Connection

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PennState
College of Earth
and Mineral Sciences

John and Willie Leone Family
Department of Energy and
Mineral Engineering

SECTIONS

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The Connections Newsletter is published once a year for alumni, students, faculty, and friends of department.

Cover Image: Colorado River, pg. 10, photo from PIXABAY

Dear EME friends and colleagues,

As the year draws to a close, I am filled with gratitude and pride to connect with each of you as the new head of the John and Willie Leone Family Department of Energy and Mineral Engineering (EME). My term began on July 1, 2024, and it has already been a rewarding journey. Building on the leadership and vision of my predecessors, Drs. Russell Johns and Sanjay Srinivasan, I am honored to step into this role and lead our community through an exciting period of growth and innovation.

I am continually inspired by the legacy of excellence and ambition that defines EME. This legacy serves as the foundation of a truly unique academic department, positioning us at the forefront of energy education, research, and innovation. It is this foundation that makes EME exceptionally well-suited to lead curricular and research advancements in the transforming global energy landscape. With award-winning research, top-ranked resident undergraduate and graduate programs, and our rapidly expanding online programs, EME provides a comprehensive ecosystem that addresses every facet of the energy transition conversation—from renewable and subsurface energy to sustainability, responsible mineral extraction, environmental impact, energy economics, and decision-making analysis.

Our shared mission is powerful. What we offer is highly relevant to today's societal challenges: energy, minerals, environment, and sustainability are all global issues—and all are integrated within EME. We provide a comprehensive suite of academic programs and an interdisciplinary research ecosystem designed to tackle the complex energy challenges of the future. As the only department focused specifically on energy with an integrated approach to both energy and earth resources, every year EME takes significant strides to ensure that we not only prepare students for impactful careers but also lead in developing solutions to the world's most pressing energy and mineral systems challenges. In the pages ahead, you'll learn about the progress and achievements across our department this year—so you continue to take pride in EME.

As we look toward the future, I am excited to work alongside our distinguished faculty, talented students, and dedicated alumni to advance our department's mission. Together, we are shaping the future of our field and empowering its future leaders. Your commitment and pride are essential to our success. Our alumni exemplify the excellence of EME, and I am proud to lead a department that benefits from such a passionate and engaged community. Thank you for being an essential part of EME.

May the year ahead bring continued growth, opportunity, and innovation for each of you and for the EME community.

Luis F. Ayala,
Department Head
John and Willie Leone Family Department of Energy and Mineral Engineering

Undergraduate Education

Dear alumni and friends of EME,

I hope this message finds you well. As we navigate the critical energy transition toward a more sustainable future, the role of undergraduate education has never been more important. Our universities are at the forefront of equipping the next generation with the knowledge and skills necessary to address the complexities of energy systems, climate change, and sustainable practices.

In light of this transition, we must ensure that our curricula not only emphasize traditional engineering and scientific principles but also integrate interdisciplinary approaches that include policy, economics, and social sciences. This holistic education will empower students to innovate and lead in a rapidly evolving energy landscape.

Alumni play a vital role in this endeavor. Your experiences and insights can significantly enrich our programs. By engaging with current students through mentorship, guest lectures, and internships, you can provide invaluable real-world perspectives that complement academic learning. Additionally, your support in fostering partnerships with industry can create pathways for students to gain practical experience, bridging the gap between theory and practice.

We also encourage alumni to contribute to scholarship programs, helping to alleviate financial burdens and ensuring that talented individuals from diverse backgrounds can pursue their education in energy-related fields. By investing in the future of our students, you help cultivate leaders who will drive innovation and champion sustainable practices.

Together, we can shape a robust educational framework that not only prepares students for careers in energy but also empowers them to make a meaningful impact in their communities and beyond. Thank you for your continued commitment to our University and its mission during this transformative time.

Sincerely,
Eugene Morgan
Associate Teaching Professor
Associate Head of Undergraduate Education

Graduate Education

Dear friends of EME,

I hope this message finds you well and thriving in your respective careers. As the department's associate head for graduate education, I am honored to share updates on our department's continuous growth and accomplishments. Our department has garnered global recognition for our commitment to excellence in graduate education and research, supporting students as they tackle critical issues in energy, sustainability, and mineral resources. This success reflects our dedication to fostering a community that addresses the ever-evolving demands of the energy and mineral industries.

The past year has been transformative for both our faculty and graduate students, marked by innovative curriculum updates and enhancements to our research capabilities. Our graduate programs continue to evolve to meet industry needs, with diverse options that include the base Energy and Mineral Engineering (EME) program, and the Energy Systems Engineering (ESysE), Fuel Science (FSc), Mining and Mineral Process Engineering (MMPE), Petroleum and Natural Gas Engineering (PNGE) options, and the online Renewable Energy and Sustainability Systems (RESS) program. These programs are tailored to equip students with both the specialized skills and interdisciplinary knowledge essential for addressing today's complex energy challenges.

We deeply value our alumni network and the vital role you play in sustaining our mission. Your ongoing support—whether through mentorship, guest lectures, or partnerships with industry—creates invaluable opportunities for students to connect their academic learning with real-world applications. We encourage you to stay involved, share your expertise, and help us inspire the next generation of leaders in energy and mineral engineering. Thank you for your dedication to EME and Penn State. Together, we can drive impactful change and build a more sustainable future in energy and environmental stewardship.

Sincerely,
Shimin Liu, Ph.D.
Associate Department Head of Graduate Education
Professor of Energy and Mineral Engineering
George H., Jr. and Anne B. Deike Chair in Mining Engineering

new faces

Amin Kordestany, Assistant Teaching Professor of Energy and Mineral Engineering

Maruf Morshed, Assistant Teaching Professor of Energy and Mineral Engineering

Jennifer Clemons, Assistant Teaching Professor of Energy and Mineral Engineering

Energy Business and Finance (EBF)

Dear friends and alumni
of the EBF program,

Greetings from a wonderful fall season in Happy Valley. I am writing as the current program chair of Energy Business and Finance (EBF), following Dr. Andrew Kleit's retirement from Penn State earlier this year. I want to acknowledge the many contributions that Dr. Kleit made in creating and leading EBF. The program is now in its twentieth year and still remains unique in its focus on business, economic, and technical education to prepare students for careers in the energy industry. I frequently encounter industry folks who have hired EBF graduates and they have been very impressed with the program.

I have spent the past few years devoted to building up Penn State's Center for Energy Law and Policy, and am excited to re-engage with the EBF program. There are a number of potential opportunities for EBF students to engage with the center's work. The EBF program has recently undergone a curriculum revision to keep up with the needs for our graduates to enter the professional world with a broader understanding of energy markets and economics, as well as the ability to think critically about policy options related to clean energy and climate change. We have also introduced EBF coursework on clean energy business strategies as well as public policy drivers of technology transition in the energy industry.

EBF has hired a new teaching professor this year, Dr. Maruf Morshed. Dr. Morshed has expertise in the electricity sector, sustainable fuels, and economic modeling. We are very excited to have Dr. Morshed join our program.

This coming year, I will be working closely with the EBF student society to continue to build a recruiting base for EBF students, and also to better connect to alumni from EBF and the former Mineral Economics program. We would love to hear from alumni! Please reach out and drop us a note to let us know what you have been doing since graduation, at sab51@psu.edu.

Sincerely,
Seth Blumsack
Professor of Energy Policy and Economics and International Affairs, Co-Director, Penn State Center for Energy Law and Policy
Program Chair, Energy Business and Finance

Energy Engineering (ENENG)

Dear friends and alumni
of the ENENG program,

As we approach the conclusion of the fall semester, it's an opportune moment to reflect on the past year's accomplishments. The Energy Engineering program proudly graduated fourteen students in spring 2024 and four more in summer, with an additional eight expected to graduate this fall. These graduates are set to embark on careers in energy and technology firms, utilities, and some will pursue further studies in graduate school. We are particularly excited to share that Olivia DiPrinzio, one of our fall graduates, has been nominated for the prestigious Rhodes and Marshall Scholarships, joining an elite group of Penn State nominees.

In April, a team of six students from our program showcased their skills by reaching the Final Championship of the Solar District Cup, organized by the U.S. Department of Energy. They presented their innovative solar power design to a panel of industry experts, competing against five other universities from across the country.

I am delighted to announce that in October, I received an Early Career Award from the Department of Energy, and Feifei Shi was honored with the Rustom and Della Roy Innovation in Materials Research Award in the Early Career Faculty Category. Additionally, Hilal Ezgi Toraman was recognized as a Pioneer of Catalysis and Reaction Engineering by the American Institute of Chemical Engineers earlier this year.

A notable project led by Mort Webster, professor of energy engineering, has been awarded up to $815,959 from the Grid Deployment Office of the U.S. Department of Energy. This initiative aims to assess market design changes to enhance the integration of batteries and unconventional resources into wholesale electricity markets, ultimately improving grid reliability.

This summer, we also celebrated the retirement of Serguei Lvov, who now holds the title of professor emeritus of energy and mineral engineering. In August, I took on the role of program chair for Energy Engineering, with Eugene Morgan supporting me as vice chair.

We welcome any news or updates you would like to share. Please feel free to reach out to me at nxd5313@psu.edu or join our LinkedIn group: Penn State Energy Engineering.

Sincerely,
Nelson Dzade
Assistant Professor of Energy and Mineral Engineering
Program Chair for Energy Engineering

Environmental Systems Engineering (ENVSE)

Dear friends and alumni of ENVSE,

After seven years of service as the Environmental Systems Engineering (ENVSE) program chair, Bill Groves has stepped down and returned to life as a "regular" faculty member, continuing to teach courses in environmental health and safety and air pollution. I have now stepped into those big shoes and am excited about the possibilities of connecting with all of our current students, alumni, and industry partners.

In a continuation of high interest in our program, we have eighty-two pre-majors and forty-seven current ENVSE majors for a total of 129 affiliated students. Of special note to our students, the College of Earth and Mineral Sciences and EME recently committed hundreds of thousands of dollars to renovate the laboratory space in 140 Hosler that is now the primary home for ENVSE 404W and ENVSE 412 activities. This investment in the continued excellence of the program is invaluable for the education of our current and future students.

The student Society of Environmental Systems Engineers (SESE) remains active, hosting bi-weekly meetings, social events such as the October Halloween outing to Harner Farms, and activities with other student societies. SESE also offers unique opportunities to explore environmental engineering applications through field trips to wastewater treatment facilities, acid mine drainage locations, the Penn State nuclear reactor, and recycling plants, among others. Additionally, SESE has maintained its tradition of inviting program alumni as guest speakers and has found the SESE Group on LinkedIn and Instagram to be very useful for maintaining ties with ENVSE alumni. The group has roughly thirty members, and all current and former ENVSE students are encouraged to join and network.

A revised ENVSE curriculum goes into effect for the Spring 2025 semester. Revisions have added GIS and data analytics content, along with a combination of the previous two option structure to return to a single set of requirements for all ENVSE graduates. Faculty implemented these changes to strengthen the skills of current and future students and better serve their needs and our industrial partners. We look forward to the continued value that we can provide to our students' careers.

Sincerely,
Jeremy Gernand,
Associate Professor of Environmental Health and Safety Engineering, Undergraduate Program Chair of Environmental Systems Engineering

Mining Engineering (MNGE)

Dear friends and alumni of Mining and Mineral Processing,

2025-1890 = 135. That's how long our mining program has been at Penn State. We have a long history of educating mining and mineral processing engineers and conducting research into the important topics of the day. I'm counting twenty-five undergraduates right now from first year to ready to graduate; that's up from last year as we had several students transfer in the program. We are encouraged by some of our outreach activities in this space. MINING ROCKS! Penn State Summer Mining Camp was a success. With seven campers for our inaugural year, we were able to get the kinks out! Our next one is scheduled for July 20-25, 2025. We hope that you'll again help to sponsor our campers in order to defray the cost for families. We'll reach out in the spring to ask for your contributions.

2024 was filled with other activities. We participated in the Penn State Climate Consortium in May with a focus on respirable dust—a major focus of our health and safety research. And, in August, we hosted the 7th International Symposium on Mine Safety Science and Engineering at the Hilton Garden Inn Southpointe in Canonsburg, Pennsylvania. We'll be there again in June 2025 to host the North American Mine Ventilation Symposium. We'll also reprise MINING PA later in the summer. If you would like to exhibit or speak, please let me know! Outreach to our Pennsylvania (and beyond) mining community is one of our top priorities. Much of our research reaches out to mining companies and suppliers—from dust to critical minerals and everything in between.

Twenty-five students—still too low to help meet the current demand for mining engineers let alone the need for critical mineral development. I participated in both a U.S. Senate and U.S. House hearing on critical mineral workforce development this year. The government is taking notice of this need for engineers and also skilled laborers. We need your help to increase these numbers. Talk to your neighbors! Encourage your relatives! Do you need talking points? Just ask! Check out the video on the website: https://www.eme.psu.edu/undergraduate/academics/undergraduate-programs/mining-engineering-major

This spring, look for us at SME MINEXCHANGE in Denver. Or stop by when you are in Happy Valley! Don't be a stranger!

Sincerely,
Barbara Arnold, '82, '85g, '89g
Chair and Professor of Practice, Mining Engineering

Petroleum and Natural Gas Engineering (PNGE)

Dear friends and alumni of PNGE,

I am pleased to announce our ongoing improvements in the Petroleum and Natural Gas Engineering (PNGE) program. In 2024, the program was ranked #4 and the graduate PNGE-option was ranked #3 nationally by the U.S. News & World Report. Dr. Zuleima Karpyn received the 2024 SPE Distinguished Member Award. Furthermore, Dr. Amin Kordestany joined as an assistant teaching professor.

For the 2024-25 academic year, 130 students are currently enrolled in the PNGE program. Additionally, over fifty M.S. and Ph.D. students are pursuing PNGE graduate studies. Over ninety percent of the class of 2024 successfully secured employment immediately upon graduation. It is anticipated that international student enrollment will decrease while domestic student enrollment will see an increase.

The PNGE program is revising its curriculum to include new courses and content on subsurface energy engineering, such as geologic CO2 storage, hydrogen storage, and geothermal energy. The curriculum will now include three courses: Data Analytics, Subsurface Energy Engineering, and Subsurface Storage Engineering. Additionally, a new certificate titled Carbon Capture, Utilization, and Storage (CCUS) is being developed.

With a growing population and rising energy needs, petroleum and natural gas will remain the top energy sources in the U.S. through 2050. In March, the PNGE program organized a two-day visit to Capitol Hill, where twelve department heads met with more than thirty congressional offices to seek federal support for university-led research in petroleum and subsurface energy production. Furthermore, our PNGE faculty organized the SPE/PEDHA Workshop in Houston, Texas to set expectations and develop plans to address these challenges that programs face with enrollment targets.

We thank those who have funded endowments and gifts to the PNGE program over the past several decades. These contributions help reduce student costs and support their travel to important events. They also aid in recruiting students and boosting enrollment. Additionally, the PNGE Industrial and Professional Advisory Council (IPAC) has been instrumental in assessing our program and offering key advice for curriculum adjustments to align with the industry's demands. We welcome all to join our activities. Your support is crucial to maintaining the program's strength.

Welcome to 2025, a year full of potential!

All the best,
Hamid Emami-Meybodi
Chair and Associate Professor,
Petroleum and Natural Gas Engineering

Online Programs

Master of Professional Studies in Renewable Energy and Sustainability Systems (RESS) and Energy and Sustainability Policy (ESP)

Dear friends and alumni of ESP and RESS,

Hello from Happy Valley. Our fall colors have crested and the chill in the air each morning foreshadows the colder days ahead. But perhaps if we didn't have our gray pause of winter, we wouldn't appreciate the tulips and Eastern red buds as much as we do when April rolls around.

Our online programs at both the undergraduate and graduate level continue to grow in popularity and attract and retain exceptional students from around the world. Both our Renewable Energy and Sustainability Systems (RESS) and Energy and Sustainability Policy (ESP) offerings maintain strong enrollment despite a field of ever-increasing competitor programs from peer institutions.

The Local Climate Action Program (LCAP) is a two-semester experience for upper-level undergraduate and graduate students, which partners students with a Pennsylvania-based local government to support local scale greenhouse gas emissions inventorying and climate planning. We offer generous flexibility in how we fit these courses into students' degree plans and have had eight RESS and twenty ESP students over the past three years participate. This program provides students with highly sought-after skills related to carbon accounting and management, data analysis, and climate policy and planning while providing local governments with capacity building and technical assistance. ESP and RESS students have partnered with communities as small as tiny boroughs like Doylestown with a few thousand people all the way up to entities as large as the cities of Erie and Scranton, Bucks County, and the Department of Conservation and Natural Resources. LCAP was recently recognized by an Excellence in Community Engagement Institutional Leadership Award from the Engagement Scholarship Consortium for providing students with innovative skills and experience. The fact that we're able to deliver this real-world experience to students who are studying at a distance is just one example of the ways we seek to innovate in our online educational endeavors to ensure our students get the best possible experiences, on or off campus.

As we look to the year ahead, we welcome Dr. Jennifer Clemons to our faculty. We are always eager to hear about the work you're doing now that you've finished your degree and we welcome the opportunity to partner with you.

Wishing you all the best,
Brandi J. Robinson
Associate Teaching Professor
Director of Online Programs

Nelson Dzade receives DOE Early Career Research Award

Nelson Y. Dzade, assistant professor of energy and mineral engineering, received a 2024 Early Career Research Award from the U.S. Department of Energy (DOE). Dzade will use the five-year, $875,000 award to develop a multi-scale framework for predicting and understanding interfaces in solar cells.

"It is an incredible honor for me to be selected for this prestigious award," Dzade said. "I feel super blessed to be considered among the nation's outstanding early research scientists who are helping tackle some of the toughest challenges and help secure the economic competitiveness of the United States for decades to come."

Thin-film solar devices consist of a multilayer structure and the properties and atomic-scale dynamics of their interfaces play an important role in the overall device performance and stability. Consequently, advances in thin-film solar cells can greatly benefit from detailed atomic-level analysis, which provides insight into the interface structure and properties that can be exploited to improve performance, according to Dzade.

"Providing clean sustainable energy is among the most urgent challenges to society and the global economy and poses fundamental, exciting scientific questions," Dzade said. "Solar energy has long been on the horizon as one of the important solutions in green energy production because the solar resource is super-abundant and freely available."

Dzade plans to develop and implement a multiscale modeling environment that will integrate a wide range of advanced computational approaches and complementary experiments to get a complete microscopic picture of interfacial phenomena in solar materials. His team plans to train high-accuracy machine learning models to enable large-scale molecular dynamics simulations of the structure and evolution of the complex interfaces in solar cells. This project will not only help to identify specific bottlenecks but also enable an insight-driven optimization of interfacial properties.

"Considering the complex nature of interfaces, it is vital to see this with different eyes," Dzade said. "This research can only happen in an interdisciplinary environment like Penn State, where I can engage with a multidisciplinary team of experimental collaborators."

Read full story online.

Zuleima Karpyn named distinguished member by Society of Petroleum Engineers

Zuleima Karpyn, Donohue Family Professor of Petroleum and Natural Gas Engineering, and associate dean for graduate education and research in the College of Earth and Mineral Sciences, was recently named a distinguished member by the Society of Petroleum Engineers (SPE) at the society's annual technical conference held in New Orleans.

This honor, limited to one percent of SPE professional membership, recognizes members who have attained eminence in the petroleum industry or the academic world, or who have made unusually significant contributions to SPE. Karpyn is one of seven recipients selected for 2024.

"SPE is an exceptional professional platform to connect with peers, mentors, and leaders," Karpyn said. "I am honored and grateful for the opportunity SPE has given me to contribute to our field."

Karpyn was recognized for "being a prolific scholar of reservoir engineering and digital rock physics, an outstanding teacher and mentor, and an accomplished administrator."

Karpyn's research specializes in multiphase flow and transport in porous media, and digital rock physics. Her areas of application include reservoir characterization and engineering, carbon sequestration, subsurface energy storage, and environmental remediation.

Read full story online.

Stay Up to Date

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Meet Thanasis Karamalidis

Athanasios K. Karamalidis, assistant professor of environmental systems engineering, focuses on reimagining the approach in processing, separation, and recovery of critical elements using above ground mining (e.g. industrial waste) with his research.

His new book, *Rare Earth Elements: Sustainable Recovery, Processing, and Purification*, explores the modern methods and technologies in use around the globe to recover, process, and purify rare earths through the prism of sustainability.

Rare earth elements (REEs) are found in most of the technologies we use, from computers to clean energy. Current projections indicate that REE demand will increase by three to seven times the existing demand in the next couple of decades. In that time, Karamalidis expects rare earths will be recovered from a wider range of sources than at present—including from more countries, more mineralogical forms, more waste streams,and end-of-life products.

"We are in the midst of energy expansion, which will require more of these elements in the future," Karamalidis said. "Developing new technologies, treatments, and methods that address the critical challenges of our times, lessen the impact of existing production, or increase the creative use of waste is essential. Really, these approaches could be viewed as part of the material circularity of the future."

According to Karamalidis, cataloging all the new and novel technologies being developed for his second book was rewarding.

"I have to admit that I have experienced various processes in writing books," Karamalidis said. "My first book was characterized by very long hours of researching, modeling, drafting, and editing, while for this one, I focused more on coordination of the various teams and technologies. I feel excited, and relieved, knowing we managed to capture and showcase very interesting technologies."

Karamalidis hopes the book, like his teaching, will help train the next generation of independent thinkers to form new approaches and push boundaries.

"Our research laboratories are the cornerstone of the next generation workforce," Karamalidis said. "The community we build and collaborations we promote, provide the necessary freedom to explore new scientific ideas and create an environment for students, and faculty, to realize their aspirations."

EME Faculty Awards

Additional notable achievements from this past year:

- *Feifei Shi, assistant professor of energy engineering, received the Rustom and Della Roy Innovation in Materials Research Award in the Early-career Faculty category.*
- *Brandi Robinson, associate teaching professor and director of online education, accepted the Ryan Moser Reilly Excellence in Community Engagement Institutional Leadership Award on behalf of Penn State for the Local Climate Action Program (LCAP) at the Engagement Scholarship Consortium annual meeting in Portland, Oregon.*
- *Sarma V. Pisupati, professor of energy and mineral engineering and director of the Center for Critical Minerals, was appointed as a John T. Ryan Jr. Faculty Fellow in the College of Earth and Mineral Sciences starting the 2024 academic year.*
- *Seth Blumsack, professor of energy and environmental economics and international affairs and director of the Center for Energy Law and Policy, received the MICASU Faculty Fellowship in the College of Earth and Mineral Sciences starting the 2024 academic year. He also was selected a Penn State Emerging Academic Leader for fall 2024.*

4.99M DOE grant to build domestic supply chain for critical minerals

A Penn State research team was recently awarded a $4.99 million grant from the U.S. Department of Energy (DOE) to develop and assess advanced separation technologies for the extraction and recovery of rare earth elements and other critical materials from coal, coal wastes, and coal by-products.

The materials, which are abundant in Earth's crust but challenging to extract and primarily sourced from overseas, serve a vital function in modern technology, such as smartphones, electric cars, wind turbines, and even in defense technologies like missiles and radar systems

The project, led by Sarma Pisupati, professor of energy and mineral engineering, chemical engineering, and director of Penn State's Center for Critical Minerals, is one of four projects selected in the latest round of $17.5 million funding focused on critical minerals from the DOE.

"Pennsylvania is leading the way to our clean energy future with each new and innovative development," said U.S. Senator Bob Casey (D-PA), who helped secure funding for the previous work through a congressionally directed spending initiative.

The project will help to establish a 100 percent domestic supply chain, reducing U.S. reliance on foreign suppliers. The United States currently imports more than 80 percent of its rare earth elements from offshore suppliers.

"The two main goals of this project are to reduce the net import reliance on critical minerals and to help clean up the environment," Pisupati said. "We want to demonstrate a 100 percent domestic supply of critical minerals that are essential for the United States' economy. Thousands of abandoned mines spew out acid mine drainage, and we want to remove the critical minerals from this waste—we are taking waste and turning it into a treasure. This can help reduce the taxpayer money needed for cleanup and help solve a national security problem."

The project, named Alliance for Critical Mineral Extraction and Production from Coal-Based Resources for Vitality Enhancement in Domestic Supply Chains—or ACME-REVIVE—is a collaborative effort with industry leaders, Rare Earth Salts Separations and Refining, LLC, Aqua Metals, Inc., General Electric Research, and an academic partner, the University of Virginia.

"Extracting and recovering rare earth elements and other critical materials from coal, coal wastes, and coal by-products has the potential to catalyze regional growth and create jobs," said Lee Kump, the John Leone Dean in the College of Earth and Mineral Sciences. "This project will also help remediate long-standing environmental problems and help the country meet its needs for critical minerals for use in an advanced, technology-driven society."

Specifically, the researchers aim to extract and concentrate high purity, mixed rare earth oxides from domestic coal-based acid mine drainage, or the acidic water flowing from coal mines and clays.

The team plans to evaluate the properties of these materials for magnet and super alloy applications and produce high-grade lithium carbonate, nickel, cobalt, manganese, and titanium.

"Our robust capabilities in critical mineral technologies make Penn State a trailblazer in the initiative to centralize a domestic supply chain," said Andrew Read, senior vice president for research at Penn State. "These efforts will ensure more stability in our technology pipeline—critical for positioning the United States as a global leader."

Read full story online.

$1.1M ARPA-E award to fund project exploring potential of geologic hydrogen

A group of Penn State researchers have been selected to receive $1.1 million in funding from the U.S. Department of Energy (DOE) Advanced Research Projects Agency-Energy (ARPA-E). The two-year cooperative agreement supports early-stage research and development to advance low-cost, low-emissions production of geologic hydrogen, which is produced naturally in Earth's subsurface and could contribute to a more sustainable, energy independent future.

The team, led by Shimin Liu, George H., Jr. and Anne B. Deike Chair in Mining Engineering and professor of energy and mineral engineering, will work to better understand how to explore and potentially extract geological hydrogen from its subsurface reservoirs. Engineering the production of subsurface hydrogen could potentially unlock substantial resources for clean energy and lead to the decarbonization of our most energy-intensive industries, according to the DOE.

Hydrogen can be extracted from a variety of sources, including water, fossil fuels, and biomass but this requires energy and can release carbon dioxide into the atmosphere. Geologic hydrogen—or natural hydrogen—is pure hydrogen, generated through water-rock interactions deep in the Earth's subsurface without active stimulation, the researchers said.

Hydrogen can be classified by color, defined by carbon emissions associated with its production process. Hydrogen actively extracted using subsurface stimulation and reservoir creation and management produces gas referred to as orange hydrogen, according to the researchers.

"Although orange hydrogen has a significant potential for hydrogen harvesting, our understanding and characterization of its production, its impact on in situ geochemical and geomechanical behaviors, and the resulting evolution of reservoir flow behavior and associated geo-environmental risks remain largely unknown," Liu said.

These knowledge gaps hinder the future large-scale hydrogen production from subsurface formations, according to the researchers.

"Until now, hydrogen has never been treated as a primary energy resource," Liu said. "Our intent to artificially engineer a geomechanical system that can sustain hydrogen production has never been done before."

"So, at each step, we will need to assess, evaluate, and develop a new process or technology."

The researchers propose leveraging the serpentinization process in peridotite, a type of rock that contains olivine as its primary mineral. The team plans to use an inert gas dynamic fracturing technology to inject carbon dioxide into a peridotite formation to increase its permeability and reactive surface area. Then, they plan to stimulate the formation with a carbon-rich solution to induce—and sustain—serpentinization.

Derek Elsworth, the G. Albert Shoemaker Chair and professor of energy and mineral engineering and geosciences and co-principal investigator , summed up the project as "high risk, high reward."

"It's similar to what's done in developing geothermal reservoirs in that you're fracturing the rock, but this technique is slightly different and it's more localized," Elsworth said. "The challenges will be to create a reactive surface area at the correct depth, with the right regents, to have the right reactions, and then recover a high yield of hydrogen in an environmentally safe way. It's not being done now, and it hasn't been done before."

Over the next two years, the team aims to develop their innovative technology using a multi-stage approach. The team will first identify potential reservoir sites by cataloging locations across the U.S. rich in olivine peridotite. The researchers will conduct additional tests and use models to characterize micro-seismicity, changes in permeability, and how fractures propagate in core samples before moving to pilot-scale experiments at a local mine. According to the researchers, the goal is to provide as much foundational data as possible for analytical models to create a framework for sustained, field-scale reservoir management.

"The imagination and creativity and the skill sets of everyone contributing to this project make research like this possible," Elsworth said. "This is blue-sky thinking. This hasn't been done before. But if it does work, then the reward is potentially quite high."

Read full story online.

Changing water conservation attitudes positively impacts water availability

The increased demand for clean water and its limited supply has made water management one of the most pressing challenges facing society today. Changing attitudes about water conservation could significantly impact water consumption and help address this issue, according to research led by Renee Obringer, assistant professor of energy and mineral engineering.

The findings were published in the Journal of the American Water Resources Association.

Many factors including population growth, agricultural needs, and land use change all contribute to an increased demand for water, especially in urban areas, Obringer said. Climate change and drought may also reduce the availability of water in some areas.

Water managers have primarily looked to solve increasing water needs by expanding or developing new water sources and supplies, such as enlarging reservoirs, but such solutions don't address the root of the issue. According to Obringer, a socio-hydrology approach that accounts for how people influence water systems through their own consumption patterns is needed to understand the best way to manage stresses to the water system.

"It's important that we acknowledge the fact that humans play a role in our hydrological system," Obringer said. "Even in the farthest corners of the planet, things are changing because of us and how we use water. We wanted to see if an individual's decisions or water conservation attitude could impact the community's water availability and see what emerges if those attitudes are changed."

Previous socio-hydrology research assessed how socioeconomic status and end-use intentions influenced consumption, but consumer attitudes and social norms were excluded, as they confused predictive models, resulting in overpredictions or misrepresentations of the water system, Obringer said.

"In periods of drought, cities often encourage reduced water consumption to help conserve the water supply," Obringer said. "However, without changing the underlying values, beliefs, and attitudes associated with water conservation, it is unlikely that these initiatives will be successful."

With the understanding that attitudes influence behavior, Obringer and her collaborator, Dave White, director of the Global Institute of Sustainability and Innovation at Arizona State University, developed an agent-based model (ABM) to investigate the impact of water conservation attitudes on overall water availability in Phoenix. ABMs are computer models used to simulate real-world systems that are made up of individual units, like people, and their interactions with each other and their environment.

"The primary entities in our model are the agents, which represent households in the city of Phoenix," Obringer said. "Using results from a previous household survey conducted across three metropolitan areas in the Colorado River Basin, we considered the Phoenix households to belong in one of seven archetypal groups that have different attitudes toward water conservation and participation in conservation programs. Since

the region is experiencing a decades-long megadrought, Phoenix residents were familiar with water conservation policies and drought situations."

The seven archetypes used to classify Phoenix households were: neutral, individualist, would-be-participant, concerned, participant, confident denier, and disengaged. Participant and would-be-participant are similar archetypes in that they both recognize the need for conservation programs, but the "would-be-participants" stated that they did not know how to get involved. While their work was limited to Phoenix, the researchers believe the archetypes and model could be applied to other areas.

The team conducted over 100 model runs to validate the model's accuracy before applying it to five hypothetical scenarios, which ranged from converting partial participants to full participants and "disengaged" to "concerned." They then conducted an additional 100 model runs for each scenario.

The researchers found the biggest effect on overall water availability occurred when the "would-be-participants" archetype converted into "participants."

"Our results indicated that the best course of action was to focus intervention efforts on a subset of residents that recognize the problem but are unsure how to help," Obringer said. "This indicates that even getting a fraction of the households to shift archetypes can benefit the water system through increased supply."

Obringer said she plans to build on the model, with the next step focused on incorporating predicted climate models to see how different scenarios might play out in the future due to climate change.

"I think one of the critical things that we were see in these results is that, while individuals might not think that they can make any difference, all you need is a critical mass—and it doesn't necessarily mean a lot of people—working towards the same goal to change the outcome," Obringer said.

Read full story online.

Designing and assessing market designs to improve electrical grid reliability

A project co-led by two Penn State professors has been selected to receive up to $815,959 from the Grid Deployment Office of the U.S. Department of Energy (DOE). The team will evaluate

prospective market design changes to efficiently integrate batteries and other unconventional resources into wholesale electricity markets, with the aim of improving electrical grid reliability.

Mort Webster, professor of energy engineering and principal investigator, and Uday V. Shanbhag, the Gary and Sheila Bello Chair Professor of Industrial and Manufacturing Engineering in Penn State's College of Engineering and co-principal investigator, will partner with PJM Interconnection (PJM) and ISO New England Inc. (ISO-NE). PJM and ISO-NE together manage the electricity grid covering nineteen states, including Pennsylvania, and account for over one-fifth of the electricity consumed in the U.S. Webster will model their electricity markets and develop market design changes to achieve the best performance across reliability, efficiency, and investment incentives, which could entice companies to build the flexible generators needed to balance supply and demand.

Wholesale electricity markets define every step of the process power must go through every time we flip the light switch or plug something in, so the researchers said this work could potentially help reduce consumer costs and aid sustainable energy transition.

According to Webster, most consumers receive power through a wholesale electricity market.

"The unique thing about electricity is that at every moment, whatever devices we turn on, collectively, the providers have to adjust almost instantly to provide exactly that amount of power," Webster said. "For the past twenty-five years, how that power has been delivered from generators to distribution utilities that pick and choose where, or whom, to buy the power from, before finally transmitting it to us has worked well. But it will have to change as we move away from fossil fuel-based power generation."

According to the researchers, the ability of the system to adjust will be more difficult with increased reliance on renewable—and more variable—energy sources, as well as battery energy storage. Currently, every five minutes, market operators must predict the regional electricity needs for the next five minutes. In that short time, they must set up the system to meet forecasted energy usage, and there is always a gap between the predicted and actual usage. More variable power sources will exacerbate this gap, Webster said.

"It may seem very nitpicky to look at these five-minute increments," Webster said, noting there are long-term questions regarding producing power with a net zero target in the future. "But really, the reason we're doing this is if we don't get this right, it is going to be hard to transition."

Increased battery energy storage will add more complexity to the systems, as operators must consider whether the battery will be available or charging.

The solution may include better market designs to reward resources that provide flexibility. The proposed project will build on the framework developed collaboratively by PJM and a team at Penn State as part of a recently concluded Advanced Research Projects Agency - Energy award. The real-life electricity market simulation successfully reproduces key features of PJM's wholesale market operations, such as the time constraints and the uncertainty that operators regularly face. The new project will apply this new simulation model to compare a broad range of potential market design changes and quantify the tradeoffs.

"Every design has tradeoffs," Webster said. "Are the incentives aligned correctly so the right action is rewarded, the investment is made, and all the stakeholders agree? This engagement will ensure stakeholders have a realistic simulation with a credible, detailed analysis that can provide critical insight to ensure the market is designed correctly."

Read full story online.

Rock permeability, microquakes link may be a boon for geothermal energy

Using machine learning, researchers at Penn State have tied low-magnitude microearthquakes to the permeability of subsurface rocks beneath the Earth, a discovery that could have implications for improving geothermal energy transfer.

Generating geothermal energy requires a permeable subsurface to efficiently release heat when cold fluids are forced into the rock. This research reveals the optimum times for efficient energy transfer by exposing the link to microearthquakes, which are monitored on the surface through seismometers. The team published their findings in Nature Communications.

Using funding from the U.S. Department of Energy (DOE) and two datasets from the EGS Collab and Utah FORGE demonstration projects, researchers used machine learning to extract the "noise" found in the data that obscured the link. Researchers then used machine learning to create a model from one site and successfully applied it to the other — a process called transfer learning — suggesting that the link was formed based on general physics of subsurface rocks. That means it's likely to be universally true for all geothermal energy sites, the researchers said.

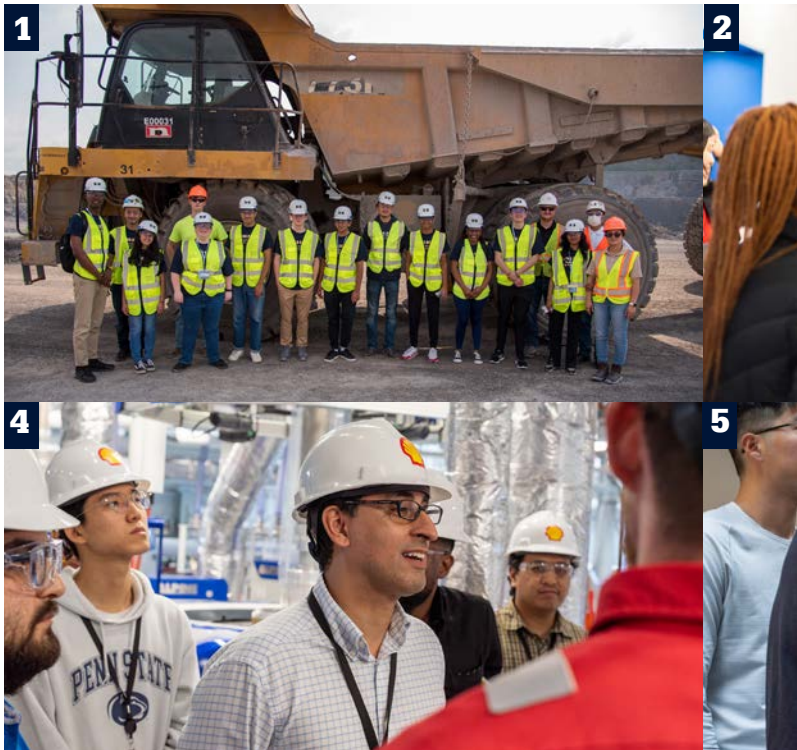
"Success of transfer learning confirms the generalizability of the models," said Pengliang Yu, postdoctoral scholar at Penn State and lead author of the study. "This suggests seismic monitoring could broadly be used to improve geothermal energy transfer efficiencies across a wide range of sites."

Increasing rock permeability is critical to a range of energy extraction methods, Yu said. Rock permeability impacts traditional fossil fuel recovery as well as renewable energies including hydrogen production. Hydrofracturing methods introduce cold fluids into the subsurface through porous rock, which creates high pressures that break the rock in tension or shear. This process creates microearthquakes similar to naturally occurring earthquakes, but at a much smaller scale. By increasing the permeability of the rock, energies such as heat and hydrocarbons are able to more easily reach the surface.

Yu said their algorithm showed a direct link, meaning the rock became the most permeable when the seismic activity was strongest. Identifying the link between seismic activity and rock permeability improves the ability to extract energy while ensuring microquakes stay below the threshold that could cause damage or be observed by the public.

Increasing the availability of geothermal energy would lessen dependence on fossil fuels, the researchers said. Additionally, they noted that linking rock permeability to microquakes can be useful in monitoring gas movement for carbon sequestration and the production and storage of subsurface hydrogen.

Read full story online.



EME staff member's White House service recognized in new book

Erica P. Cooper, administrative support manager, has been recognized for her service at the White House Communications Agency (WHCA) in the recently published book *The No-Fail Mission: The Men and Women Behind the Presidential Service Badge*.

The Presidential Service Badge was established in 1964 and only about 39,000 have been awarded.

Cooper served at the WHCA for five years, where she supported the Executive Office of the President of the United States, and in the U.S. Air Force for twenty-four years. Her responsibilities included providing secure communications worldwide to presidential airport sites, Air Force One, the president, vice president, first lady, senior White House staff, and the Secret Service.

"It was a responsibility that was both terrifying and exciting. At each event and moments before Air Force One landed there was an indescribable high and level of pride felt by all," Cooper said. "We confidently and quietly arrived at each site, set up, seamlessly executed "game day," tore down, and got out without anyone knowing we were there."

She never expected to be the subject of a book, but when the author, Anthony Knopps, reached out, she was curious where it could lead. After months of discussions, their talk turned to one of Cooper's most impactful experiences while at the WHCA—the Boston Marathon bombing. Cooper's home is Massachusetts. She recalled being asked to lead the team to her hometown amid tragedy. The task of preparing a presidential visit in less than forty-eight hours while grieving was one of the greatest challenges of her life.

"As I was securing the communications on Air Force Once, I kept thinking how much I wanted my mum," said Cooper. "When securing Air Force One, I would walk to the plane and under the wheel as the president was walking down the stairs off the plane. At that time, my mum called. She asked where I was, and I told her in D.C. as I didn't want to blow my cover. I learned the camera caught me as I was passing the president, so she knew I was in Boston. Though I couldn't get to her, hearing her voice was such a comforting moment for me."

For Cooper, she believes the book's power is in how it shines a light on all who work behind the scenes.

"This book is not about politics," Cooper said. "When we supported the Executive Office of the President, our political beliefs, race, religion, sex, sexual preference, background, ethnicity, and everything else was left at the door. Our only mission was to provide a no-fail environment, 100 percent of the time. We were ordinary people chosen to support the most extraordinary events in history, while serving the greatest leader in the world. I can say without a doubt this was the greatest honor of my life."

Read full story online.

3

Fun Photos

See photos from our events and everything going on at EME!

1. Mining Camp
2. Graduate Student Potluck
3. International Symposium on Mine Safety Science and Engineering
4. Shell Facility Tour
5. Fall 2024 EME Student Research Poster Contest

Student chapter wins Society of Petroleum Engineers Presidential Award

A team of five EME graduate students won first place in the 2024 Chevron National Engineering Competition. The annual competition challenges teams to present novel ideas about contemporary subjects in the petroleum and energy industry, with this year's topic focused on use cases for implementing artificial intelligence (AI).

Nicolas Bueno, Nijat Gasimli, Ianna Gomez, Hanif Yoga , and Baran Yucel, whose team took second place the previous year, were part of this year's winning team.

The members all agreed that the topic's broad nature would be demanding. AI can be utilized across every department in the oil industry, from operations and reservoir management to finance and human resources.

"I was very excited because I've been working directly with AI the past three years, but I knew the competition would be difficult," said Yucel who utilizes AI in his work to improve geostatistical modeling.

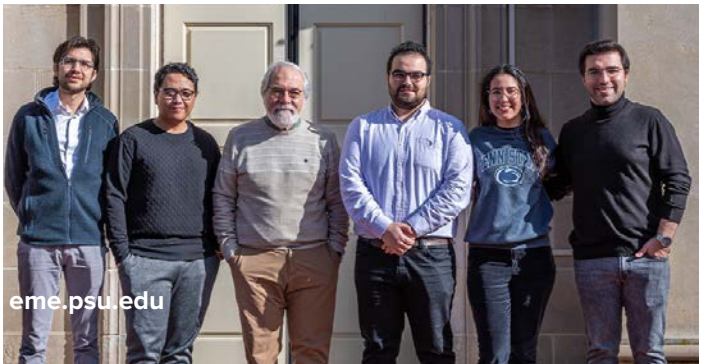
The team decided on a holistic approach with each member focused on the key strengths, weaknesses, and potential uses for AI across every industry cycle stage.

According to Yoga, the opportunity to receive feedback and direction from Turgay Ertekin, professor emeritus of petroleum and natural gas engineering and former department head, was invaluable.

"AI is such a hot topic and it's talked about as this new thing," said Yoga. "In reality though, Dr. Ertekin has been researching the use of AI since the 90s. We were thankful to consult with him."

Ertekin said he was happy to help. In his forty years, he has seen the adoption of many new technologies. To Ertekin, the key is to not abandon the tools you already have.

"Petroleum engineers have always found themselves in the middle of ill-defined problems," said Ertekin. "Imagine trying to solve a 10,000-piece puzzle that has 200 pieces missing. Which pieces are missing, what shape do they have, and where do they go—and there's still the thousands of other pieces you must fit together. AI is a tool that can help identify potential solutions or eliminate possibilities to solve the puzzle quicker, but humans need be there to feed it the correct parameters and ensure it's accurate as they are the final decision makers."



The team's focus on the big picture, and recommendation of a hybrid approach to implementing AI with human supervision as a safeguard and decision maker, proved to be the winning formula.

Read full story online.

EME students win Solar District Cup division competition

The future is bright for six Penn State students who recently took first place in their division of the U.S. Department of Energy's Solar District Cup, which is a national collegiate competition that challenges multidisciplinary student teams to design and model distributed energy systems for a campus or district.

The Penn State team "Nittany Solar" comprised students in Nelson Dzade's "EGEE 437: Design of Solar Energy Conversion Systems" class and included Khaleah Jackson, Olivia DiPrinzio, Olivia Williamson, Joseph Hokky, Al-Harith Al Amir, and Mahmood AlFarqani. Dzade, an assistant professor of energy and mineral engineering, advised the team, and Sahil Inaganti, an industry expert from Nexamp, served as the team's mentor.

They beat eight other teams to win the University of Washington Use Case Division and competed in the final pitch championship against five other finalists, with the University of Puerto Rico at Mayaguez emerging as the overall champion.

DiPrinzio, a senior with dual degrees in energy engineering and Earth science and policy, said she learned a lot about the permitting process and the vast amount of work it takes to bring a great idea to fruition.

DiPrinzio said she spent her time at Penn State focused on solar energy because of its potential to mitigate climate change while reducing global energy poverty. She chose Penn State because the faculty are engaged in both research and industry advances.

"Penn State is a good place for learning about and working with renewable energy as a result of its unique energy engineering program in the College of Earth and Mineral Sciences," DiPrinzio said. "Additionally, the faculty at Penn State who are actively working on renewable energy is a large pool so there are so many opportunities to get involved with research, and for promoting renewable energy at Penn State and beyond, or by simply taking extra classes to inform yourself."

Read full story online.

EME graduate student awarded Intergovernmental Panel on Climate Change scholarship

Joy Adul, a graduate student in EME, was one of twenty students selected to receive a scholarship from the United Nation's Intergovernmental Panel on Climate Change (IPCC) Scholarship Programme. The IPCC is the leading international body for assessing climate change.

The aim of the Scholarship Programme is to "provide scholarships for Ph.D. students from developing countries for research that advances the understanding of the scientific basis of risks of climate change, its potential impacts, and options for adaptation and mitigation."

"It was so exciting to find out that I received the scholarship," Adul said. "I just felt so emboldened like I was being told 'You're going in the right direction, and we are all behind you.' It's encouraging to know I have this support because it's the people who are most affected by climate change—the voices from the most vulnerable communities—that need to be a part of the energy transition conversation."

Growing up in Kenya, Adul saw the effects of energy poverty every day, from routine blackouts in the city to visiting her grandmother, who did not have access to electricity. Increased flooding due to climate change, she said, caused her to realize the connection between climate change and energy poverty. She then shifted her focus to studying energy as she saw a real need for professionals working towards a more sustainable future.

"In Africa, you see energy poverty, and you think that's just the way it is," Adul said. "When I realized it doesn't have to be that way, it was really clear that I wanted to study energy. That's why I'm so grateful that the IPCC is helping to empower professionals who understand the struggles of climate change so they can lead the technology advancements in the right way."

The scholarship will help Adul develop a machine-learning-based model that could predict how renewable energy generation is impacted by climate change across the United States and Kenya. According to Adul, renewable energy generation, such as solar, wind, and hydroelectricity, is more dependent on climate and, therefore, more sensitive to changes.

Her research has the potential to help policymakers and regional stakeholders determine the long-term viability of building new renewable energy infrastructure, she said.

"Climate change is a global issue," said Adul. "How it will affect the United States and how it will affect Kenya may be different to an extent, but both will have to be prepared for the changes it brings. When I see the diverse voices coming together to enhance, to enrich, these conversations I'm excited to see what the future holds."

Read full story online.

Meet Ian Myers

Growing up, Ian Myers said he attended every football game from when he was five years old until he graduated from Penn State with distinction with a bachelor's degree in petroleum engineering in 2010. With a natural inclination for math, science, and physics–and an environmental engineer father–pursuing engineering was almost a given. A fateful Chevron information session inspired Myers to shift gears.

"I started at Penn State as a chemical engineer focused in biomedical," said Myers. "Then I learned about big deepwater projects, and it piqued my interest."

Myers thinks that learning about the big capital projects and hard-engineering problems spoke to his entrepreneurial spirit, which was always bubbling in the background. His new plan was to learn the ropes at a big company before venturing on his own.

"I love building," Myers said. "Folks view entrepreneurship as very glamorous, but you need to roll up your sleeves and do a lot of dirty work when you're starting from scratch. I love setting things up and simultaneously trying and evaluating many strategies during those early stages."

Built on the rigor of oil and gas engineering, Myers pursued an executive master of business administration and expanded his understanding of marketing, behavioral science, behavior economics, and game theory to become a negotiation expert. Through it all, he believes his Penn State engineering background was a critical factor in his success.

"Ultimately, petroleum engineering is all about making asset-based decisions, with uncertainty and limited data—even today," Myers said. "Understanding how to manage risk and make probabilistic decisions and carrying that engineering mindset to understand the mechanics of negotiation science has been important. And Penn State, because of its size and diversity, allowed me to interact with so much that I developed those essential interpersonal skills and conflict skills that helped me separate early in my career."

Myers' most recent endeavor was to form Mainline Ventures, a leading-edge strategic sourcing and procurement advisory firm, in 2023 with his brother, a fellow petroleum and natural gas engineering Penn State alum. There, the two continue the Penn State tradition of rolling up their sleeves and getting to work to create the first AI based strategic sourcing platform, allowing firms to measure and maximize their purchase efficiency.

Read Ian Myers' spotlight online.

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