants energy independent would not only cut electricity use and emissions but also make them immune to blackouts -- a major advantage in places such as California, where recent wildfires have led to large-scale outages.

The Stanford group's battery isn't the first technology to succeed in capturing blue energy, but it's the first to use battery electrochemistry instead of pressure or membranes. If it works at scale, the technology would offer a more simple, robust and cost-effective solution. The process first releases sodium and chloride ions from the battery electrodes into the solution, making the current flow from one electrode to the other. Then, a rapid exchange of wastewater effluent with seawater leads the electrode to reincorporate sodium and chloride ions and reverse the current flow. Energy is recovered during both the freshwater and seawater flushes, with no upfront energy investment and no need for charging. This means that the battery is constantly discharging and recharging without needing any input of energy.

https://www.sciencedaily.com

Measuring bluefin tuna with a drone

Researchers have used an unmanned aerial system (or drone) to gather data on schooling juvenile Atlantic bluefin tuna in the Gulf of Maine. This pilot study tested whether a drone could keep up with the tuna while also taking photographs that captured physical details of this fast-moving fish. The drone was equipped with a high-resolution digital still image camera. Results show that drones can capture images of both individual fish and schools. They may be a useful tool for remotely monitoring behavior and body conditions of the elusive fish.

Individual fish lengths and widths, and the distance between fish near the sea surface, were measured to less than a centimeter of precision. We used an APH-22, a battery-powered, six-rotor drone. The pilot study was conducted in the Atlantic bluefin tuna's foraging grounds northeast of Cape Cod in the southern Gulf of Maine.

Results from the APH-22 study were published in March 2020 in the *Journal of Unmanned Vehicle Systems*. Researchers conducted their work in 2015. They then compared their study results to values in published data collected in the same general area. They also compared it to recreational landings data collected through NOAA Fisheries' Marine Recreational Information Program. Taking precision measurements of animals that are in constant motion near the surface proved easier with a drone that is lightweight, portable, and agile in flight. It can carry a high-quality digital still camera, and be deployed quickly from a small fishing boat. Short flight times limit a drone's ability to survey large areas. However, they can provide two-dimensional images of the shape of a fish school and data to count specific individuals just below the ocean surface.

The APH-22 system has been tested and evaluated for measuring other marine animals. It's been used in a number of environments—from Antarctica to the Pacific Ocean—prior to its use in the northwest Atlantic Ocean. Previous studies estimated the abundance and size of penguins and leopard seals, and the size and identity of individual killer whales.

https://phys.org