ENVIRONMENTAL SYSTEMS DIVISION NEWSLETTER

01 AUGUST 2021

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

ASME Upcoming Conferences

ICONE28, August 4 – 6, 2022
This conference is a global event for professionals who want to stay current on new technology and industry trends and developments in nuclear technology. ASME's Nuclear Engineering division, the Japanese Society of Mechanical Engineers (JSME), and the Chinese Nuclear Society (CNS) will host the virtual conference.

FEDSM Fluids Engineering Division Summer Meeting, August 10 – 12, 2022
The 2021 Fluids Engineering Division's (FED) Summer Meeting where FED continues to strive to meet the challenges of disseminating timely technical information by organizing technical conferences and conducting workshops and panel discussions. Every year FED organizes the Fluids Engineering Division Summer Meeting (FEDSM).

IDETC-CIE 2021, International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, August 17 – 19, 2021
This year's Fully Virtual event, IDETC/CIE 2021, will highlight emergent technologies that impact the critical engineering issues of product design and development, manufacturing, and the management and integration of information systems throughout the product life-cycle. These events are key international meetings for design and manufacturing engineers in academia, government and industry.

SMASIS, The ASME 2021 Conference on Smart Materials, Adaptive Structures and Intelligent Systems, September 14 – 15, 2021
Adaptive Structures and Materials Systems by definition are intelligent, flexible systems that sense and respond to ever changing environments. The field has rapidly matured due to synergistic interdisciplinary efforts across sectors of universities, government, and industry. To continue the high impact growth of this field and lead it into the future, the purpose of this conference is to assemble world experts across engineering and scientific disciplines (mechanical, aerospace, electrical, materials, and civil engineering, biology, physics chemistry, etc.) to actively discuss the latest breakthroughs in smart materials, the cutting edge in adaptive structure applications and the recent advances in both new device technologies and basic engineering research exploration.

ACES, Advanced Clean Energy Summit, "Achieving the Clean Energy Promise", September 21 – 22, 2021
Be part of a dynamic, new global forum for energy industry professionals and innovators in clean energy technology and management. We will bring together perspectives and expertise from around the globe as we learn and network in a collaborative, open environment. Gain exclusive access to companies looking for better ways to address the challenges and opportunities for clean energy.

AMRGT, Advanced Manufacturing & Repair for Gas Turbines, October 5 – 8, 2021
Hosted by ASME's Gas Turbine Segment and IGTI Division, this 4-day symposium, October 5 - 8, will bring together engineers, designers, researchers, repair professionals and business leaders at companies that design, manufacture, repair and own gas turbines.

ICEF, The Internal Combustion Engine Fall Conference, October 13 – 15, 2021
The ASME Internal Combustion Engines Fall Conference (ICEF) is a premier conference on internal combustion engines and their applications. It features a robust technical paper program, two days of keynote speakers, work-in-progress poster session, undergraduate student competition, industry tour, and focused workshops. Attended by industry experts, academicians, students and professionals, ICEF aims to explore the cutting edge of this important, and dynamic field. The conference explores fundamental advancements and technologies related to IC engines of various sizes ranging from automotive light- and heavy-duty engines to large bore engines for locomotive, propulsion and power generation applications. The conference provides an excellent networking opportunity for students and young professionals with leading industry experts.

FPMC, ASME/BATH Symposium on Fluid Power and Motion Control, October 19 – 21, 2021
The Fluid Power Systems & Technology Division (FPST) of the American Society of Mechanical Engineers (ASME) and University of Bath Centre for Power Transmission and Motion Control (PTMC) invite you to this international symposium on fluid power and motion control. The Bath/ASME Symposium on Fluid Power and Motion Control (FPMC) has been an annual event since 1988, and in the past decade, it has been being held in alternate years at Bath, UK and in the USA.

InterPACK®, International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems, October 26 – 28, 2021
InterPACK is the premier international conference for exchange of state-of-the-art knowledge in research, development, manufacturing, and applications of electronics packaging and heterogeneous integration. It is the flagship conference of the ASME Electronic and Photonic Packaging Division (EPPD). InterPACK is a systems-focused conference covering topics on Heterogeneous Integration, Servers of the Future, Edge and Cloud Computing, Internet of Things, Additive Printed Electronics, Flexible and Wearable Electronics, Photonics and Optics, Power Electronics, Energy Conversion and Storage, and Autonomous, Hybrid and Electric Vehicles. The international nature of the meeting has been highly beneficial in promoting global interactions between industry, academia, research institutions, funding agencies, start-ups and entrepreneurs. In addition to paper presentations and exhibits, InterPACK 2021 will include panel discussions, workshops, tutorials, keynote and technology talks by prominent speakers, and a joint industry, national laboratory, and academia poster session.

IMECE®, International Mechanical Engineering Congress & Exposition®, November 1 – 5, 2021
The International Mechanical Engineering Congress and Exposition (IMECE) is ASME's largest research and development conference focused primarily on mechanical engineering, but

encompasses perspectives from many engineering disciplines. IMECE is THE place for you to present your technical research and expertise, while also learning from and connecting with thousands of your peer researchers on a global level.

Gas Turbine India Conference, December 2 – 3, 2021
The 2-day virtual event attracts the industry's leading professionals and key decision makers, whose innovation and expertise are shaping the future of turbomachinery. Authors and presenters are invited to participate in this event to exchange ideas on research, development and best practices on Gas Turbines and allied areas. The conference is an excellent opportunity to initiate and expand international co-operation. **Back to Newsletter's Page 1**

Volunteers – ESD Honors & Awards Committee

The Environmental Systems Division (ESD) is looking for volunteers to serve on the ESD Honors and Awards Committee.
The ESD Honors and Awards (H&A) Committee is responsible for seeking and coordinating recommendations from ESD members concerning persons and papers for honors and awards. The Honors and Awards Committee shall initiate, review and submit recommendations to the ESD Executive Committee for Dixy Lee Ray Award (Society level), the Regulatory Engineering Award (when finalized) and other ASME and/or ESD honors and awards.
The Dixy Lee Ray Award (DLR Award), established in 1998, recognizes significant achievements and contributions in the broad field of environmental protection. As a general rule, in alternate years achievement in the following areas will be recognized: environmental engineering, including environmental technology and related topics; other environmental areas, including environmental health, environmental sciences, environmental management and policy, and related topics. The award was established in honor of Dixy Lee Ray's advocacy to the development of those technologies that serve humanity. She believed that the engineering profession was uniquely qualified to develop and implement environmentally acceptable technologies. The DLR Award includes: $1000 prize, a Bronze Medal, a Certificate and Travel supplement to attend the award presentation.
Membership on the ESD Honors and Awards Committee shall be from members of the Division and shall be appointed by the ESD Chair with approval of the Executive Committee. The Committee shall have a maximum of seven (7) members. The Executive Committee shall appoint a Chair from its membership.
Award Committee membership is for a 5-year term. The Committee meets by teleconference only. For more information and those interested should contact Ryan Neil (ryanneil84@hotmail.com). **Back to Newsletter's Page 1**

International Conference on Radioactive Waste Management and Environmental Remediation (ICEM) 2023

ASME, the Nuclear Engineering and the Environmental Systems Divisions, are pleased to announce the return of the International Conference on Radioactive Waste Management and Environmental Remediation (ICEM). The Conference is set for Oct 3 - 6, 2023 in Stuttgart, Germany that had been postponed due to COVID. As with past ICEM's the Conference will feature Plenary and Luncheon speakers, breakout sessions and an exhibit hall suitable for large equipment displays for radioactive D/D&D tasks. The breakout sessions will feature panel discussions, invited speakers, articles and presentations as well as peer reviewed papers.

If you are interested in chairing Track 5 (L/ILW Radioactive Waste Management), becoming a Session Chair or helping to develop the conference please do not hesitate to contact Arnie Feldman (jjdsenv@att.net) or Bob Stakenborghs (Bob@advclean-Energy.com).

Look for additional news and announcements on ICEM 2023 on our new website, LinkedIn, Facebook or the ESD Newsletter. For further information contact Arnie or Bob at the above email addresses.

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ASME Student/Early Career Competition - General Topic

ESD in conjunction with eFest held its first Student/Early Career Competition in the Spring of 2021. The Competition had participants from all over the world. The main topic was Waste to Energy. The judges found the entries to be thoughtful and in some cases very enlightening. The winners for 2021 in the College level was:

ESD Oral Competition	Team
1st Place	Team 11 - Md. Fahim Hossain & Md. Mahadi Hassan, Chittagong University of Engineering & Technology
2nd Place	Team 7 - Kamlesh Sahu & Ankan Man, IIEST Shibpur
3rd Place	Team 6 - Anand D Revgade & Shreyas N Dhisale, Walchand College of Engineering

The Environmental System Division (ESD) in conjunction with 2022 ASME eFest will be holding its 2nd Annual Student/Early Career Competition. The Competition will take place in early 2022 and similar to 2021, it will be divided into three levels:

- College Student level
- Post Graduate Student level
- Early Career Engineers

For more information or to submit a topic please contact Arnold Feldman at jjdsenv@att.net .

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ASME/A&WMA WASTE INFORMATION EXCHANGE

ASME (ESD, the Research Committee on Energy, Environment and Waste (RCEEW) and the Materials Energy Recovery Division (MER)), in conjunction with the Air and Waste Management Association (A&WMA) are planning a Waste information Exchange (WIE) in 2022-23 in the DC Metropolitan Area. The WIE is being modeled after the [Air] Information Exchange, which has been held annually since 1975 in Research Triangle Park (RTP), NC, in which USEPA (QAQPS and ORD) are key participants. The WIE will not require a written paper and any graphics used will be made available to attendees at the discretion of the speaker. The purpose of the Information Exchange is to make participation as a speaker as easy and simple as possible. The idea is to invite experts to come talk about research or regulations on which they are working without having to spend a lot of time in preparation. The WIE will cover policy updates, regulatory changes, and research on the latest waste topics.

ESD, RCEEW and MER are looking for individuals who want to participate in the planning including Track Chairs, Session Chairs, and Panel Chairs. In addition, ESD is looking for a Technical Chair to represent them on the planning Committee. If you are interested in volunteering or want further information, please contact Arnold Feldman at jjdsenv@att.net . Look for more information on the WIE in future ESD Newsletter's and on the web in Linked-In and Facebook. **Back to Newsletter's Page 1**

TEC UPDATE

A TEC Meeting was held July 23, 2021. The 5 candidates for TEC Vice Chair gave brief presentations. The Candidates are:

- Steve Unikewicz
- Columbia Mishra
- Vicki Risinger
- Thomas Lavertu
- Bob Stakenborghs

Voting will take place July 26, 2021 thru August 6, 2021. Two candidates are to be chosen. The position of TEC Sr VP has yet to be confirmed by the Board of Governors.

Publications – The call for Authors, Editors and reviewers for the Journal of Engineering was complete July 31, 2021.

Awards – A reminder was given for Divisions to submit Dedicated Service Awards.

Financial – There will be a call for Grant Proposals for TEC Development funds in August. Details will be provided as they become available.

There will be a Tech Talk on August 26 sponsored by SERAD – see the meeting announcement for details.

A special thank you was given to Rick Cowan for his service as Acting VP of TEC for the past year.

The Next meeting will be August 27, 2021 at 10 – 11.30 CDT. **Back to Newsletter's Page 1**

WELCOME NEW ESD TEC OPERATIONS MANAGER - LAURA HERRERA

On behalf of ESD, its members and the Executive Committee, I would like to welcome Laura Herrara as our new ESD TEC Operations Manager. Laura has been with ASME for over seven years serving mostly on events. I. the Executive Committee and all our members look forward to working with Laura in the coming years.
Ryan Neil, Chair, ESD

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2. ENVIRONMENTAL TECHNOLOGIES

How climate change is driving adoption of technology in agriculture?

Environmental phenomena such as climate change and its manifestations, including extreme weather events, are featuring more prominently on the risk radar of investors, banks and commercial farmers, as agricultural activity intensifies in order to provide sufficient food for a growing population. To illustrate how seriously the issue is regarded, the World Economic Forum ranks environmental risks among the top five global risks in its '2020 Global Risk Report'. The report discusses the prominence of extreme weather, failure to adapt to climate change, environmental damage caused by humans, major biodiversity loss, ecosystem collapse and major natural disasters. Financial institution Nedbank believes that, while agriculture is a key contributor to environmental impacts, it finds itself on the receiving end of these devastating effects. The bank states that, for example, climate change is making farming far less predictable and more challenging than ever before. Agricultural intensification has a negative effect on soil, water and biodiversity, resulting in declining crop yields and quality and, ultimately, increased adverse effects of climate change.
Nedbank recommends that the agriculture industry focus on sustainable production, using farming practices that consider ecological cycles and are sensitive to microorganisms and the environment. Climate change is also undeniably changing the environmental, social and economic conditions affecting agriculture. According to World Bank's estimates, carbon dioxide equivalent emissions are now 60% higher than they were in 1990 and are growing at about 2.5% a year. Without intervention, the surge will continue – driven primarily by increasing populations and economic growth. If the world continues on this trajectory, the Intergovernmental Panel on Climate Change warns, global mean surface temperatures will likely increase by 4.8 ºC in 2100, compared with preindustrial levels. The World Wide Fund for Nature (WWF) says climate change poses a significant threat to South Africa's water resources, food security, health, infrastructure, ecosystem services and biodiversity. It points out in a policy assessment published in 2016 that, over the past two decades, agriculture in South Africa has undergone drastic economic and social evolutions.
Agriculture in South Africa faces a variety of risks associated with climate change, such as changes in rainfall patterns, increased evaporation rates, higher temperatures, more pests and diseases, changes in diseases and pest distribution ranges, reduced yields and a spatial shift in optimum growing regions. The emergence of such risks calls for urgent, ambitious action to ensure the resilience of the local agriculture sector by adapting to climate change impacts.

Policy initiatives that aim to harness the benefits of technology in agriculture include the Information and Communications Technology Research, Development and Innovation Roadmap, which promotes the role of information and communication technology in the sector to improve agricultural production and support emerging farmers, while the 2017 National e-Strategy outlines a nine-point sectoral intervention plan. The plan includes the revitalisation of the agriculture sector through the deployment of so-called smart farming initiatives throughout the agriculture value chain, with an emphasis on emerging smallholder farmers. (Ref. 1) **Back to Newsletter's Page 1**

Yeast discovery set to boost 2G biofuel production from crop residues

IN A a major technological breakthrough, Australian biotech company, MicroBioGen, has successfully produced ethanol and high-value feedstock from non-food plant waste, such as crop residues and sugarcane pulp. The breakthrough follows 15 years of research and development in MicroBioGen's high-tech laboratories in Sydney to enhance a genetically-modified version of the common yeast, Saccharomyces cerevisiae. The unique yeast strain converts both hard-to-catalyse sugars derived from non-food substrates into what is known as 2G biofuel, and waste by-product into a high-value food source. For the first time ever, a single yeast strain – optimised using our proprietary technology – can produce both clean fuel and food from non-food biomass. The new technology overcame the key barriers that had been holding back the development of 2G biofuels. First-generation (1G) ethanol production typically relied on processing corn or sugarcane, converting some of the food portion of these crops into fuel. This limited both the production volumes and the amount of CO_2 that could be removed from the atmosphere. Currently, the liquid waste stream provided little or no economic nor environmental benefits.

2G ethanol was produced from agricultural waste products such as timber offcuts, crop residues or waste sugarcane pulp (bagasse). As this material was difficult and relatively costly to break down into component sugars, progress in commercialising 2G technology using conventional yeasts had been slow. Converting waste streams into higher-value products economically had also remained challenging. The unique properties of our yeast allow it to convert the biomass sugars to biofuels more efficiently, where other yeasts struggle. Crucially, our optimised yeast can then grow on its own waste stream, converting this waste to a high-value protein suitable as an animal feed.

MicroBioGen's $8 million project commenced in 2017 with the intention of optimising yeast genetics to reduce the cost of 2G biofuel production and boost its performance on key sustainability metrics. A peer-reviewed analysis of the research findings found that 2G biofuel manufacture using MicroBioGen's yeast strain and process, compared with benchmark commercial 2G yeast strains, reduced CO_2 emissions by 29 per cent, fossil energy use by 11pc and water use by 75pc. It also established that the food created from sugarcane bagasse in MicroBioGen's production process would be the equivalent of 2.4 times the food of crops grown elsewhere. The results exclude the additional potential benefits from sequestering CO_2.

The project was funded in part with a $4 million grant from the Federal Government's Australian Renewable Energy Agency (ARENA).(Ref. 2) **Back to Newsletter's Page 1**

3. ENVIRONMENTAL REGULATIONS

ISO Publishes Standard Evaluating Methods for Assessing the Release of Nanomaterials from Commercial, Nanomaterial-Containing Polymer Composites

The International Organization for Standardization (ISO) has published ISO/TR 22293:2021, "Evaluation of methods for assessing the release of nanomaterials from commercial, nanomaterial-containing polymer composites." ISO states that an understanding of what is released from products containing manufactured nanomaterials "is critical to planning and managing safe development and use of those products." The document aims to provide a guide to the information to be taken into account in determining the methods for identifying and evaluating releases of manufactured nanomaterials from matrices; providing a framework for understanding how these methods and the information they produce can support decision-making; and identifying opportunities for developing standards in this area. According to ISO, the document provides practical support for decisions related to product development and use through early consideration of the potential for release of manufactured nanomaterials and through focus on realistic use scenarios where exposures to the released manufactured nanomaterials might occur. The intended users of the document include:

- Those planning to develop or adapt technical specifications for manufactured nanomaterials used in commercial products;
- Risk managers, product developers, exposure measurement practitioners, and other stakeholders seeking guidance on the availability and utility of methods to measure releases that could occur from uses of specific manufactured nanomaterials in composites;
- Methods and instrumentation developers seeking to identify needs of the risk management community; and
- Those planning basic and applied research programs for measurement and modeling to support decisions about sustainably safe uses of manufactured nanomaterials. (Ref. 3) **Back to Newsletter's Page 1**

EU Proposed Carbon Border Adjustment Mechanism

On July 14, 2021, the European Commission adopted a package of proposals including a proposal for a Carbon Border Adjustment Mechanism (CBAM). The CBAM proposal is a key element of the European Green Deal (Green Deal), which sets an ambitious goal for the European Union (EU) to reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, and to make Europe a climate-neutral continent by 2050. Businesses in Russia,

Turkey, China, and the United Kingdom are expected to be impacted the most by the new legislation, since they are the largest suppliers of products covered by the CBAM to the EU. The ambitions from the Green Deal result in high CO2 costs due to higher tax rates for companies producing in the EU. Because these costs are not incurred or are only incurred to a lesser extent by companies in other regions, the disparity can lead to so-called carbon leakage where companies in the EU shift their activities to regions that impose lower or no costs on a company's carbon emissions. In that case, the "waterbed effect" would prevent the global emissions from decreasing.

To prevent this, the new CBAM will put a carbon price on imports of a targeted selection of products. This reduces the economic incentive to shift production to countries that impose a lower cost on carbon emissions and creates greater certainty that European carbon regulation will contribute to an actual decline in global carbon emissions. The CBAM also aims to encourage industry outside the EU to take steps in the same direction. Under the CBAM, companies importing into the EU (EU importers) will buy carbon certificates corresponding to the carbon price that would have been paid on certain goods had the goods been produced under the EU's carbon pricing rules. Conversely, once a non-EU producer can show that it has already paid a price for the carbon used in the production of the imported goods in a third country, the corresponding cost can be fully deducted for the EU importer. The CBAM will be phased in gradually and will initially only apply to a selected number of goods with a high risk of carbon leakage, such as iron, steel, cement, fertilizer, aluminum and electricity generation. As from 1 January 2023, EU importers will have to report emissions embedded for those types of products.

The price of the certificates will be calculated depending on the weekly average auction price of EU ETS allowances expressed in EUR / ton of CO2 emitted. EU importers of the goods will have to, either individually or through a representative, register with national authorities where they can also buy CBAM certificates. National authorities will authorize registration of declarants in the CBAM system, as well as reviewing and verifying declarations. The compliance under the CBAM is technical and therefore expected to have substantive administrative impact. In principle, imports of goods from all non-EU countries will be covered by the CBAM. As stated above, initially it will apply only to a selected number of goods at high risk of carbon leakage. Certain third countries who participate in the ETS or have an emissions trading system linked to the EU's already incur carbon costs similar to domestic companies and, as a result, will be excluded from the mechanism. This is the case for members of the European Economic Area and Switzerland.

The CBAM should initially apply to direct emissions (i.e., emissions taking place as part of the production process of goods of which the producer has direct control) from the production of goods up to the time of import into the customs territory of the EU, and after the end of a transition period and upon further assessment, as well to indirect emissions (i.e., emissions from the production of electricity, heating, and cooling, which is consumed during the production processes of goods), mirroring the scope of the EU ETS. Finally, goods can only be imported into the customs territory of the EU by a declarant that is authorized by the competent authority.

As stated above, this concerns a proposal. The CBAM is therefore still subject to discussion and review within the EU, and the final version may differ slightly. Companies importing any of the goods in scope of the CBAM should understand the potential impact of the costs of the CBAM on their business process. It is furthermore essential to make sure the correct formalities are considered to ensure compliance with the CBAM and subsequently avoid potential penalties. If the proposal is adopted without change, EU importers will have to report emissions embedded in iron, steel, cement, fertilizer, aluminum, and electricity generation as from 1 January 2023. In addition, EU importers will start paying a financial adjustment from 1 January 2026. (Ref. 4) **Back to Newsletter's Page 1**

4. EDITORIAL BOARD SELECTIONS

Racing Toward Zero: The Untold Story of Driving Green R-501

In Racing Toward Zero, the authors explore the issues inherent in developing sustainable transportation. They review the types of propulsion systems and vehicle options, discuss low-carbon fuels and alternative energy sources, and examine the role of regulation in curbing emissions.

All technologies have an impact on the environment, from internal combustion engine vehicles to battery electric vehicles, fuel cell electric vehicles, and hybrids—there is no silver bullet. The battery electric vehicle may seem the obvious path to a sustainable, carbon-free transportation future, but it's not the only, nor necessarily the best, path forward. The vast majority of vehicles today use the internal combustion engine (ICE), and this is unlikely to change anytime soon. Improving the ICE and its fuels—entering a new ICE age—must be a main route on the road to zero emissions.

How do we go green? The future requires a balanced approach to transportation. It's not a matter of choosing between combustion or electrification; it's combustion and electrification. As the authors say, "The future is eclectic." By harnessing the best qualities of both technologies, we will be in the best position to address our transportation future as quickly as possible. (Ref. 5) **Back to Newsletter's Page 1**

Our New Name is also a New Vision

The Office of Fossil Energy officially added "Carbon Management" to its name as of July 4, 2021. This change signifies that our vision has changed: The Biden-Harris Administration recognizes that to meet our climate goals, we have to manage the carbon that comes with the legacy and continued use of fossil fuels. Rising to the challenge of the climate crisis – and seizing the opportunity to do things better – is one of the Administration's primary goals. Our job is– above all – to limit the climate and environmental impacts of fossil fuels. Adding "carbon management" encompasses this vision fully into our name, so that everyone across the Department of Energy (DOE), the Federal government, and the country has a better

understanding of what we do.

The Department of Energy has a major leadership role in the Biden Administration's all-of-government approach to addressing the climate emergency. Our agency uses its unparalleled scientific strength, based in our 17 National Laboratories, to engage the best available research to combat the climate crisis. Our agency takes designs for a new, clean energy economy off the drawing board and makes them into real world solutions. The Office of Fossil Energy and Carbon Management (FECM) is an integral part of these solutions. FECM is using our extensive research capabilities to minimize the climate and environmental impacts of fossil energy and to advance carbon management – in many ways. Among them, point source carbon capture, carbon dioxide (CO_2) removal, CO_2 conversion into products, reliable CO_2 storage; blue hydrogen production; and critical mineral production from industrial and mining waste.

Point source carbon capture and reliable storage (CCS), as well as CO_2 removal to address our hardest to decarbonize sectors, are essential to meeting our climate goals. Many international bodies, from the Intergovernmental Panel on Climate Change[6a] to the International Energy Agency,[6b] recognize that these are essential technologies for a low-carbon economy at the lowest possible cost. DOE is a global leader in the research and development of CCS, carbon removal, reliable storage, and the conversion of CO_2 into products. FECM, along with its industry and commercial partners, has long been at the forefront of researching and developing these critical technologies. FECM is the key to developing and deploying low-carbon supply chains like cement and concrete, steel, paper, fuel, nylon polyester, and other important products.

Going forward, we know that sourcing low-carbon hydrogen will be critical to produce fuels and chemicals with CO_2 as a feedstock. There's potential for applying carbon capture to help advance a low-cost and low-carbon hydrogen economy. Our office is also responsible for ensuring there are NOx controls to limit any air pollution when it comes to using hydrogen for power. Our research on critical minerals and rare earth elements offers potential support to our renewable energy supply chain and our national security. Coal and its waste byproducts can help supply critical minerals that are essential to making solar panels, wind turbines, and electric vehicles, all of which are essential to our clean energy transition. FECM is dedicated to pursuing these important technologies to make sure we can reach our net-zero goals in a just and sustainable way. It is not just about the research and development (R&D) we support, but how and where we implement that R&D. We're committed to improving the conditions of communities impacted by the legacy and continued use of fossil fuels, and we envision a clean energy transition that produces good-paying jobs. (Ref. 6) **Back to Newsletter's Page 1**

A plant pandemic could be next. Here's how we can prepare

For decades before COVID-19, scientists warned that a pandemic was inevitable and urged preparation, but governments around the world did very little. When it arrived, COVID-19 laid bare the fragility of many of our systems—including global food supply chains. It also showed how scientists can mobilize quickly to solve a huge vulnerability. Across farms worldwide, there are now warning signs of a pandemic in food crops. More than 600 pest species have

developed some form of resistance to pesticides, which causes $10 billion in losses in the United States alone each year. Climate volatility intensifies these threats, and many crops are already suffering—citrus blight and banana fungus wreak havoc for growers and supply chains. With global food supplies vulnerable and food prices at their highest in almost a decade, a plant pandemic could push more people into poverty and cause social unrest. The agricultural industry must harness the urgency with which scientists responded to COVID-19 to get ahead of a full-blown crop pandemic. Just as the scientific community tackled COVID-19 with a toolkit of treatments, vaccines, and preventative measures, the ag industry can develop a set of safe, effective resources with which growers can rapidly respond to emerging threats. This is already happening: just as the Food & Drug Administration granted emergency use authorization (EUA) of COVID-19 vaccines, the Environmental Protection Agency has granted EUA to treat plant diseases like allowing chemical fungicides for use against coffee rust in Hawaii. Stopgap measures like these prevent existing problems from getting worse, but they can also force growers to use older, more toxic ingredients because there are no other options available.

During the pandemic, unclear communication from health authorities and misinformation led to widespread distrust of COVID-19 vaccines. As a result, the U.S. is still struggling to contain the virus even though vaccines are available to almost everyone. The agricultural industry has faced similar challenges. Its lack of transparency with consumers about concepts like organic farming and GMOs have led to misunderstanding and distrust with serious consequences. Some organic farms are causing more environmental harm than good, and the backlash against GMOs has undermined progress toward more resilient crops. Rebuilding consumers' confidence in its innovations requires the ag industry to trust that the public can handle the facts. That means sharing more information on the safety and environmental impacts of its practices than regulators require. For instance, ag companies can explore using blockchain to track and transparently share supply chain information. Currently, President Biden is pushing for food labels with clearer supply chain information about the origins of not only where meat is processed, but where it was raised. Companies should also translate complex science into ideas that a layperson will understand and care about. Impossible Foods has done this effectively, capturing consumers' interest on how a plant-based burger can taste like meat. Tools like gene editing and selective chemistry can help stave off a plant pandemic, but they will only work if consumers understand them and the agricultural industry is transparent about their safety and effectiveness. (Ref. 7)

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Nanoparticles Simplify Desalination: Simultaneously Removing Toxic Metals and Salt to Produce Clean Water

University of California, Berkeley, chemists have discovered a way to simplify the removal of toxic metals. like mercury and boron. during desalination to produce clean water, while at the same time potentially capturing valuable metals, such as gold. Desalination — the removal of salt — is only one step in the process of producing drinkable water, or water for agriculture or industry, from ocean or waste water. Either before or after the removal of salt, the water often has to be treated to remove boron, which is toxic to plants, and heavy metals like arsenic and mercury, which are toxic to humans. Often, the process leaves behind a toxic brine that

can be difficult to dispose of. The new technique, which can easily be added to current membrane-based electrodialysis desalination processes, removes nearly 100% of these toxic metals, producing a pure brine along with pure water and isolating the valuable metals for later use or disposal. Desalination or water treatment plants typically require a long series of high-cost, pre- and post-treatment systems that all the water has to go through, one by one. The UC Berkeley chemists synthesized flexible polymer membranes, like those currently used in membrane separation processes, but embedded nanoparticles that can be tuned to absorb specific metal ions — gold or uranium ions, for example. The membrane can incorporate a single type of tuned nanoparticle, if the metal is to be recovered, or several different types, each tuned to absorb a different metal or ionic compound, if multiple contaminants need to be removed in one step.

The polymer membrane laced with nanoparticles is very stable in water and at high heat, which is not true of many other types of absorbers, including most metal-organic frameworks (MOFs), when embedded in membranes. The researchers hope to be able to tune the nanoparticles to remove other types of toxic chemicals, including a common groundwater contaminant: PFAS, or polyfluoroalkyl substances, which are found in plastics. The new process, which they call ion-capture electrodialysis, also could potentially remove radioactive isotopes from nuclear power plant effluent. In their study, published recently in the journal Science, they demonstrate that the polymer membranes are highly effective when incorporated into membrane-based electrodialysis systems — where an electric voltage drives ions through the membrane to remove salt and metals — and diffusion dialysis, which is used primarily in chemical processing. Water shortages are becoming commonplace around the world, including in California and the American West, exacerbated by climate change and population growth. Coastal communities are increasingly installing plants to desalinate ocean water, but inland communities, too, are looking for ways to turn contaminated sources — groundwater, agricultural runoff and industrial waste — into clean, safe water for crops, homes and factories.

While reverse osmosis and electrodialysis work well for removing salt from high-salinity water sources, such as seawater, the concentrated brine left behind can have high levels of metals, including cadmium, chromium, mercury, lead, copper, zinc, gold and uranium. But the ocean is becoming increasingly polluted by industry and agricultural runoff, and inland sources even more so. This would be especially useful for those areas that have low levels of contaminants that are still toxic at these low levels, as well as different wastewater sites that have lots of types of toxic ions in their streams. Most desalination processes remove salt — which exists largely as sodium and chlorine ions in water — using a reverse osmosis membrane, which allows water through, but not ions, or an ion exchange polymer, which allows ions through, but not water. The new technology merely adds porous nanoparticles, each about 200 nanometers in diameter, that capture specific ions while allowing the sodium, chlorine and other non-targeted charged molecules to pass through.

The nanoparticles used in these polymer membranes are called porous aromatic frameworks, or PAFs, which are three-dimensional networks of carbon atoms linked by compounds made up of multiple ring-shaped molecules — chemical groups referred to as aromatic compounds. The internal structure is related to that of a diamond, but with the link between carbon atoms lengthened by the aromatic linker to create lots of internal space. Various molecules can be attached to the aromatic linkers to capture specific chemicals. To capture mercury, for

example, sulfur compounds called thiols, which are known to tightly bind mercury, are attached. Added methylated sulfur groups enable capture of copper, and groups containing oxygen and sulfur capture iron. The altered nanoparticles make up about 20% of the weight of the membrane, but, because they are very porous, account for about 45% of the volume. Calculations suggest that a kilogram of the polymer membrane could strip essentially all of the mercury from 35,000 liters of water containing 5 parts per million (ppm) of the metal, before requiring regeneration of the membrane. (Ref. 8) **Back to Newsletter's Page 1**

How 3D printing can save trees

Early in the 3D printing industry, there were efforts to take wood byproducts and use that material to make parts. These early efforts were interesting for the novelty. Today, however, there's a more serious effort to turn wood into a usable 3D printable material. Desktop Metal launched Forust, a process to sustainably produce functional end-use wood parts using its single pass binder jetting AM technology. The Forust process upcycles waste byproducts from wood manufacturing (cellulose dust) and the paper industry (lignin) and re-materializes functional wood parts through high-speed 3D printing including digital grain throughout the part. While primarily aimed at architects and designers of custom wood pieces for home decor, interiors, transportation, and architectural design, this development shows the flexibility of 3D printing/additive manufacturing technology and how it can be used to solve some environmental issues. The Forust technology allows us to take something that was previously wood waste and re-materialize it into exquisitely beautiful and useful things. They are honoring the cellulose and lignin of the trees by rearticulating them into assets for present and future generations. By allowing millions of trees to remain in place in their forests, Forust is launching a highly evolved technology for the circular technosphere that supports and celebrates stewardship of the natural, regenerative, and diverse biosphere, making it not only smart, but wise. The 3D printing of wood using waste natural materials is a gamechanger.

The Forust process combines two waste streams from traditional wood production, sawdust and lignin, to sustainably produce isotropic, high-strength wood parts. Depending on the size of the parts, Forust can manufacture wood products using either the Shop System or a custom version of the 3D printer, which supports prints up to two cubic meters in volume at speeds in excess of 100 liters of parts per hour. During the printing process, layers of specially treated sawdust are spread and selectively joined by a non-toxic and biodegradable binder. Digital grain is printed on every layer and parts can then be sanded, stained, polished, dyed, coated and refinished in the same manner as traditionally manufactured wood components. Applications for Forust's wood parts are really limitless. "There are many applications where polymers and plastics are used today where you can now cost-effectively replace with sustainably manufactured wood parts – luxurious, high-end components in interiors, consumer electronics, instruments, aviation, boats, home goods and eventually in flooring and exterior roofing applications. For the first time, we can produce beautiful parts with the same durability and characteristics you would have in traditionally manufactured wood, but printed using upcycled materials which does not require cutting down or harvesting trees. With Forust, we have the opportunity to have a meaningful impact on sustainability, climate change and waste issues that we as a humanity have brought to the planet. For each tree saved, we

are reducing the carbon footprint by a metric ton over its lifetime."(Ref. 9)
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How the anti-GMO movement devolved from dangerous to irksome to irrelevant

Introduced in the 1990s, crops genetically engineered (GE) to withstand exposure to the weed killer glyphosate (Roundup) were a game-changer for agriculture. They saved many farmers money on weed control, slashed greenhouse gas emissions caused by tilling and fossil fuel use, and indirectly boosted crop yields, all of which translated into lower food prices for consumers. But these incredible benefits came at a cost, namely herbicide-resistant weeds. The combination of GE seeds and glyphosate worked so well that some growers overused it, which accelerated the evolution of weed populations that could survive glyphosate exposure. Developing solutions to this growing problem is now a major focus for agricultural scientists, and a study recently published in Proceedings of the National Academy of Sciences of the United States of America (PNAS) may contribute to that effort [10a]. According to the paper, some glyphosate-tolerant weeds defeat the herbicide roughly the same way cancer cells dodge the lethal effects of drugs designed to kill them: by pumping the chemicals out of the region of the cell where they're most effective, using proteins called ABC transporters.

This is a helpful insight for farmers and weed scientists, but the finding also highlights two important reasons the anti-GMO movement is losing its cultural relevance that are worth considering. The researchers identified the over-expressed ABC transporter genes in an herbicide-resistant population of Echinochloa colona (barnyard grass), a weed species most common in tropical and subtropical regions. They then introduced those genes into rice and treated it with glyphosate to reveal the source of herbicide resistance. Finally, the researchers targeted one of the genes with CRISPR/Cas9-mediated knockout to increase the plant's susceptibility to glyphosate. The experiment, the researchers wrote, provides "evidence of a plant ABC transporter (ABCC8) that likely serves as a plasma membrane glyphosate exporter, lowering the cytoplasmic glyphosate level and thereby endowing glyphosate resistance." This mechanism bears a striking resemblance to the drug-fighting pump found on certain cancer cells.

In small cell lung carcinoma, for instance, cancer cells are equipped with a pump that allows them to eject drugs that would typically bind to the cells and kill them, making the disease effectively untreatable. Using a mechanism called RNA interference (RNAi), cancer researchers can silence (turn off) this pump gene and thus make the cancer cells sensitive to chemotherapy again. This innovation is in its infancy, but RNAi is helping experts develop more targeted cancer drug therapies, and there are dozens of clinical trials in progress to test RNAi-based cancer treatments.

With that research in mind, the study authors suggested their discovery could lead to the development of herbicides that weeds can't beat with the same mechanism. "New well-designed anti-cancer drugs cannot be pumped out of human cancer cells and this herbicide resistance finding should further stimulate the search for new chemical and non-chemical solutions for weed control in global agriculture,". While anti-biotech groups often warn that

GE crops speed the development of herbicide-resistant "super weeds," they have little say about these herbicide resistance-fighting applications, except that they don't like them. Therein lies takeaway number one: consider the risks and benefits of a technology. GE crops, to some extent, contributed to the problem of pesticide resistance; nobody denies that. But it's misguided to downplay workable solutions. This is why the anti-GMO movement is gradually campaigning itself into irrelevancy—it's complaints about the dangers of crop biotechnology either never materialized or are being solved. On a related note, while the anti-GMO movement coalesced around food safety issues in the 1990s, this was because earlier attacks on the use of genetic engineering in medicine failed to rouse public concern, not because agricultural biotechnology poses some unique risk.

The same technology, with the same kind and degree of risks, when used to create medical products attracts minimal such concerns. That is, if GM soybeans, due exclusively to the process of r[ecombinant]DNA in their development, were eventually found to cause some unexpected medical disorder, then GM insulin should also cause the disorder and warrants the same current concern. But it does not; the public seems not only to tolerate medical applications of biotechnology, but also to embrace them. Watching anti-biotech groups strain to justify their opposition to biotechnology in agriculture while defending its use in medicine offers a powerful confirmation of McHughen's analysis and another clear reason why these advocacy groups are gradually sliding back into obscurity. (Ref. 10b)
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5. ESD NEWSLETTER READER COMMENTS

None received this month.

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