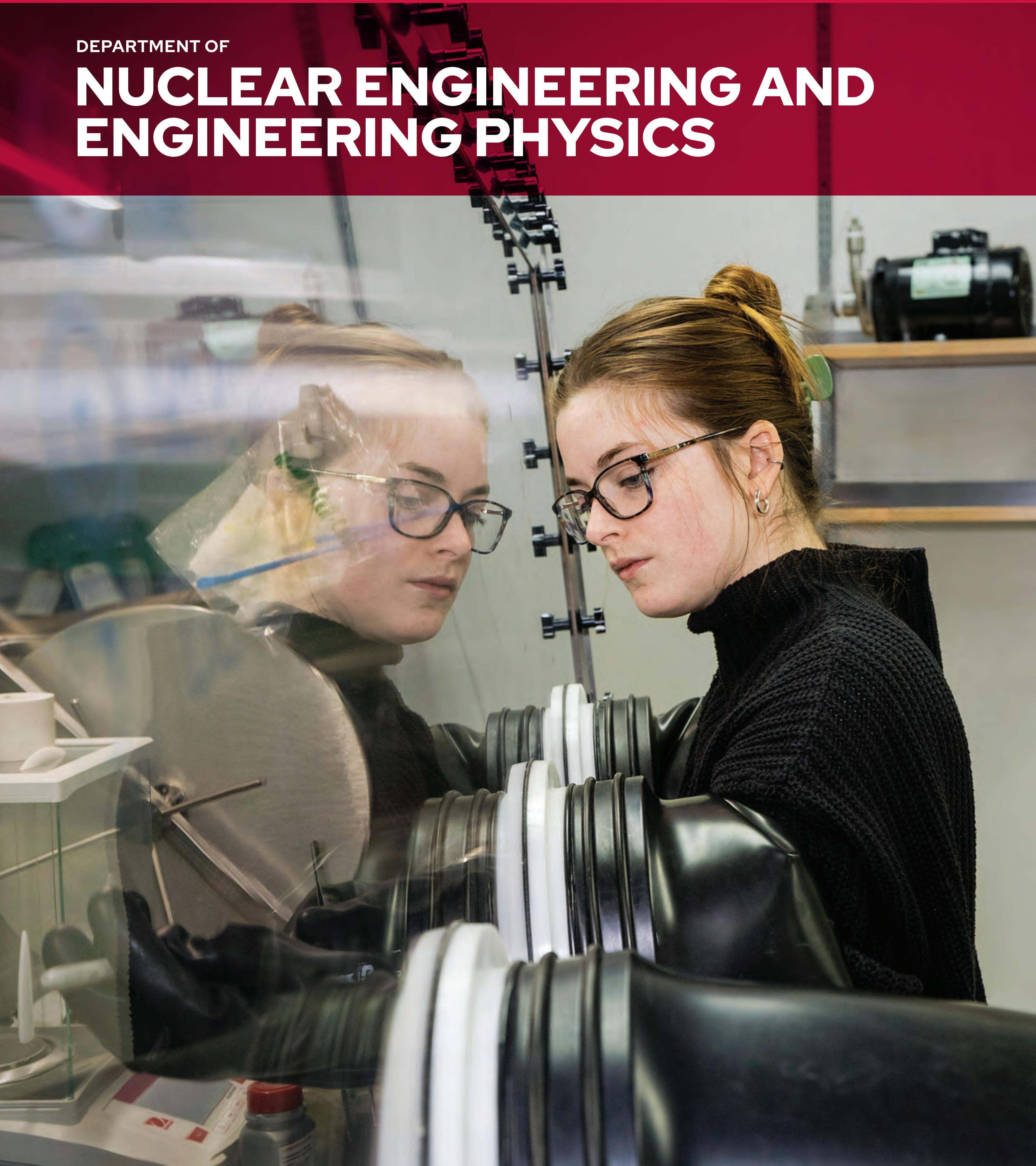
College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

SPRING 2025 NEWSLETTER

DEPARTMENT OF

# NUCLEAR ENGINEERING AND ENGINEERING PHYSICS



**Greetings from Madison!**

Earlier this year, the state of Wisconsin joined the long list of states with official interest in expanding nuclear energy. A joint resolution, introduced on Feb. 5, 2025, with bipartisan support from eight senators and 26 representatives, seeks to have the state of Wisconsin declare "its commitment to the continuation and expansion of nuclear power, fusion energy, and nuclear technologies," while recognizing the "world class academic institutions capable of providing the innovative nuclear and fusion workforce." A few weeks later, the governor's budget address included a request to fund a siting study for a nuclear energy facility in the state. Our department looks forward to the role we can play in the expansion of nuclear energy, by providing our technical expertise to policymakers in the short term and educating future generations of nuclear professionals in the long term. In this newsletter, you'll find a number of stories that describe how we are already providing leadership and innovation while educating future leaders.

To support our continued leadership, we are currently seeking three new faculty members, including two who will be part of the campus Research, Innovation and Scholarly Excellence (RISE) Initiative. With one of the central themes of the RISE-EARTH initiative being clean energy, a new faculty member supporting the expansion of fission and/or fusion energy will be an obvious fit. With the growing application of machine learning and artificial intelligence to the design and operation of fission and/or fusion energy systems, we are also poised to participate in the RISE-AI initiative's thrust in domain-informed applications of those tools. In addition to the contributions these new faculty will make to our department, they will be connected to the broader RISE research communities to leverage the collective expertise to address key societal issues.

If you were to visit the Engineering Research Building today, you'd find early evidence of the coming new building project. We are about halfway through a major utility upgrade which has temporarily blocked access to many of the most obvious ways of entering the building. This project will ensure robust access to our campus' district steam and chilled water, as well as making it easier to make adjustments in the future without having to dig a new hole. At about the same time as that ends, we'll begin to see the new building emerge, offering state-of-the art spaces for teaching and research across the college.

**On, Wisconsin!**

Paul Wilson
Chair and Grainger Professor of Nuclear Engineering
(608) 263-0807
chair@neep.wisc.edu

On the cover: Senior Shea McCarthy conducts research in Professor Adrien Couet's lab, which develops new materials that won't degrade or corrode in advanced reactor environments. Photo: Joel Hallberg.

Photo: Joel Hallberg

# Extracurricular opportunities help undergrad decide career path

NEEP students can take advantage of many opportunities beyond the classroom to enrich their learning, such as participating in undergraduate research, internships and student organizations. For senior Shea McCarthy, pursuing extracurricular opportunities helped her decide her next step after graduation.

Early in her engineering education, McCarthy was interested in potentially pursuing graduate studies. Fortunately, the department excels in providing undergraduates with hands-on opportunities to participate in research with faculty, which helps students better understand what it's like to work as a researcher.

McCarthy quickly secured a position as an undergraduate research assistant in Professor Adrien Couet's group, which develops new materials that won't degrade or corrode in advanced reactor environments. These materials could enable advanced nuclear reactors that use molten salt as a coolant, making them potentially smaller, safer and more economical than current nuclear power plants.

In Couet's lab, McCarthy assisted PhD student Kailee Buttice with her research focused on the corrosion rate and mechanisms of molten salts on alloys in nuclear environments. "I really enjoyed working with Kailee. We're very alike, and it was a great experience," says McCarthy, who is from Northbrook, Illinois.

McCarthy also worked with Buttice on a major research project that involved regular visits to the National Synchrotron Light Source II at Brookhaven National Laboratory in Upton, New York, to perform cutting-edge in-situ experiments on molten salt using the synchrotron beam. The research is part of a large DOE-funded Energy Frontier Research Center, led by Brookhaven National Laboratory, called Molten Salt in Extreme Environments.

Then, in summer 2024, McCarthy completed an internship with energy company Constellation to get experience in industry. She worked on core design for boiling water reactors in the company's nuclear fuels department. It helped that she had taken NE 405: *Nuclear Reactor Theory* in the semester before starting her internship. "The NE 405 course really helped me wrap my head around many concepts involved in core design, and I was able to directly apply knowledge that I learned in class in my internship," she says. "I found that I enjoyed doing hands-on design work in the corporate setting."

During her internship, she worked on a low-enrichment core design project. Specifically, she was tasked with creating a core design that had more "less-enriched" bundles, with the goal of mitigating a problem called moisture carryover. This occurs when there's too much moisture from the steam, which can cause reactor materials to erode.

McCarthy's design successfully lowered the moisture carryover throughout the fuel cycle, and the company is using her design as part of a new fuel reload cycle it's developing. "I'm really grateful to have worked on this project, because it gave me great insight into how to do fuel design and core design and also into the day-to-day operations of a core designer in industry," she says. "It's awesome that work I did as an intern can have an impact in the real world."

The internship was such a positive experience that McCarthy has already accepted a job in Constellation's core design group after she graduates. Looking back on her undergraduate experience, she's happy that she took advantage of diverse opportunities outside of her coursework.

"Having these experiences with both academic research and industry really helped me decide what I want to do after graduation, and I'm confident that going into industry is the right path for me," she says. "I'm also really grateful for my undergrad research experience. I met so many great people through it and it has really supplemented my learning."

Photo: Joel Hallberg

# Juliana Duarte discusses what's on the horizon for nuclear in the nation's overall energy landscape

Assistant Professor Juliana Duarte's research focuses on thermal hydraulics, which concerns heat transfer through fluids within nuclear reactors. Duarte also studies reactor safety during transient and severe accident scenarios—or things that can go wrong while reactors are running. In this interview, she discusses the future of nuclear power, including safety, technology and policy challenges, how the field is continuing to evolve, and how it can continue to integrate into the U.S. power grid.

Q: What role do you think nuclear power plays in a more diverse energy generation portfolio?

A: Nuclear has a lot of incentives nowadays because of the need to produce more energy without the emission of carbon dioxide ($CO_2$) and other gases that drive climate change. The United States and other countries have tax incentives for producing nuclear power. But it is important to say that nuclear power is *part* of the solution when it comes to clean energy. It is not *the* solution.

Today, the United States has 94 nuclear reactors, which provide almost 20% of our energy. We don't want to build another 400 reactors that we'd need to get that to 100%, but we do need to make sure we're building enough to either maintain or increase that roughly 20% to further reduce the amount of power that comes from coal and natural gas.

Q: Many of our nuclear power plants are aging. Beyond the recently completed Plant Vogtle nuclear power unit in Georgia, which ran infamously late and over budget, it seems the United States doesn't build big commercial reactors that often. What challenges does that present for the future?

A: There are a few things at play there. Once we build something for the first time, we never really know how long it's going to last. Usually, we're pretty conservative and license reactors for 40 or so years initially. Most of the reactors we have today were built in the 1970s and 80s, so they have been through inspections, license extensions, equipment replacements, and so on.

But every power plant, nuclear or not, can only run for so long and will eventually have to be decommissioned. So now the challenge facing us is that in the coming decades, some of these older reactors will be facing decommission. If we don't start building new reactors, that 20% of the energy we get from nuclear power is going to decrease.

We've built this one in Georgia, but before that, it had been a very long time (the last reactor to come online in the U.S. prior to Vogtle was Watts Bar Unit 2 in Tennessee, which was activated in 2016; work on the unit began in 1973, but halted from 1985 to 2007). And when you don't build new reactors, you lose the skill in the workforce. That means when you need to start up again, it's harder.

Q: What are small modular reactors, and how do they fit into the overall picture?

A: All of the reactors in operation today produce about a few hundred megawatts or more of electricity. In recent years, there have been major investments in developing small modular reactors that can produce up to 200 to 300 megawatts due to their economic potential benefits. Now we even have micro reactors that are being developed to generate on the scale of 10 to 15 megawatts of electricity.

And there are lots of projects like this in development. Right now, my group has funding from the Department of Energy to work on the NuScale small modular reactor, with the goal of increasing the power density in the reactor from 160 to 250 megawatts. We are also working on a project funded by the Nuclear Regulatory Commission on a boiling water reactor that is similar to General Electric's BWRX-300. With that, we want to understand how to operate it more safely—because those reactors can be a little unstable—and to what degree safety margins can be adjusted so the reactor can be run in a way that's economically viable, but still safe.

So, this small modular reactor technology exists and is ready but has to go through licensing and review with the NRC. These are the types of reactors that might one day supply part of a community's power instead of being the backbone. Or they might be used for some of these energy-intensive industries because they're simpler and more compact.

They bring lots of benefits, but cost will be an initial challenge. They're a new type of technology, and whenever you're building something for the first time, it's going to be expensive.

Q: What are some advancements in the nuclear field that are exciting to you?

A: It's not super-new, but one of the things we've been analyzing is the use of more passive safety systems in reactors. Nuclear reactors are very complex machines, and these passive safety technologies try to simplify them by using gravity and buoyancy, for example. Reactors need a coolant, and all reactors in the United States use water. That water needs to flow, and that's typically done with a pump. But with passive systems, we can do that without a pump. NuScale, for example, uses gravity—the reactor heats the water, and the different densities naturally make the water flow within it. That's a system you can use for normal operation, but you can also use passive systems in accident scenarios.

Another exciting topic has been around the recent investments in fusion technology. And at least in our department (and I believe at several other departments across the United States), we're using the knowledge that we on the fission side have about how to build reactor systems to help with plasma physics to build fusion machines. Investments in fusion have been so much in the science of it so far, but in the last year, I've seen so many calls for funding to have more engineering research on how to design and build the systems that are going to work. There are a lot of things in common between fission and fusion in terms of heat removal and how to deal with radiation from the plasma. There is this growing collaboration and it's very exciting.

## Couet leads material discovery panel during DOE roundtable


Adrien Couet

Professor Adrien Couet served as a panel lead in the Foundational Science to Accelerate Nuclear Energy Innovation roundtable hosted by the U.S. Department of Energy's Office of Basic Energy Sciences in July 2022. A report summarizing the roundtable discussions and their implications was published in December 2024.

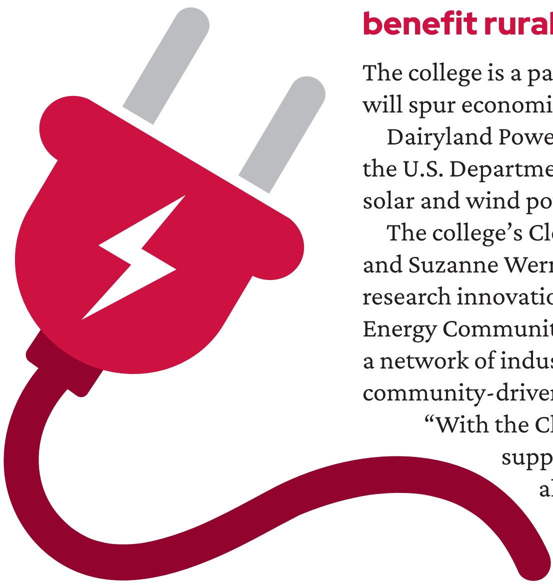
The report identifies five priority research opportunities that address key scientific challenges surrounding the development of next-generation fission and fusion energy systems. These opportunities span materials science, advanced coolants, interfacial chemistry, AI-driven material discovery, and multiscale experimental and computational techniques—all essential for making nuclear energy more sustainable and competitive in the global energy mix.

Couet led the panel on harnessing artificial intelligence and machine learning to accelerate the discovery of materials that can withstand extreme nuclear environments. Nuclear reactor designs are advancing to operate at higher temperatures, with novel coolants, and under extreme radiation conditions. To withstand these conditions without relying on expensive and time-consuming component monitoring and replacement campaigns, materials must be designed to be inherently resilient.

"Traditional material discovery approaches are often slow and costly," Couet says. "AI and machine learning techniques provide an unprecedented opportunity to discover new materials faster, reduce experimental costs and improve predictive modeling."

AI-enhanced frameworks aim to elevate, not replace, traditional research approaches.

"While AI tools provide powerful predictive capabilities, they must be carefully grounded in fundamental physics and chemistry to be effective," Couet says. "The challenge is not just generating data faster but combining AI-driven predictions with experimental validation to ensure the discovery of materials that are both theoretically promising and practically viable."



## UW-Madison supports clean energy project to benefit rural Wisconsin communities

The college is a partner in a major clean energy project led by Dairyland Power Cooperative that will spur economic growth and job creation while lowering energy costs for rural communities.

Dairyland Power Cooperative, based in La Crosse, Wis., will use $579 million in funding from the U.S. Department of Agriculture to procure 1,020 megawatts of renewable energy through solar and wind power installations in rural portions of Wisconsin, Iowa, Minnesota and Illinois.

The college's Clean Energy Community Initiative is supporting the project. Led by Thomas and Suzanne Werner Professor Oliver Schmitz (who also is the college associate dean for research innovation and director of the college's Grainger Institute for Engineering), the Clean Energy Community Initiative employs a two-way engagement approach to bring together a network of industry, policy, research and community partners to co-create equitable and community-driven clean-energy solutions throughout Wisconsin.

"With the Clean Energy Community Initiative, we have created a partner network to support such large-scale clean-energy projects to aid in an equitable execution along community priorities and needs, and to leverage the projects for sustainable community benefits through career perspectives and the advantages technology innovation brings to the region," Schmitz says.

## UW-Madison, Japan's National Institute for Fusion Science strengthen research partnership

UW-Madison and Japan's National Institute for Fusion Science (NIFS) leaders have signed task agreements that will strengthen collaboration and cooperation between the two institutions to advance science and technology for realizing fusion energy.

"These new agreements position UW-Madison at the forefront of stellarator research in the United States," says Assistant Professor Adelle Wright. "We are looking forward to building on UW-Madison's strong history of fusion science research and education and developing deeper collaboration with NIFS to enable significant breakthroughs in this field."

In August 2024, UW-Madison hosted U.S. Department of Energy Office of Fusion Energy Sciences Research Director John Mandrekas, NIFS Director General Zensho Yoshida, and eight other NIFS researchers, for a three-day strategic planning workshop on fusion energy. The event included research presentations and tours of UW-Madison's fusion research in the NEEP department and the Department of Physics to showcase the capabilities and expertise offered at the university. Organized by Wright, the workshop culminated in the signing of the task agreements, which were added to a memorandum of understanding that already exists between UW-Madison and NIFS.

The collaboration between UW-Madison and NIFS will focus on research related to stellarators, which are viewed as the main alternative to tokamaks for fusion energy systems. Stellarator-type fusion devices use electromagnetic coils to create three-dimensional magnetic fields that confine a high-temperature plasma inside a vacuum chamber. The researchers plan to study large-scale phenomena as well as microphysics and turbulence that occur in these devices. The Helically Symmetric eXperiment (HSX), an optimized stellarator in the Department of Nuclear Engineering and Engineering Physics, will serve as a testbed.

"UW-Madison is a leader in theory and simulation for stellarators and boasts the world's only quasihelically symmetric stellarator (HSX). NIFS is doing cutting-edge work with 3D configurations, so the research capabilities at both institutions are really complementary and there's a lot we can learn from each other," Wright says.

In addition, she says, the agreements support personnel exchange opportunities for faculty, staff and students and access to new funding sources.

From left: Eric Wilcots, dean of the College of Letters & Science; Frances Vavrus, dean and vice provost of the UW-Madison International Division; NIFS Director General Zensho Yoshida; and David A. Noyce, College of Engineering executive associate dean, at the signing of the task agreements in Bascom Hall. Photo: Adrienne Nienow.

## Meet the college's next dean

Devesh Ranjan, a mechanical engineer and a leader at one of the country's largest and highest-ranked engineering programs, will be the college's 10th dean. He will begin on June 16.

Ranjan, the Eugene C. Gwaltney Jr. School Chair and Professor of Mechanical Engineering at the Georgia Institute of Technology, remembers the promise he felt when he first arrived at UW–Madison in 2003 to begin graduate school in the college he will now lead.

"I've been blessed from that day onward," Ranjan says. "The thing I say about UW–Madison is if you dream about doing something here, it will happen. It will happen because of the opportunity and the support here for you at UW-Madison."

After earning a doctorate at UW-Madison in 2007 in the lab of Professor Riccardo Bonazza, Ranjan was a Director's Postdoctoral Fellow at Los Alamos National Laboratory before joining the faculty at Texas A&M University in 2009. He moved to Georgia Tech in 2014, where his own work has focused on the dynamics of fluids at very high speeds—air across the surface of supersonic jets, the plume of a volcanic eruption, shock waves that fragment kidney stones—and designing next-generation power cycles optimized for solar energy sources or incorporating the efficiency of supercritical carbon dioxide as in heat pumps.

Read more about incoming Dean Ranjan.

## Through research, undergrad contributes to the future of nuclear

When undergraduate Gabe Dengler-Jeanblanc started working on a research project in Assistant Professor Ben Lindley's lab, he didn't anticipate it would lead to him presenting his work at the American Nuclear Society's annual conference in front of experts from industry and academia.

Dengler-Jeanblanc joined Lindley's group as a sophomore, eager to gain hands-on experience doing research. He began working on a project that required him to learn a software program developed by Sandia National Laboratories called MELCOR, which is used to analyze thermal-hydraulic conditions in nuclear reactors, including accident conditions. Using MELCOR, Dengler-Jeanblanc aimed to replicate a previous PhD student's experiments on particle transport in a sodium loop. "My goal was to see if the simulation results MELCOR produced matched the experimental results, and if they were different, to understand why they were different," he says. "It was a big task. It took a long time to build the model and ensure it was accurate."

The research led to a unique opportunity: Dengler-Jeanblanc met virtually with researchers at Sandia National Laboratories for an in-depth discussion about his project. "That was a really cool experience, to be a student in my junior year and to lead a dialog with these experts in the field," he says. "They were very helpful in assisting me with the model I was working on so I could progress with the research."

After a few more months of work, Dengler-Jeanblanc completed the model and generated some notable findings. With Lindley's encouragement, Dengler-Jeanblanc submitted a successful proposal to the 2024 ANS Annual Conference to present his research.

"Presenting my work in person at the ANS conference in Las Vegas was an unforgettable experience," he says. "As an undergrad, I felt like a minor league player going up to the major league for the first time. It was really one of the most satisfying things I've done in my academic career, and I'm very excited to do more presentations in the future."

With this rewarding experience under his belt, Dengler-Jeanblanc was excited to dive into a new research project as a member of Lindley's group—a large multi-university project studying how using accident-tolerant fuel could enable an existing nuclear power plant to increase its licensed power level. Dengler-Jeanblanc is modeling unique fuel assemblies in a variety of conditions to ensure operational limits are maintained while searching for improvements to the reactor's power production.

"Advanced nuclear reactors are cool, but I think pursuing power uprates for the existing fleet can be a much cheaper path to increasing the share of nuclear power in our energy mix," he says. "Even though my work is just a small part of this huge project, it's really exciting to be contributing to a group that's working on research that I believe could open a promising path for advancing nuclear."

Dengler-Jeanblanc, who will graduate in May 2025, plans to pursue graduate studies in nuclear engineering.

Department of
Nuclear Engineering
& Engineering Physics

1500 Engineering Dr., Room 151
Madison, WI 53706
engineering.wisc.edu/neep



## Badger engineers selected for *Nuclear News* 40 Under 40 list


Ben Lindley

*Nuclear News*, the flagship publication of the American Nuclear Society, has named Assistant Professor Ben Lindley and alumni Grace Stanke, Kathryn Huff, Erik Nygaard and Kevin Field to its inaugural 40 Under 40 list.

The list honors talented young professionals who are leading the charge in nuclear, making significant strides across the industry—from advanced reactor technology to policy shaping.

Lindley's expertise is in reactor physics, and his research focuses on designing and analyzing new nuclear reactors. He has substantial research and leadership experience in the areas of digital engineering for nuclear reactors, fusion reactor simulation, and advanced reactor core and primary system design. He is also a co-founder and technical advisor for Realta Fusion Inc., a UW-Madison spinoff focused on commercializing mirror machines as fusion energy reactors.

Stanke (BSNE '23) was Miss America 2023 and used her platform to advocate for clean-energy solutions, with a strong focus on nuclear energy. She currently works as a nuclear fuels engineer and clean energy advocate at Constellation.

Huff (PhDNEEP '13), former assistant secretary of energy at the U.S. Department of Energy's Office of Nuclear Energy, is an associate professor in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois at Urbana-Champaign.

Nygaard (BSNE '09, MSNE '11) is director of product development at BWX Technologies.

Field (MSMS&E '09, PhDMS&E '12) is an associate professor of Nuclear Engineering and Radiological Sciences at the University of Michigan. He is an experimental material scientist with expertise in advanced alloy development and radiation effects in material systems relevant for nuclear power generation.