Gateway for Accelerated Innovation in Nuclear

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CIBO

GAIN
Gateway for Accelerated Innovation in Nuclear

INL/MIS-18-50189

Mission and Vision

Vision (2030)

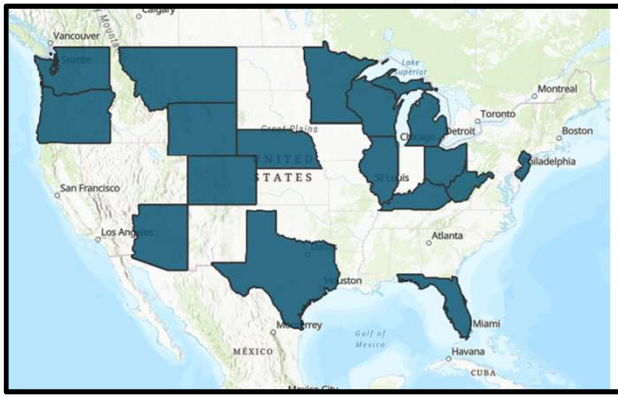
The U.S. nuclear industry is equipped to lead the world in deployment of innovative nuclear technologies to supply urgently needed abundant clean energy, both domestically and globally.

Mission

Provide the nuclear energy industry with access to cutting-edge R&D, along with the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward *commercialization* in an accelerated and cost-effective fashion.

2022 Activities

GAIN Gateway for Accelerated Innovation in Nuclear



State Level Outreach

- Policymakers, NGOs, Utilities, Regulators, Industrials, Commissioners
- Introduce Advanced Nuclear through direct conversation or testimony
- Help connect states to financial or technical resources across DOE complex
- Looking at state level regs

Advanced Nuclear Industry Milestones

Purdue University and Duk...
DATE
4/27/2022

VA Legislature Passes Bill ...
DATE
4/11/2022

Indiana Passes SMR Bill
DATE
3/18/2022

NuScale Power and KGHM ...
DATE
2/14/2022

West Virginia Repeals New...
DATE
2/8/2022

Oklo Partners with Argonn...
DATE
2/8/2022

USNC Partners with Coppe...
DATE
2/2/2022

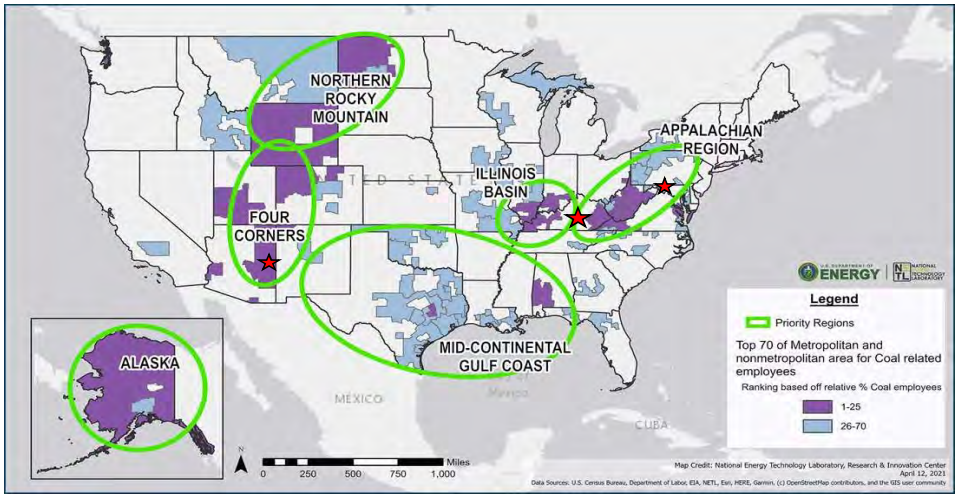
gain.inl.gov

COAL TO NUCLEAR
ENERGY COMMUNITY TRANSITIONS

GAIN Gateway for Accelerated Innovation in Nuclear

Case Study Pilot (in partnership with DOE-FECM)

GAIN is in the process of scoping several case studies of specific coal sites/plants to understand the parameters that will have the most influence on moving forward with transitioning a coal site to nuclear. Scope several this year – complete 1 or 2 in the calendar year and initiate others in the future.



TerraPower A Nuclear Innovation Company · GAIN Gateway for Accelerated Innovation in Nuclear · EPRI Electric Power Research Institute · Fastest Path to Zero University of Michigan · Microsoft · Bryden Wood Simpson Gumpertz & Heger · NEI · Oak Ridge National Laboratory · MIT · Terra Praxis · University at Buffalo · INL Idaho National Laboratory · SODI Southern Ohio Diversification Initiative · Argonne National Laboratory · TVA · Southern Company · NRIC National Reactor Innovation Center · orano · CATF Clean Air Task Force

Coal to Nuclear Research Group

Each group is leading important projects associated with potential repurposing coal sites with nuclear technology. Use group discussions to align our individual efforts to make the most of this opportunity for the broader industry. In addition, get constructive feedback on GAIN case study pilot project.

Industrial Outreach

- GAIN has a subcontractor doing some research for determining interest in end users of nuclear
- Goals are:
  - Where does nuclear fit?
  - What makes nuclear attractive to end users?
  - What are the hurdles to adoption in these other markets?
  - What is the timeline for your deployment?

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Figure 4.5: **Process temperature ranges by industrial application and reactor capabilities**

Source: Bredimas (2014) and Bredimas (2011a).

Future clean energy systems – transforming the energy paradigm

Nuclear Energy Generation

Light water reactors, high temperature advanced reactors, small modular reactors.

Other Energy Generation

Variable renewables, municipal waste, fossil with carbon capture, etc.

Integrated energy systems (IES) leverage the contributions from nuclear fission beyond electricity

Biofuel

New chemical processes

Clean water

Industry

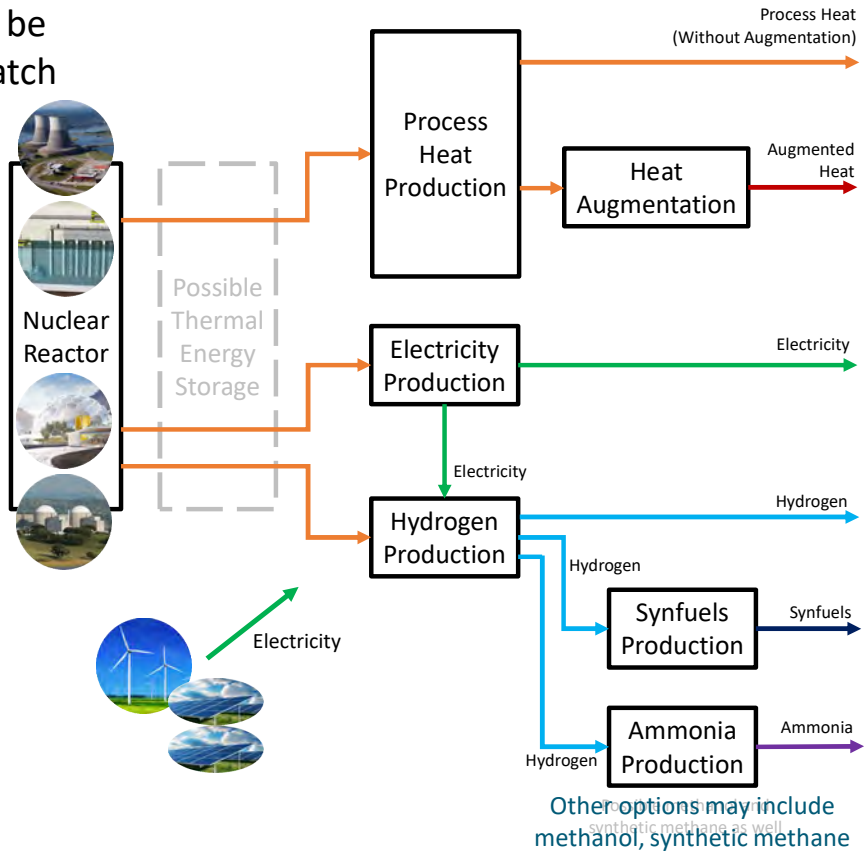
Electricity

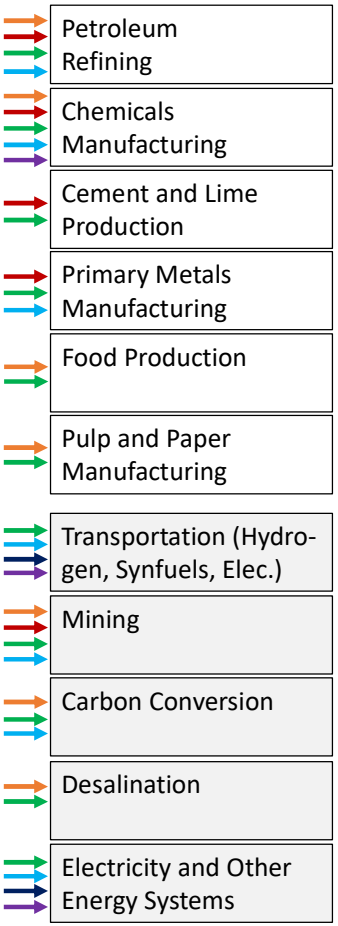
Hydrogen for vehicles and industry

IES Integrated Energy Systems

Summary of potential nuclear-driven IES opportunities

Reactor sizes align with the needs of each application, heat augmentation can be applied if needed to match process temperature demands.





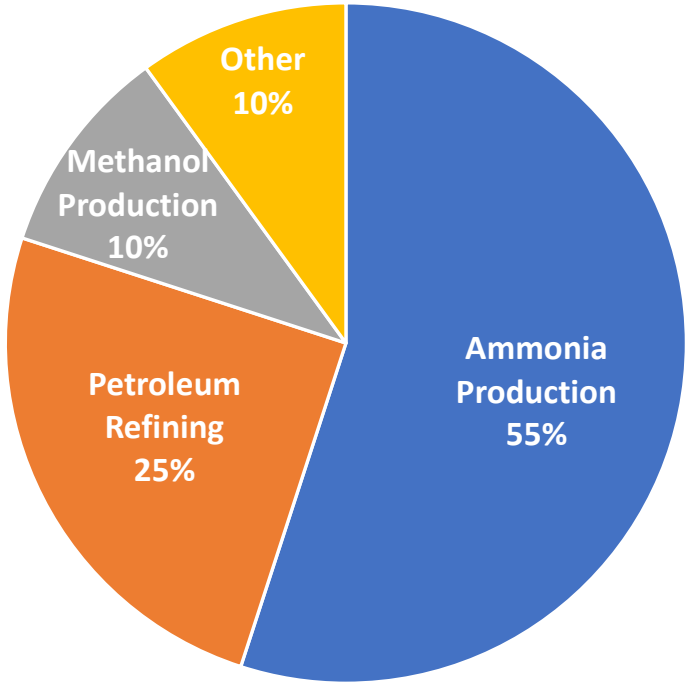
Source: INL, *National Reactor Innovation Center (NRIC) Integrated Energy Systems Demonstration Pre-Conceptual Designs*, April 2021

Why the focus on hydrogen?

Hydrogen applications in industry

- Agriculture/chemical industry: ammonia, ammonia-based fertilizers
- Petroleum refining: hydrocracking to produce gasoline, diesel
- Methanol production
- Other:
  - Food (e.g., hydrogenated oils)
  - Metalworking
  - Welding
  - Flat glass production
  - Electronics manufacturing
  - Medical applications

Fraction of Global Hydrogen Use by Industry



Data source: Hydrogen Europe
hydrogeneurope.eu/hydrogen-applications

IES
Integrated Energy Systems

GAIN Vouchers

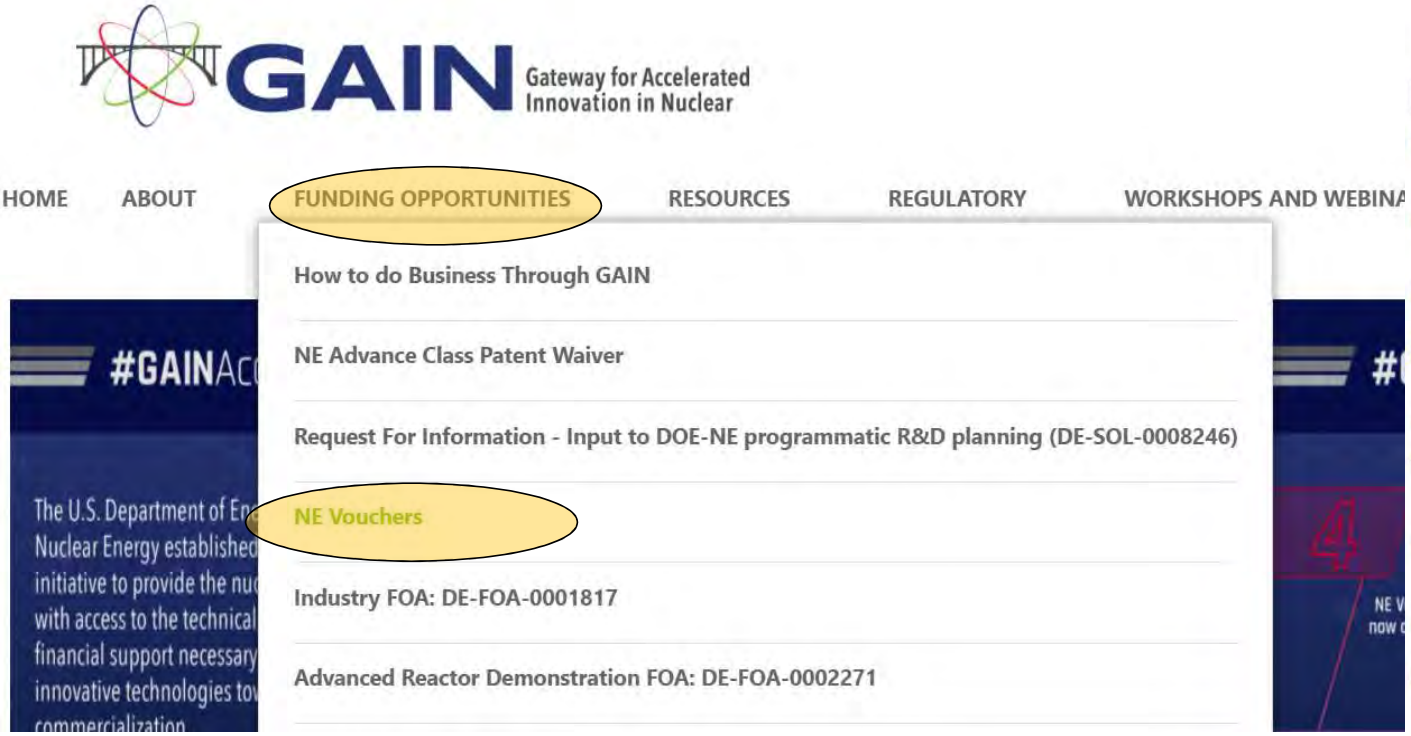
- GAIN Vouchers started in 2016
- Since Inception
  - 74 vouchers awarded - 47 completed - 44 different companies
  - $26.4M awarded to date
- GAIN Vouchers are open to support multiple areas for advanced nuclear technology developers.

GAIN Voucher Details

- Vouchers competitively award access to facilities and staff in the DOE national laboratory complex – NOT a financial award
- Voucher value is ~$50K to $500K
- Voucher recipient is responsible for 20% cost share
- One-year Period of Performance
- Standard CRADA
- Available to businesses that are majority (>51%) U.S. owned
- Limit to one application per cycle
- Four cycles per year – Next deadline is October 31st

GAIN Vouchers – How to Apply

- Go to the GAIN Website: https://gain.inl.gov



Helpful Links

How to do business through GAIN

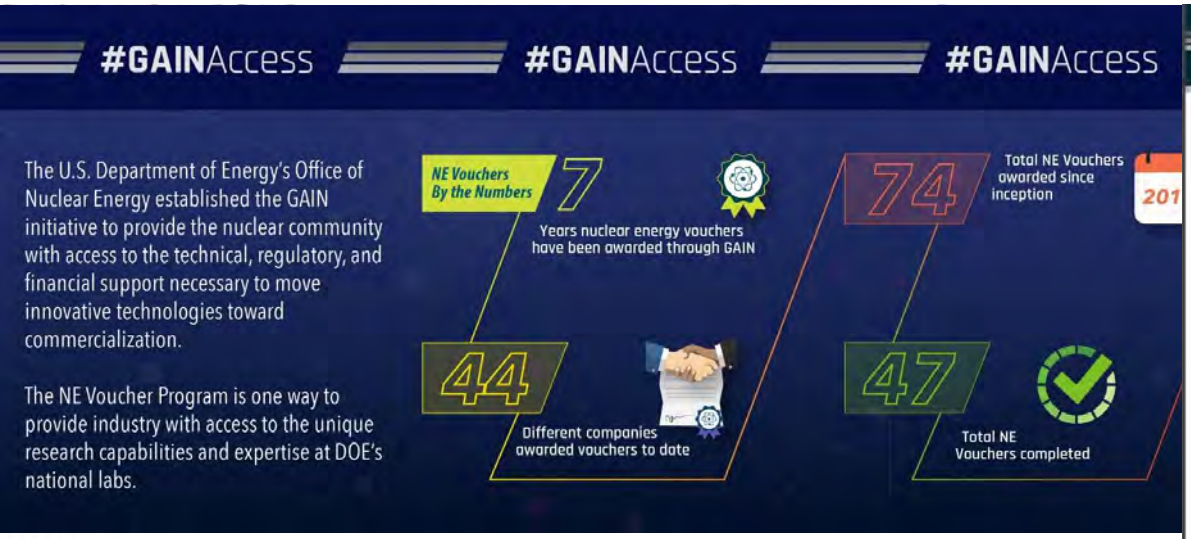
- How to do Business through GAIN

Proposal Submission System

- Submit a Proposal

Nuclear Energy Voucher Documents

- NE Voucher Process Flowchart
- NE Voucher Request 5.1.2020
- Voucher RFA Summary of Changes 5.01.2020
- Ten Tips for Writing a Successful NE Voucher Request
- NE Voucher FAQ's 5.1.2020
- GAIN Small Business Voucher CRADA 11.1.18
- DOE Standard CRADA 11.1.18

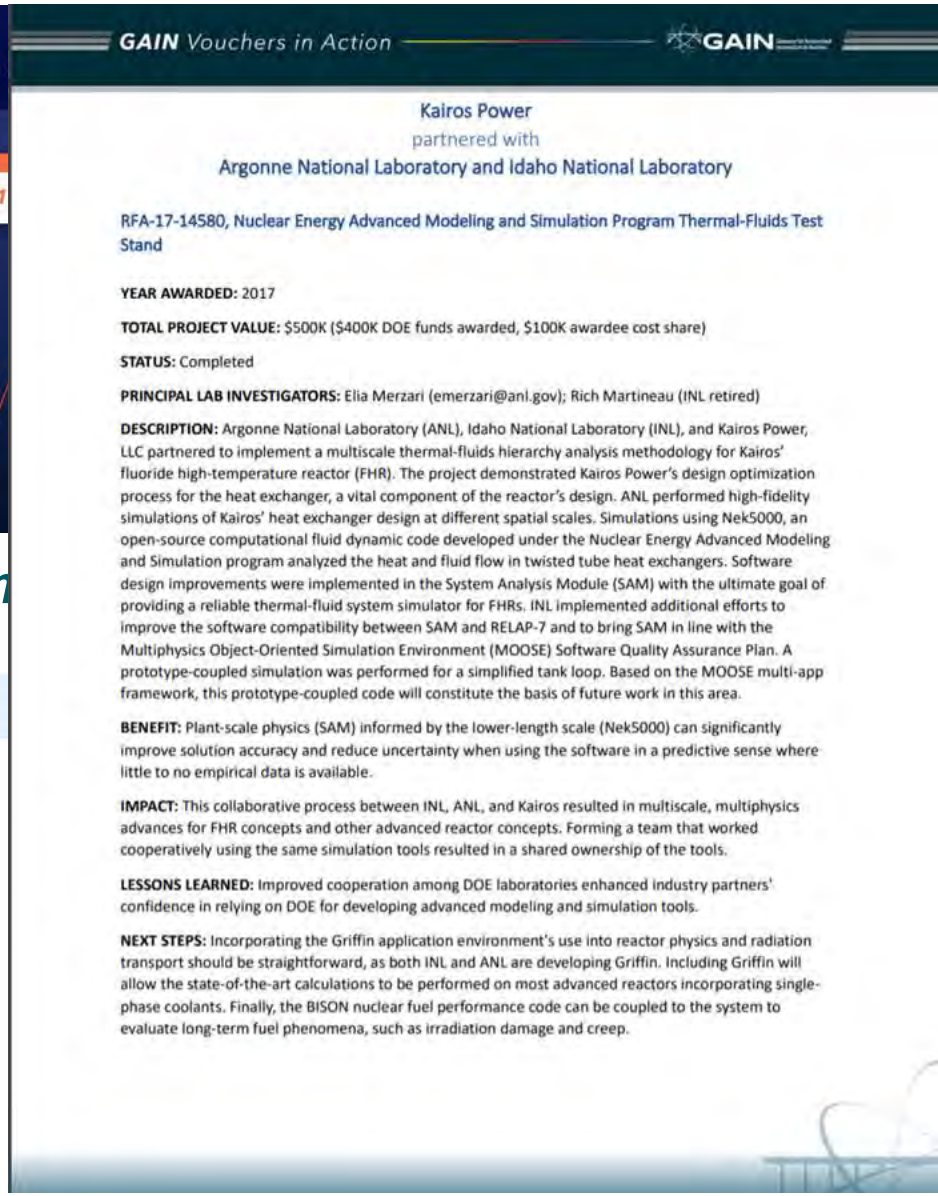


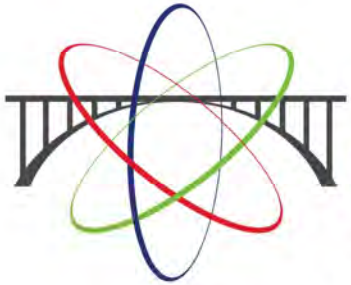
AVAILABLE NOW: Completed Voucher Sum

Year	Recipient	Proposal
2019	Analysis & Measurement Services Corp.	Testing of I&C Sensors and Cables for Small Modular Reactors
2018	Exelon Corporation	Plasma Separation Process Feasibility Study for the Commercial Enrichment of Gadolinium-157
2018	Vega Wave Systems	Radiation Testing for Nuclear Inspection Systems
2018	Oklo Inc.	Accelerate Development of Industry-Relevant Features in Modern Simulation Tools
2017	Micro Nuclear LLC	Development of the Microscale Nuclear Battery
2017	Kairos Power	Nuclear Energy Advanced Modeling and Simulation Program Thermal-Fluids Test Stand

GAIN Voucher

https://gain.inl.gov/SitePages/Nuclear%20Energy%20Vouchers.aspx





GAIN

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GAIN Mission-Driven Goals

GAIN: small enough to be nimble, big enough to be relevant

1. **Provide private entities access to financial support opportunities and national laboratory capabilities (facilities, expertise, and tools)**
2. **Identify gaps, gather needs, and develop viable paths forward to inform DOE research programs.**
3. **Enable the completion of key portions of a modernized risk-informed regulatory framework.**
4. **Engage with non-nuclear audience to introduce nuclear energy to help investigate potential applications using national lab capabilities (expertise and tools) and federal funding opportunities.**
5. **Contribute tailored, factual information to key stakeholders to motivate the integration of nuclear energy into state, regional and local plans.**

INL research and development in integrated energy systems will enable a clean hydrogen future

- INL is the U.S. lead nuclear laboratory

  AND

- The lead laboratory for high temperature steam electrolysis (i.e., breaking water—steam—into its constituent parts)

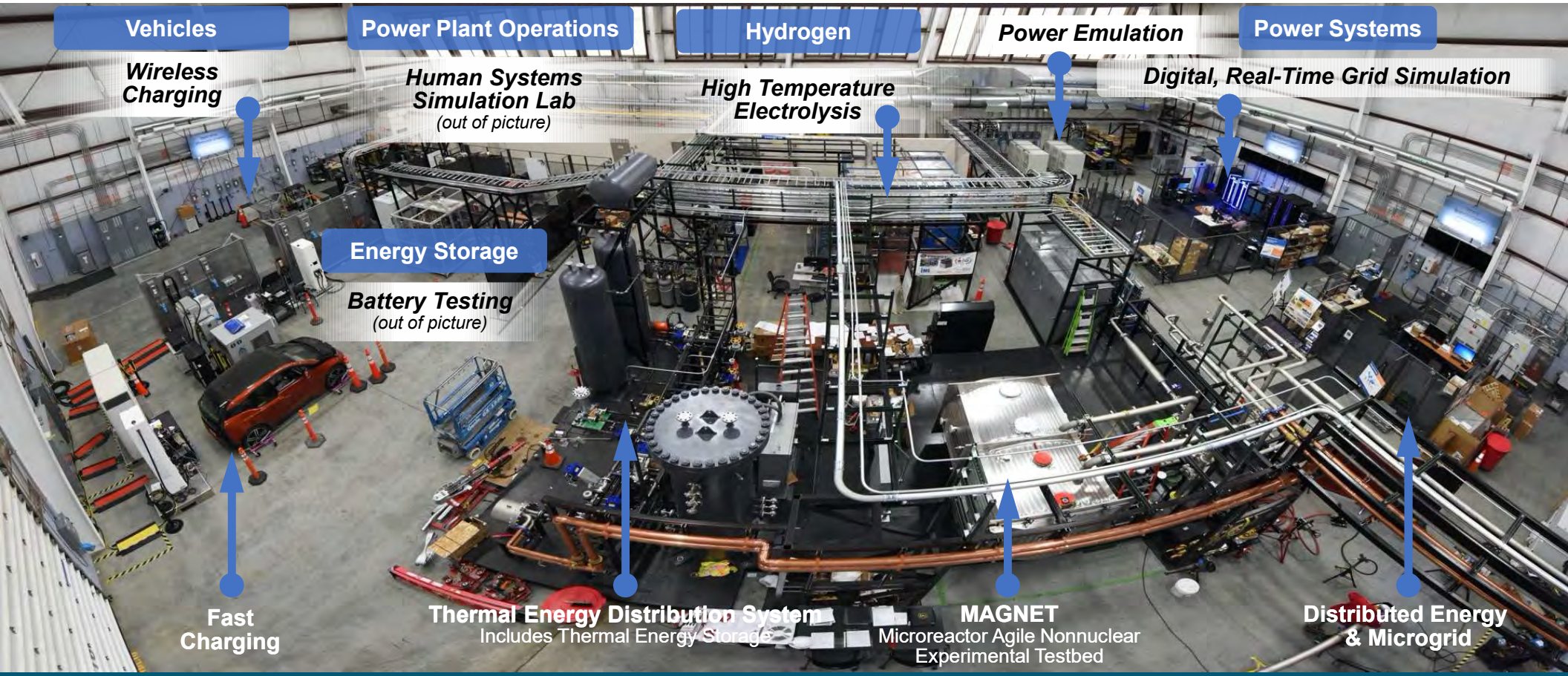
IES
Integrated Energy Systems

Guiding questions in evaluating integrated energy systems

- What are **economically and technically viable** options for integrated energy system (IES) coupling to nuclear power plants in specific grid energy systems?
- What is the **statistically ideal** mix for Nuclear-IES within various markets?
- What are **driving economic factors** that existing and future nuclear technologies can leverage though IES production coupling?
- What are the **optimal coupling strategies** between IES technologies and nuclear plants?

IES
Integrated Energy Systems

Dynamic Energy Transport and Integration Laboratory (DETAIL) for electrically heated testing of integrated systems



Nuclear-H_2 demonstration projects

Multiple projects have been selected for demonstration of hydrogen production at U.S. nuclear power plants (NPP)

- H_2 production using direct electrical power offtake
- Develop monitoring and controls procedures for scaleup to large commercial-scale H_2 plants
- Evaluate power offtake dynamics on NPP power transmission stations to avoid NPP flexible operations
- Produce H_2 for captive use by NPPs and clean hydrogen markets

Projects

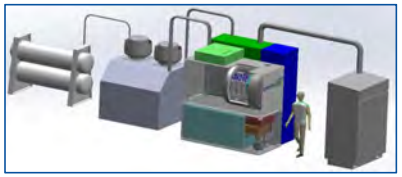
- Constellation: Nine-Mile Point NPP (~1 MWe LTE/PEM)
- Energy Harbor: Davis-Besse NPP (~1-2 MWe LTE/PEM)
- Xcel Energy: Prairie Island NPP (~150 kWe HTSE)
- FuelCell Energy: Demonstration at INL (250 kWe)

Nine Mile Point NPP LTE/PEM

Davis-Besse NPP LTE-PEM

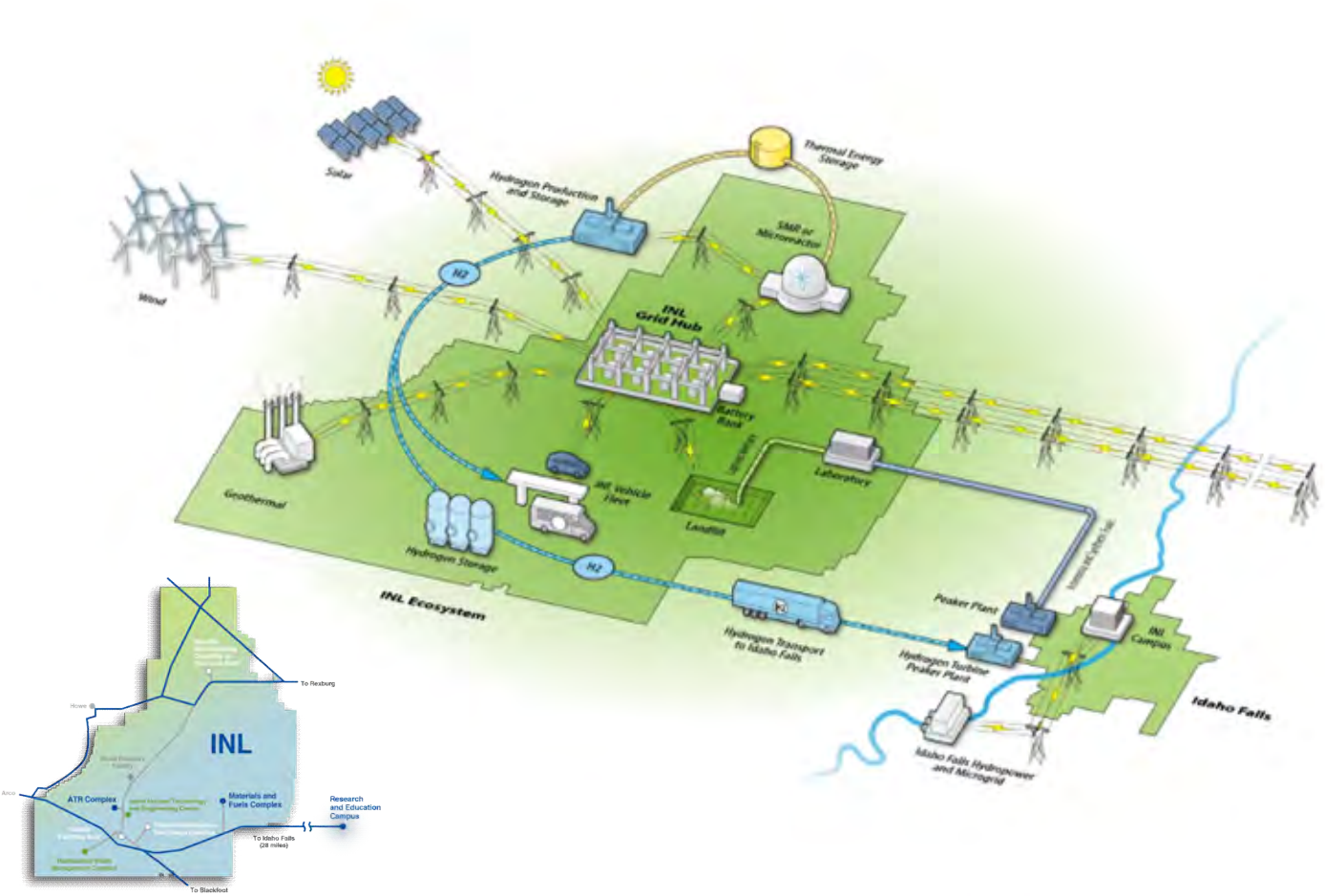
Thermal & Electrical Integration at Prairie Island NPP HTSE/SOEC

FuelCell Energy at INL, SOEC at increasing scale



~2024

INL's commitment to net-zero will be a leading demonstration ushering in a secure, resilient net-zero energy future



- INL has committed to becoming a net-zero campus by 2031
- Attributes of a small city or county
- 890 sq mi
- >5400 employees
- >50 MWe purchased in FY2020
- >300 DOE-owned buildings
- Existing microgrid
- 3 fire stations, 1 museum, medical facilities, …
- >40 miles primary roads

IES Integrated Energy Systems