

ENERGY INNOVATION

Summer 2024

EMS Energy Institute Newsletter



PennState
College of Earth
and Mineral Sciences

Energy Institute



Energy Innovation is an annual publication from the EMS Energy Institute in the College of Earth and Mineral Sciences. The EMS Energy Institute is a leading research and development organization focused on energy science and engineering.

Cover Image: Close-up of silicon carbide
Credit: Adobe Stock

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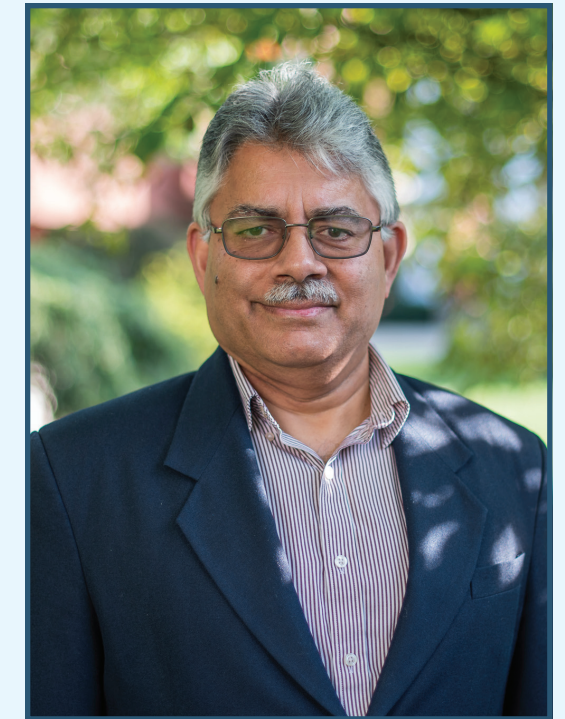
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Letter from the Director

Hello friends:

Greetings to you on a beautiful sunny day in State College after a rainy and damp winter and the beginning of spring. The University Park campus is resplendent with the colors of azaleas, phlox, and the ever-pleasing roses. The lines at the Nittany Lion Shrine are slowly starting to become more manageable, after the frenzy of spring graduation. It is indeed gratifying to note that the University has put forth the next generation of talented and well-trained young professionals to take on the myriad of challenges facing our society. The EMS Energy Institute also had its share of graduate and undergraduate students, well-trained in many aspects of energy research, who are eager to unleash their skills to shape the transformation that is ongoing in the energy sector. We wish them well and look forward to hearing about their career exploits and the major ways in which they have impacted the energy industry.

In the meantime, I have spent my first year as the director of the EMS Energy Institute mostly familiarizing myself with the current activities within the institute. We have an incredibly talented group of administrative and technical staff, and they constantly strive to outdo each other in contributing to making the institute a fantastic place to work. Despite budget reductions, personnel reorganization initiated by the University, and numerous demands placed by funding organizations, these staff members go about doing their jobs with the utmost dedication and diligence, and for that, I am extremely grateful. It gave us much happiness to celebrate our esteemed colleague Elizabeth Wood's retirement. Liz, as many of you know, was the key person responsible for maintaining the institute's presence on the worldwide web. She is a graphic artist par excellence, and her artistic touch is visible in nearly every poster on display on the walls of the institute.



Thanks to the enthusiasm of the staff and the army of research affiliates associated with the institute, we have been successful in launching several initiatives during this year.

Some of these are:

- Reorganization of the institute into four thematic areas:
 - Materials and Minerals for the Energy Transition
 - Science and Engineering of Energy Systems
 - Socioeconomic and Environmental Aspects of the Energy Transition
 - Predictive Data Analytics and Computational Aspects of the Energy Transition

For each thematic area, we identified a team of area leads. We entrusted these leads to engage researchers in discussions and produce recommendations for allocation of research resources such as labs, facilities, assignment of graduate assistants, seed funds, etc., recommend members to join the institute's advisory board, and suggest names of speakers for the Energy Exchange Seminar Series.

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EMS Energy Institute INITIATIVE Q&A

Silicon Carbide Innovation Alliance (SCIA) Joshua Robinson

The Silicon Carbide Innovation Alliance (SCIA)'s objective is to establish a deep understanding of silicon carbide (SiC) crystal growth, processing, and metrology that guides breakthroughs in SiC science and technology, while educating the next generation of semiconductor researchers. They aim to become the nation's leading resource for SiC crystal science, technology, and workforce development.

Q: Who is leading this effort?

A: SCIA is directed by Joshua Robinson, with associate directors Adri van Duin and Suzanne Mohney.

Q: Where are you located?

A: SCIA is operated through the EMS Energy Institute and the Materials Research Institute. Research labs that contribute to its research are housed within the institute and around campus.

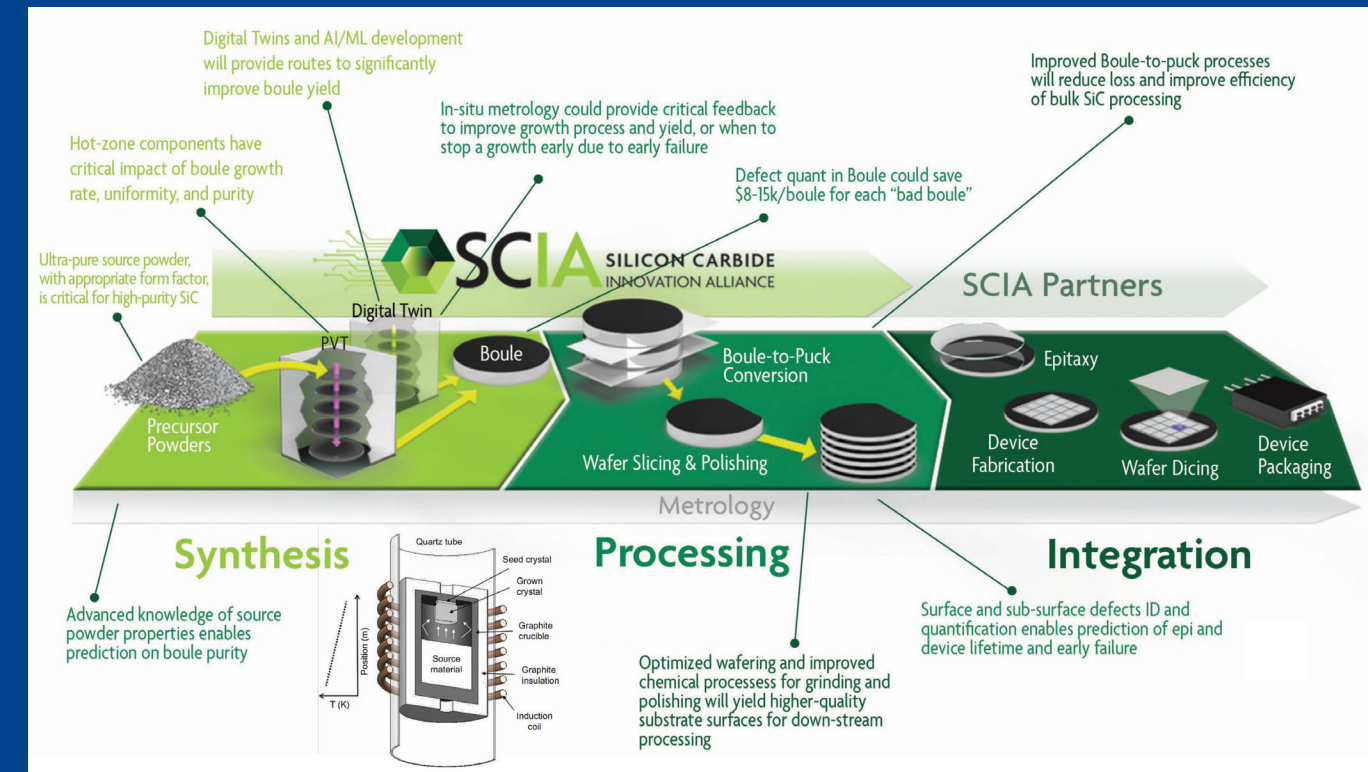
Q: How are you funded?

A: Penn State was awarded \$3 million from the Air Force Office of Scientific Research to purchase the needed equipment for the alliance and has partnered with onsemi to establish the onsemi Silicon Carbide Crystal Center (SiC3) that is supported by an \$8 million strategic collaboration. This was then followed by an additional



Silicon carbide (SiC) is vital for enabling efficiency in electric vehicles (EVs); EV charging and energy infrastructure; and contributes to the decarbonization of the global economy. Penn State and onsemi are partnering to develop next generation crystal growth research and to raise awareness about the increasing demand for tech jobs in the semiconductor industry that will also have a major impact on the energy transition.

Credit: Jennifer M. McCann



memorandum of understanding with Morgan Advanced Materials for a \$2 million collaboration. Finally, the SCIA is a member-based alliance, funded through industrial memberships that guide the research.

Q: What are your big goals?

A: The main objectives of the SCIA are to establish a growth, processing, and metrology research center that serves as a national resource for advancing SiC crystal science; to establish an academic and industry ecosystem that accelerates SiC R&D in a synergistic manner to all participants; to establish training protocols for SiC crystal growth, processing, and metrology for all academic levels and develop a workforce development (WFD) pipeline for SiC growth, processing, and metrology; and to develop a curriculum ensemble for undergraduate and graduate students to acquire certificates or academic minors focused on SiC and wide bandgap semiconductor theory and experiment.

Q: How do you plan to accomplish these goals?

A: The goals of the research will be accomplished through partnerships with industry leaders in this semiconductor space.

Q: Why is this research so important?

A: Silicon carbide (SiC) is vital for enabling efficiency in electric vehicles (EVs); EV charging and energy infrastructure; and contributes to the decarbonization of the global economy. Academic research in SiC made significant advancements in the late 1990s and early 2000s but has since diminished in the United States. This alliance will put SiC crystal research in America back on the map.

Q: What makes this research new/different/innovative?

A: The SCIA will be the only one of its kind in the United States. There are no other centers or institutes or alliances of similar nature, giving Penn State a unique advantage to pushing the boundaries of research and WFD.

EMS Energy Institute INITIATIVE Q&A

Center for Critical Minerals (C²M)

Sarma Pisupati

The purpose of the Center for Critical Minerals (C²M) is to provide the science and technology needed for the commercial sector to reestablish a robust domestic supply chain for the country and the required training for the workforce. This is a multidisciplinary effort. Rather than looking at just one piece of the puzzle, C²M looks at the complete supply chain, from characterization, mining, processing, recovery, and making new materials.

Q: Who is leading this effort?

A: C²M is directed by Sarma Pisupati. However, the accomplishments of the center are a collective endeavor. There are a lot of faculty members who are brought together by the center to support this cooperative effort.

production of those goods, the U.S. was completely dependent on imports of twenty-one out of the fifty nonfuel commodities. C²M's overarching goal is to help industry establish a strong domestic supply chain that helps fulfill the country's needs, making the U.S. less reliant on imports.

Q: Where are you located?

A: C²M is housed in the EMS Energy Institute. Research labs that contribute to its research are spread throughout the institute's buildings and around campus.

Q: How do you plan to accomplish these goals?

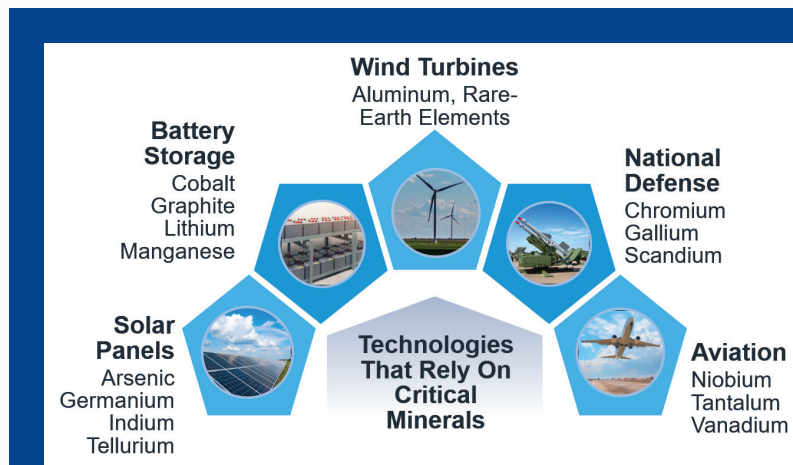
A: C²M's approach is a multidisciplinary and comprehensive one. We don't want to approach the problem from an environmental engineering standpoint, but incorporate geosciences, mineral processing, material sciences, engineering, and

Q: How are you funded?

A: Most of the funding for C²M is federal funding; however, there are industrial collaborations as well.

Q: What are your big goals?

A: C²M works to mitigate risk posed to the United States' dependency on raw and semi-finished materials for advanced manufacturing. In 2021, the U.S. produced an estimated \$90.4 billion worth of nonfuel materials. Those base materials were used in energy, medical, and defense applications along with consumer electronics. However, in



energy business economics as well, looking at multiple feedstocks, various methods, and numerous approaches to analyze what is economically feasible and give industry something they can use that will, in turn, reduce the taxpayer burden as well.

Q: Why is this research so important?

A: C²M's methodologies are not going to eliminate foreign dependence, but the goal is to reduce foreign dependence because that dependency poses a national security and economic risk if the U.S. does not begin to develop methods and technologies to create its own supply of critical materials.

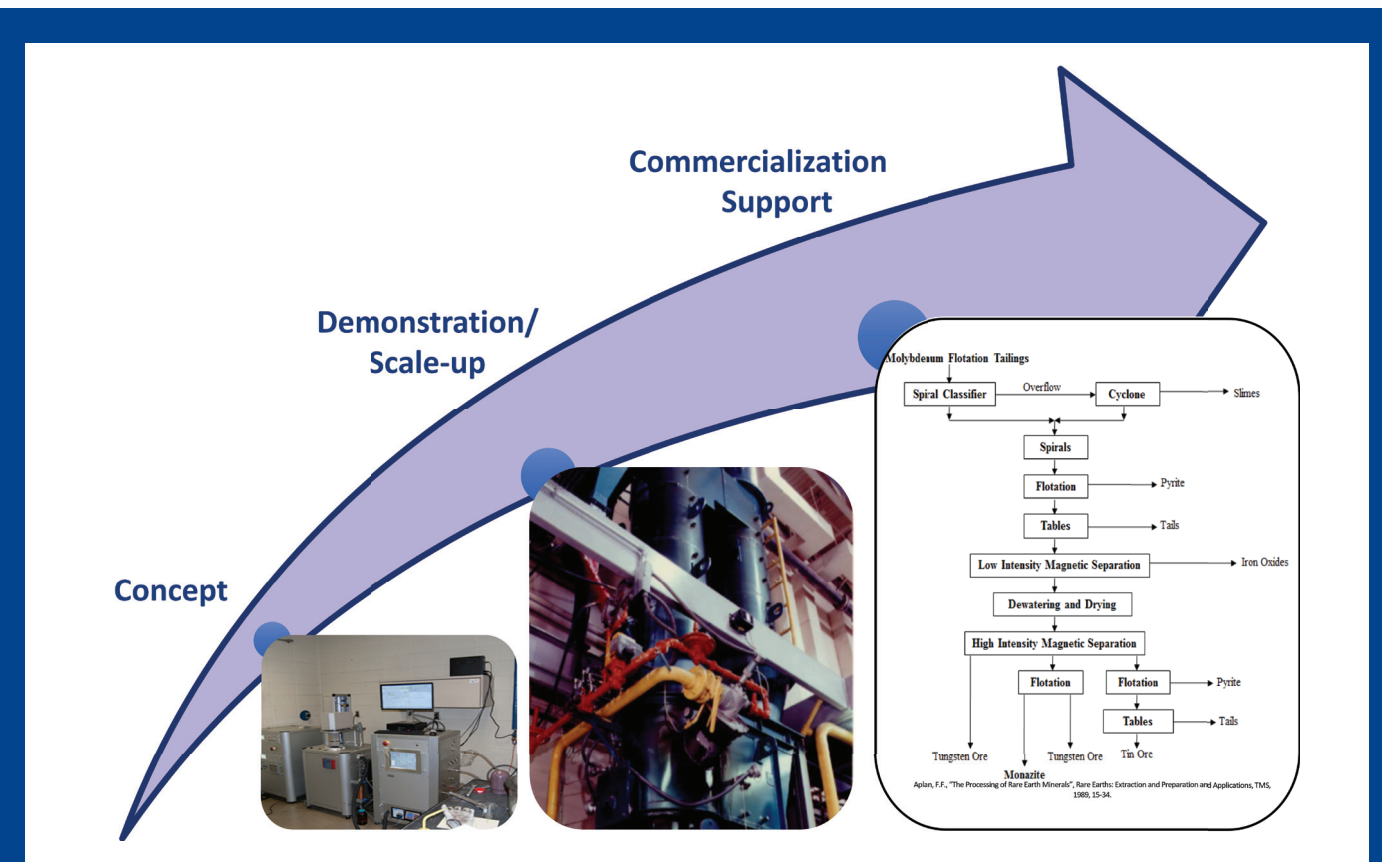
Q: What makes this research new/different/innovative?

A: C²M's approach is to treat polluted water, particularly acid-mine drainage, using a similar approach to pre-existing methods, so there are no significant additional capital requirements for modifications, but by replacing the environmentally

hazardous chemicals used in the extraction process with less harmful ones that will allow the researchers to not only treat polluted water, but also extract critical minerals, providing the domestic supply chain of those minerals.

Q: Is there anything else you'd like to share?

A: The uniqueness is that it is a multidisciplinary and multi-investigator, complete supply chain approach. Penn State is the only university where we have resource characterization, mining, mineral processing, material science, chemistry, chemical and mechanical engineering researchers, and energy and mineral economists work together for a techno-economic and environmentally sustainable solutions. That is the common thread that is unique. None of our competitors have that kind of capacity. C²M has the breadth and the depth to reestablish a robust domestic supply chain, including delivering final products that people can use.



EMS Energy Institute INITIATIVE Q&A

Subsurface Energy Recovery and Storage (SERS) Joint Industry Partnership (JIP)

Hamid Emami-Meybodi

The Subsurface Energy Recovery and Storage (SERS) JIP focuses on energy recovery from geological reservoirs, improved hydrocarbon recovery, and geo-storage of hydrogen and carbon dioxide (CO₂). The SERS JIP includes research topics in enhanced oil recovery, hydrocarbon production from unconventional reservoirs, hydrogen and carbon dioxide geo-storage, and geothermal energy. Related research projects use analytical, experimental, and numerical methods.

Q: Who is leading this effort?

A: The JIP is co-directed by Hamid Emami-Meybodi, Russell Johns, and Shimin Liu. The effort is led by Emami-Meybodi.

Q: Where are you located?

A: The JIP is operated through the EMS Energy Institute and the John and Willie Leone Family Department of Energy and Mineral Engineering. Research labs and faculty and student offices are in Hosler Building, Coal Utilization Lab, and Academic West.

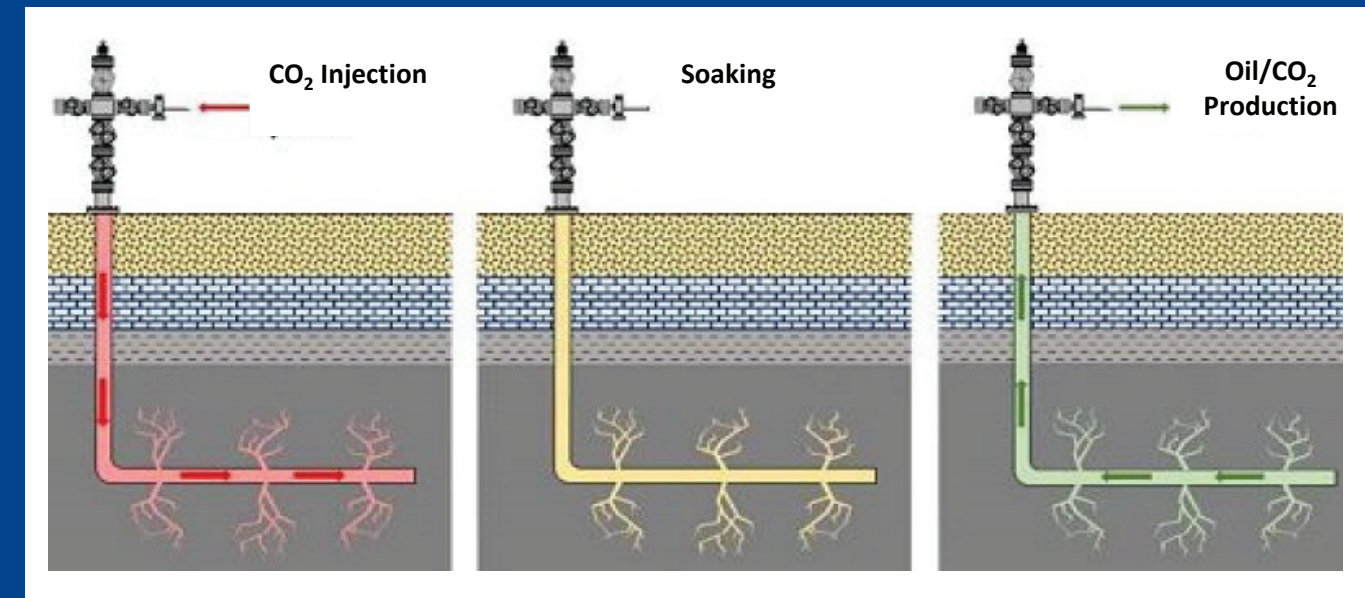
Q: How are you funded?

A: JIP members consist of industry partners—oil, gas, and energy companies—that pay annual membership fee of \$75K/yr.

Q: What are your big goals?

A: The JIP goals are to:

- Generate innovative short- and long-term analytical, numerical, and experimental research in improved geo-energy efficiency and storage and closely related areas.



- Recruit and train bright students for careers in the energy industry to ensure a viable and well-trained future workforce in petroleum engineering, subsurface energy engineering, and closely related disciplines.
- Create useful and practical software “toolkits” and disseminate research results via a central web page and annual meetings.
- Design and conduct specialized laboratory analyses for related applications.
- Build long-term and sustainable research capacity on selected research topics.

Q: How do you plan to accomplish these goals?

A: An advisory board comprised of the members of the SERS JIP has been established to provide recommendations on proposal requests, educational topics, and technology research and development projects related to the mission of SERS JIP.

Q: Why is this research so important?

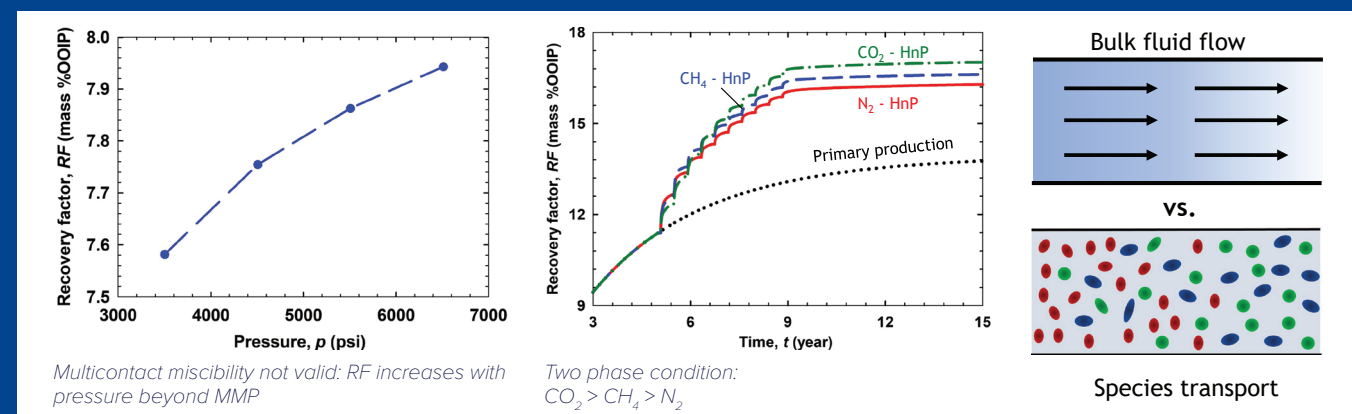
A: It is evident that subsurface energy resources, such as hydrocarbon reservoirs, will be needed for the foreseeable future even as the energy transition occurs. Engineering innovation will be essential to ensure these resources will be part of the solution for the energy transition.

Q: What makes this research new/different/innovative?

A: The JIP is one of the first of its kind worldwide in sustainable geo-energy production and storage with a focus on increasing energy efficiency and reducing emissions. Because some countries and companies will forego the exploration of new subsurface energy resources, this JIP will develop new technologies to maximize energy recovery from new and mature fields. The JIP also considers how to maximize CO₂ storage during and potentially after hydrocarbon depletion. Hydrogen storage and geothermal energy present new challenges in subsurface engineering as well.

Q: Is there anything else you'd like to share?

A: Membering companies share the risks for conducting high-risk, high reward projects though the JIP. Through combining expertise and resources of multiple co-directors and companies, the JIP members can effectively manage and mitigate risks throughout the projects. Members have ease of access to updated versions of the most advanced toolkits available in the topic areas. Members will also have ease of access to laboratory services, such as routine and special reservoir rock characterization and testing.



Multicontact miscibility not valid: RF increases with pressure beyond MMP

Two phase condition: CO₂ > CH₄ > N₂

EMS Energy Institute INITIATIVE Q&A

Repurposing Center for Energy Transition (ReCET)

Arash Dahi Taleghani

ReCET is a new center for repurposing fossil energy infrastructure for energy transition applications. Its mission is to lead in the creation of high-impact, scientifically driven solutions that transcend traditional disciplinary boundaries and transform the trajectory of our world, focusing on subsurface innovations for a sustainable future. It strives to bridge the gap between knowledge and action in geothermal energy, underground pumped hydro storage, hydrogen storage, carbon sequestration, and more.

Q: Who is leading this effort?

A: The center is led by Arash Dahi Taleghani. Zhen Li is the associate director.

Q: Where are you located?

A: ReCET is based in the EMS Energy Institute. Research labs that contribute to their efforts are housed within the institute and around campus.

Q: How are you funded?

A: ReCET has received initial funding from the Department of Energy and Mineral Engineering, the College of Earth and Mineral Sciences, the Institute of Energy and the Environment, and the Office of the Senior Vice President for Research at Penn State. Additionally, it has an externally funded project from the U.S. Department of Energy that is currently in the negotiation stage.

Q: What are your big goals?

A: Through rigorous research and innovation, the center hopes to develop cutting-edge subsurface technologies that drive the transition to convert fossil energy infrastructure into clean energy while ensuring fair access and benefits for all

communities. In addition to this research, it is committed to an active outreach initiative. It aims to educate and engage the broader community, fostering understanding and support for sustainable practices. Its outreach program includes partnerships with local schools, workshops for industry professionals, and public workshops on the importance of repurposing solutions for a greener planet. It also plans to work with policymakers to inform regulations and policies that protect our environment.

Q: How do you plan to accomplish these goals?

A: Repurposing mines and oil and gas wells uses existing underground infrastructure for renewable, clean energy technologies. However, each site needs a thorough assessment for technical, environmental, and economic feasibility, requiring multidisciplinary research teams to work on different aspects of such projects such as drilling, cementing and wellbore integrity, geological evaluations, reservoir characterization, seismic monitoring, risk assessment, decision analysis, policy analysis, and project economics. In parallel

with efforts to reuse existing infrastructures, the center will also revisit existing technologies in the oil and gas industry and adapt them to be reutilized in challenging subsurface environments such as for hydrogen storage, carbon sequestration, and geothermal production.

Q: Why is this research so important?

A: Pennsylvania has many abandoned mines and about 300,000 abandoned oil and gas wells. Each of these mines or wells may have associated infrastructure in place. These fossil energy assets have historically provided employment opportunities for nearby communities. As we transition to a clean energy economy, it is crucial to revitalize the economies in these energy communities. The new center aims to develop innovative technologies and methodologies to repurpose existing fossil energy assets and infrastructure, both social and economic, into revenue-generating opportunities.

Q: What makes this initiative new/different/innovative?

A: This initiative stands out in several ways:

- Repurposing existing assets: Instead of building new infrastructure from scratch, ReCET aims to convert abandoned mines, oil and gas wells, offshore platforms, pipelines, and other fossil energy assets into facilities for renewable energy generation, energy storage, carbon sequestration, and mineral extraction.
- Multidisciplinary research: ReCET brings together experts from various disciplines, including drilling, geology, reservoir engineering, seismic monitoring, risk assessment, decision analysis, policy analysis, and project economics. This multidisciplinary approach is essential for addressing the technical, environmental, and economic feasibility of repurposing projects, ensuring comprehensive solutions.
- Adapting existing technologies: In addition to repurposing infrastructure, ReCET plans to adapt existing technologies from the oil and gas industry for new clean energy applications.



Credit: Adobe Stock

- Bridging knowledge and action: ReCET aims to bridge the gap between research and implementation by developing cutting-edge subsurface technologies that drive the conversion of fossil energy infrastructure into clean energy solutions.
- Community engagement and outreach: ReCET recognizes the importance of community engagement and plans to educate the broader community through partnerships with local schools, workshops for industry professionals, public workshops, and interfacing with policymakers to inform regulations and policies.

Q: Is there anything else you'd like to share?

A: ReCET is a multidisciplinary endeavor that brings together faculty members with diverse expertise and backgrounds to address the environmental challenges while reviving the economies of energy communities affected by the transition to less carbon-intensive industries. Our mission is to ensure that the climate benefits derived from repurposing abandoned fossil energy assets are accompanied by tangible social and economic benefits for these communities. By using the collective knowledge and skills of our team, we aim to develop holistic solutions that not only mitigate environmental impacts but also support the well-being and prosperity of the very communities that have historically driven our nation's energy landscape.

Welcome New Faculty and Staff

The EMS Energy Institute welcomes the following new members who have joined the Institute since our last publication. Detailed profiles can be found at energy.psu.edu.

FACULTY



Thandazile Moyo
Assistant Professor

Moyo is an assistant professor in the John and Willie Leone Family Department of Energy and Mineral Engineering and a co-funded faculty in the Materials Research Institute. She is experienced in the hydrometallurgical processing of gold and base metals. Her research interests are developing flowsheets and testing green technology for metal recovery from primary and secondary resources. Some of her research uses electrochemistry and electroanalytical tools to study surface reactions in mineral dissolution. Beyond the purely technical, Moyo is passionate about the sustainable development of mineral resources and researches the long-term impacts of mineral extraction. She researches artisanal and small-scale mining, looking at the technological challenges and the sector's contributions to sustainable development. Before she joined Penn State, Moyo completed her doctoral degree in chemical engineering at the University of Cape Town. She worked as a researcher, focused on flowsheet development and testing for metal recovery from waste polychlorinated biphenyls, and co-developed and taught courses on sustainability in minerals extraction at undergraduate and postgraduate levels.



Olumide Samuel Ogunmodimu
Assistant Professor

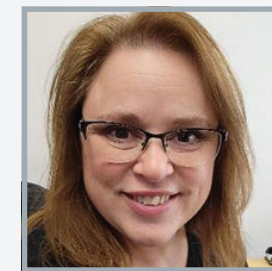
Ogunmodimu is an assistant professor in the John and Willie Leone Family Department of Energy and Mineral Engineering, with roles in the EMS Energy Institute, Institute for Computational and Data Sciences, and the Materials Research Institute. With an academic foundation in physics and solar, advanced degrees in energy studies, and a doctorate in chemical engineering from the University of Cape Town, South Africa, his expertise lies in comminution and classification in mineral processing. Before joining Penn State, he gained experience as a research fellow at the University of Cape Town and the University of Queensland's Julius Kruttschnitt Mineral Research Centre. His research spans the full spectrum of mineral processing, particularly emphasizing the detailed study of granular flow modeling to enhance energy efficiency and sustainability within the mineral processing value chain. Utilizing cutting-edge techniques like positron emission particle tracking and advanced mathematical and computational models, Ogunmodimu is dedicated to advancing mineral processing and materials science, aiming for more sustainable and efficient methodologies.

STAFF



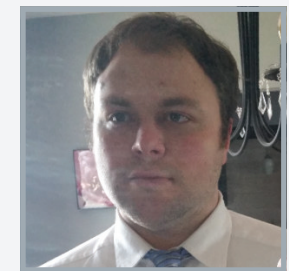
Jeralyn Brewer
Multimedia Specialist

Brewer joined the EMS Energy Institute in January 2024. She has experience in various areas of graphic and digital design. She currently creates print and digital materials, including flyers, posters, brochures, slides, and more. Prior to joining the institute, Brewer worked in the news media business. She has a bachelor of science degree in geography.



Aime Jones
Administrative Assistant

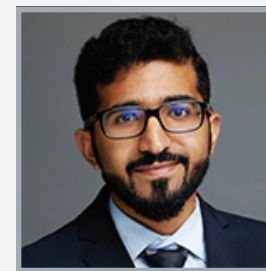
Jones joined the institute in November 2023. Before starting in her current role, she worked beginning in April 2023 in the College of Information Sciences and Technology. She studied labor and human resources at Penn State.



Colin Minnick
Research Assistant

Minnick joined the institute as a research assistant in December 2023. He holds a bachelor of science degree in mechanical engineering technology from Penn State.

RESEARCHERS



Faras Al Balushi
Post-doctoral Scholar

Al Balushi joined Penn State as a postdoctoral scholar in the Arash Dahi Taleghani research group in January 2024. He received his bachelor of science, master of science, and doctorate degrees, all in petroleum and natural gas engineering, from Penn State. His research interests include multiscale—pore-, particle-, and field-scale—modeling of subsurface systems for applications in oil and gas and geothermal reservoirs. His doctoral research focused on finding an innovative solution for thermal breakthrough in enhanced geothermal systems and performing sensitivity and feasibility analyses to determine the effectiveness of the developed approach.



Livio Yang Santos
Post-doctoral Scholar

Yang Santos joined Penn State as a postdoctoral scholar in the Arash Dahi Taleghani research group. His research interests include expandable proppants for hydraulic fracturing.

RECENT AND UPCOMING EVENTS

2024 EXTERNAL REVIEW

On April 22-24, 2024, the institute was evaluated by an external panel of experts as part of a mandatory eight-year review cycle. This review's objective was to evaluate the institute within an international and national context of education and service and to provide constructive feedback on institute plans. This could include examining the institute's short-term and long-term goals, the educational experience of graduate and undergraduate students, research accomplishments, service requirements, organization, facilities, and resource allocation decisions.

Our external visiting panel consisted of four experts:

- Franklin (Lynn) Orr, Jr., Keleen and Carlton Beal Professor of Petroleum Engineering, Emeritus, Stanford University
- Rodney Andrews, Associate Vice President for Research and Development, Director of Center for Applied Energy Research, and Professor of Chemical and Materials Engineering, University of Kentucky
- Liang-Shih Fan, Distinguished University Professor, C. John Easton Professor in Engineering, and Professor of Chemical and Biomolecular Engineering, The Ohio State University

- Laura J. Pyrak-Nolte, Distinguished Professor of Physics and Astronomy, and Director, Rock Physics Research Group, Purdue University

During their visit, Lee Kump, the John Leone Dean in the College of Earth and Mineral Sciences, and Sanjay Srinivasan, institute director, welcomed the external visiting panel. They were presented with a focused self-study prepared by the institute, and, during the review, the external visiting panel had meaningful interactions with faculty, staff, and graduate students. Some of these were in the form of individual meetings and some were in the form of judiciously selected groups. The panel also toured the institute's facilities. On the final day, the panel members prepared a report from the visit with commendations and recommendations.

External reviews are essential elements in improving the overall quality of education, research productivity and connectivity, and faculty service at the University, and the institute would like to thank the reviewers for their time and thoughtful advice to best advance our goals and mission.

Critical minerals' role in green energy topic of 2024 Shoemaker Lecture

Edward C. Dowling Jr., president and chief executive officer and board of directors' member at Compass Minerals, gave the 2024 G. Albert Shoemaker Lecture in Mineral Engineering at Penn State. His talk, "*Challenges and Opportunities of the Critical Minerals Revolution*," was held on April 19, in the Hub-Robeson Center's Freeman Auditorium and online via Zoom. A reception followed in Alumni Hall.

The lecture focused on the realities of climate change and how the global need to transition to non-carbon-emitting energy generation, distribution, and utilization creates fundamental national security implications. The transition also drives an order of magnitude demand increase for various critical and essential minerals. Dowling discussed how significant



Edward C. Dowling Jr.

Credit: Provided

increases in critical and essential mineral production are strategically vital to achieving the desired green energy transition. His lecture presented the scale of critical and essential mineral requirements and focused on the many technical, human resource, jurisdictional, financial, environmental social, and governance challenges and opportunities that the mining industry faces.

Benefits, risks of a more electrified world discussed at recent workshop



Credit: Pixabay

A workshop focusing on the rise of cross-border electricity interconnections—and the high-stake challenges they introduce—was held on April 15, in 603 Barron Innovation Hub. The workshop was also available online via Zoom.

Moderated by Chiara Lo Prete, associate professor of energy economics at Penn State, the workshop, "*The Geopolitics of Cross-border Electricity Grids*" featured a twelve-person panel of policy and academic experts who discussed the implications of increased international electricity trade implications in Europe, Asia, Africa, and Latin America, as well as the impact on research.



Tour of labs during the EMS Energy Institute open house.

Credit: Jennifer Matthews

PENN STATE EMS ENERGY INSTITUTE OPEN HOUSE

The Penn State EMS Energy Institute hosted an open house from 4-7 p.m. on September 27, 2023, on the Penn State University Park campus to introduce faculty, staff, and students to new director Sanjay Srinivasan and to discuss the path of the institute.

The event began with a presentation led by Srinivasan and Bruce Miller, associate director of the institute. Miller presented an overview of the institute with a historical timeline and an overview of the types of fundamental and applied research performed, strategic program areas, and a breakdown of personnel and funding.

Srinivasan highlighted the benefits of being affiliated with the institute and his plans for the institute's future, which include fostering collaboration, identifying and supporting

niche areas, and leveraging resources to better support researchers. He hopes to build a vibrant student community, promote professional development opportunities, and advance students' research writing and presentation abilities. In addition, he wants to build a stronger infrastructure that better supports collaboration with industry, national laboratories, and other research organizations.

Participants were also led on a tour of several laboratories to get a better look at facilities and research being conducted at the institute. The labs highlighted included some used for critical minerals research, shared analytical labs, and pilot-scale facilities.

<https://www.energy.psu.edu/ei-open-house-2023>

Energy Exchange Seminar Series

Energy Exchange is a seminar series hosted by the EMS Energy Institute as part of its outreach mission. The seminars focus on highly relevant energy topics. Energy topics discussed include new innovations in carbon dioxide utilization, clean coal, petroleum and natural gas, fuel cells, and more. Speakers include Penn State faculty as well as government and industry professionals. The Energy Exchange Seminar Series will return in the fall. Please check our website often for updates: energy.psu.edu

This year's speakers were:

Eugene Morgan

Associate Head for Undergraduate Education, Undergraduate Program Chair of Energy Engineering, Associate Teaching Professor, in the John Leone Family Department of Energy and Mineral Engineering

"CO₂-SMART: A New Industry-University Collaborative Research center for CO₂ Storage Modeling, Monitoring, Analytics, and Risk Reduction Technologies"

February 8, 2024

Erica Smithwick

Director of the Earth and Environmental Systems Institute and Distinguished Professor of Geography

"Penn State's Climate Consortium: Partnerships for People and the Planet"

March 14, 2024

Sarma Pisupati

Professor of Energy and Mineral Engineering, Chemical Engineering, and Director of the Center for Critical Minerals (C²M)

"Mineral Security Challenges in Meeting the Goal of Net-Zero Carbon Emissions by 2050"

March 28, 2024

Thandazile Moyo

Assistant Professor of Energy and Mineral Engineering

"Integrating Sustainability in Minerals and Energy Resource Extraction Education"

April 18, 2024

Joshua Robinson

Acting Associate Dean for Graduate Education and Research and Professor of Materials Science and Engineering

"Silicon Carbide: The Critical Semiconductor for the Energy Transition"

May 9, 2024

energyXchange
a seminar series
on energy science
and technology

ENERGY INSTITUTE NEWS

Machine learning to monitor stored carbon dioxide saves cost and time, researchers report



Carbon sequestration could potentially bridge some areas of transportation and manufacturing that are more difficult to shift to carbon neutral sources because the greenhouse gases can be stored deep in the earth. Yet the technology is costly. New work from researchers at Penn State demonstrates that machine learning could greatly reduce the long-term costs of monitoring carbon sequestration sites. Credit: Pixabay

Incorporating field data for the first time, researchers at Penn State demonstrated machine learning can be a powerful and cost-effective tool for monitoring sequestered carbon dioxide, overcoming a hurdle for the burgeoning technology aimed at combating climate change.

<https://bit.ly/4aEudw2>

\$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.

<https://bit.ly/44zglBC>



An acid-mine sludge pond in central Pennsylvania. A byproduct of coal mining, such sites may be rich with critical minerals. Credit: Provided by Sarma Pisupati

Penn State, Morgan Advanced Materials partner to improve semiconductor materials

Penn State and Morgan Advanced Materials have signed a memorandum of understanding to catalyze research and development of silicon carbide, known as SiC, a semiconductor material that operates more efficiently at

high voltages than competing technologies. This agreement includes a new five-year, multimillion-dollar initiative and a commitment by Morgan to become a founding member of the recently launched Penn State Silicon Carbide

Innovation Alliance, as well as to supply the graphite materials and solutions needed for SiC development to Penn State for use by internal and external partners. The initiative is a coalition of industry leaders, academic institutions, and government support led by Joshua Robinson, professor of materials science and engineering and acting associate dean for research in Penn State's College of Earth and Minerals Sciences.



Morgan Advanced Materials visited Penn State recently to sign a memorandum of understanding. Credit: Christie Clancy/Penn State

<https://bit.ly/49BXOWk>

Carbon sequestration and mineralization

Addressing the incontrovertible risks of climate change requires deep decarbonization. In addition to green measures like upscaling renewables and improving energy efficiency, there is broad scientific consensus that large-scale carbon capture and sequestration (CCS) remains critical to limiting global temperature rise below 2° Celsius. CCS involves capturing carbon dioxide from a point source or directly from the air; compressing and transporting it via a pipeline; and storing it deep underground or utilizing it as a feedstock or agent in another industrial process.

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Stock image

Credit: Unknown

Pennsylvania's mine waste could play an important role in the nation's green-energy future

Critical minerals, including rare earth metals, are vital components of our consumer goods, national defense, and emerging green-energy technologies, but the U.S is heavily dependent on imports for an adequate supply. Penn State researchers are looking for ways to tap Pennsylvania's coal mine waste as a domestic source for these materials and reduce environmental pollution at the same time.

<https://bit.ly/3R6nbJs>



A core sample of clay in the lab. The Mercer Clay, a large deposit in central Pennsylvania, may be a secondary source of the battery metal lithium. Credit: Patrick Mansell



Credit: Penn State



Experimental set-up in Sarma Pisupati's lab for extracting and separating critical minerals from acid mine drainage. Credit: Patrick Mansell

Hydrogen battery: Storing hydrogen in coal may help power clean energy economy

The quest to develop hydrogen as a clean energy source that could curb our dependence on fossil fuels may lead to an unexpected place—coal. A team of Penn State scientists found that coal may represent a potential way to store hydrogen gas, much like batteries store energy for future use, addressing a major hurdle in developing a clean energy supply chain.

<https://bit.ly/3VIRgWT>

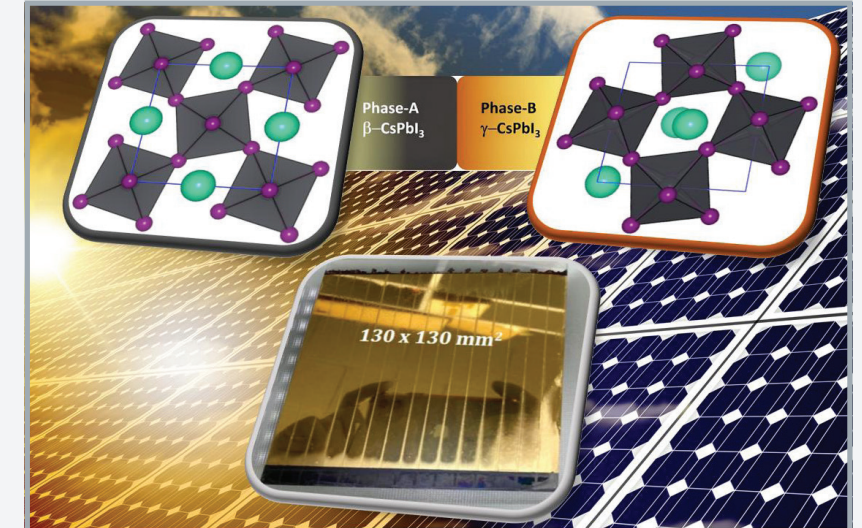


A Penn State researcher holds a large piece of coal.

Credit: Penn State

Scientists develop new method to create stable, efficient next-gen solar cells

Next-generation solar materials are cheaper and more sustainable to produce than traditional silicon solar cells, but hurdles remain in making the devices durable enough to withstand real-world conditions. A new technique developed by a team of international scientists could simplify the development of efficient and stable perovskite solar cells, named for their unique crystalline structure that excels at absorbing visible light. The scientists, including

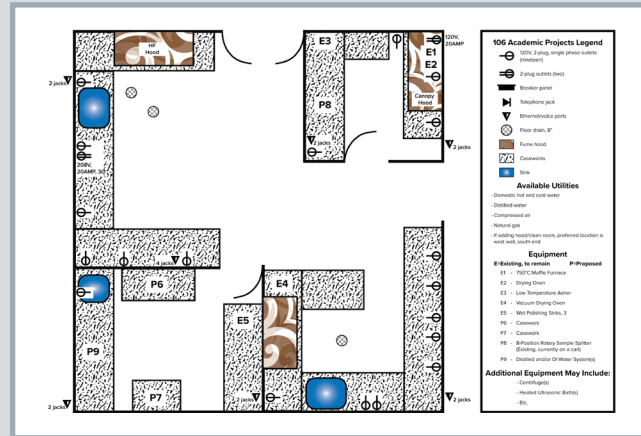


An international research team, including Penn State faculty Nelson Dzade, reported a new method for creating more durable solar cells that still achieve high efficiency for converting sunlight to electricity. Credit: Provided by Nelson Dzade

Penn State faculty Nelson Dzade, reported in the journal *Nature Energy* their new method for creating more durable perovskite solar cells that still achieve a high efficiency of 21.59% conversion of sunlight to electricity.

<https://bit.ly/3V4rp5g>

RECENT UPGRADES



New Lab Spaces

We are pleased to announce the creation of new shared laboratories. These labs boast state-of-the-art equipment, including relocated gas chromatography-mass

spectrometers, surface analyzers, and thermogravimetric analyzers. Additionally, a dedicated sample preparation area featuring centrifuges, ovens, and grinding and polishing equipment is now available for researchers' use.

Student Engagement

To enhance the graduate student experience, we launched professional development and student engagement opportunities. This includes workshops, seminars, career skills training, and hands-on training, as well as new collaborative lounges for graduate students across two locations to foster more open communications and collaborations.



Seminar Series

We're excited to announce the return of our Energy Exchange Seminar Series after an eight-year hiatus. These seminars delve into critical energy issues of today. We have had discussions on cutting-edge advancements in carbon capture and utilization, clean coal technologies, the latest in oil and gas exploration, fuel cell development, and more. Our speakers are a distinguished group, featuring Penn State faculty alongside experts from government agencies and industry leaders.



New Signage

We've been busy making improvements to the EMS Energy Institute facilities to improve your next visit. This includes clearer signage to help you find us more easily, a modernized lobby with a large information display and searchable people locator and upgraded conference rooms, and more than seventy new posters throughout our buildings to display our ongoing research and initiatives. We're confident these changes will make your experience at the institute smoother and more efficient.

SPRING 2024 SEMINAR SERIES



Thandazile Moyo
Assistant Professor of Energy and Mineral Engineering
John and Willie Leone Family Department of Energy and Mineral Engineering

Integrating Sustainability in Minerals and Energy Resource Extraction Education

It is recognized that the transition to clean energy will require significant volumes of minerals, which in the immediate future will be supplied through primary mining. Future energy scenarios going into the next few decades reflect an energy mix that remains blended, with renewables growing in dominance but fossil fuels remaining a key contributor. Extraction, particularly mining, suffers a poor public image and is seen as dirty, non-innovative, and outdated. However, the role of extraction in sustainability has never been stronger, but challenges remain in integrating sustainability and responsible extraction into the education curriculum. Broadly speaking, education for sustainable development (ESD) provides the knowledge, skills, values, and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, inequality, etc. In this seminar, Moyo will talk about opportunities and experiences in teaching sustainability in mineral and energy resource extraction, and why sustainability literacy is a knowledge gap for the future workforce.

APRIL 18
4 p.m.* – 5 p.m.

Coffee • Snacks • Connections

EMS ENERGY INSTITUTE
C213 Coal Utilization Laboratory



EMS Energy Institute

* Parking is available at the Institute at 4 p.m.

www.energy.psu.edu

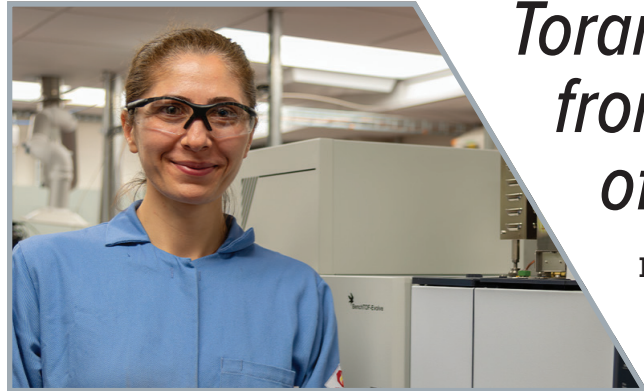


Energy Institute

Persons with disabilities who anticipate needing accommodations or who have questions about physical access may contact Jennifer Matthews at jmatthews@psu.edu in advance of the talk.

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HONORS AND AWARDS



Hilal Ezgi Toraman, assistant professor of energy engineering and chemical engineering at Penn State, in research lab. Credit: Courtney Robinson / Penn State

Toraman receives recognition from the American Institute of Chemical Engineers

Hilal Ezgi Toraman, assistant professor of energy engineering and chemical engineering, was selected as a "Pioneer of Catalysis and Reaction Engineering (CRE)" by the CRE division of the American Institute of Chemical Engineers.

<https://bit.ly/3R4tL2Y>

Petroleum engineering faculty receive regional achievement awards

The Society of Petroleum of Engineers (SPE) has recognized three faculty members of the John and Willie Leone Family of Energy and Mineral Engineering (EME) for their exceptional service and leadership, as well as their significant professional contributions within their technical disciplines at the regional level.

- **Hamid Emami-Meybodi**, associate professor of petroleum of natural gas, was awarded the Distinguished Achievement Award for Petroleum Engineering Faculty for his superior teaching, excellence in research, significant contributions to the profession, and special effectiveness in advising and guiding students.
- **Luis Ayala**, William A. Fustos Family Professor in Energy and Mineral Engineering, was awarded the Regional Service Award for contributions to the



Hamid Emami-Meybodi, chair and associate professor of Petroleum and Natural Gas Engineering, Zuleima Karpyn, associate dean for graduate education and research at the College of Earth and Mineral Sciences and Donohue Family Professor of Petroleum and Natural Gas Engineering and Luis Ayala, William A. Fustos Family Professor in Energy and Mineral Engineering. Credit: Courtney Robinson / Penn State

SPE mission that exhibits an exceptional devotion of time, effort, thought, and action.

- **Zuleima Karpyn**, associate dean for graduate education and research at the College of Earth and Mineral Sciences and Donohue Family Professor of Petroleum and Natural Gas Engineering, was awarded the Reservoir Description and Dynamics Award for her outstanding achievement and contributions to the advancement of petroleum engineering in reservoir technology.

<https://bit.ly/4bDC5Pp>

Energy and mineral engineering doctoral candidate awarded fellowship grant



Younes Shekarian, doctoral degree candidate in the John and Willie Leone Family Department of Energy and Mineral Engineering. Credit: David Kubarek / Penn State

Younes Shekarian, a doctoral degree candidate in the John and Willie Leone Family Department of Energy and Mineral Engineering received the SME Ph.D. Fellowship grant from the Society for Mining, Metallurgy and Exploration (SME). The award helps support exceptional doctoral students who are seeking a career in academia.

<https://bit.ly/454bZCN>

Ezgi Toraman named to Chemical & Engineering News' 'Talented 12' list

Ezgi Toraman, assistant professor of energy and mineral engineering and chemical engineering at Penn State, is one of twelve early-career scientists named to Chemical & Engineering News' (C&EN) 2023 "Talented 12" list that highlights early-career researchers in the chemical sciences who are fearlessly tackling difficult global problems. Toraman was selected for her research in technologies that turn waste into fuels, chemicals, and other products.

<https://bit.ly/4aLAVOT>



Ezgi Toraman, assistant professor of energy and mineral engineering and chemical engineering at Penn State, is one of 12 early-career scientists named to Chemical & Engineering News' (C&EN) 2023 "Talented 12" list. Credit: C&EN

Srinivasan named to the 2023 Energy & Environment Power 100 list

Ever since America's first commercial oil well began gushing in Pennsylvania in 1859, the state has profited from a robust energy industry. More recently, conservation and green-energy organizations have sprouted across the commonwealth's three-quarters-rural landscape, pushing Pennsylvania to diversify into wind, solar, and other renewable resources. Whether drilling shale, promoting green alternatives, or keeping the power grids stable, the people on the 2023 Energy & Environment Power 100 list are all helping to write Pennsylvania's sustainable next chapter.

<https://bit.ly/4aEec9n>



Sanjay Srinivasan

Credit: Penn State

Penn State professor awarded technical honor from Society of Petroleum Engineers



Russell Johns, professor of petroleum and natural gas engineering at Penn State, was selected to receive the 2023 SPE/AIME Anthony F. Lucas Gold Medal from the International Society of Petroleum Engineers (SPE) for technical leadership. Credit: Penn State

Russell Johns, professor of petroleum and natural gas engineering, was selected to receive the 2023 SPE/AIME Anthony F. Lucas Gold Medal from the International Society of Petroleum Engineers (SPE) for technical leadership. The medal is SPE's highest international technical award. Johns received the award at the 2023 SPE Annual Technical Conference and Exhibition October 16-18, 2023, in San Antonio, Texas.

<https://bit.ly/4bWAaF5>

EMS doctoral alum receives national 2023 Rong Yu Wan Ph.D. Dissertation Award

Behzad Vaziri Hassas received the 2023 Rong Yu Wan Ph.D. Dissertation Award in Metallurgical Engineering from the Society for Mining, Metallurgy, and Exploration. Hassas, who earned his doctorate in energy and mineral engineering from Penn State last year, was recognized for his dissertation, "Process development for selective separation of critical elements from secondary resources."

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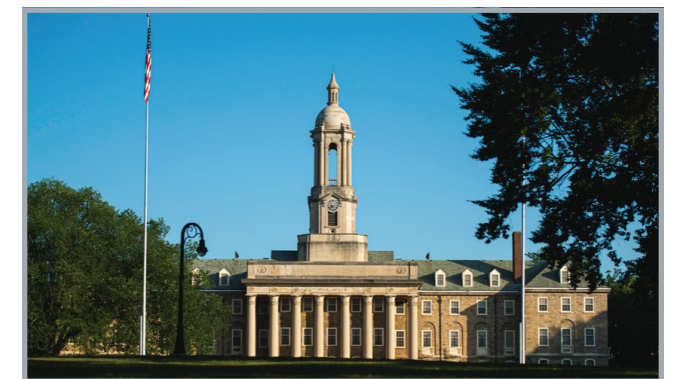
Behzad Vaziri Hassas received the 2023 Rong Yu Wan Ph.D. Dissertation Award in Metallurgical Engineering from the Society for Mining, Metallurgy, and Exploration. He was recognized for his dissertation, "Process development for selective separation of critical elements from secondary resources." Credit: Penn State

Pisupati named fellow of the Indian Institute of Chemical Engineers

Sarma Pisupati, professor of energy and mineral engineering, professor of chemical engineering, and director of the Center for Critical Minerals, was recently elected as a fellow of the Indian Institute of Chemical Engineers. The induction ceremony was held in Kolkata, India on December 27, 2023.

Karpyn named recipient of 2023-24 U.S. Fulbright Scholar award

Eleven Penn State faculty, including **Zuleima Karpyn**, have received Fulbright Scholar Awards for the 2023-24 academic year, according to the Fulbright U.S. Scholar Program. The Fulbright U.S. Scholar Program is the U.S. government's flagship international educational exchange program. Through the program, Penn State faculty members, staff, and administrators have opportunities to conduct advanced research, teach, or do both, and attend seminars



Old Main on Penn State's University Park campus. Credit: Michelle Bixby / Penn State

abroad. The program also gives recipients the opportunity to interact with and impact their host communities during their Fulbright tenure.

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END OF YEAR AWARDS

WILSON AWARDS

25-Year Service Award



Jonathan Mathews, professor of energy and mineral engineering

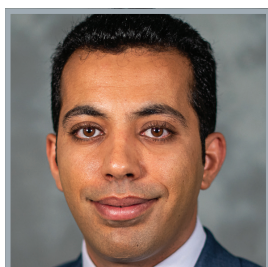
Promotion and Tenure



Shimin Liu, professor of energy and mineral engineering



Amin Mehrabian, associate professor of petroleum and natural gas engineering



Mohammad Rezaee, associate professor of mining engineering

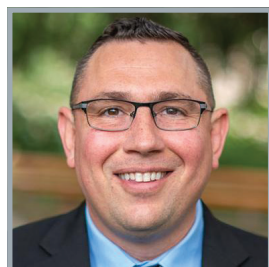


Mamoru Fujii, technician

DEPARTMENT OF ENERGY AND MINERAL ENGINEERING AWARDS

The 2022 and 2023 John and Willie Leone Family Department of Energy and Mineral Engineering awards banquets recognized students and faculty in the department. The banquet is held in conjunction with the G. Albert Shoemaker Lecture. EMS Energy Institute students who received awards are listed.

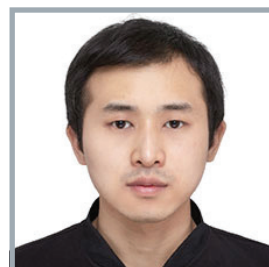
2024 EME Student Merit Awards



James W. Heim II



Madhav Patel



Shihua Han

Letter from the Director

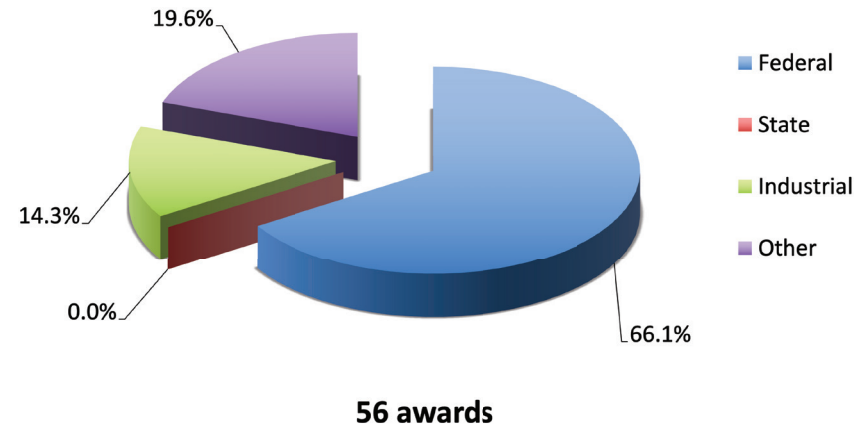
CONTINUED FROM PAGE 3

- The institute underwent an external review in April 2024. Several activities were initiated and completed in preparation for the review. These included:
 - Compilation of a self-study report. Although we decided to use much of the content in the report that was prepared in 2020 in preparation for the review that year, prior to it getting cancelled due to COVID-19, there were several items that needed to be revised and new sections added to highlight the future plans of the institute. We also added several new appendices to the report to highlight new initiatives, consortia, etc.
 - Complete overhaul of posters and displays throughout the institute. This was a major job that involved drafting, printing, and displaying about seventy new posters around the EI complex.
 - Sprucing up of laboratory facilities throughout the EI complex. As part of this effort, we have eliminated 98 percent of our old chemical inventory. In addition, we also went through the equipment in labs and tagged several old pieces of non-operational equipment to be hauled to salvage.
 - Commissioned two new laboratories with shared analytical equipment. We accomplished this by relocating some of the gas chromatography-mass spectrometers, surface analyzers, and thermogravimetric analyzers and equipment that were sitting idle in single principal investigator's labs into a shared lab. In addition, we have also created a sample preparation area with centrifuges, ovens, grinding and polishing equipment, etc.
 - Cleaned out and created new laboratory spaces for research into plastics recycling and for creating a database of reaction kinetics for catalyst-aided low temperature oxidation, hydrogen storage in reservoir environments, mineral extraction, and optimization of energy usage for mineral comminution.
 - Established an advisory board for the EMS Energy Institute consisting of members representing the various activities in the institute. This outstanding group of industry thought leaders and top-notch research managers in research labs are anxious to help the institute formulate its vision and engage in strategic development in key areas pertaining to the energy transition.
 - Launched professional development activities for graduate students affiliated with the institute. This included the launch of a graduate seminar series that featured laboratory managers of major facilities on campus, a resume building session with a career planning professional, as well as a hands-on session focused on explaining the use of plastic, copper, and stainless-steel tubing with discussions on the use of Swagelok fittings. In addition to these activities, we have also invested some resources to create collaborative lounges for graduate students in two areas of the institute.
 - Engagement in several other minor projects focused on upgrading the EI facilities. That includes projects like improved signage to indicate the EI facilities, a revamped lobby with a large monitor that serves both as an information display unit as well as a searchable people locator, and improved conference room facilities. I am sure you will appreciate these changes during your next visit to the institute.
- Through all these activities, the institute has striven to provide top notch research support to all our affiliates. Whether it be helping projects with research accounting, ordering supplies and chemicals, aiding with organization of meetings, or assisting researchers in the setup of their lab, our staff remain committed to make these as streamlined and efficient as possible. They may be lean in number but large-hearted in their efforts to assist everyone affiliated with the institute. Together we will strive to attain even higher standards in service and efficiency.
- Sanjay Srinivasan
Director, EMS Energy Institute
Penn State

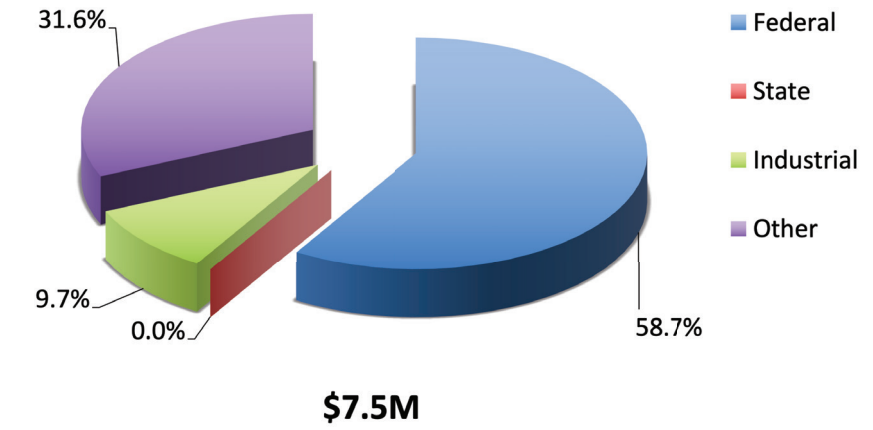
SUMMARY OF PROJECTS

AND FUNDING

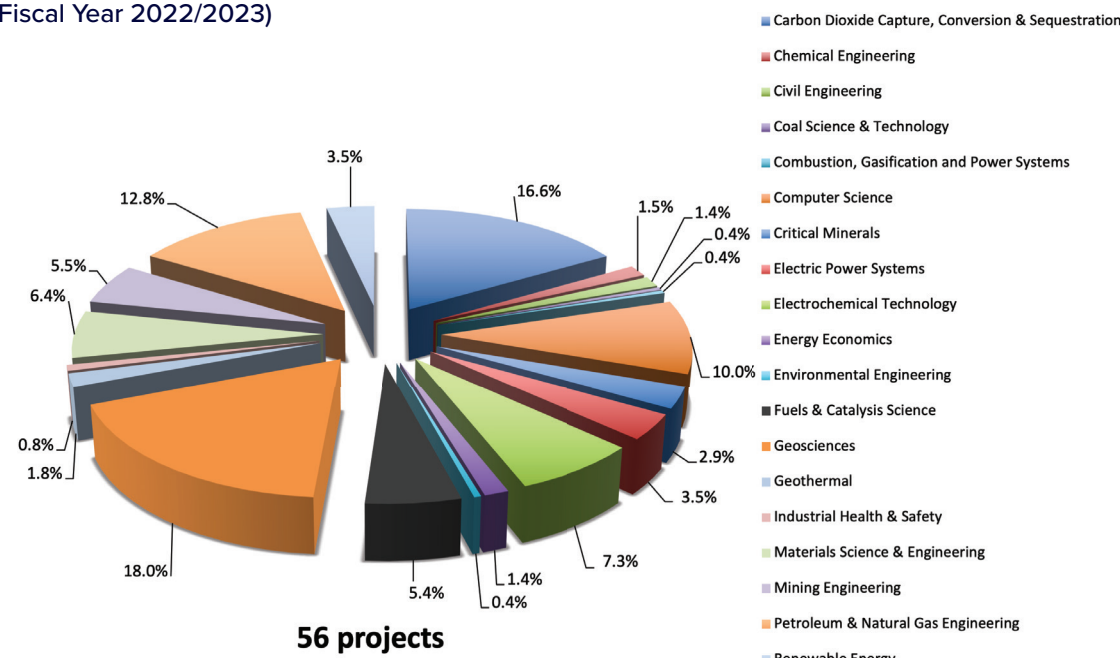
EMS Energy Institute Awards by Source
(Fiscal Year 2022/2023)



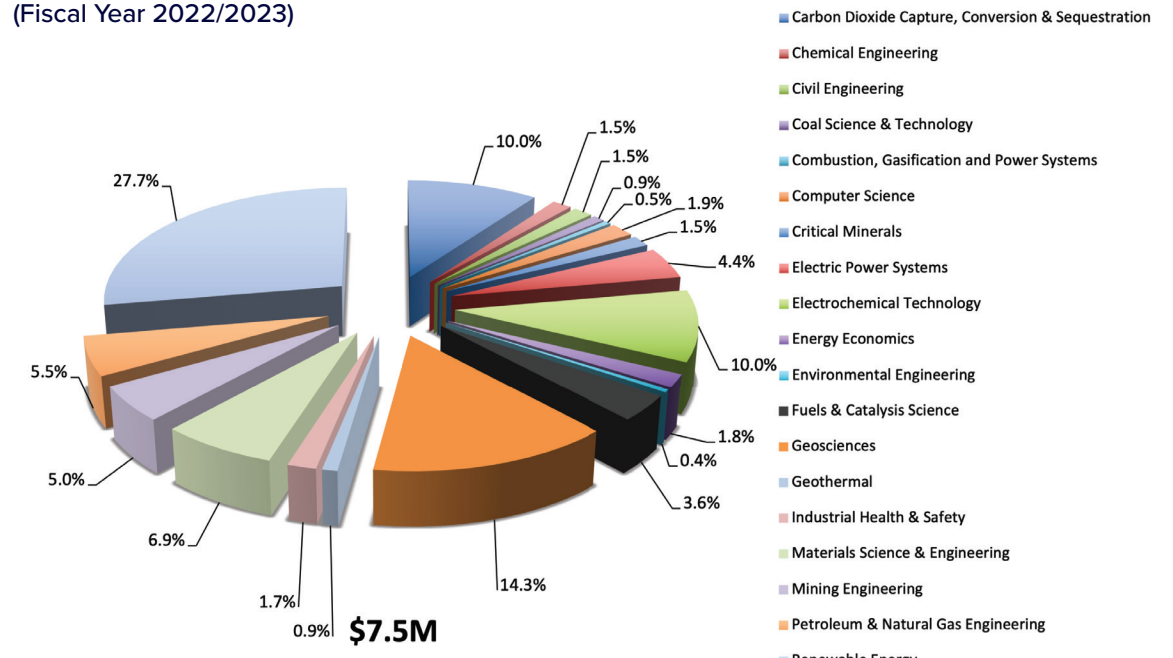
EMS Energy Institute Funding by Source
(Fiscal Year 2022/2023)



EMS Energy Institute Projects by Program Area
(Fiscal Year 2022/2023)



EMS Energy Institute Funding by Program Area
(Fiscal Year 2022/2023)



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Visit our website. Check energy.psu.edu regularly for Penn State energy-related news and events. We also have information on our faculty and their research activities, facility descriptions and schematics, and more.



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