

# Derisking Advanced Nuclear at University of Illinois

NRC Regulatory Information Conference | March 15, 2023



UNIVERSITY OF  
**ILLINOIS**  
URBANA-CHAMPAIGN



# UIUC Project Team



Dr. C.S. Brooks



Dr. A. Di Fulvio



Dr. T. Kozlowski



Dr. J.F. Stubbins



Dr. R. Uddin



Mr. L. Foyto



Dr. T. Grunloh



Dr. W.R. Roy



Mr. C. Townsend

**Harun Ardiansyah**  
**Joe Bottini**  
**Anthony Boyd**  
**Roberto Fairhurst**  
**Aya Hegazy**  
**Kholod Mahmoud**  
**Brady Moore**  
**Ethan Nicolls**  
**Natalie Panczyk**  
**Bella Paquette**  
**Mouna Soumahoro**



## University of Illinois at Urbana-Champaign

- Public, land-grant university founded in 1867
- Flagship of the University of Illinois system
- \$731M in R&D expenditures in FY2021
- 15 colleges and instructional units
- 651 buildings within 9.9 square miles (6,370 acres)
- 3,029 Faculty
- 56,257 Students
- 470,000+ alumni

## Grainger College of Engineering

- 39 top ten ranked degree programs
- #10 overall graduate program ranking
- #6 nuclear engineering graduate program



‘The University of Illinois at Urbana-Champaign is charged by our state to enhance the lives of citizens in Illinois, across the nation and around the world through our leadership in learning, discovery, engagement and economic development.’



# Illinois and UIUC legacy



## Illinois leadership

- 1942: Chicago, IL, First sustained fission
- 1946: Lemont, IL, Argonne National Laboratory
- 1959: Morris, IL, First fully commercial nuclear power
- Today: Majority of Illinois electricity is nuclear

## UIUC TRIGA®

- In heart of UIUC 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



UIUC TRIGA® Image provided by University of Illinois



TRIGA® is a registered trademark of General Atomics



# Project Focus



## Core Mission: Education, training, and outreach

- general public,
- undergraduate,
- graduate,
- professional,
- operator training.

## Core Mission: Research capability

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

## Cross-cutting Mission: Production demonstration

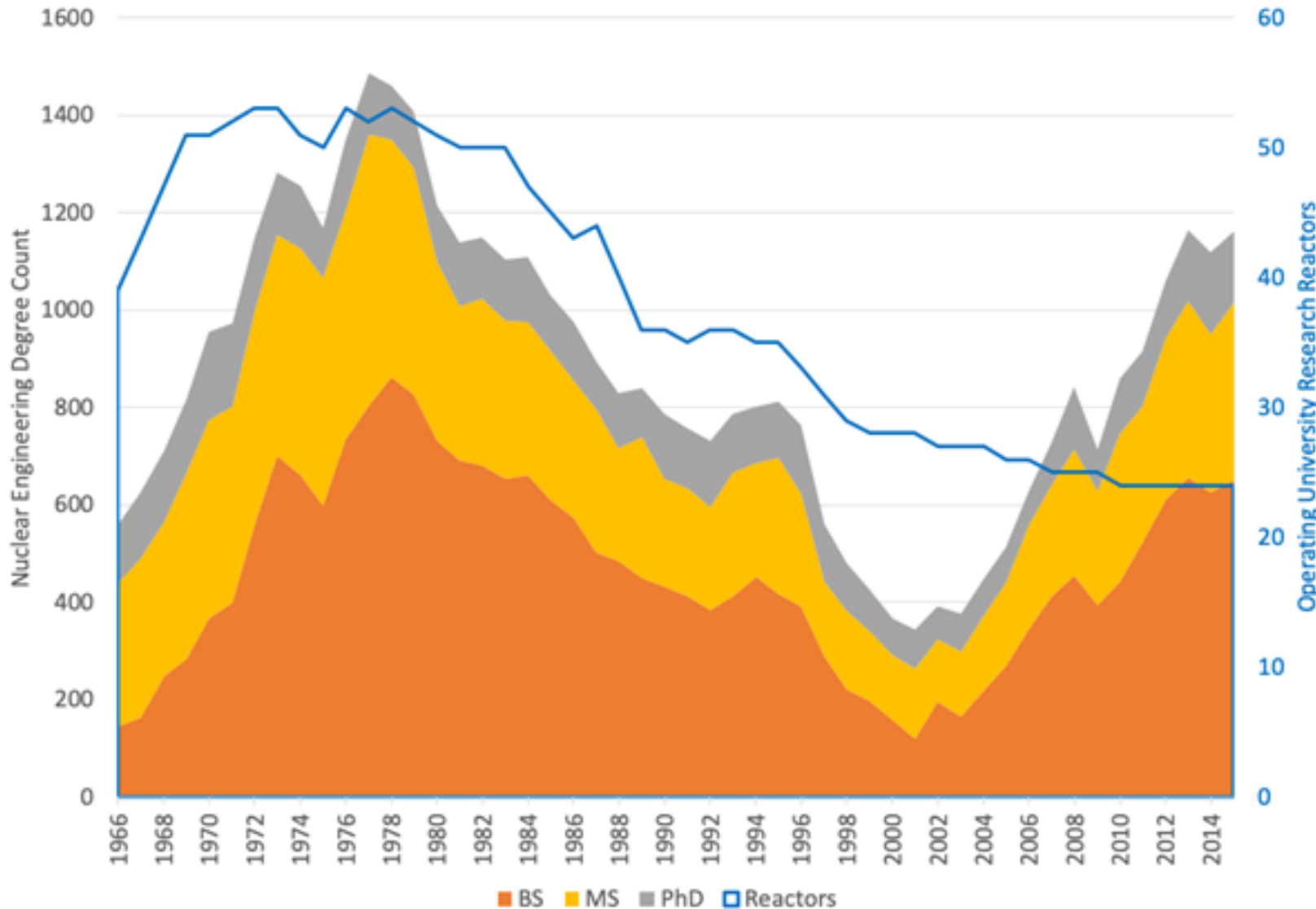
- electricity,
- district heat,
- hydrogen production,
- Integrated thermal storage,
- Other high value processes.



*Consistent with the Atomic Energy Act, Class 104(c) small reactors for **research, testing, and training** can contribute to the **public good** through their role in **higher education, workforce development, research, and technology/market demonstration**.*



# Need: Next Generation Nuclear Workforce



- Resurgence in student interest in Nuclear has not been met with new university reactors for education, training, and research.
- No new university-based research reactors for nearly 30 years.
- Advanced nuclear needs advanced research and test reactors.

Data compiled from ORISE, 2019; Morrell et al., 2017; Anderson et al. 2016



# Need: Next Generation Research & Development



- Instrumentation & control, Human-Machine Interface
  - Radiation monitoring and detection
  - Construction modernization
    - Grid security/resiliency
    - Micro-grid technology
    - Hybrid energy systems
    - Advanced power conversion cycles
    - Advanced reactor multiphysics validation
    - Hydrogen economy
    - Advanced materials
  - Reactor simulator and digital twin
  - Agricultural sustainability & food security
- High temperature water purification processes



# Need: Next Generation Market Demonstration



**Microreactors are expected to be attractive to markets and institutions that value:**

## Emissions Reductions & Sustainability

- Replacement of fossil generation
- Process heat for chemical and industrial processes

## Small scale generation (1-20 MW)

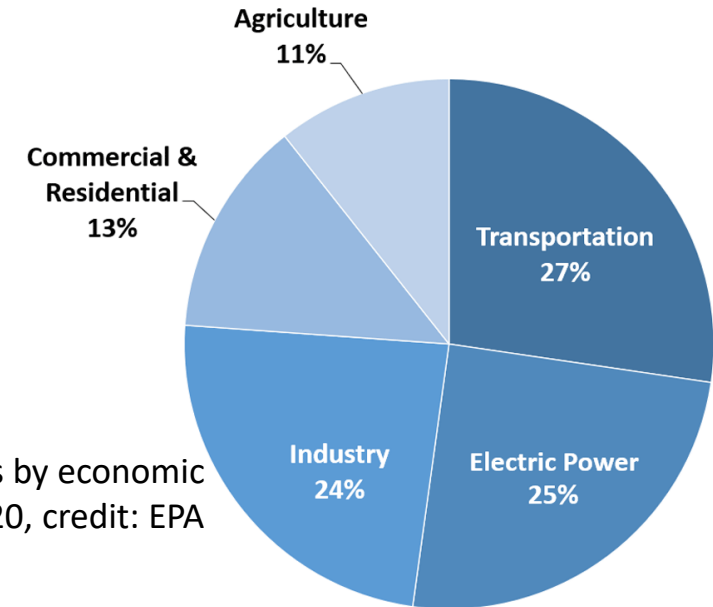
- Microgrids
- Embedded Grids
- Small Communities
- Remote Communities

## Thermal Power

- Combined Heat and Power Applications
- District Heating
- Energy Intensive Processes
- Process Heat Applications

## Resilience & Reliability

- Critical Infrastructure
- Backup Power
- Data Centers



US Greenhouse gas by economic sector in 2020, credit: EPA

Average Price [cents/kWhr] of Electricity to Ultimate Customers by End-Use Sector, EIA, Nov 2022 and percent increase since Nov 2021 in ().

Region or State	Residential	Commercial	Industrial	All Sectors
New England	26.29 (20.2%)	18.13 (16.5%)	14.95 (10%)	20.83 (14.6%)
Alaska	23.07 (2.3%)	20.4 (2.7%)	17.12 (2.2%)	20.61 (2%)
Hawaii	43.91 (26.4%)	42.0 (30.9%)	38.64 (36.2%)	41.29 (31%)
California	26.14 (9.5%)	22.01 (25%)	16.94 (16.7%)	22.49 (19.1%)
Illinois	17.27 (11.2%)	11.17 (7.8%)	8.43 (4.8%)	12.16 (12.4%)
US Total	15.64 (11.2%)	12.5 (10.7%)	8.3 (12.5%)	12.46 (11.8%)

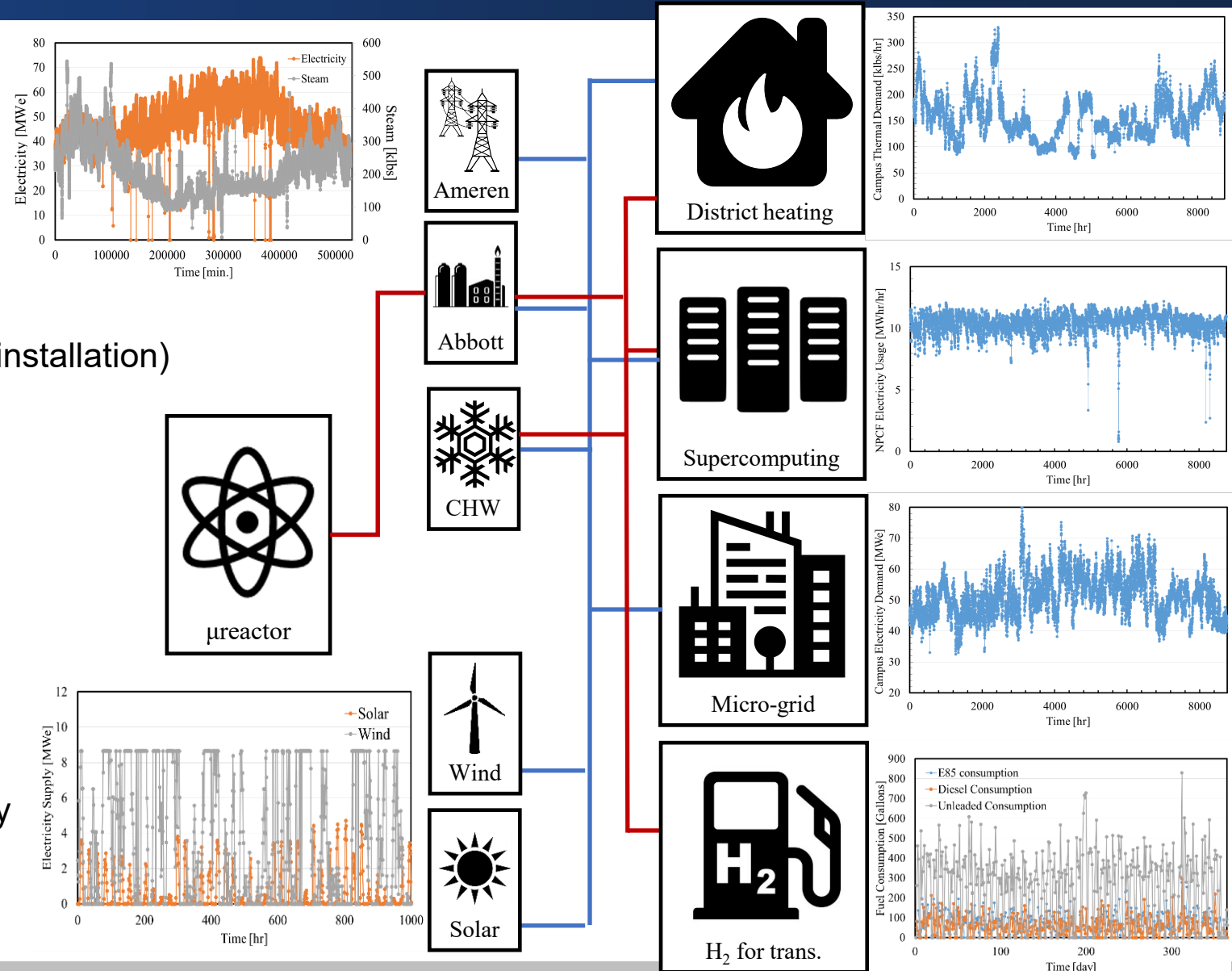
\*Data from the US Energy Information Administration (EIA)

# Campus energy portfolio

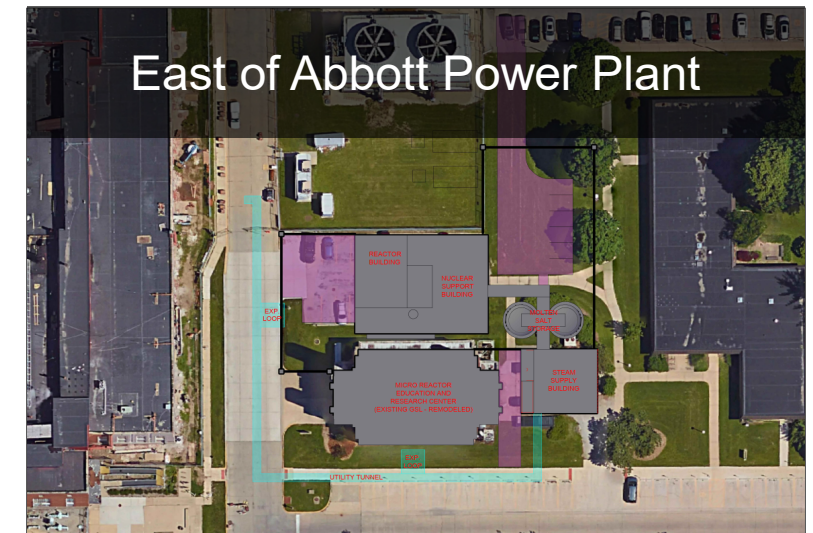


## UIUC Energy Portfolio

- **Electrical**
  - 55 MWe average demand
  - Blue Waters Supercomputer up to ~12 MWe
  - Wind: ~25,000 MWh/yr
  - Solar: ~8,000 MWh/yr (25,000 MWh/yr new installation)
  - Chillers: ~8.5 MWe peak
- **Thermal**
  - 60 MWt average demand
  - 7 Chilled water plants (2 steam, 5 electric)
  - Energy storage (37,500 tons chilled water)
- **Transportation**
  - Campus fleet ~ 800 gallons/day
  - Campus bus system: up to 3,400 gallons/day
  - Bus system already investing in H<sub>2</sub> busses







Google Earth, 10/2021



# USNC Micro-Modular Reactor (MMR)

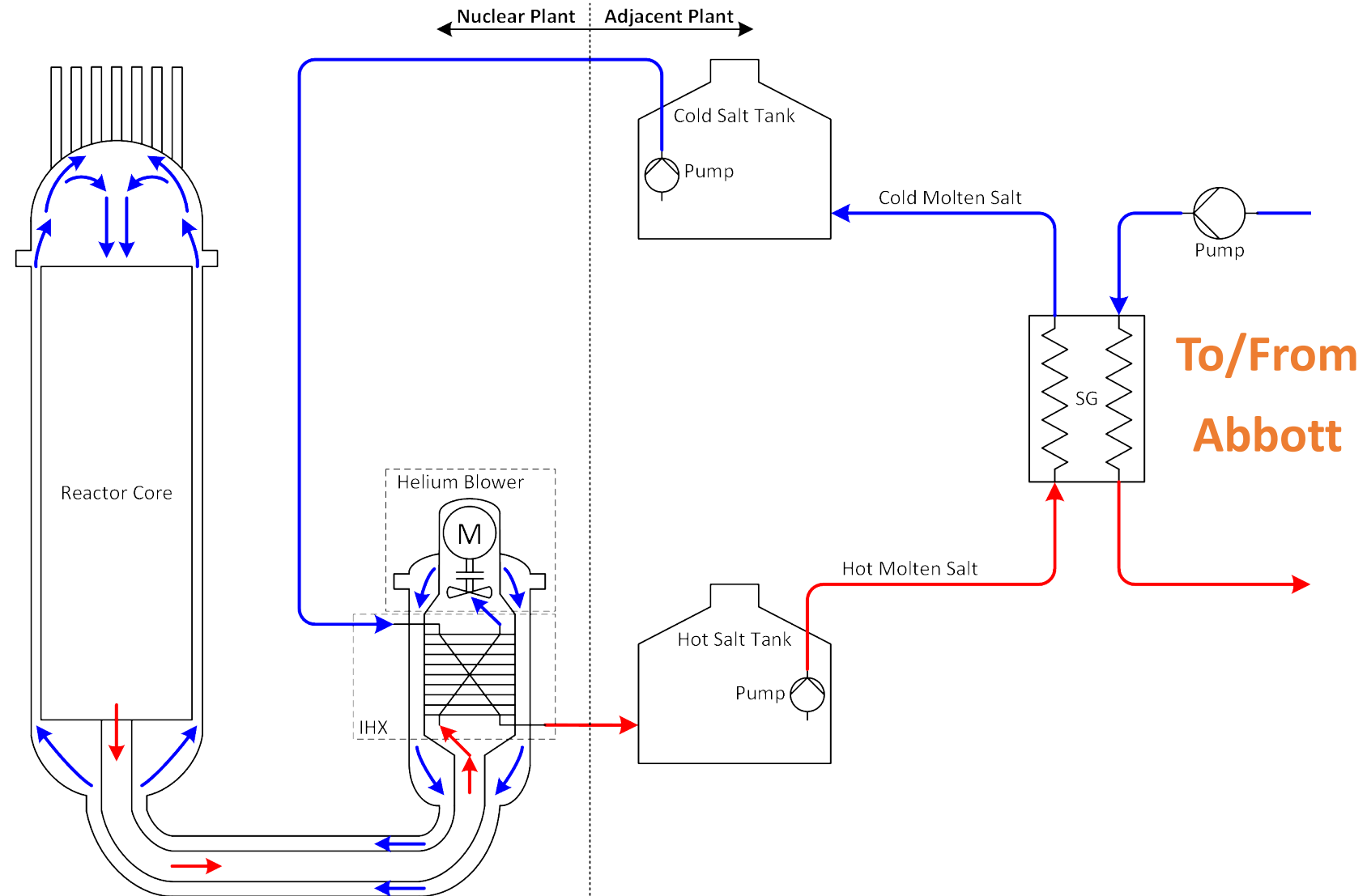


## Fluid Characteristics:

- Helium
  - 3 MPa,
  - 300°C - 630°C
- Molten Salt
  - 0.5 MPa,
  - 270°C - 565°C

## Safety Methodology:

- Retain all fission products
- Strong negative feedback with Temp.
- Cooling through natural forces (passive)





# More info and stay connected



- Pre-application Engagement
  - Target PSAR and ER submittal: Q1 of 2024
- Project [Website](#)
- Featured article in [NN, April 2022](#)
- [Illinois Microreactor RD&D Center](#)
- [NRC](#)
  - [NRC UIUC Project site](#)
  - [NRC listserver](#)
- Contact info  
Caleb Brooks  
[csbrooks@illinois.edu](mailto:csbrooks@illinois.edu)  
217-265-0519

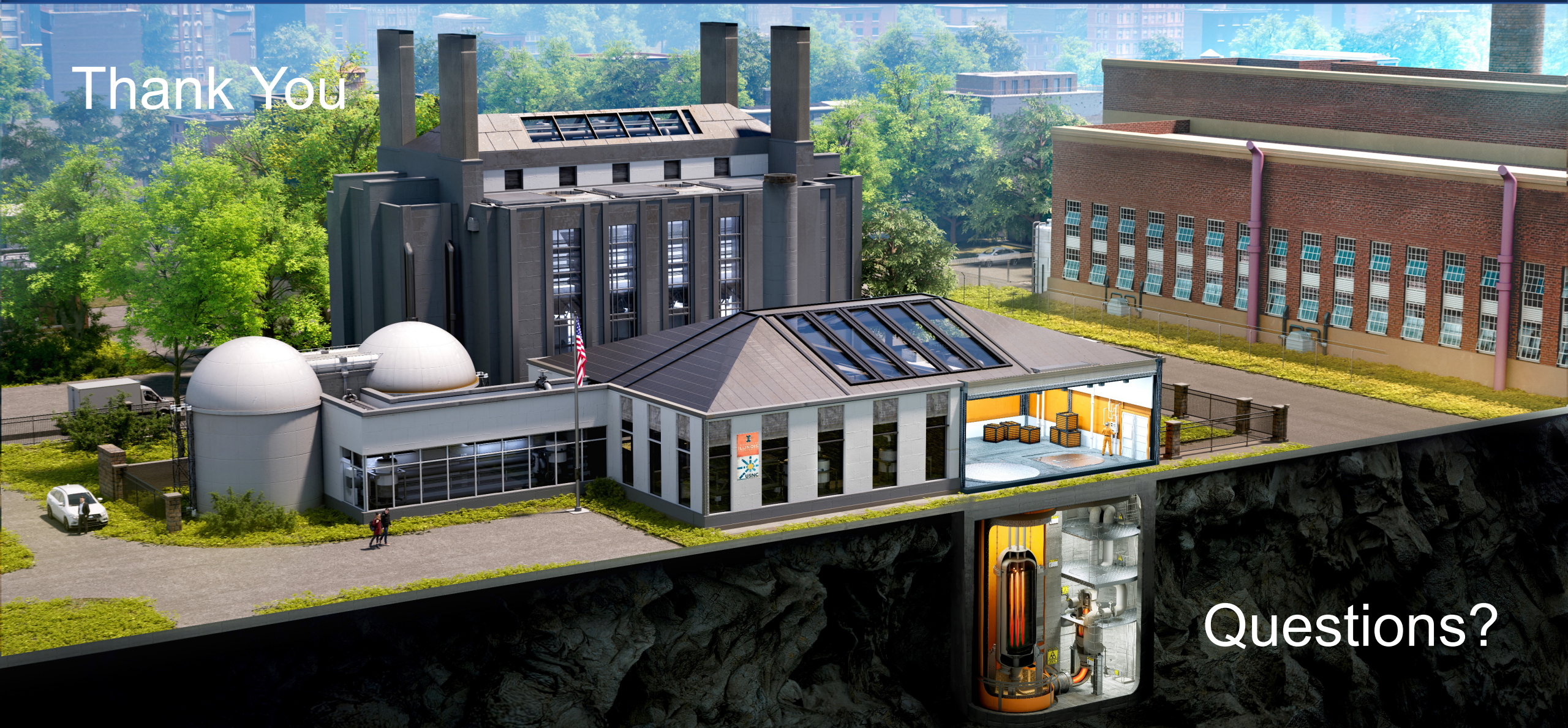






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Thank You



Questions?