

Illinois Microreactor Demonstration Project

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UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN



- **What is a ‘microreactor’ and how is it different?**
- **What’s the Illinois Microreactor Demonstration Project?**
- **Nuclear energy application development**

'Micro' reactor Technology



Small-scale:

- Power output <math><1 - 50^* \text{ MW}</math>
- Long core life: up to 20yrs
- Similar in size to research & test reactors.

Transportable:

- Reactor vessel small enough for truck, railcar, or airplane.
- reduced onsite construction: plug-and-play

Factory fabricated:

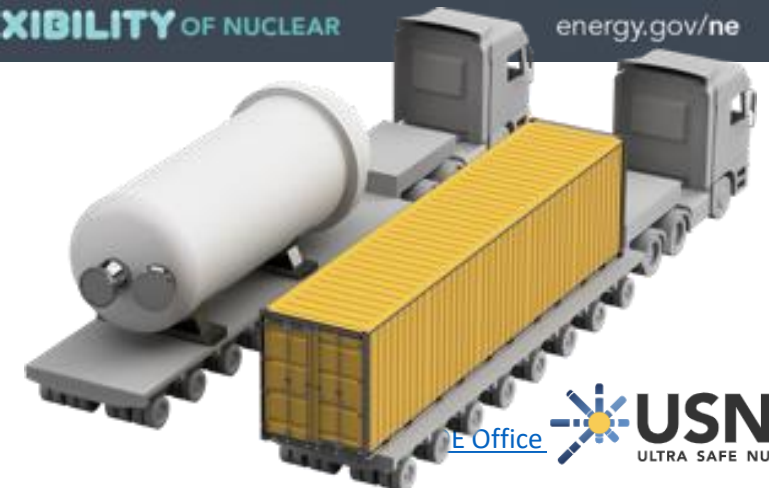
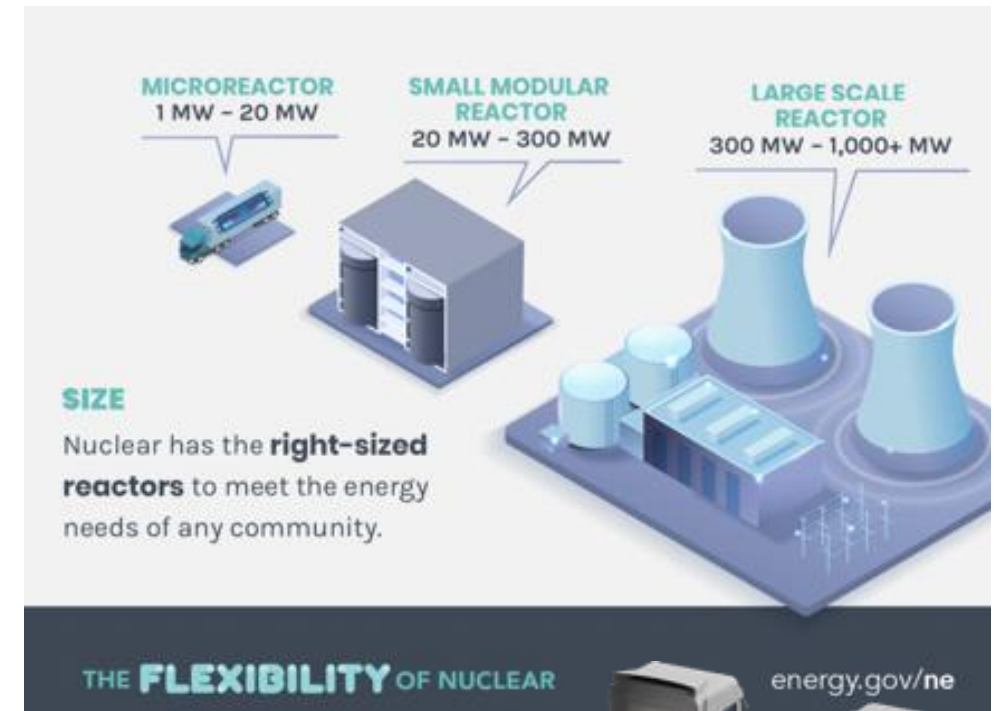
- Fully assembled and tested at a factory before delivery.

Self-adjusting:

- Simple and responsive design concepts.
- Inherently safe.

Promising:

- Dozens of start-up companies have competing designs.
- Right-sized for space, disaster response, resilient energy, remote locations, developing grids, energy intensive industry, and more...

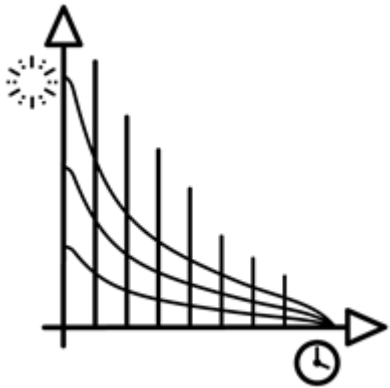


Microreactor Safety



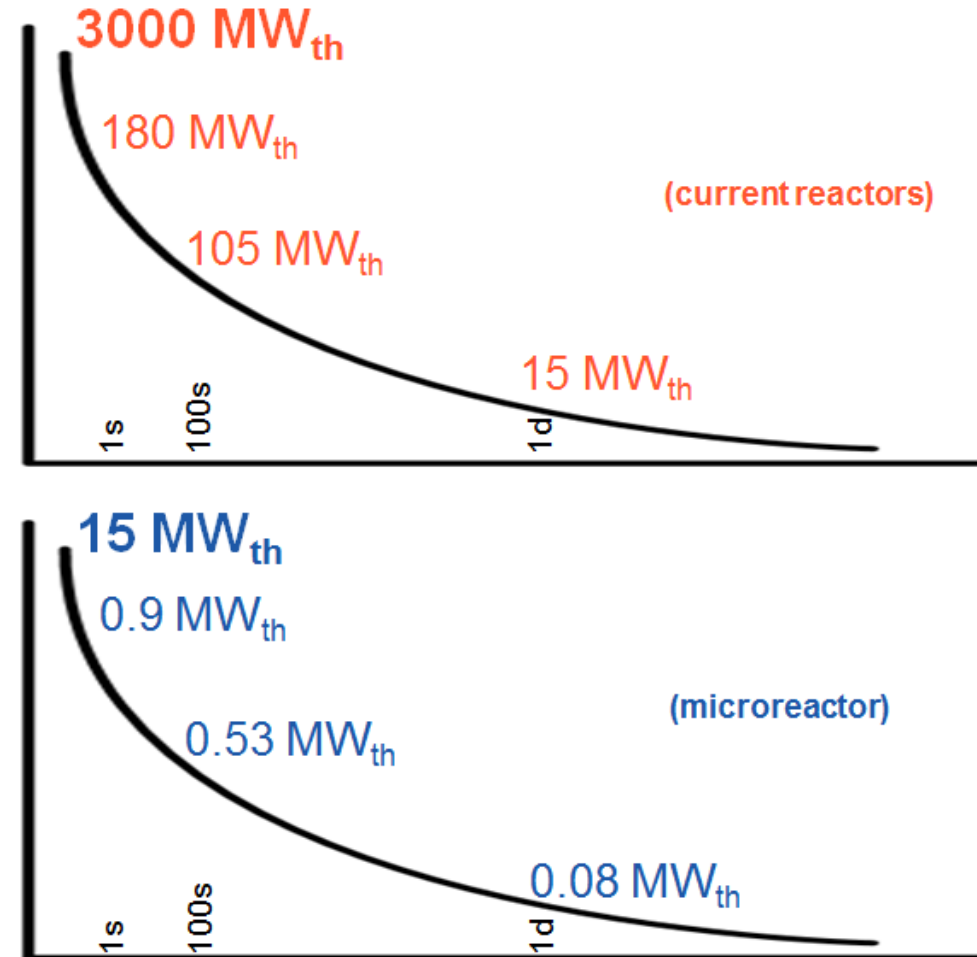
Safety in size

Conventional nuclear systems must be actively cooled after shutdown to remove residual power.



Micro-reactors are so small, they cool naturally, with all heat dissipating passively into the surrounding structures.

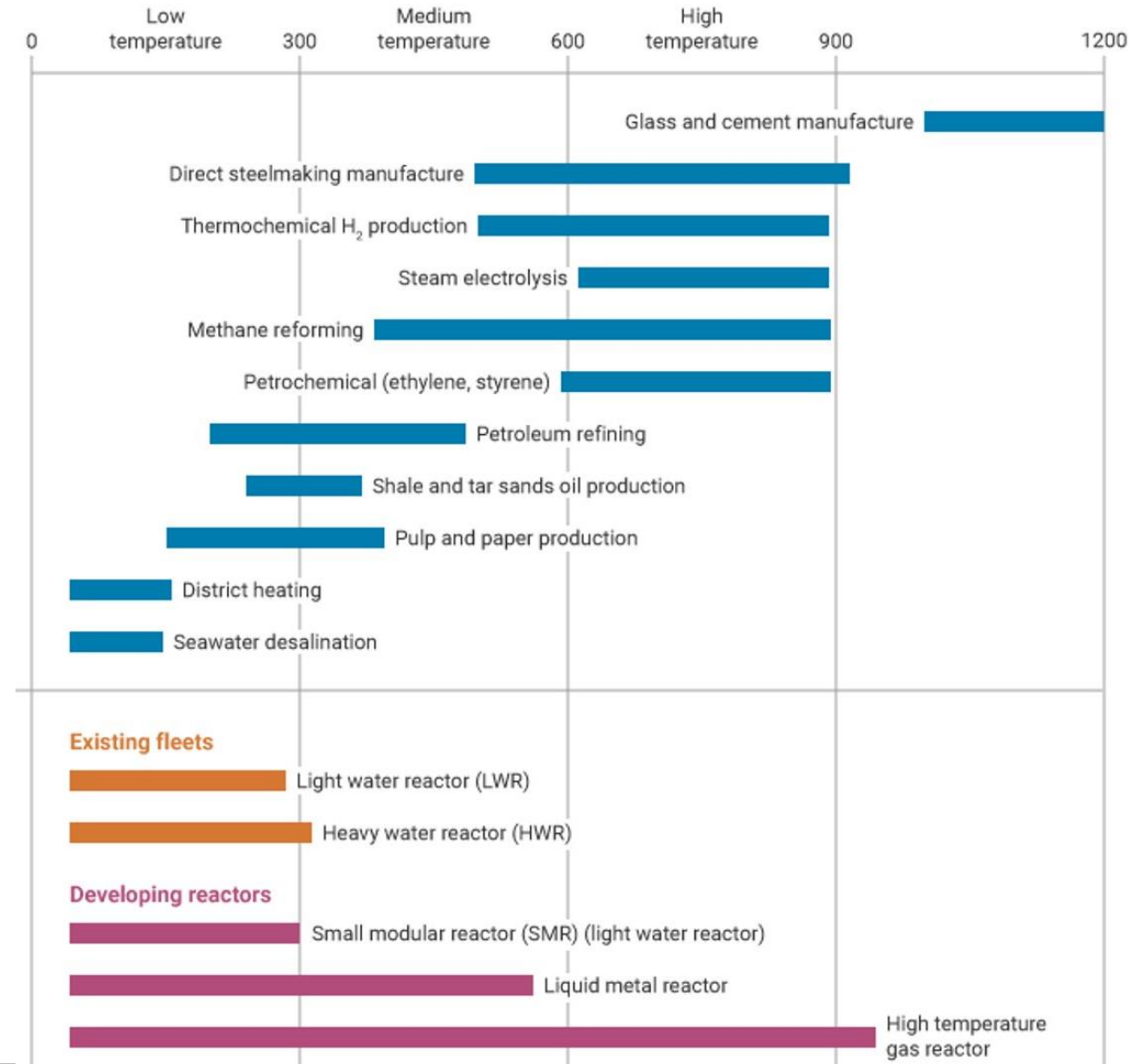
200x lower power means 200x less residual power after shutdown.



Benefits of Advanced Reactors



- Currently operating reactors are designed for baseload
 - Steady operation at full power
 - Relatively low temperature
- More variation in deployed designs allows penetration into diverse markets
 - Higher temperatures leads to more efficient industrial processes
 - Smaller footprint allows integration with local users and infrastructure
- Proven technology basis



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

The Illinois Microreactor Demonstration Project's mission is to de-risk advanced reactor deployment and enable a new paradigm of nuclear power through education, research, and at-scale demonstration.

Demonstrate the realizability of advanced nuclear in a representative setting

Seize the moment and cement the coming nuclear resurgence with leadership that only universities can provide

Perform the research and development needed to pave the way for safe and economic operation of advanced reactors

Project Missions



Core Mission

Education, Training, and Engagement

Engineers and scientists

general public

operator training

installation and maintenance

Producing the future workforce & redeeming public perception of nuclear power



Cross-cutting Mission: At-scale Demonstration

electricity,

district heat,

hydrogen production,

Integrated thermal storage,

Other high value processes.

Demonstrating the future of nuclear power

Core Mission

Research & Development

Reactor and component

optimization

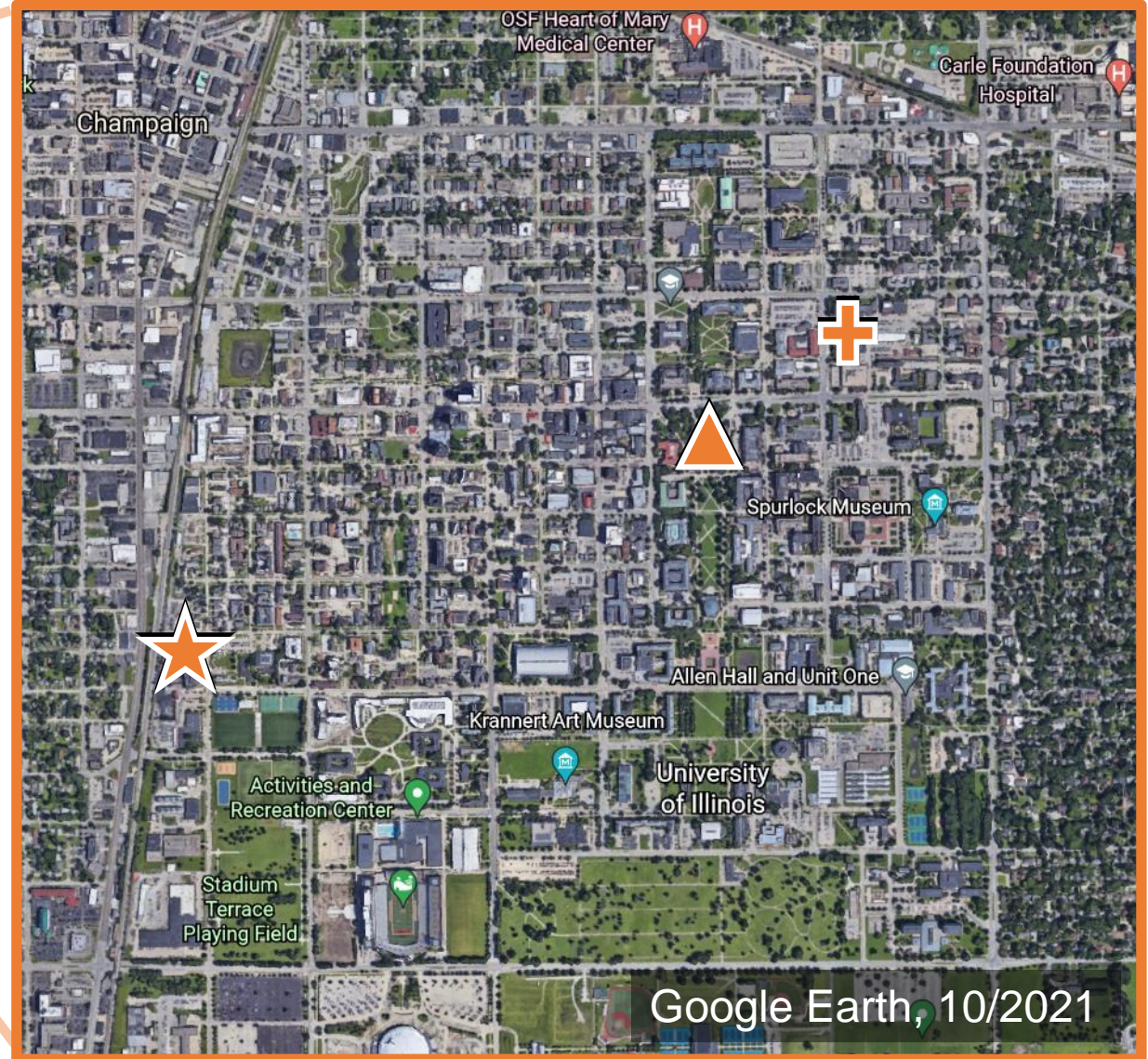
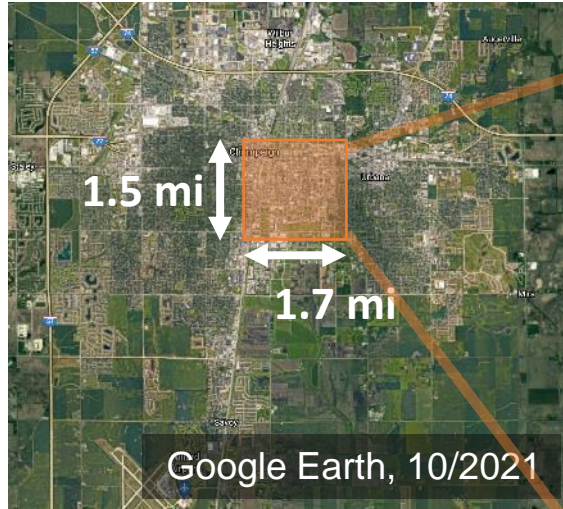
critical enabling technologies




synergistic applications

Enabling a new paradigm of nuclear



Campus



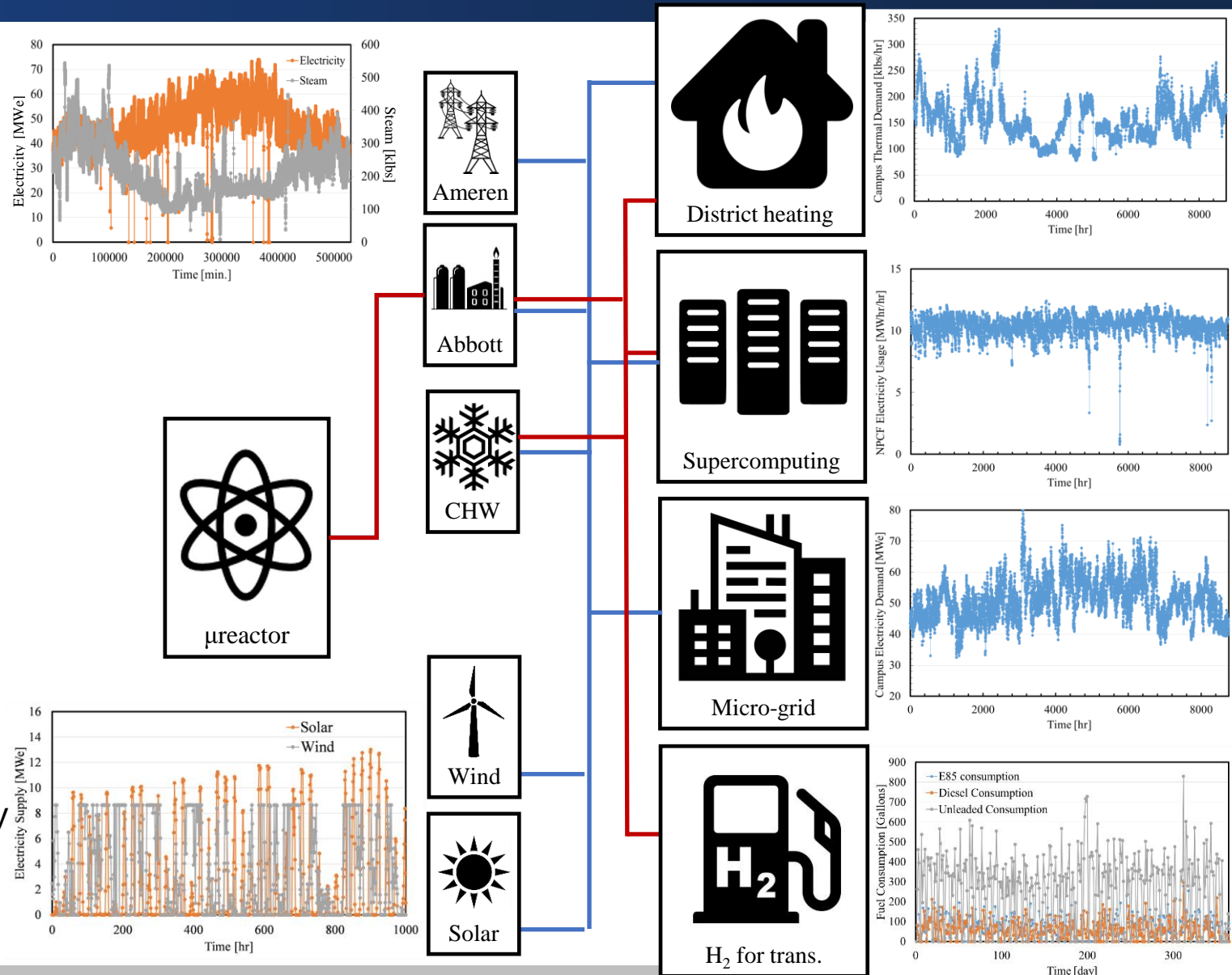
-  Illini Union Building (campus center)
-  UIUC TRIGA reactor site
-  Abbott Power Plant

Campus energy portfolio

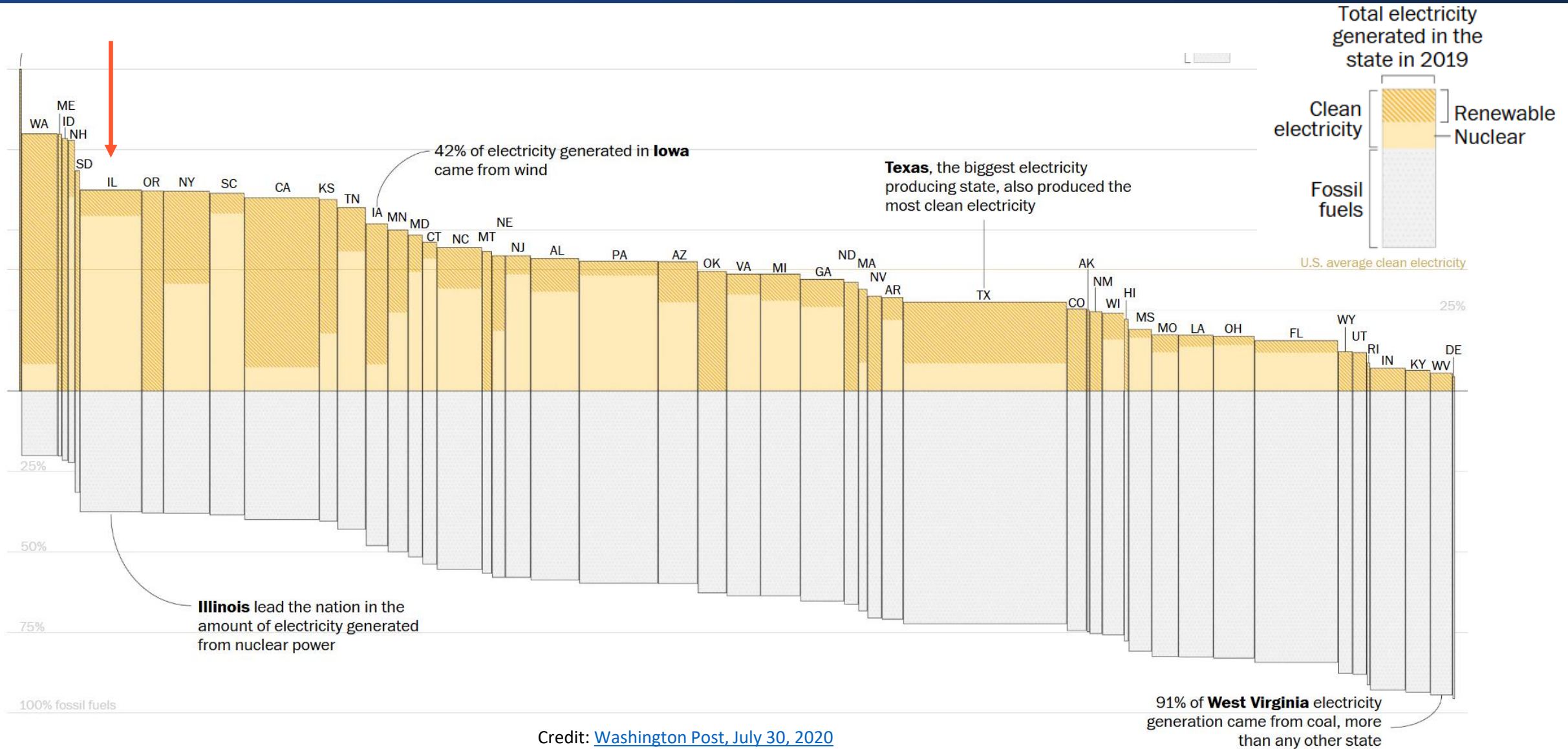


UIUC Energy Portfolio

- **Electrical**
 - 55 MWe average demand
 - Blue Waters Supercomputer up to ~12 MWe
 - Wind: ~25,000 MWh/yr
 - Solar: ~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 H₂ busses



US Clean energy outlook

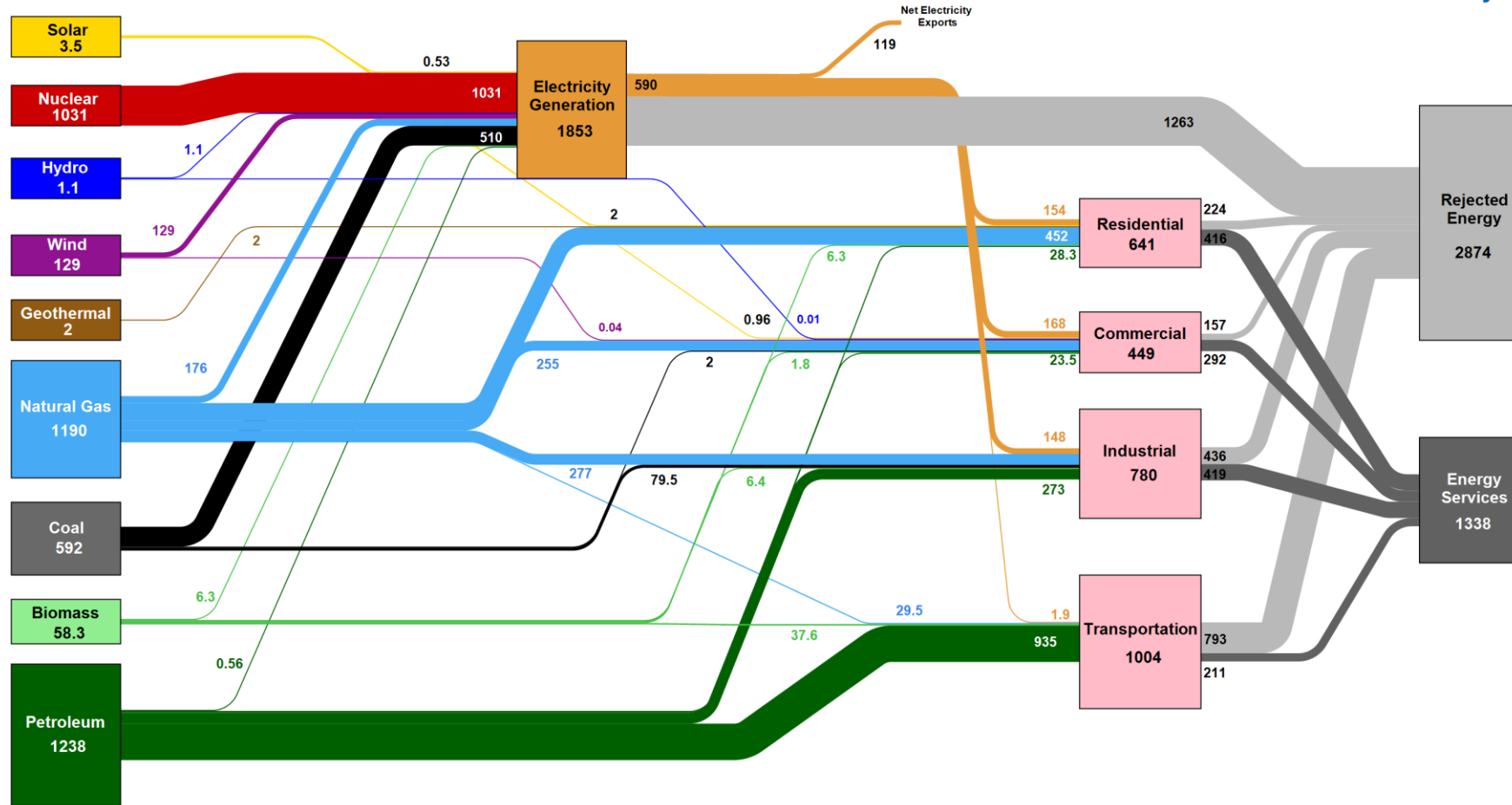


Credit: [Washington Post, July 30, 2020](https://www.washingtonpost.com/archive/local/2020/07/30/)

Illinois Energy Use



Illinois Energy Consumption in 2019: 4331 Trillion BTU



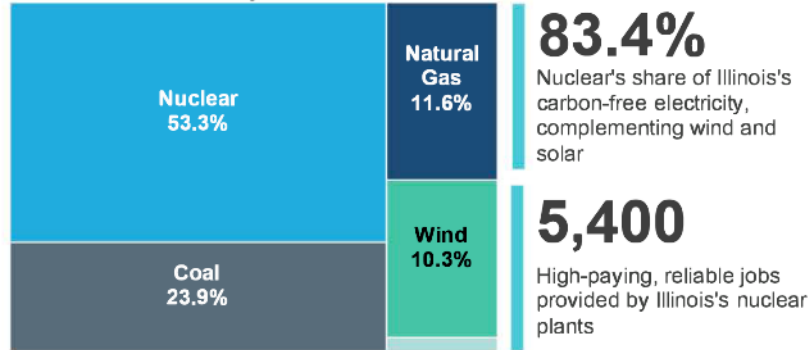
Source: LLNL August, 2021. Data is based on DOE/EIA SEDS (2019). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.49% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527

Diversified Nuclear in Illinois



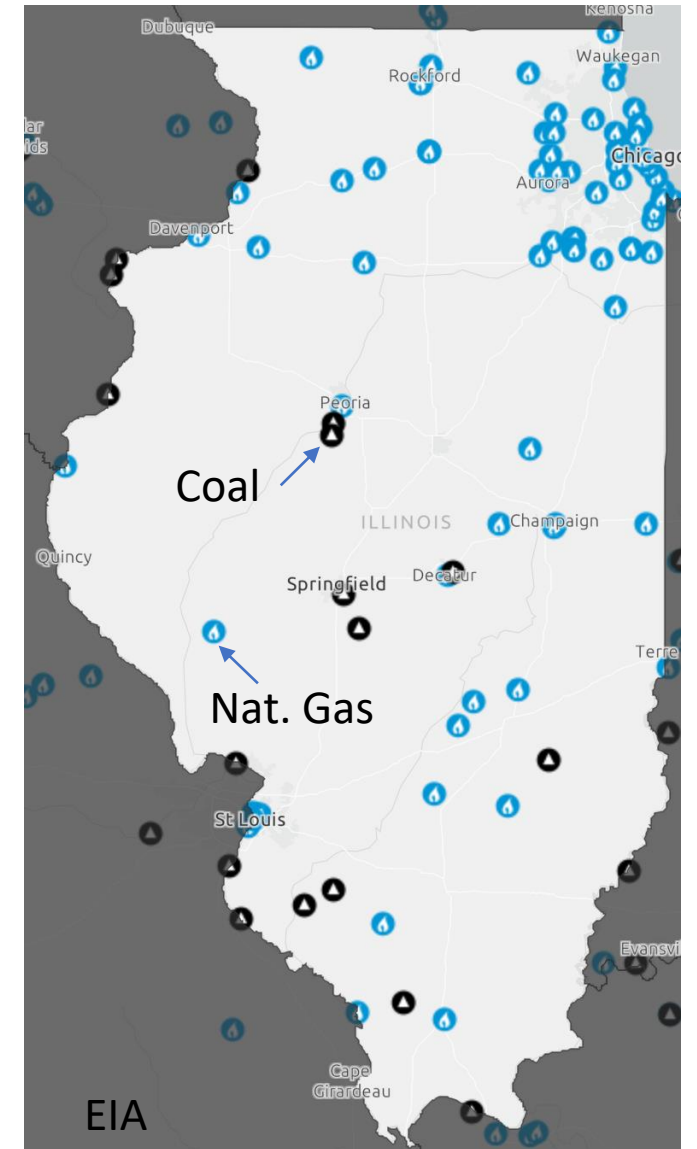
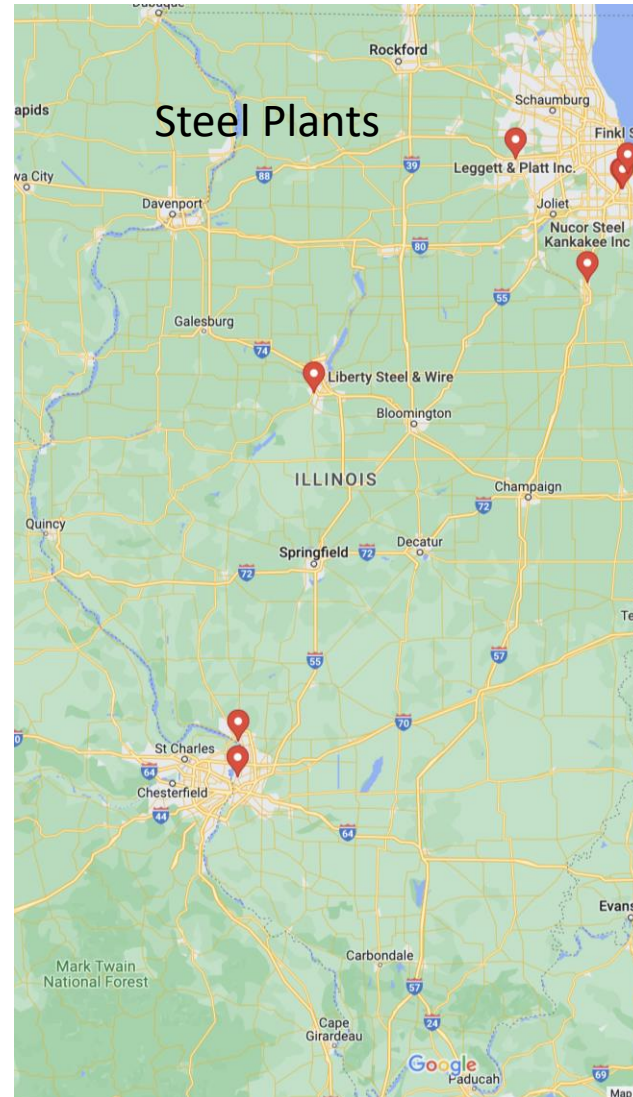
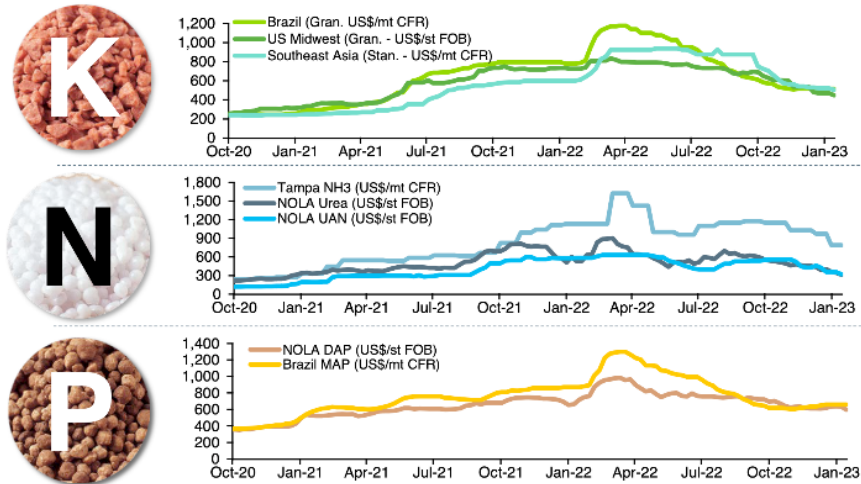
STATE ENERGY PROFILE

Sources of electricity in Illinois



Selected Fertilizer Prices

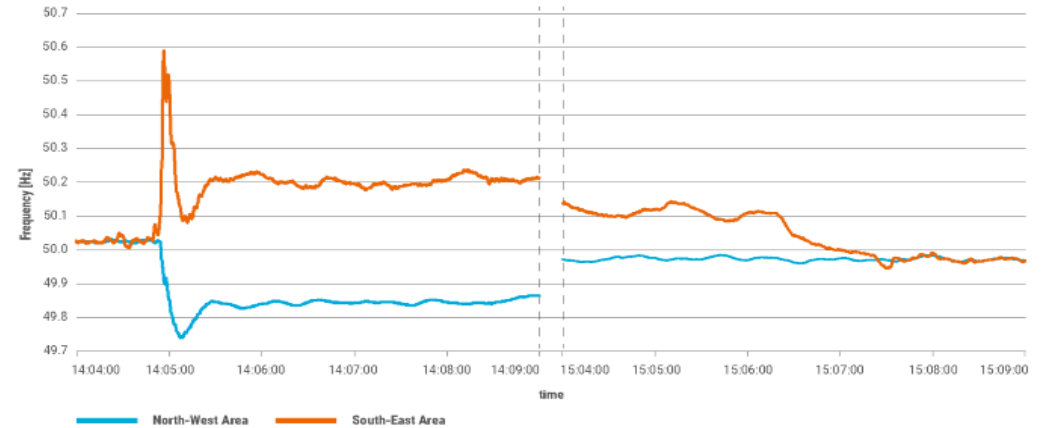
US\$ per Unit



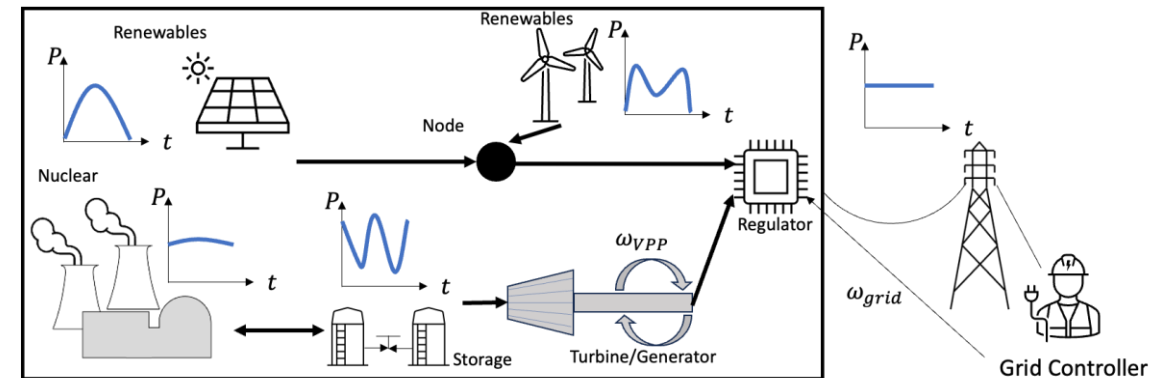
Integrating with Renewables



- Renewables are a growing part of the energy portfolio
- Potential negative effects on grid stability
- Ongoing research at UIUC enables new operational paradigms
- Frequency regulation and other ancillary grid services
- Operation in aggregation with local renewables to reduce transmission requirements for utilities

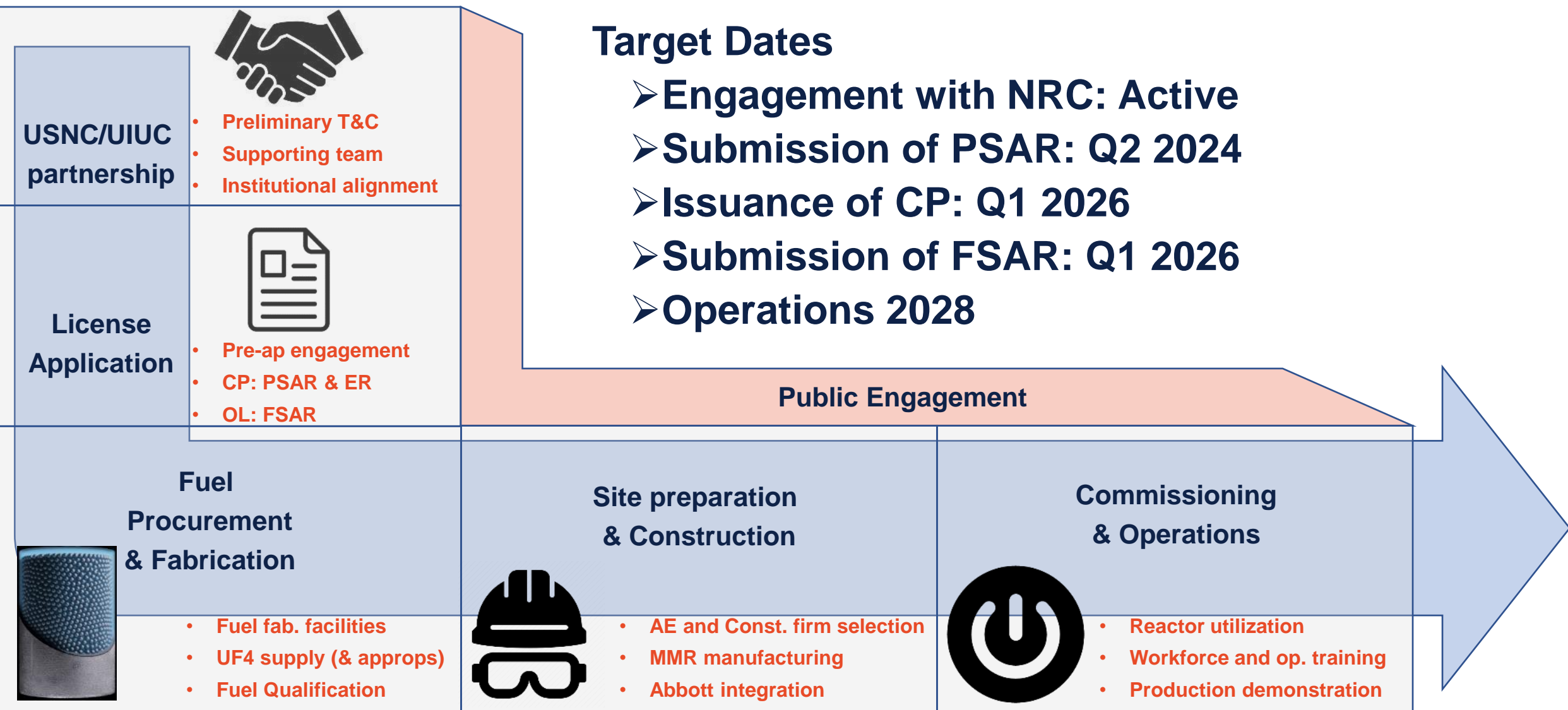


<https://www.axpo.com/ba/en/about-us/magazine.detail.html/magazine/energy-market/how-axpo-power-plants-prevented-a-blackout.html>



- A very near term application of small nuclear plants is combined heat and power for campus-type users
- UIUC uses Abbott power plant to provide non-electric energy services (e.g., heat) to hundreds of building
- We are engaged with the Electric Power Research Institute (EPRI) on translating our project knowledge to other interested institutions through the NuIDEA program
- Project will serve as template for integrating facilities with nuclear and non-nuclear requirements





UIUC Project Team



Dr. C.S. Brooks



Dr. A. Di Fulvio



Dr. T. Kozlowski



Dr. J.F. Stubbins



Dr. R. Uddin

**Harun Ardiansyah
Anthony Boyd
Roberto Fairhurst
Kholod Mahmoud
Ethan Nicolls
Natalie Panczyk
Bella Paquette
Mouna Soumahoro
Luke Seifert
Bruce Ciccotosto**



Mr. R. Dobey



Mr. L. Foyto



Dr. T. Grunloh



Dr. W.R. Roy



Mr. C. Townsend



Mr. D. Craig

Mission Statement

The Illinois Microreactor Demonstration Project's mission is to de-risk advanced reactor deployment and enable a new paradigm of nuclear power through education, research, and at-scale demonstration.

- Nuclear enables the clean energy future
- Small reactors, big potential

- Opportunity for Illinois leadership in clean energy
- Deep decarbonization without disruption

More info and stay connected

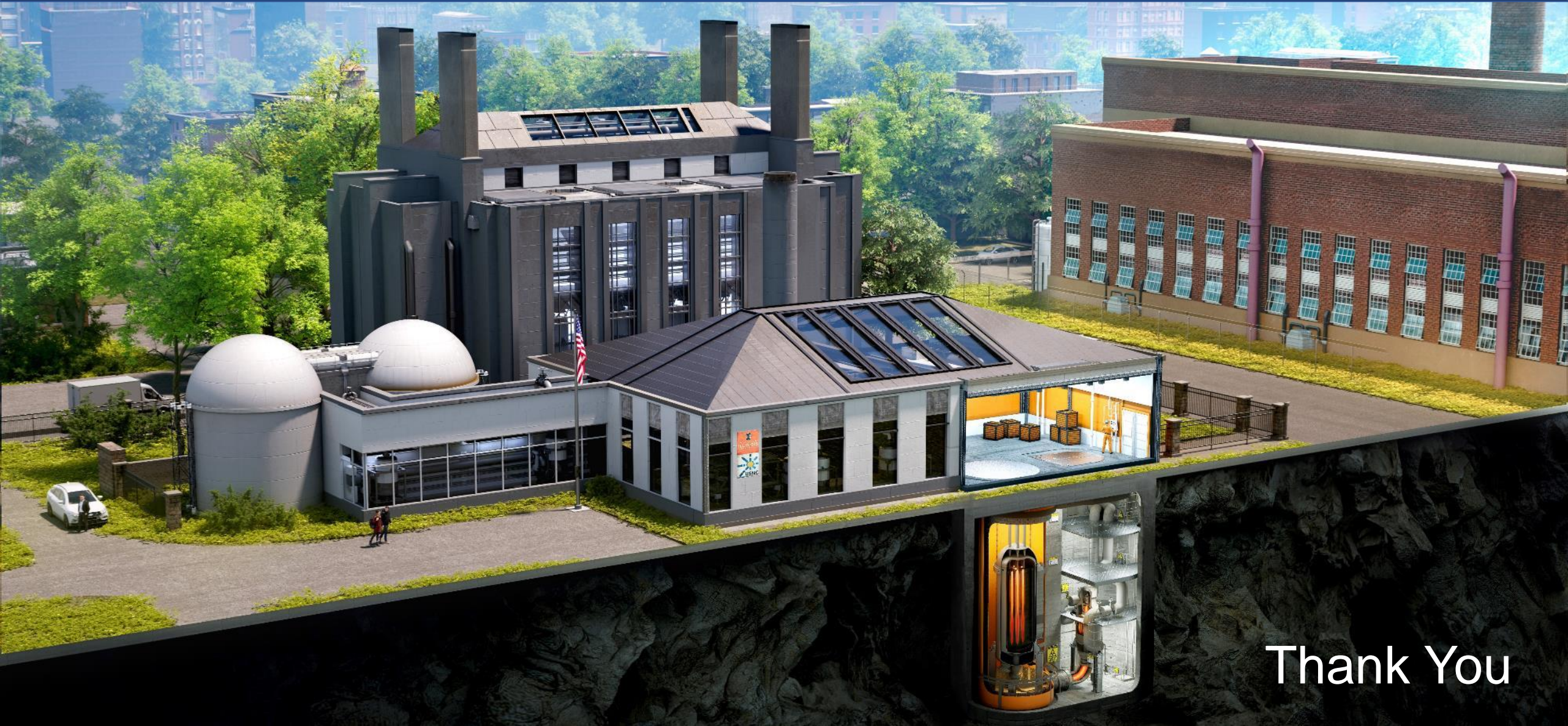


- Project [Website](#)
- Featured article in [NN, April 2022](#)
- [Illinois Microreactor RD&D Center](#)
- [NRC](#)
 - [NRC UIUC Project site](#)
 - [NRC listserver](#)
- Contact info
Caleb Brooks
csbrooks@illinois.edu
217-265-0519





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Thank You