

RIC 2025

U.S. Nuclear Regulatory Commission
37th ANNUAL REGULATORY INFORMATION CONFERENCE



MARCH 11-13, 2025

www.nrc.gov
#nrcric2025



Panelist: Rizwan Uddin

Position Title: Department Head
and Professor

Agency/Organization: University of
Illinois / Department of Nuclear,
Plasma, and Radiological
Engineering

**CHARTING THE
NEXT 50 YEARS**

RIC-2025 --- Charting the Next 50 Years

37th Annual Regulatory Information Conference March 11-13, 2025

Session T8: The Next Generation Workforce: Charting the Course for Another 50 Years

Next Generation Nuclear Workforce Development in the Most Nuclear State: Illinois

**Rizwan-uddin, Professor and Head
Department of Nuclear, Plasma, and Radiological Engineering
University of Illinois at Urbana-Champaign**

Content



- Workforce needs and stakeholders
- History – Illinois (the first sustained-fission state)
- Workforce development in IL: Current
- Workforce development in IL: Future

Acknowledgement: Presentation material is drawn from various sources including, ORAU and NEI reports

Workforce Need



Full scale industrialization of advanced nuclear power through 2050 would require advancements in the following areas across the value chain:

- **Workforce:** The U.S. would need ~375,000 additional workers with technical and non-technical skillsets to construct and operate 200 GW of advanced nuclear.

Section 3.c.i: Workforce

Building 13 GW of new nuclear capacity per year would require ~375,000 workers by 2050 for construction, manufacturing, and operations; roughly ~100,000 would be required to operate the 200 GW of reactors in 2050 and ~275,000 would be required for construction and manufacturing. Many of these jobs are often union jobs with a significant ramp rate, so scaling up the workforce would require advance planning and collaboration with unions to ensure trained labor is available.

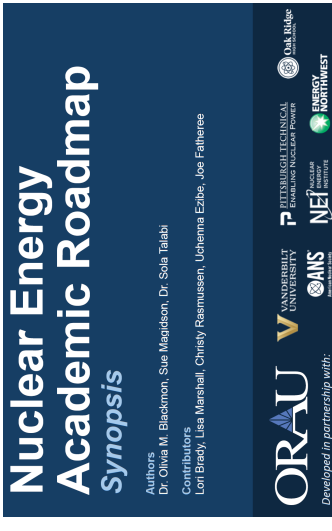


Pathways to
Commercial Liftoff:
Advanced Nuclear

Around the Country: National Efforts towards Workforce Development



- Nuclear Engineering Departments and Programs
- ANS
- NEI
- ORAU
- INPO
- Others



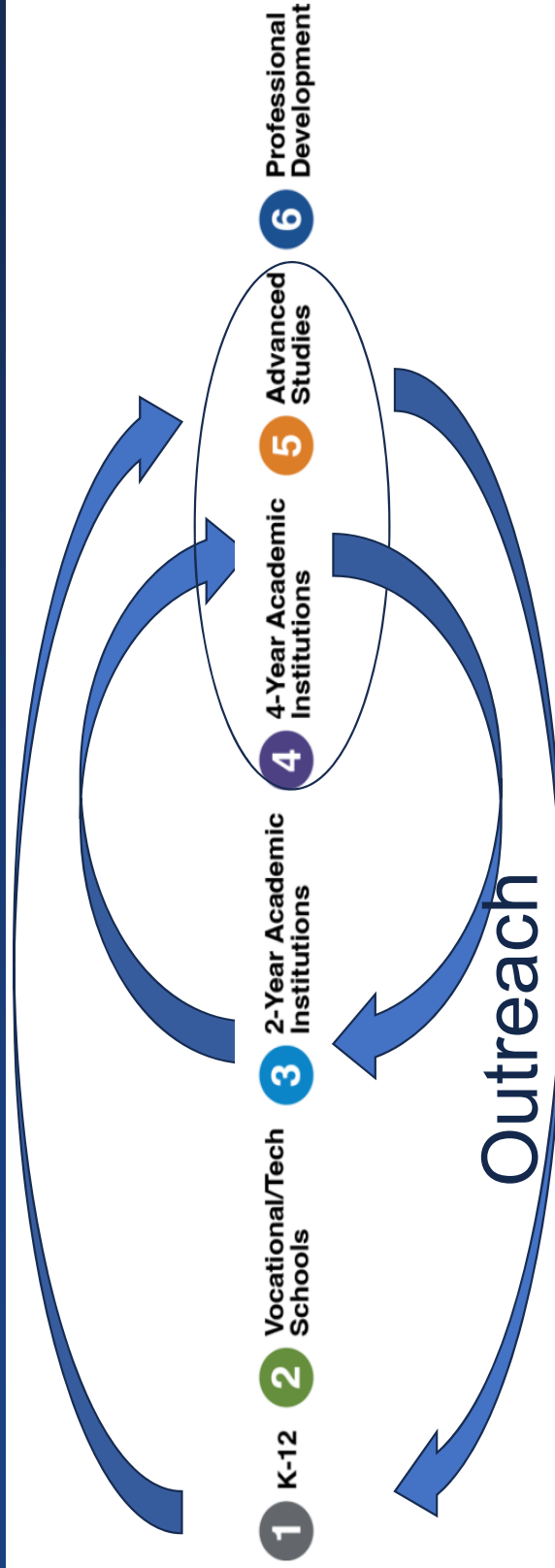
[Home](#) > [STEM Workforce Development](#) > [Workforce Studies](#) > [Nuclear Engineering Enrollments and Degrees Survey](#)

Nuclear Engineering Enrollments and Degrees Survey

The [2021–2022 ORISE Nuclear Engineering Enrollments and Degrees Survey](#) (.PDF, 210 KB) reports



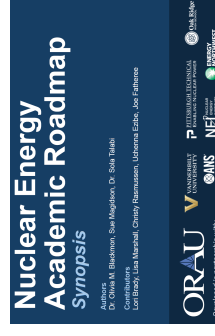
Around the Country: National Efforts Towards Workforce Development



To assist with development of the roadmap, a framework has been developed that identifies four topical areas that will be addressed including:

- Enhancing Nuclear Career Awareness
- Supporting Pipeline Development
- Identifying Financial Support, Resources, and Programs
- Optimizing Academic Resources

The roadmap will include recommendations in each of these areas for the following groups: K-12, vocational-technical schools, 2-year academic institutions, 4-year academic institutions, advanced studies, and professional development.



ILLINOIS: History



Illinois (State and the University) legacy

Illinois leadership

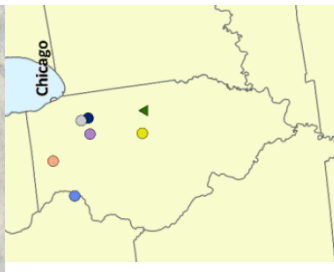
- 1942: Chicago, IL, First sustained fission (CP-1)
- 1946: Lemont, IL, Argonne National Laboratory
- 1959: Morris, IL, First fully commercial nuclear power (Dresden Generating Station is the first privately financed nuclear power plant built in the United States. Dresden 1 was activated in 1960 and retired in 1978. Dresden units 2 and 3 (1970), two BWR-3 units are operating.)
- Today: Majority of Illinois electricity is nuclear

UIUC TRIGA®

- In the heart of Illinois campus
- 38 years of safe operation
- Thousands of public visitors
- 6,000 MW transients, 1MW steady state power
- Shutdown in 1998 and returned site to greenfield
- ANS National Historic Landmark



TRIGA® is a registered trademark of General Atomics
UIUC TRIGA® Image provided by University of Illinois



History and Growth of Nuclear Engineering at the University of Illinois



- 1951:** Discussions begin for a nuclear engineering program.
- 1954:** Eisenhower prioritizes nuclear energy; Atomic Energy Act becomes law.
- 1958-59:** Master's degree curriculum launched; Ph.D. track soon follows.
- 1960:** TRIGA nuclear reactor dedication at Urbana campus enhances the program.
- 1976:** First bachelor's degree graduates; 129 undergraduates and 99 graduate students by late 1970s.
- 1986:** Nuclear Engineering becomes a department.
- 2003:** Name changed to Department of Nuclear, Plasma, and Radiological Engg.
- Early 2000s:** Enrollment grows during the "nuclear renaissance"; historic high of 200+ undergraduates in 2011-12.
- 2010:** Faculty expansion in nuclear power safety, materials, and homeland security.
- 2014:** Acquisition of HIDRA plasma/fusion facility from the Max Planck Institute.
- Today:** Focus on nuclear power, materials science, plasma physics, radiological science, and reliability & risk, utilizing world-class research facilities.

college make-up:

11,000 Undergraduate Students
6,300 Graduate Students

488 Tenure/Tenure-track Faculty
149 Specialized Faculty
820 Academic Professionals, Staff, Post-Docs
\$573M College Budget
\$290M Annual Extramural Research Expenditures



- **Ten departments, three integrated research labs and numerous centers are involved in energy-related work.**
- **Many in Mechanical, Civil, Electrical and Chemical Engineering take NPRE-402 (Nuclear Power Engg)**
- **Department of Nuclear, Plasma, and Radiological Engineering offers BS, MS and PhD degrees in NPRE**

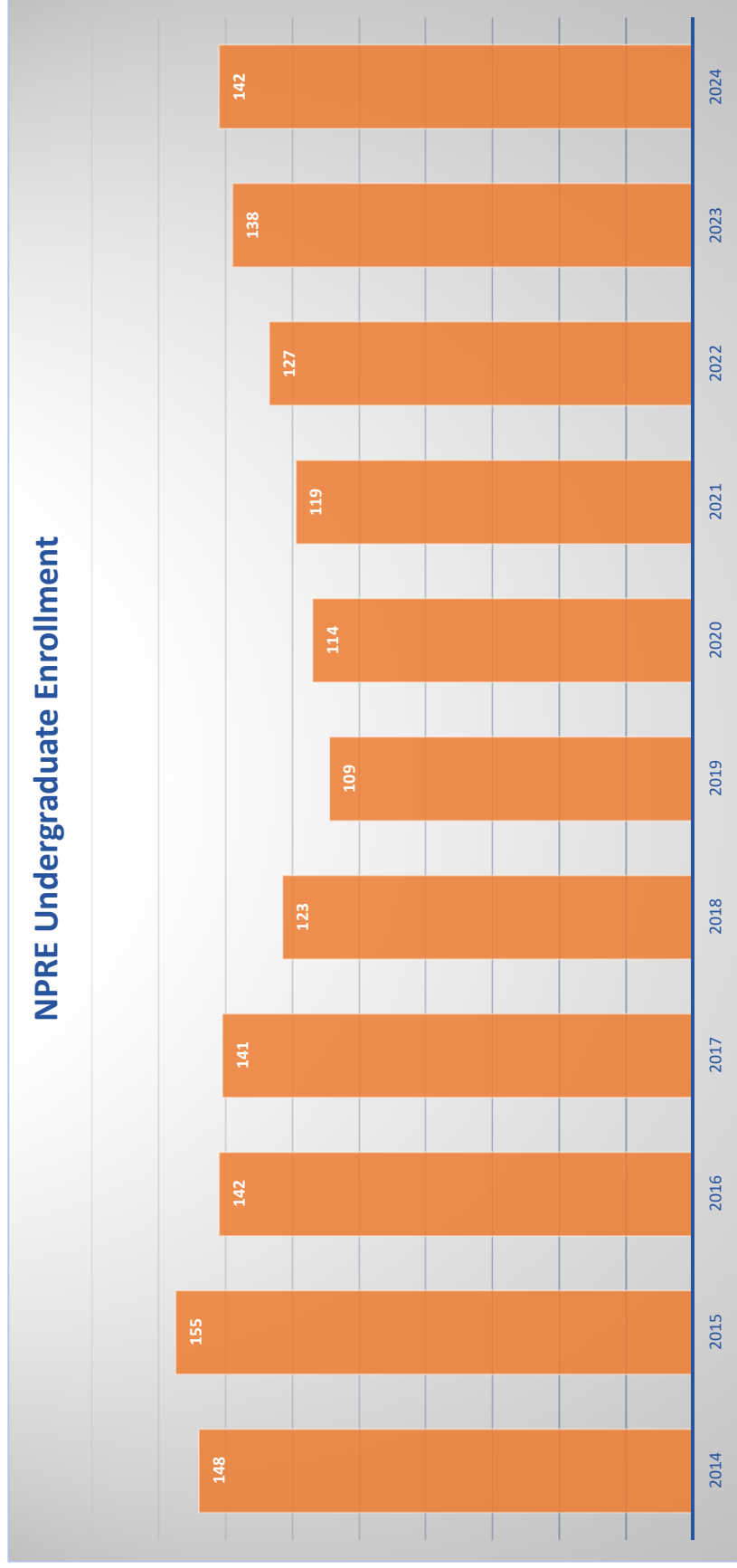
BS/MS/PhD in NPRE

**~ 240 students in NPRE degree programs
(UG (~140) + Grad (~100))**

~300 BS degrees awarded over 10 years



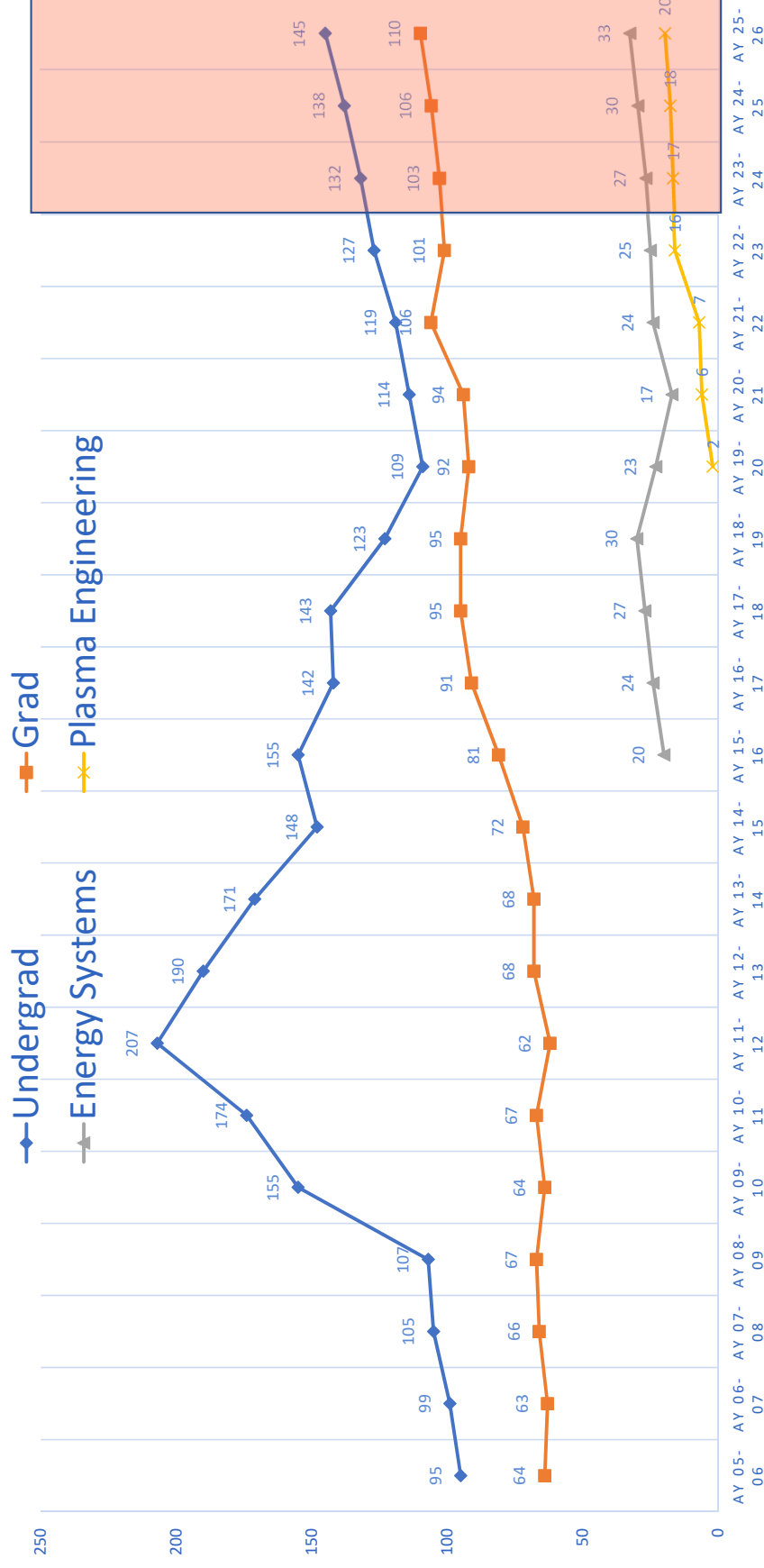
NPRE Undergraduate Enrollment



Enrollment Trends



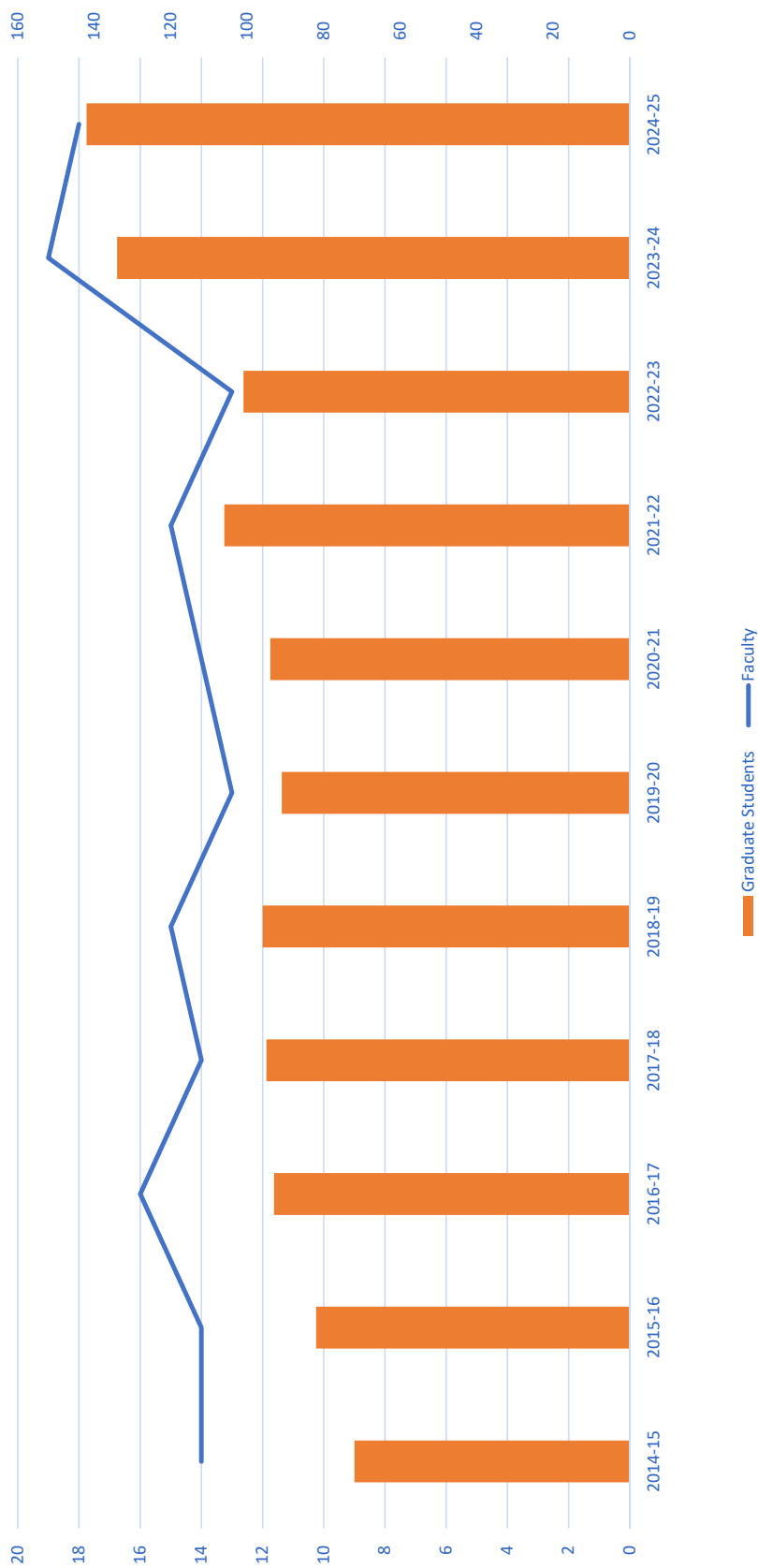
NPPE ENROLLMENT WITH THREE-YEAR PROJECTIONS



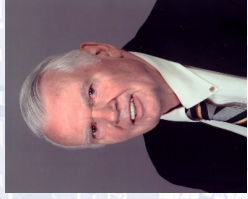
Enrollment Trends



NPRE Graduate Student and Faculty(TT+Specialized) Growth



NPRE Faculty in Fall 2011



E N G I N E E R I N G A T I L L I N O I S

NPRE Faculty Today (Growth supported by NRC Faculty Development Grants)



Nuclear Power

**Syed Bahauddin Alam***

**Caleb Brooks**

**Kathryn Huff**

**Tomasz Kozlowski**

**April Novak**

**Magdi Ragheb**

**Rizwan Uddin**

Plasma and Fusion Engineering

**Daniel Andruczyk**

**Davide Curreli**

**Dren Qerimi**

**Mohan Sankaran**

Radiological Science

**Ling-Jian Meng**

**Angela Di Fulvio**

Materials Science

**James Stubbins**

**Lorenzo Vergari***

**Jianqi Xi**

Energy Systems

**Leon Liebenberg**

Reliability and Risk

**Zahra Mohaghegh**

+ THREE RESEARCH
SCIENTISTS

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HALEU AND THE PROMISE OF NUCLEAR ENERGY:

An interview with the DOE's Kathryn Huff

Deploying a fleet of advanced reactors in the 2030s means deploying high-assay low-enriched uranium (HALEU) infrastructure now. The future fleet will need more than 40 metric tons of HALEU by 2030, according to Department of Energy projections. Getting to the 5-20 percent fissile uranium-235 content of HALEU involves either enriching natural or low-enriched uranium (LEU) or downblending high-enriched uranium (HEU).

Because downblending the limited stocks of HEU held at the DOE's Idaho National Laboratory and Savannah River Site is a short-term option at best, the Energy Act of 2020 authorized a HALEU Availability Program to build a sustainable enrichment infrastructure by the time advanced reactors are ready for commercial deployment.

Comments on a request for information reached the DOE in February 2022, just before Russia's invasion of Ukraine amplified global energy security

concerns. While the war in Ukraine didn't change the DOE's plans, it "accelerated everything," said Kathryn Huff, who leads the DOE's Office of Nuclear Energy (DOE-NE) as assistant secretary. "Our attention is now laser-focused on this issue in a way that it wouldn't have been in the past."

As assistant secretary of nuclear energy, Huff is charged with overseeing the HALEU Availability Program. Before joining the DOE, Huff was an assistant professor in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois-Urbana-Champaign, where she led the Advanced Reactors and Fuel Cycles Research Group with a focus on the modeling and simulation of advanced nuclear reactors and fuel cycles.

Nuclear News staff writer Susan Gallier spoke with Huff in September as the DOE prepared to release guidance and a request for proposals for the HALEU Availability Program.

Many people have said that HALEU availability is not a technical problem, but a "chicken and egg" problem. Do you agree?

I think both the chicken and the egg have now been solved by the twin DOE programs of ARRP (the Advanced Reactor Demonstration Program) and the \$700 million in IRA (Inflation Reduction Act) funding for HALEU. Between these two things you now have a chicken and an egg—you can decide which one to start with.

We now are supporting advanced reactor demos, which will signal the future of an advanced reactor commercial market. The IRA's \$700 million for HALEU is the other signal that enrichers need to stand up and make fuel available for these reactor demos. Of that \$700 million, \$200 million will be for reducing risks, but about \$500 million likely will be dedicated to offtake agreements that will allow us to establish a HALEU bank. So advanced reactor companies can rest assured that the fuel will be available when commercialization needs to happen in the late 2020s and 2030s, and HALEU providers can rest assured that those reactors will exist.

How much more money does the DOE need to support this program? Is the \$1.5 billion September 2nd supplemental request from the White House critical to the program?

It's absolutely critical. The \$1.5 billion would focus on standard LEU, given the situation in Ukraine and Russian dependence that we have in our front end of the fuel cycle. But it's still not quite enough. This is a down payment on what needs to be a longer-term set of offtake agreements to support our broader uranium strategy.

The \$700 million in the IRA will get us fairly far, but it's likely to cover only the first couple of years—maybe only the first year, depending on the amount that we procure. We'll release a request for proposals, and the offtake agreements will depend on what prices the enrichers in the United States are able to offer. Those prices should inform how far those dollars will reach, but we expect it will probably need to be met with additional funds over the coming years.

Continued
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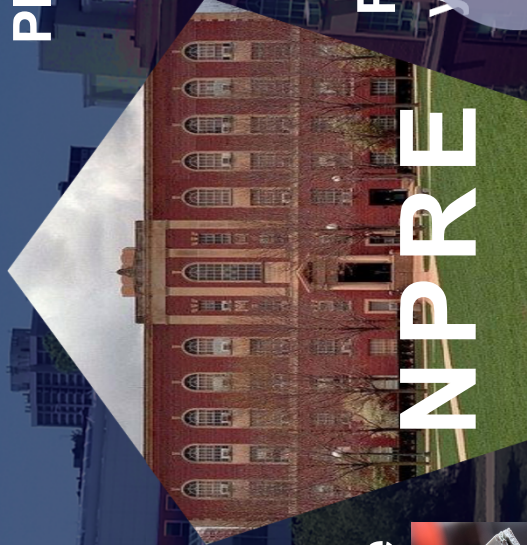
**Nuclear
Power**



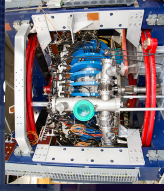
Materials Science



NP RE



Plasma/Fusion



Risk/Reliability



/Safety



Radiological Applications



Nuclear, Plasma &
Radiological Engineering
GRAINGER COLLEGE OF ENGINEERING

Research Focus

Distinguishing Areas at Illinois for Workforce Development for Advanced Nuclear



- Reliability and Risk (461/561, NSF/DOE/NRC/Industry)
- Digital Twins, Cyber Security, Autonomy, AI/ML
- Micro Reactor Initiative
- Nuclear+Data-Science Undergraduate Degree
- Master of Engineering (MEng) in Energy Systems Degree

Workforce for the future



SoTeRiA Laboratory teams up with law school to analyze risk-informed regulation of advanced nuclear reactors

The Socio-Technical Risk Analysis (SoTeRiA) Research Laboratory, led by NPRE Associate Professor Zahra Mohaghgh, has teamed up with UIUC College of Law Professor Arden Rowell on a new research grant from the Nuclear Regulatory Commission (NRC). The grant, titled “Context-Based Analysis of a Risk-informed, Performance-based Regulatory Approach for Advanced Nuclear Reactors,” will span from 2024 to 2027.

Co-PI Arden Rowell brings to the project her experience as an academic specializing in risk regulation and decision making by federal agencies. Her involvement will integrate an applied



New Alam paper hopes to solve the bottleneck of real-time prediction capabilities for nuclear digital twin systems

The challenges of traditional machine learning (ML) for real-time systems are primarily related to the issue of “dataset shift” in digital twins and the need for frequent retraining. In dynamic reactor/plant environments, ML models trained on specific operating conditions (specific datasets) may not generalize well to new, varied operational reactor conditions. This leads to a decrease in model performance and reliability when

New reactor on campus?

UIUC's choice for research,
education, and training

By Caleb S. Brooks,
Tomasz Kozłowski,
Clive Townsend,
James F. Stubbins,
and Rizwan-uddin

NPRe featured in Nuclear News cover story

24

Nuclear News April 2022

NuclearNews

April 2022

University Programs

re

UIUC Energy Workforce development potential

A next-generation energy workforce is needed for next-generation energy systems.



MISSION:

De-risk advanced reactor deployment and enable a new paradigm of nuclear power through education, research, and at-scale demonstration.

Core Mission: Education, training, and outreach

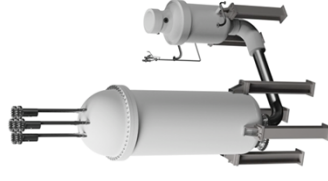
- workforce training, general public, etc.

Core Mission: Research capability

- leverage strength areas across campus
- reactor testing, research, and development
- critical enabling and synergistic technologies

Cross-cutting Mission: Production demonstration

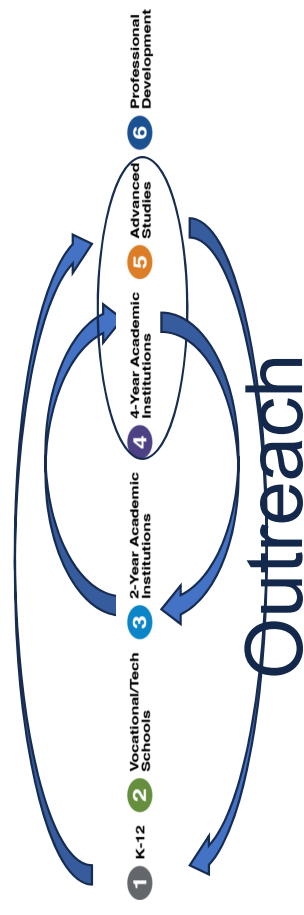
- electricity, district heat, hydrogen production, Integrated thermal storage, other high value processes.



Outreach and Bridging Efforts to Attract Workforce to Nuclear



- Outreach by NPRE, ANS and Women-in-Nuclear (WiN) student chapters
- Alliance with Chicago Community Colleges (CCC)
- Increasing the intake from community colleges thru “pathway program”
- Interns at NRC



Nuclear Outreach ...



COVER STORY “Passionate” Illinois chapter of Women in Nuclear stands above its peers

When you are in the thick of work, sometimes you don't realize your successes until you hear about them from someone else.

In the case of our University of Illinois chapter of Women in Nuclear (WIN), being named the most outstanding student chapter in the country came as a surprise to its current members, even though it's the second time in five years the chapter has earned such an honor.



New nuclear simulator at NPRE offers students hands-on, risk-free training in reactor operations

In recent years, NPRE has expanded the educational and research opportunities for its students and faculty, including new labs in and out of Talbot Laboratory and the establishment and growth of the Illinois Plasma Institute.

NPRE now also has a classroom-size nuclear simulator that allows students to learn and make mistakes without the risk of a meltdown.



ENGINEERING ACCESS ALLIANCE

CITY COLLEGES[®]
OF CHICAGO



**The Grainger College
of Engineering**
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN



Build upon the current GCOE Engineering Pathways program to facilitate transfer from CCC to GCOE while enhancing support and programming at both institutions.
Looking to engage departments and faculty to:

- » Help students explore majors
- » Provide introductory coursework that is not offered at CCC
- » Offer paid summer research opportunities through the GearUP program



Critical Support from the NRC to Facilitate Workforce Development at Illinois

- Undergraduate Scholarship Program (26 students, 7 awards)
- Graduate Fellowship Program (23 students, 6 awards)
- Faculty Development Program (9 faculty, 7 awards)
- R&D Program (6, more R&D grants than any other school)

Last 10 years:

~50 graduates to nuclear utilities
2 graduates to NRC
7 interns at NRC

ILLINOIS
Nuclear, Plasma &
Radiological Engineering
GRAINGER COLLEGE OF ENGINEERING

Thank you!

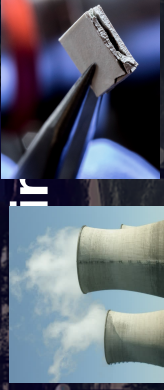
Supporting slides

MEng in Energy Systems

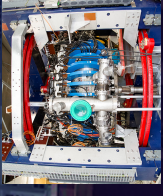
Research



Campus



Education



Outreach



Industry



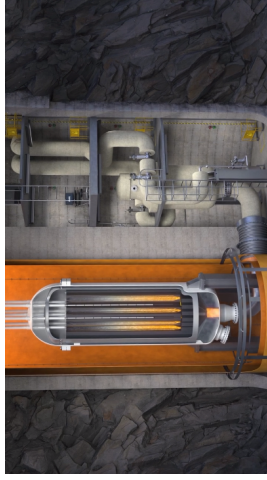
I ILLINOIS
Nuclear, Plasma &
Radiological Engineering
GRAINGER COLLEGE OF ENGINEERING

Energy

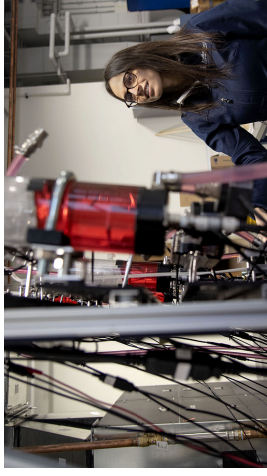
Small Department, Big Aspirations: Grainger College Moonshot Initiatives



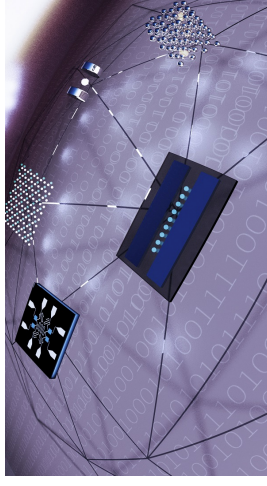
I-ACT



Micro-nuclear



**Autonomy, Mobility,
Electrification**



Quantum Computer



Hydrogen Hub



**Singapore ADSC
and more**

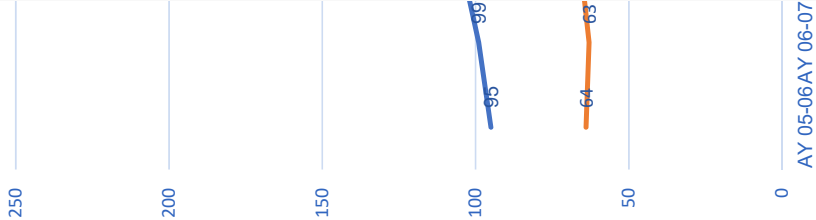


Hypersonics



AI + X

Enrollment Trends



NUCLEAR, PLASMA & RADIOLOGIC

UNIVERSITY OF ILLINOIS URBANA - CHAMPAIGN

RESEARCH AREAS

- Nuclear Power
- Plasma and Fusion
- Radiological Sciences
- Materials Science
- Reliability & Risk

Nuclear, Plasma & Radiological Engineering

2024-25 Fact Sheet

\$13.67 M
FY24 Sponsored Research Expenditures (ASEE)
(Over 900k per tenure track faculty)

- ### FACULTY
- 15 Tenure Track Faculty
 - 2 Endowed Professorships
 - 3 Endowed Faculty Scholars
 - 2 Research Faculty
 - 1 Teaching Faculty
 - 21 Affiliate/Adjunct Faculty
 - 6 Emeritus

STUDENTS

Degrees Granted, 2023-24

- 31 Bachelor of Science
 - 12 Master of Science
 - 16 Master of Engineering
 - 13 Doctor of Philosophy
- Enrollment, Fall 2024**
- 138 Undergraduates
 - 104 Graduate Students (MS/PhD)
 - 36 MEng. (Energy Systems)
 - 2 MEng. (Plasma Eng.)
 - 13 DOE NEUP Scholarships



Members of our American Nuclear Society chapter celebrating Nuclear Science Week



Current and former members of our Women in Nuclear chapter commemorating their national award for Outstanding Chapter

