ENVIRONMENTAL SYSTEMS DIVISION NEWSLETTER

01 DECEMBER 2020

The ESD Newsletter is a monthly newsletter involving ALL members of ESD. Members are encouraged to forward materials, authored papers on Environmental and Environmental Systems topics, and comments on newsletter topics or current events to the Editor. Your participation is greatly appreciated.

The ESD newsletter features **Five** Sections:
(Please use the **blue** links below to navigate within the newsletter)

1. ESD DIVISION NEWS

ESD Technical Representative to Waste Information Exchange Planning Committee – Volunteer Opportunity

The Environmental Systems Division (ESD), in conjunction with the ASME Materials and Energy Recovery Division, the ASME Research Committee on Energy, Environment and Waste, and the Air and Waste Management Association (A&WMA) are planning a Waste Information Exchange (WIE) in the Washington, DC area in 2021. The WIE will be based on the [Air] Information Exchange held annually in North Carolina. The main presenters will be EPA personnel.

ESD is looking for a volunteer to be the ESD Technical Representative to the Planning Committee. The individual should be familiar with the RCRA/HSWA regulatory program (including guidance and compliance/enforcement issues) on both solid and hazardous waste. Contacts in the Office of Resource Conservation and Recovery (ORCR) in DC would be a plus. Most of the work will be by telephone or electronic mail.

Submit a letter or email of interest to Arnie Feldman at jjdsenv@att.net or Ryan Neil, ESD Chair, at ryanneil84@hotmail.com **Back to Newsletter's Page 1**

Dixy Lee Ray Award Committee – Volunteer Opportunity

The Dixy Lee Ray Award Committee is looking for a volunteer to serve as a committee member. The Dixy Lee Ray Award is a prestigious ASME level award honoring those that have made a major impact in the environmental protection field. See https://www.asme.org/about-asme/honors-awards/achievement-awards/dixy-lee-ray-award for additional details.

Committee members' primary responsibility is to review nominations and select the annual Dixy Lee Ray Award winner. Committee members also help promote and publicize the award to their colleagues and friends. The committee normally meets thru conference calls and emails. Nominations are due to the committee by February 15 each year so most of the discussion and teleconference meetings occur February, March, and April. All committee members must be ASME members. The term of service is 5 years.

Submit a letter or email of interest to Ryan Neil, ESD Chair, at ryanneil84@hotmail.com.

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NEW ASME PLANT SYSTEMS DESIGN STANDARD

ASME has approved development of a new standard for Plant Systems Design (PSD). The charter is:
"To develop, review and maintain a technology neutral standard for design of plant systems for nuclear, fossil and petrochemical, chemical, and hazardous waste plants and facilities. The standard provides processes and procedures for design organizations to: (a) integrate process hazard analysis in the early stages of design; (b) incorporate and integrate existing systems engineering design processes, practices and tools with traditional architect engineering design processes, practices and tools; and (c) to integrate risk informed probabilistic design methodologies with traditional deterministic design. The focus is to provide requirements and guidance for design processes, methodologies and tools that will provide safer and more efficient system and component designs with quantified safety levels."
There are over 40 volunteers actively contributing to development of the Plant Systems Design standard. To create a truly technology neutral standard the Committee needs additional volunteers to add expertise and diversity for all types of plants and facilities that have significant health and safety risk to the worker and the public. The greatest applicability of this standard will be for new plant design. The focus is to reduce costs of new plant design and construction.

Please contact Ralph Hill at (hillr@asme.org) for more information or to join the PSD Committee.

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ASME ENERGY STORAGE COMMITTEE

The Energy Generation and Storage Technology Group (EGSTG) formed a new Energy Storage Committee (ESC) in the Spring of 2020. The ESC is dedicated to the advancement of energy storage systems: for both utility and distributed system. The focus of ESC extends across most of the other ASME Divisions and Sectors. This Committee works with government, industry, academia, ASME Codes & Standards, ASME Government Relations and other relevant professional and regulatory organizations to discuss, review, and promote practices which lead to the development, enhancement, and deployment of energy storage technologies.
The core values of ESC are to:

- Support international/intersociety professionals wishing to advance the application of energy storage thru basic research, applied research, development, and implementation
- Create and publish peer-reviewed high value content, reference documents
- Facilitate the creation, dissemination, and application of knowledge (science, engineering, technology) and information in energy storage within and outside ASME
- Attract students and young engineers into this area and provide them a forum to grow and advance their careers
- To encourage and facilitate a process for members to provide their expertise in the standards-setting process for energy storage
- To promote codes and standards for new areas energy storage
- To provide closer interface within and outside ASME through joint efforts/collaboration
- To help members keep pace with the latest developments

The main purposes of the Committee are fivefold:

- To develop and maintain the Energy Storage Matrix so that all (not only those on the Committee) know the status of the various technologies
- To develop standards (both ASME and IEEE as well as others) for energy storage: the Committee is a resource (e.g., people, volunteers, knowledge) for the various groups working on standards
- As central coordinating Committee (group) for sharing knowledge and answering questions on Energy Storage
- As a networking center for those directly (and indirectly) working on Energy Storage
- To develop events on Energy Storage such as webinars, forums and conferences

ESC members include engineers (and others) conducting research and practicing engineers in energy storage, storage equipment design, regulatory programs and the operations, design, maintenance, and testing of energy storage systems. Membership on the ESC is open to all ASME members, other professional society's (e.g., IEEE, AIChE, etc.), the governmental and regulatory community, and other interested individuals. Membership on the Committee is free to all. The intent is for the ESC to transition into an ASME Energy Storage Division in approximately one to two years. If you are interested in becoming a member of the Committee or need more information please contact Arnie Feldman, Chair, at (jjdsenv@att.net).

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RCEEW on PFAS Test Methods & Emissions

The ASME Research Committee on Energy, Environment and Waste (RCEEW) is forming a subcommittee to work on input into test methods and emissions for PFAS. If you want more information or are interested in serving on the subcommittee please contact Bob Hall at (bobhall27513@gmail.com).

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ASME Environmental Systems Division Competition for Students & Early Career Professionals

NEW COMPETITION! Show off your speaking skills and highlight your technical, management and policy knowledge as they relate to the environment. The competition aims to encourage students and early career engineer's involvement in technical, management, and policy-making issues related to the environment.

ASME is excited to host an E-Fest Digital event on April 24, 2021 (finals). The competition is open to and divided in to three groups: Undergraduate Students, Graduate Students and Early-Career Engineers.

The topics for each Group are:

GROUP NO.	GROUP/ LEVEL	TOPICS	FOCUS AREAS
I	Undergraduate Students	Waste to Energy	Technical Solutions to Environmental Problems
II	Graduate Students	Clean Energy Technologies & Systems	Technical Solutions to Environmental Problems and Environmental & Sustai nable Management
III	Early Career	Environmental Remediation & Restoration	Environmental Management and Policy Making Aspects

The Competition will have three rounds (each round being an elimination round) including an abstract submission, semi-final video and live (digital) final presentation. For the schedule of see the Competition Rules and Timing at **download the 2021 Environmental Systems Division Competition Rules.** Abstract submission due by January 10, 2021 11:59pm EST.

Have questions and want to learn more about the competition? Join us for a FREE webinar on December 4, 2020 at noon EST. If you have other questions about the Environmental System Division Competition please email: (esd@asme.org) **Back to Newsletter's Page 1**

Obituary: John Elter (1941-2020)

John Elter, Ph.D., a renowned authority on sustainability and sustainable systems as well as former member of the ASME Board of Governors and chair of the ASME Industry Advisory Board, passed away on April 21 at the age of 78.

Dr. Elter was president of Sustainable Systems LLC, a management consulting firm in Latham, N.Y., specializing in strategy, technology, and product development for sustainable systems. He had served as president of the company since 2008. Prior to heading Sustainable Systems, Elter had been the Empire Innovation Professor of Nanoengineering and executive director of the Center for Sustainable Ecosystem Nanotechnologies at the State University of New York (SUNY) at Albany. His academic research focused on the development of nanomaterials, structures and devices for clean water, and efficient energy generation, conversion and storage. Before joining the faculty at SUNY Albany, Elter worked from 2001 to 2008 at Plug Power, where he served as chief technology officer and led the company's advanced fuel cell systems development efforts. Elter had previously spent more than 30 years

at Xerox Corporation, where he held such executive leadership roles as vice president and chief engineer of strategic programs.
Elter, who was an ASME Fellow, also held a number of noteworthy leadership position at ASME during his 27 years of membership. In addition to being a member of the Board of Governors, a post he held from 2012 to 2015, he served on the ASME Industry Advisory Board from 1993 until 2018 and was IAB chair from 1998-2001.
In addition, Elter served on the ASME Foundation Board as director from 2004-2010 and chair from 2008-2009. He was also a member of the Board on Government Relations from 2008-2010. He received the ASME Dixy Lee Ray Award for environmental protection in 2001 and the Society's Dedicated Service Award in 2004. John earned a bachelor's degree in mechanical engineering from Purdue University, a master's degree in mechanical engineering from New York University, and a Ph.D. in mechanical and aerospace sciences from the University of Rochester, where he had been named a Distinguished Alumnus.

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2. ENVIRONMENTAL TECHNOLOGIES

New material 'mines' copper from toxic wastewater

A promising solution relies on materials that capture heavy metal atoms, such as copper ions, from wastewater through a separation process called adsorption. But commercially available copper-ion-capture products still lack the chemical specificity and load capacity to precisely separate heavy metals from water. Now, a team of scientists led by the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has designed a new material -- called ZIOS (zinc imidazole salicylaldoxime) -- that targets and traps copper ions from wastewater with unprecedented precision and speed. In a paper recently published in the journal Nature Communications, the scientists say that ZIOS offers the water industry and the research community the first blueprint for a water-remediation technology that scavenges specific heavy metal ions with a measure of control at the atomic level that far surpasses the current state of the art. "ZIOS has a high adsorption capacity and the fastest copper adsorption kinetics of any material known so far -- all in one." This research embodies the Molecular Foundry's signature work -- the design, synthesis, and characterization of materials that are optimized at the nanoscale (billionths of a meter) for sophisticated new applications in medicine, catalysis, renewable energy, and more.
"ZIOS helps us to choose and remove only copper, a contaminant in water that has been linked to disease and organ failure, without removing desirable ions, such as nutrients or essential minerals." Such specificity at the atomic level could also lead to more affordable water treatment techniques and aid the recovery of precious metals. "Today's water treatment systems are 'bulk separation technologies' -- they pull out all solutes, irrespective of their hazard or value." "Highly selective, durable materials that can capture specific trace constituents without becoming loaded down with other solutes, or falling apart with time, will be critically important in lowering the cost and energy of water treatment. They may also enable us to 'mine' wastewater for valuable metals or other trace constituents." X-ray experiments at Berkeley Lab's Advanced Light Source revealed that the material's tiny pores

or nanochannels -- just 2-3 angstroms, the size of a water molecule -- also expand when immersed in water. This expansion is triggered by a "hydrogen bonding network," which is created as ZIOS interacts with the surrounding water molecules. (Ref. 1)

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Biomining: Turning Waste into Gold with Microbes

High-value metals make the modern world go round, but the way we extract and dispose of them is far from sustainable. The domestication of metal-mining microbes could be an elegant and lucrative alternative. From the gold and silver in consumer electronics to the rare earth elements needed to power renewable energy technologies, metals underpin the transition to a high-tech, low-carbon economy. It's estimated that precious metals worth billions are lost every year from electronic waste alone, the vast majority of which goes unrecycled. There are growing concerns around the environmental and humanitarian effects of conventional mining practices. In addition, many countries seek to reduce their reliance on mineral imports to distance themselves from tensions between the West and China — a major supplier of precious metals and rare earth elements. Fortunately, there is an emerging alternative. A wealth of microbial species, often from extreme environments, have evolved the ability to extract metals from their surroundings. Some produce acids and metal-scavenging proteins to dissolve metals from solid rocks, in a process called bioleaching. Others employ their own cell walls to extract and accumulate metal ions from liquids. By harnessing these miniature miners, the emerging field of biometallurgy could tackle many of the issues associated with conventional metal supply chains. In Germany, a company called BRAIN (Biotechnology Research and Information Network) is leveraging a huge collection of more than 50,000 microbes to identify the most talented metal-extracting microbes and put them to work.

"BRAIN's engagement in biometallurgy was, as is so often in science, a coincidence: in 2008, when they were working on surface-active biomolecules, they observed that a bacterial strain originating from our microorganism collection attached very selectively to hydrophobic gold surfaces. At that moment, the idea of a biological gold tweezer was born." The recovery of gold from electronic waste is a major target for BRAIN, but the company also has its sights set on other waste streams that contain valuable metals which would otherwise be lost, or heavy metals that pose health and environmental risks. For example, ashes from incinerators, dust from steel production, and even sewage sludge contain recoverable amounts of precious and heavy metals. BRAIN's most advanced biomining product takes the form of a modular, shipping container-sized unit called the BioXtractor. The unit contains all the necessary components for the bioleaching of precious metals, and is designed to be a flexible option for industrial companies looking to extract metals from various waste streams. In a process that takes up to 48 hours, finely ground waste is incubated along with the biomining microbes. Once they have leached out the metals, these are recovered from the mix using an adsorber resin. "The major advantage is the sustainability of the processes." "It replaces aggressive or toxic chemicals by microbial biomass and significantly reduces the energy demand and consequently the CO_2 footprint of metal recovery processes by a factor of three compared to the virgin mining and chemical recycling of gold. Compared to pyrometallurgical recycling (smelting), the CO_2 footprint is still reduced by a factor of two." (Ref. 2)

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3. ENVIRONMENTAL REGULATIONS

Why we need policies to reduce meat consumption now

Many of the massive wildfires that have scorched the Amazon this summer and in recent years can be linked to dinner plates in China and other countries around the world. Cattle ranchers have been using illegal burning to tame the rainforest into pastureland to meet rising global beef demand, a strategy that spells disaster for climate change and biodiversity.

These fires are but the latest distress signal from a deeply unsustainable global food system. Emissions are embedded in every part of the food supply chain, from deforestation to grow crops or raise cattle, as in Brazil — which releases carbon dioxide and nitrous oxide — to rice fields and cow burps, which emit methane, another potent greenhouse gas. A new study published in Science reveals just how important tackling food-related emissions is to mitigating the swiftly accelerating climate crisis. For the first time, the researchers isolated food system emissions and showed that these emissions alone will most likely put the Paris agreement climate targets out of reach.

Even if all non-food greenhouse gas emissions were cut off today, the researchers project that food systems emissions would cause us to cross the threshold of 1.5 degrees Celsius temperature rise around the middle of the century. That is under their business-as-usual scenario in which food system trends from the past 50 years extend forward. The food system is responsible for about 30 percent of greenhouse gas emissions currently, and these emissions are expected to rise rapidly as people around the world become more affluent and consume more meat and dairy products. Given that dire trend, immediate changes to the way we produce and eat food are essential to stay within the Paris agreement targets. The study models five interventions to rapidly cut food emissions. The most effective, according to the authors, is the global adoption of a plant-rich diet. Yet relying on individuals to make a massive behavior change, especially in wealthy countries like the US where per capita meat consumption is far above the global average, is difficult and risky, given the urgency of the climate crisis. This means, policymakers need to get more creative and ambitious, to help consumers eat less meat and dairy. So far, governments have been slow to embrace dietary change as a climate solution, but they can draw from public health policies that have successfully changed diets to start taking action. According to the Science study, food system emissions alone will nearly eat up the world's remaining carbon budget. To stay below 2 degrees Celsius temperature rise, we have only 1,500 gigatons of carbon dioxide equivalent left to emit by the end of the century. Under the business-as-usual scenario, food emissions would take up 1,356 gigatons, leaving almost no room for other sectors.

Of course, the food system will need to share that budget with the biggest source of emissions: the energy sector. So the researchers modeled a scenario showing how both the non-food and food sectors would need to decarbonize to stay within the Paris agreement climate targets. In this scenario, they assume that emissions from fossil fuel combustion (in both food and non-food sectors) decline to net zero by 2050. Reducing the consumption of animal products is critical because they have an outsize carbon footprint. Meat, dairy, eggs, and aquaculture account for around 56 percent of food-related greenhouse gases while only providing 37 percent of protein and 18 percent of calories, according to a 2018 study in Science. Plant-based

"burgers" may be trending, but so far they haven't made a dent in consumption patterns in the US. Gallup polling shows the rate of vegetarianism in the US has hovered around 5 to 6 percent from 1999 to 2018. And per capita meat consumption has been rising in the US, although researchers project that it could go down this year due to the impact of Covid-19 on the meat industry. So for people to start eating more plant protein in line with climate targets, strong policies are needed. Unfortunately, governments have taken very little action to date. (Ref. 3)

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EFSA Publishes Environmental Risk Assessment of the Application of Nanoscience and Nanotechnology in the Food and Feed Chain

On November 19, 2020, the European Food Safety Authority (EFSA) published a report entitled "Environmental Risk Assessment (ERA) of the application of nanoscience and nanotechnology in the food and feed chain." The authors analyzed existing ERA guidance documents for their adequacy to cover issues that are specific for nanomaterials, but note that none of the guidance has a specific focus on the food and feed chain. Each nanospecific issue was addressed by briefly reviewing the existing methods to address the issue in each separate step of ERA. The report suggests adaptations necessary in exposure assessment and hazard and risk characterization to address nanomaterials. The report lists the following issues that should be addressed in preparing ERA guidance of the application of nanoscience and nanotechnology in the food and feed chain:

- Collaboration with other European Union (EU) agencies that face similar tasks in updating their ERA guidance for nanomaterials, such as the European Chemicals Agency (ECHA) and the European Medicines Agency (EMA), as well as with method developments in organizations like the Organization for Economic Cooperation and Development (OECD) or the International Organization for Standardization (ISO), to prevent duplication of work and contradictory recommendations in ERA guidance for nanomaterials;
- Environmental exposure scenarios and models, including their computational implementation for modeling of fate and release, are an essential part of ERA of nanomaterials, meaning that either the existing scenarios and models need to be adapted, or new models need implementation for use with products containing nanomaterials;
- Development of standardized approaches for conducting exposure and hazard assessment for nanomaterials in benthic and terrestrial environments is lagging behind the developments for the pelagic environment;
- The aim of applying a nanomaterial formulation needs to be taken into account in its efficacy testing;
- Dose metrics other than the mass-based metrics commonly used for soluble chemicals are needed for nanomaterials. Metrics based on particle number or surface area may be more informative for fate and hazards of nanomaterials; and
- Several of the default/shortcut values currently used in lower tiers of ERA need revision where they are derived based on diffusion or thermodynamic equilibrium-based approaches. Several approaches for revision are available for nanomaterials. (Ref. 4)

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4. EDITORIAL BOARD SELECTIONS

Big electric trucks and buses are coming. How to speed up the transition?

There's a growing consensus in the climate change community that the key to transitioning the US economy from fossil fuels is to electrify everything — shift the electricity grid over to carbon-free power and shift other big polluting sectors like transportation and heating over to electricity. When it comes to transportation, electrification is going to be tricky. Not long ago, the consensus was that the cost and power limitations of batteries would make it difficult to fully electrify anything larger than passenger vehicles. But batteries have been progressing in leaps and bounds. Full electrification is still beyond the reach of huge vehicles, the long-distance airliners and container ships, but recently it has become a possibility for a large and significant category of vehicles in the middle: medium- and heavy-duty trucks and buses.

According to the Environmental Protection Agency, just 6 percent of the registered vehicles on US roads in 2018 were medium- and heavy-duty, but they were responsible for 23 percent of transportation-sector greenhouse gas emissions (about 7 percent of total US emissions). Since they mostly run on diesel engines, they also produce enormous amounts of air and noise pollution, which fall disproportionately on low-income and communities of color that may live closer to highways and are more likely to use buses. Long-haul trucks alone, while responsible for less than 6 percent of vehicle miles traveled on US highways, produce about 40 percent of its particulate pollution and 55 percent of its nitrogen oxides. The global toll is immense: 180,000 deaths a year from diesel pollution. That's where medium- and heavy-duty electric trucks (MHDETs) come in. They are quiet, emit zero tailpipe pollution, and draw power from an increasingly clean electricity grid. An impossible dream a decade ago, they are now the subject of fierce competition from big automakers like Daimler, Volvo, VW, and Tesla, with multiple models slated to hit the road in coming years.

As countries across the world start cracking down on carbon emissions — and cities ramp up their fight against diesel pollution — there's going to be an enormous market for clean alternatives. According to the Department of Transportation, there are over 14 million large trucks and buses on US roads. Wood Mackenzie expects the number of electric trucks on US roads to rise from 2,000 in 2019 to more than 54,000 by 2025, around 27 times growth. The research firm IDTechEx expects the MHDET market to reach $47 billion by 2030. Policymakers are helping, too. In July, governors of 15 states signed a memorandum agreeing to set up a MHDET task force, develop an action plan, and jointly "strive to make sales of all new medium- and heavy-duty vehicles in our jurisdictions zero emission vehicles by no later than 2050," and in the interim, "strive to make at least 30 percent of all new medium- and heavy-duty vehicle sales in our jurisdictions zero emission vehicles by no later than 2030." New York City, Los Angeles, Houston, and other cities are already exploring electric buses. The purchasers of big buses and trucks are not typically buying single vehicles. They are almost all managers of fleets of vehicles. So the question of whether to electrify goes beyond whether the next truck might be cheaper electric. Electrifying a fleet is a big, complicated process that involves buying and installing new charging infrastructure and changing operational procedures, in the face of considerable uncertainty and risk. Environmental Defense Fund (EDF) offers a framework that tries to pull all these costs and risks together into a single metric: the total cost of electrification (TCE). TCE goes beyond the conventional metric of total cost of ownership (TCO), meant to be inclusive of capital, operations, and infrastructure costs, to include less quantifiable social,

operational, and even psychological costs. (Ref. 5) **Back to Newsletter's Page 1**

New wheat and barley genomes will help feed the world

Researchers from the 10+ Wheat Genomes Project have sequenced a suite of genomes of both cereals, published in the journal Nature. They say it will open the doors to the next generation of wheat and barley varieties. It is estimated that wheat production alone must increase by more than 50% over current levels by 2050 to feed the growing global population. This published research brings scientists closer to unlocking the entire gene set -- or pan genomes -- of wheat and barley. Through understanding the full extent of genetic variation in these cereals, researchers and plant breeders will have the necessary tools to realize the required increased global production. Advances in genomics have accelerated breeding and the improvement of yield and quality in crops including rice and maize, but similar efforts in wheat and barley have been more challenging. This is largely due to the size and complexity of their genomes, our limited knowledge of the key genes controlling yield, and the lack of genome assembly data for multiple lines of interest to breeders. Modern wheat and barley cultivars carry a wide range of gene variants and diverse genomic structures that are associated with important traits, such as increased yield, drought tolerance and disease resistance.

This variation cannot be captured with a single genome sequence. Only by sequencing multiple and diverse genomes can we begin to understand the full extent of genetic variation, the pan genome." The two international projects have sequenced multiple wheat and barley varieties from around the world. The Adelaide component was supported by the Grains Research and Development Corporation (GRDC). The information generated through these collaborative projects has revealed the dynamics of the genome structure and previously hidden genetic variation of these important crops, and shown how breeders have achieved major improvements in productivity. The inclusion of two Australian varieties of wheat, AGT-Mace (PBR) and Longreach-Lancer (PBR) reflecting both the southern and northern growing areas, means that potential genetic variation for adaptation to our different production environments can be identified. The University of Adelaide also sequenced three barley varieties with desirable traits such as high-yield and potential for tolerance to heat, frost, salinity and drought, and novel disease resistance. These genome assemblies will drive functional gene discovery and equip researchers and breeders with the tools required to bring the next generation of modern wheat and barley cultivars that will help meet future food demands. (Ref. 6) **Back to Newsletter's Page 1**

New genetic tools will deliver improved farmed fish, oysters, and shrimp.

Genetic engineering has been slow to take hold in aquaculture; only one genetically modified species, a transgenic salmon, has been commercialized. But companies and research institutions are bolstering traditional breeding with genomic insights and tools such as gene chips, which speed the identification of fish and shellfish carrying desired traits. Top targets include increasing growth rates and resistance to disease and parasites. Breeders are also improving the hardiness of some species, which could help farmers adapt to a shifting climate. And many hope to enhance traits that please consumers, by breeding fish for higher quality

fillets, eye-catching colors, or increased levels of nutrients. Aquaculture breeders can tap a rich trove of genetic material; most fish and shellfish have seen little systematic genetic improvement for farming, compared with the selective breeding that chickens, cattle, and other domesticated animals have undergone. Amid the enthusiasm about aquaculture's future, however, there are concerns. It's not clear, for example, whether consumers will accept fish and shellfish that have been altered using technologies that rewrite genes or move them between species. And some observers worry genomic breeding efforts are neglecting species important to feeding people in the developing world. Still, expectations are high. Breeders are most excited about a technique called genomic selection. To grasp why, it helps to understand how breeders normally improve aquaculture species. They start by crossing two parents and then, out of hundreds or thousands of their offspring, select individuals to test for traits they want to improve. Advanced programs make hundreds of crosses in each generation and choose from the best performing families for breeding. But some tests mean the animal can't later be used for breeding; measuring fillet quality is lethal, for instance, and screening for disease resistance means the infected individual must remain quarantined. As a result, when researchers identify a promising animal, they must pick a sibling to use for breeding—and hope that it performs just as well.

With genomic selection, researchers can identify siblings with high-performance traits based on genetic markers. All they need is a small tissue sample—such a clipping from a fin—that can be pureed and analyzed. DNA arrays, which detect base-pair changes called single nucleotide polymorphisms (SNPs), allow breeders to thoroughly evaluate many siblings for multiple traits. If the pattern of SNPs suggests that an individual carries optimal alleles, it can be selected for further breeding even if it hasn't been tested. Genomic analyses also allow breeders to minimize inbreeding. Cattle breeders pioneered genomic selection. Salmon breeders adopted it a few years ago, followed by those working with shrimp and tilapia. (Ref. 7)

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Research creates hydrogen-producing living droplets, paving way for alternative future energy source

Scientists have built tiny droplet-based microbial factories that produce hydrogen, instead of oxygen, when exposed to daylight in air. The findings of the international research team based at the University of Bristol and Harbin Institute of Technology in China, are published in Nature Communications. Normally, algal cells fix carbon dioxide and produce oxygen by photosynthesis. The study used sugary droplets packed with living algal cells to generate hydrogen, rather than oxygen, by photosynthesis. Hydrogen is potentially a climate-neutral fuel, offering many possible uses as a future energy source. A major drawback is that making hydrogen involves using a lot of energy, so green alternatives are being sought and this discovery could provide an important step forward. The team, trapped ten thousand or so algal cells in each droplet, which were then crammed together by osmotic compression. By burying the cells deep inside the droplets, oxygen levels fell to a level that switched on special enzymes called hydrogenases that hijacked the normal photosynthetic pathway to produce hydrogen. In this way, around a quarter of a million microbial factories, typically only one-tenth of a millimetre in size could be prepared in one millilitre of water.

To increase the level of hydrogen evolution, the team coated the living micro-reactors with a thin shell of bacteria, which were able to scavenge for oxygen and therefore increase the

number of algal cells geared up for hydrogenase activity. Although still at an early stage, the work provides a step towards photobiological green energy development under natural aerobic conditions. "Using simple droplets as vectors for controlling algal cell organization and photosynthesis in synthetic micro-spaces offer a potentially environmentally benign approach to hydrogen production that is expected to develop in future work." "This methodology is facile and should be capable of scale-up without impairing the viability of the living cells. It also seems flexible; for example, the study team recently captured large numbers of yeast cells in the droplets and used the microbial reactors for ethanol production." (Ref. 8)

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E-Waste in Developing Countries: Treasure to Trash?

E-waste refers to electronics such as computers, phones, radios, refrigerators, and other devices or appliances that have been discarded. Either these products reached the end of their functional life-cycle prior to disposal or they were simply discarded for newer models. Fortunately, some programs exist for donating, refurbishing, or recycling used items to safely dispose of or reuse materials. However, companies do not always comply with measures for proper disposal, even if the technology is available to do so. Often, the EU, U.S., or other "developed" countries will export e-waste into developing countries like China, Taiwan, Mexico, Pakistan, etc. A 2015 report by the European Union Action to Fight Environmental Crime estimated that the EU produces eight to nine million tonnes of e-waste annually. In 2006 alone, the EU exported 1.9 million tonnes to other countries, and of that, 1.1 million tonnes were exported illegally. Electronics imported to developing countries can litter towns and villages and introduce serious health and environmental risks. For example, Guiyu, China receives a significant amount of e-waste and also contains some of the highest amounts of cancer-causing dioxins. Certain types of e-waste are made up of hazardous materials. Toxins such as lead, mercury, cadmium and arsenic may leach into the land or atmosphere by way of dangerous processing techniques such as burning, crushing or acid baths.

The United States and other developed nations have made it illegal to dispose of electronics in landfills due to the risk of toxic chemicals and the disruption to human health and ecosystems. However, many developing countries do not have these laws or the ability to refuse many of these imports. To improve these conditions, the International E-Waste Management Network, run by the U.S. Environmental Protection Agency (EPA) and the Taiwan EPA, held a workshop for 11 countries in 2018. Their goal was to assess possible markets for e-waste material, protect people and the environment and better interact with the industry and new technology. While industries must make improvements to attain a more circular economy, there are also several actions that individuals can take to avoid contributing to dangerous disposal methods. One thing that individuals can do is buy previously owned electronics or appliances. Individuals can also help by holding onto their electronics longer, rather than disposing of products that still work. To ensure proper disposal of items, it is a good idea to research disposal sites, as well as municipal centers and nonprofits that offer recycling services, ahead of time. (Ref. 9)

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5. ESD NEWSLETTER READER COMMENTS

None received this month.

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ABOUT NEWSLETTER

ENVIRONMENTAL ENGINEERING features the application of environmental technologies to engineering systems to attain optimal performance according to established standards. The Newsletter of the Environmental Systems Division (ESD) will attempt to highlight a variety of environmental technology applications aimed at enhancing engineering systems performances in accordance with the latest standards by presenting excerpts of and links to selected articles from a variety of websites.

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