

# ***GAIN Overview***

**Chris Lohse**

**February 28, 2024 – INFUSE Workshop**

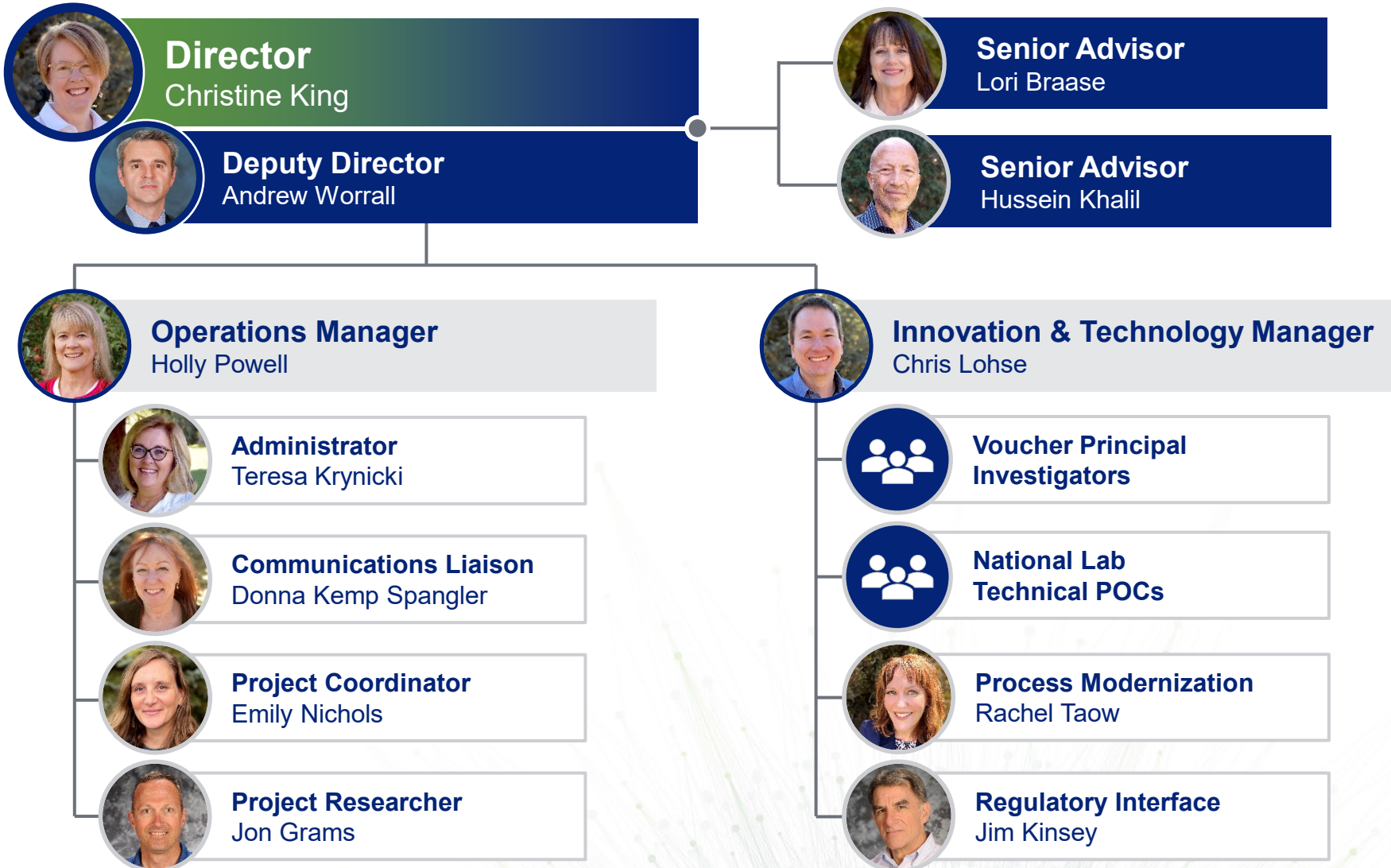
# Gateway for Accelerated Innovation in Nuclear

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

- Initiative from Department of Energy: Office of Nuclear Energy
- Mission is to simplify private industry's access to the assets of the DOE complex: expertise, historical data and facilities.
- Accelerated must match advanced nuclear developer pace and reflect the market window (next 5-10 years).
- Innovation is not just about technology. Be creative in all spaces with a bias toward taking risks.
- Focus on initiating and completing projects that support commercial deployment.

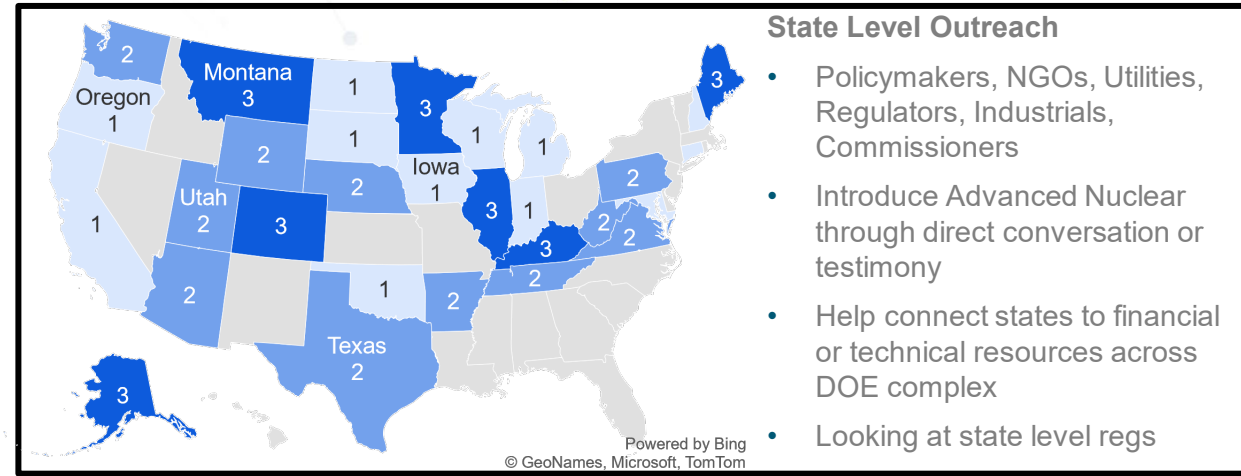
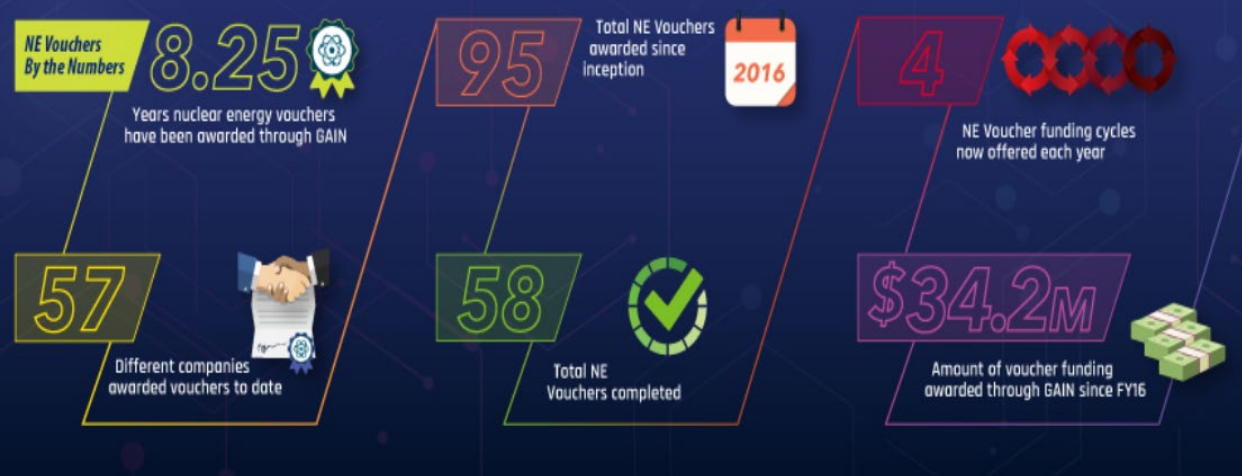


# The GAIN Team





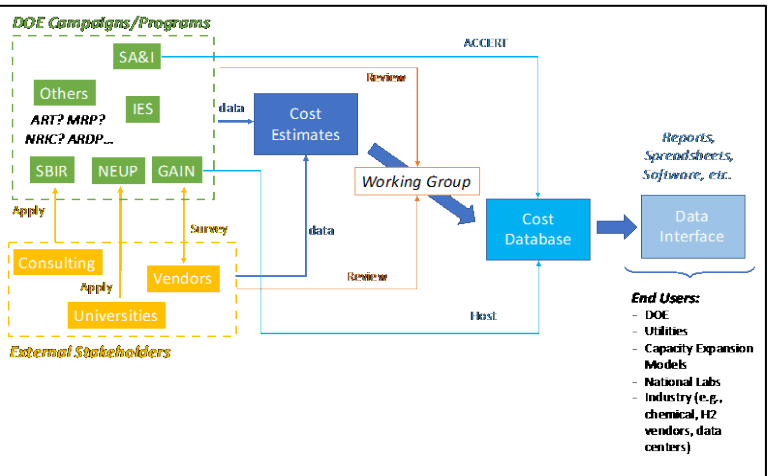
# 2024 Activities



### Advanced Reactor Cost

Project will update latest costs combining two approaches

- Use existing public nuclear cost data to develop advanced reactor cost ranges.
- Work with developers and utilities under NDA to collect cost projections to develop an anonymous advanced reactor cost ranges.



**ADDING NUCLEAR TO THE MIX WORKSHOP**

**NOVEMBER 14 & 15, 2023**

**MORGANTOWN, WEST VIRGINIA**

A workshop designed to gather those interested in exploring the expansion and integration of nuclear power alongside existing energy sources.

Hear about the latest research recommendations, updates from early movers, utility and community perspectives of repowering projects.

# GAIN Vouchers

- GAIN Vouchers started in 2016
- Since Inception
  - 95 vouchers awarded - 58 completed - 57 different companies
  - \$34.2M awarded to date
- GAIN Vouchers are open to support multiple areas for advanced nuclear technology developers.

#GAINAccess

#GAINAccess

#GAINAccess

#GAINAccess

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The U.S. Department of Energy's Office of Nuclear Energy established the GAIN initiative to provide the nuclear community with access to the technical, regulatory, and financial support necessary to move innovative technologies toward commercialization.

The NE Voucher Program is one way to provide industry with access to the unique research capabilities and expertise at DOE's national labs.



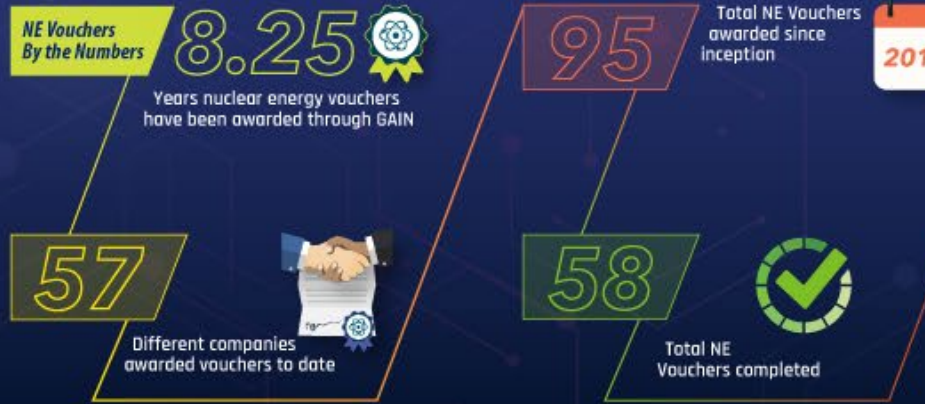


## ***GAIN Voucher Details***

- 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 April 30<sup>th</sup>

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## AVAILABLE NOW: Completed Voucher Summary

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>

Kairos Power  
partnered with  
Argonne National Laboratory and Idaho National Laboratory

RFA-17-14580, Nuclear Energy Advanced Modeling and Simulation Program Thermal-Fluids Test Stand

**YEAR AWARDED:** 2017

**TOTAL PROJECT VALUE:** \$500K (\$400K DOE funds awarded, \$100K awardee cost share)

**STATUS:** Completed

**PRINCIPAL LAB INVESTIGATORS:** Elia Merzari (emerzari@anl.gov); Rich Martineau (INL retired)

**DESCRIPTION:** Argonne National Laboratory (ANL), Idaho National Laboratory (INL), and Kairos Power, LLC partnered to implement a multiscale thermal-fluids hierarchy analysis methodology for Kairos' fluoride high-temperature reactor (FHR). The project demonstrated Kairos Power's design optimization process for the heat exchanger, a vital component of the reactor's design. ANL performed high-fidelity simulations of Kairos' heat exchanger design at different spatial scales. Simulations using Nek5000, an open-source computational fluid dynamic code developed under the Nuclear Energy Advanced Modeling and Simulation program analyzed the heat and fluid flow in twisted tube heat exchangers. Software design improvements were implemented in the System Analysis Module (SAM) with the ultimate goal of providing a reliable thermal-fluid system simulator for FHRs. INL implemented additional efforts to improve the software compatibility between SAM and RELAP-7 and to bring SAM in line with the Multiphysics Object-Oriented Simulation Environment (MOOSE) Software Quality Assurance Plan. A prototype-coupled simulation was performed for a simplified tank loop. Based on the MOOSE multi-app framework, this prototype-coupled code will constitute the basis of future work in this area.

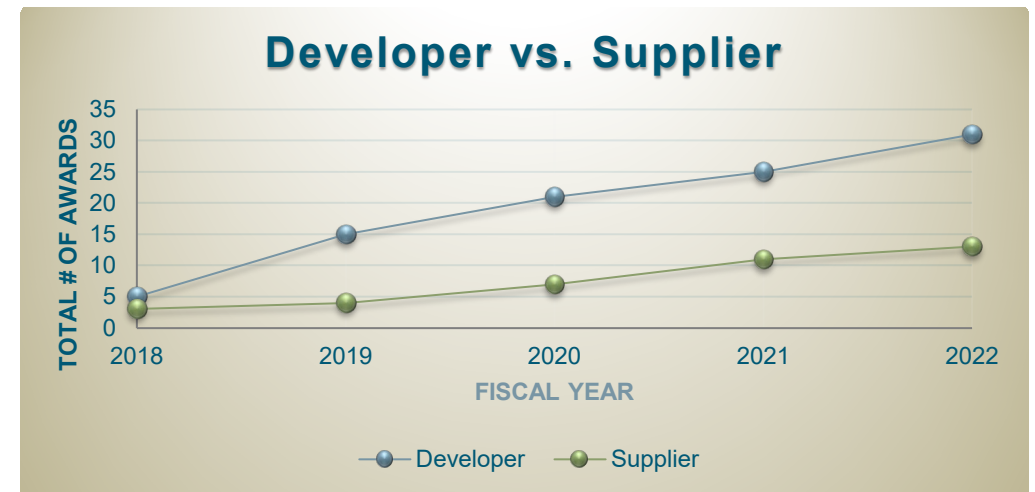
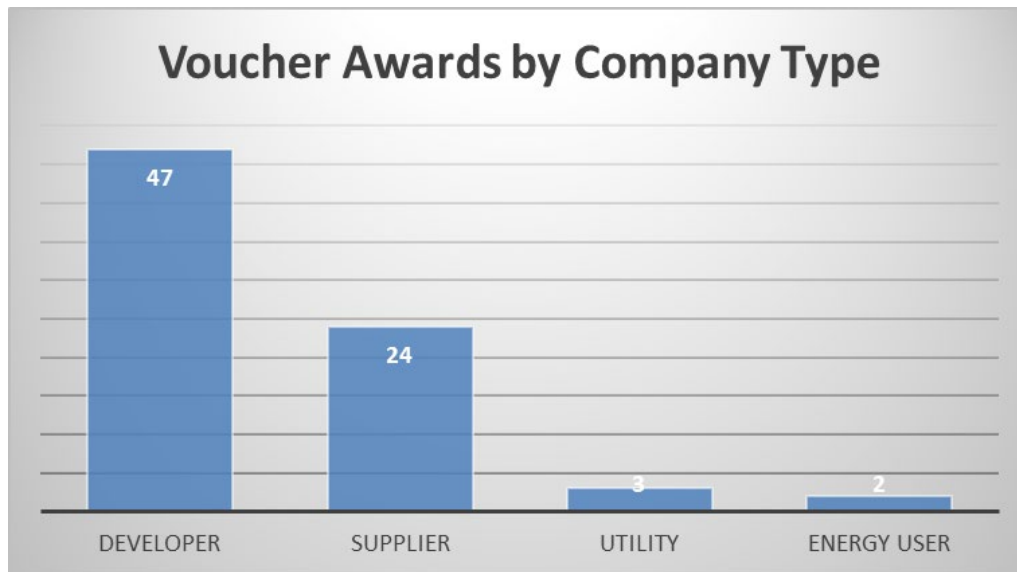
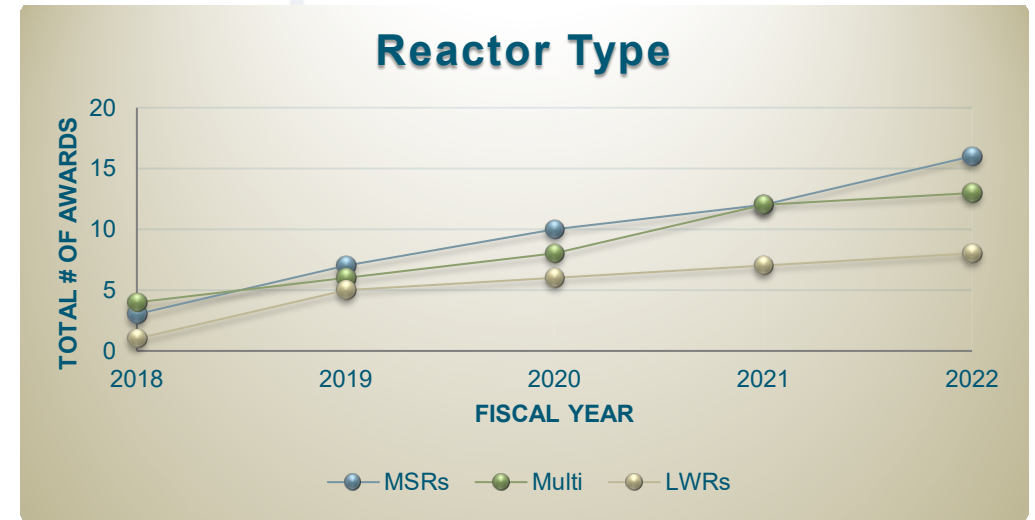
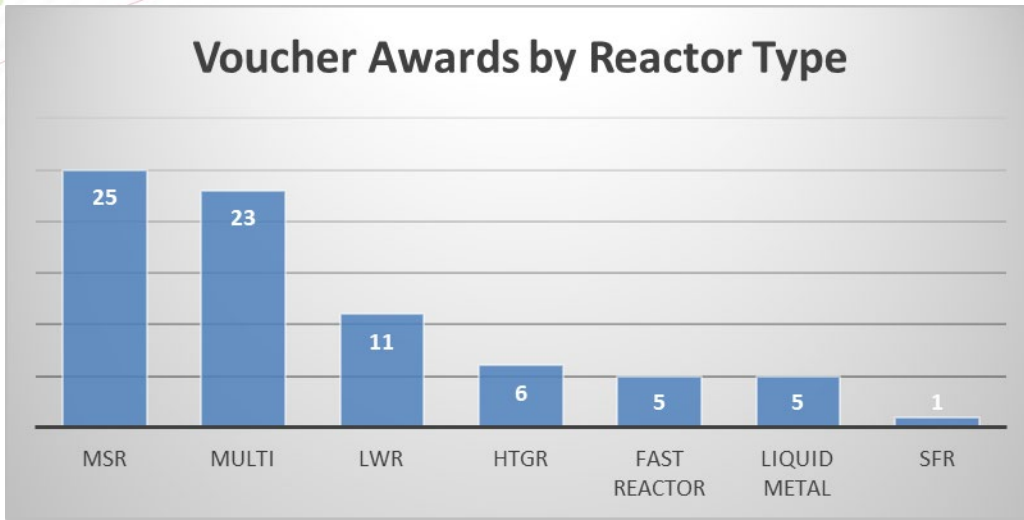
**BENEFIT:** Plant-scale physics (SAM) informed by the lower-length scale (Nek5000) can significantly improve solution accuracy and reduce uncertainty when using the software in a predictive sense where little to no empirical data is available.

**IMPACT:** This collaborative process between INL, ANL, and Kairos resulted in multiscale, multiphysics advances for FHR concepts and other advanced reactor concepts. Forming a team that worked cooperatively using the same simulation tools resulted in a shared ownership of the tools.

**LESSONS LEARNED:** Improved cooperation among DOE laboratories enhanced industry partners' confidence in relying on DOE for developing advanced modeling and simulation tools.

**NEXT STEPS:** Incorporating the Griffin application environment's use into reactor physics and radiation transport should be straightforward, as both INL and ANL are developing Griffin. Including Griffin will allow the state-of-the-art calculations to be performed on most advanced reactors incorporating single-phase coolants. Finally, the BISON nuclear fuel performance code can be coupled to the system to evaluate long-term fuel phenomena, such as irradiation damage and creep.

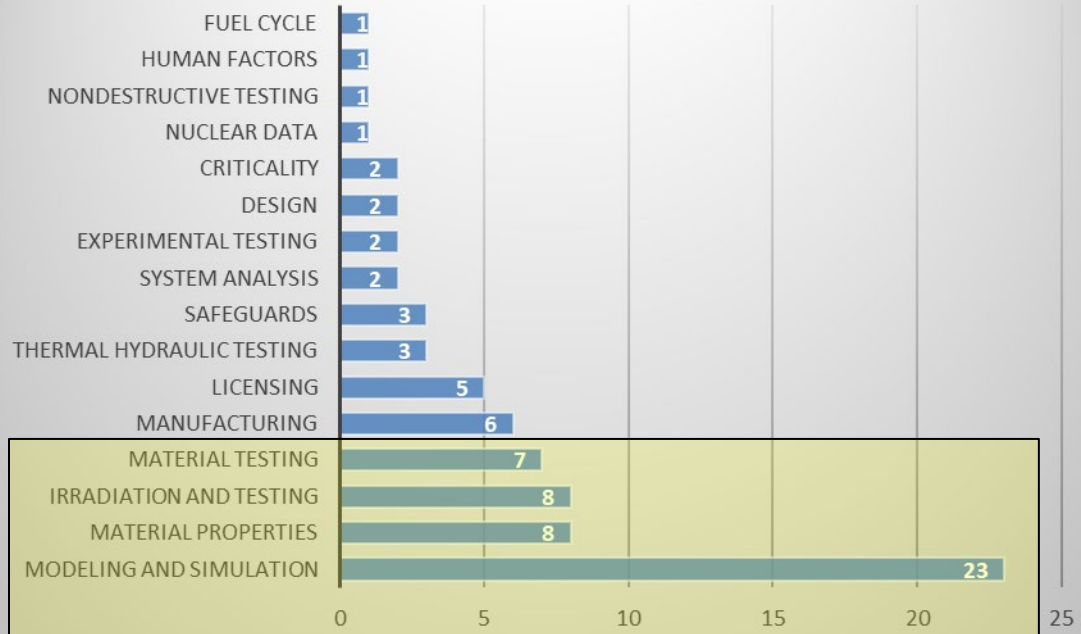
# Voucher Statistics – Rx and Company



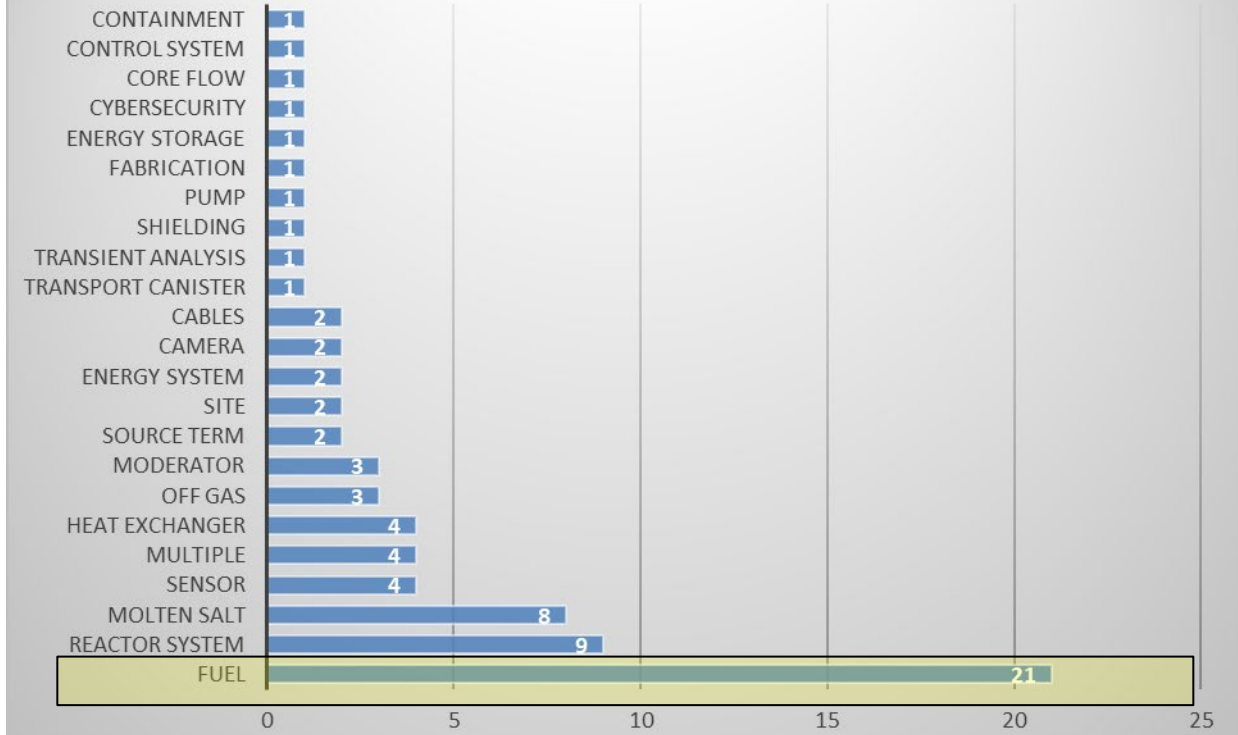


# Voucher Statistics – Work Areas

## Voucher Awards by Work Type



## Voucher Awards by Component Type



## *Rediscovering the past, to power the future*



### **The Who**

DOE-NE, OSTI, GAIN, the DOE laboratory complex, and industry partners

### **The What**

A process to release export-controlled documents to industry partners

### **The Where**

The process will happen at many locations simultaneously.

### **The When**

Three test cases were completed over the summer 2022, full process roll-out slated for early 2023.

### **The Why**

In the past, there has not been a way for a U.S. company to easily request and obtain access to export-controlled information.



## ***National Lab and Regional Visits***

- GAIN works with each lab to curate a visit that highlights their capabilities directly related to advanced nuclear development
- Industry partners tour the lab and get time to meet the researchers and explore potential areas of collaboration
- GAIN will also visit local companies involved in the development of nuclear technology to understand their perspective and needs.
- Meet with local leaders to understand economic development activities underway or planned.
- Use our social media platforms to share the highlights of the visit



## ***Why state engagement and why GAIN?***

GAIN is a nimble instrument of NE to find novel ways to ensure the assets of the DOE and national labs are used and useful in the pursuit of new nuclear tech

- Vouchers, legacy data, state engagement, commercialization research

As nuclear designs approach commercial markets, GAIN's audience has expanded to include the regions, states, and communities where these technologies will be considered and possible built.

Mission is the same – the audience is expanding

Key elements critical to our success: small, flexible, responsive, nimble, autonomy, handoffs



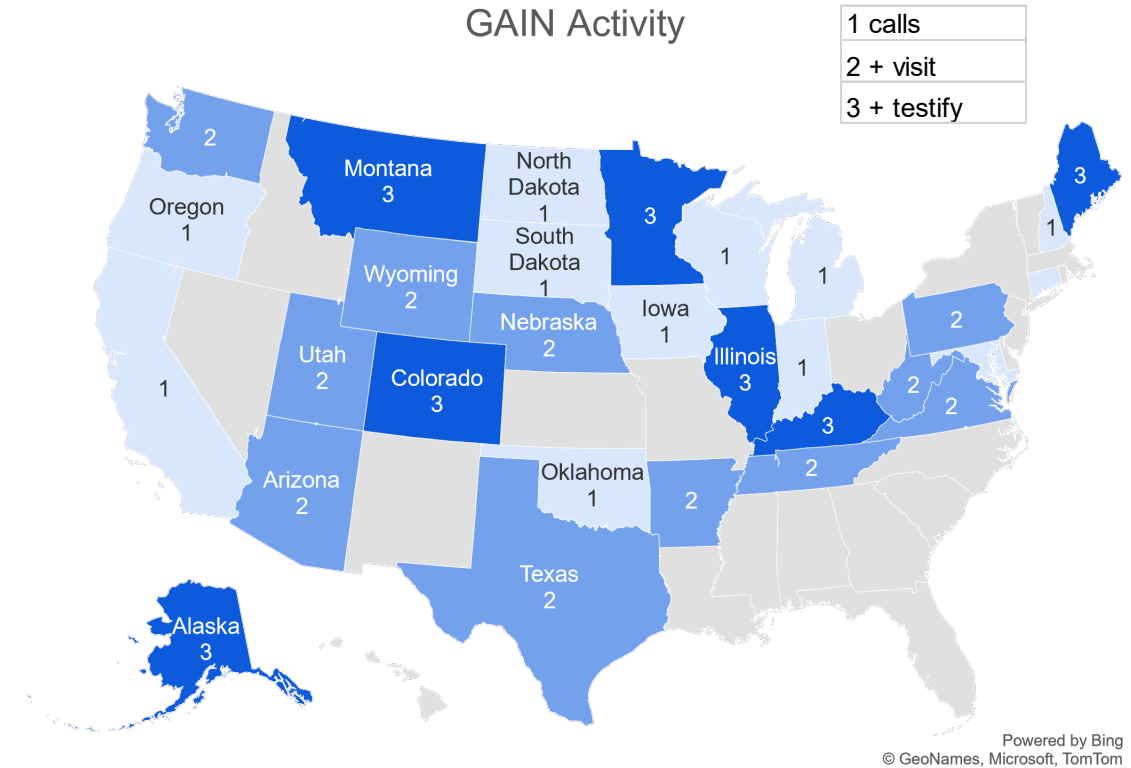
...implementing small changes can have a significant impact...  
– little hinges swing on big doors.

SJ Scott



# GAIN Approach

- Primary objectives:
  - Bridge the gap
  - Help introduce and demystify nuclear
  - Provide technical support
  - Share what we have learned
- Principles
  - Only go where we are invited
  - Show up and listen
  - Customized support
  - Be committed to multiple engagements
  - Informing, not educating, not selling

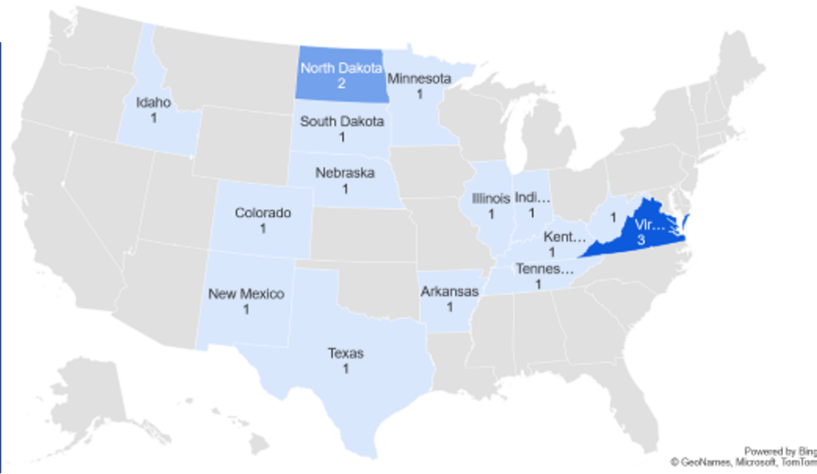


Successful Engagement: Our state/local partners...  
 know the value of local/region assets  
 become a better nuclear customer  
 understand how to engage

## U.S. SNAPSHOT (as of Feb 20, 2024)

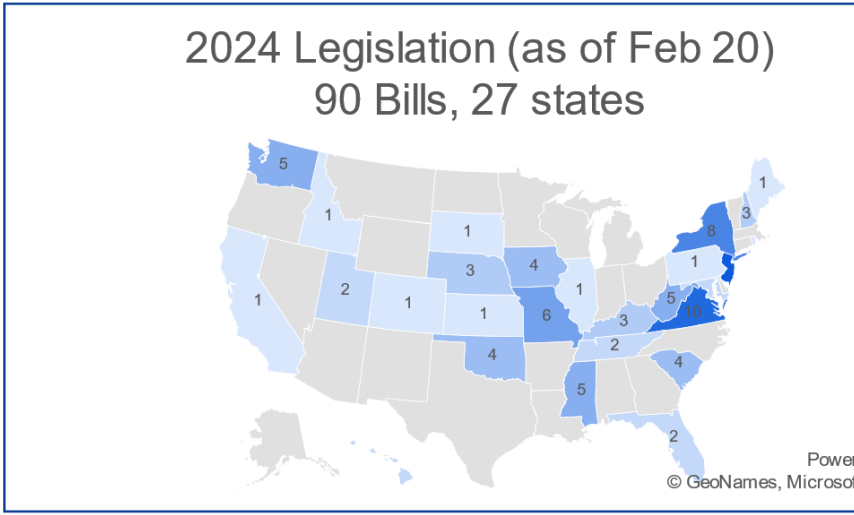
2023 Passed Legislation (15 states)

- Arkansas
- Colorado
- Idaho
- Illinois
- Indiana
- Kentucky
- Minnesota
- Nebraska
- New Mexico
- North Dakota
- South Dakota
- Tennessee
- Texas
- Virginia
- West Virginia



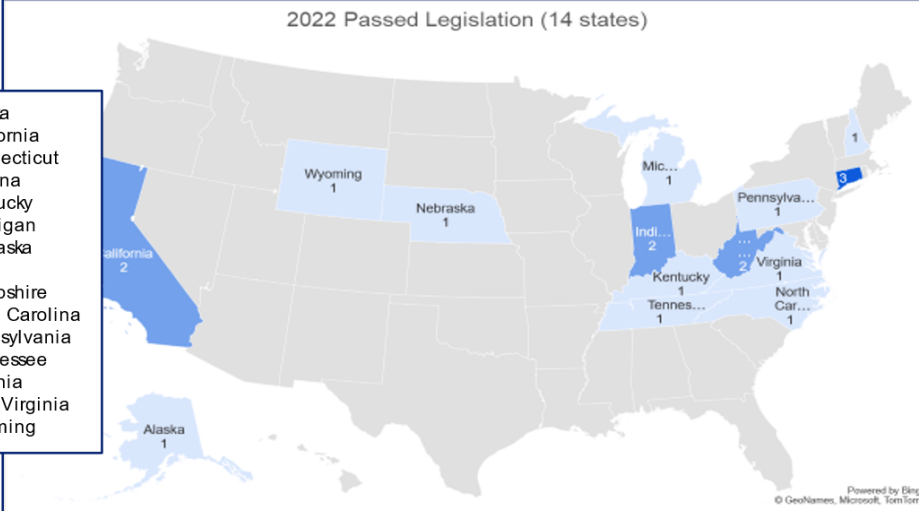
2024 Legislation (as of Feb 20)  
90 Bills, 27 states

- California
- Colorado
- Florida
- Hawaii
- Idaho
- Illinois
- Iowa
- Kansas
- Kentucky
- Maine
- Maryland
- Mississippi
- Missouri
- Nebraska
- New Hampshire
- New Jersey
- New York
- Oklahoma
- Pennsylvania
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Utah
- Virginia
- Washington
- West Virginia



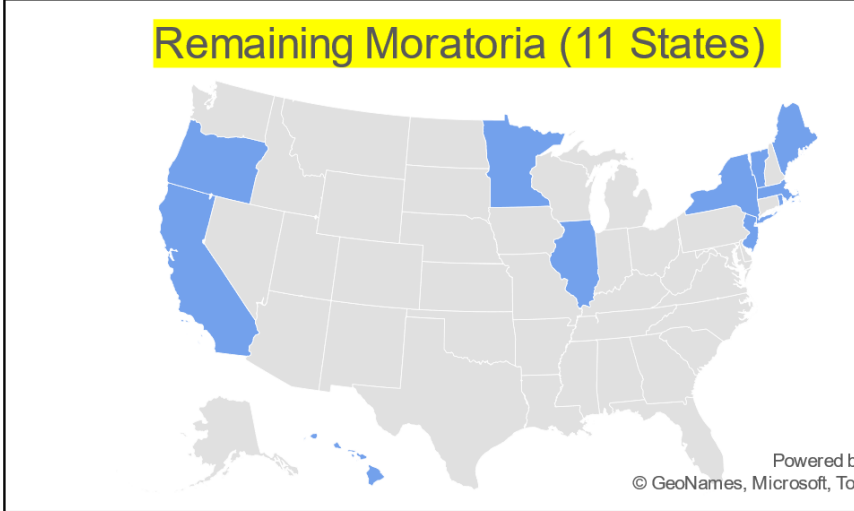
2022 Passed Legislation (14 states)

- Alaska
- California
- Connecticut
- Indiana
- Kentucky
- Michigan
- Nebraska
- New Hampshire
- North Carolina
- Pennsylvania
- Tennessee
- Virginia
- West Virginia
- Wyoming



Remaining Moratoria (11 States)

- California
- Oregon
- Hawaii
- Maine
- Massachusetts
- Minnesota
- New Jersey
- New York
- Rhode Island
- Vermont
- Illinois





## Examples of Local Engagement



- Public Meetings in Arizona, Montana, Pennsylvania, and Colorado with local partners (Senators or Utility)
- Testimony to State Level Energy Committees: Minnesota, Montana, Illinois, Alaska, Colorado
- Briefing to staffers for a variety of legislative delegates in numerous states
- Customized Webinars/Workshops: Kentucky, Virginia, California
- Work with local economic development teams: West Virginia, Pennsylvania, Tennessee, Montana, Utah.
- Support the DOE engagement with NASEO, NARUC, Governor's Association and NCSL

KENTUCKY OFFICE OF ENERGY POLICY  
AND GAIN PRESENT

Shaping our  
**ADVANCED ENERGY FUTURE**

WEBINAR SERIES: February 23rd, 10-11:30 AM ET; 8-9:30 AM MT  
Please register: <https://attendee.gotowebinar.com/register/6744118872261430030>

[eec.ky.gov/Energy/Pages/default.aspx](http://eec.ky.gov/Energy/Pages/default.aspx) | [gain.inl.gov](http://gain.inl.gov)



**SEL** SOUTHERN ENVIRONMENTAL LAW CENTER

**Fission Fridays: A Four Part Info-Series on All Things Nuclear**

# States Interested in Coal Transitions



Arizona



Colorado



Kentucky



Maryland



Montana



North Carolina



Pennsylvania



Utah



Virginia



West Virginia



Wisconsin



Wyoming



# ***GAIN Nuclear Feasibility Studies***



## ***Coronado Generating Station***

### **Primary Objective:**

Assess the feasibility of transitioning from coal to nuclear; Learnings can be applied to other coal units within commuting distance from CGS.

**In one year, utility changed commitment from retirement to developing a repurposing plan for the site.**



## ***Ghent Generating Station***

### **Primary Objective:**

Assess feasibility of nuclear energy at Ghent Generating Station (GGS) from a siting and technology perspective.

**Draft project results are under review by utility.  
Station retirement is planned by 2040s.**



# COAL TO NUCLEAR ENERGY COMMUNITY TRANSITIONS



## 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.



## ***New Studies on coal transitions in U.S.***



Pilot Studies with  
Non-nuclear Utilities



Stakeholder guidebook on economic  
impacts, infrastructure, and licensing



Practical guidebook on  
coal-to-nuclear transition



Overview of  
transition  
issues



Policy recommendations  
on early site permits



Policy recommendations associated with  
market opportunities for coal transitions

# GAIN Other Areas

- Regulatory Support – NRC MOU
- Contract Modernization – GAIN Access CRADA
- Databases
- Directory, Workshops, Communications

### Databases of Experimental Information

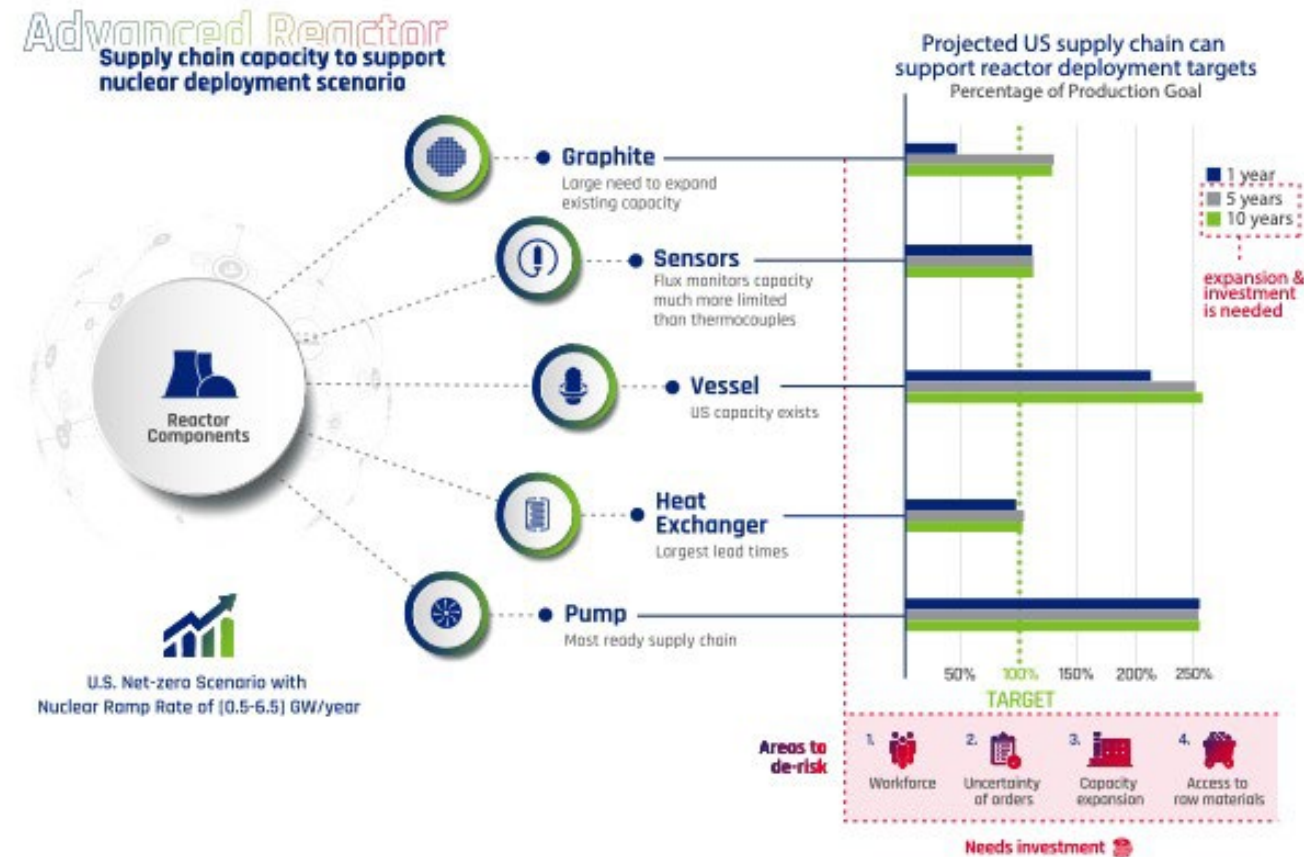
Database	Lab	Status (22Jan2021)
<b>TREXR</b> TREAT Experiment Relational Database	ANL	<a href="https://www.trexr.anl.gov/">https://www.trexr.anl.gov/</a> External access available by application
<b>NaCoRD</b> Sodium System & Component Reliability Database	SNL	<a href="https://www.sandia.gov/nascord/">https://www.sandia.gov/nascord/</a> External access available by application Phase II Complete – FY20
<b>ETTD</b> EBR-II Transient Testing Database	ANL	<a href="https://ettd.ne.anl.gov/">https://ettd.ne.anl.gov/</a> External access available by application
<b>FIPD</b> EBR-II Metallic Fuel Irradiation Database	ANL	<a href="https://fipd.ne.anl.gov/">https://fipd.ne.anl.gov/</a> External access available by application Data for U-Zr fuel type employed in commercial designs being qualified in accordance with NRC approved QAPP





# Overview of Supply Chain Assessment

- Builds on the prior DOE supply chain work.
- Assessed the capacity of certain critical nuclear components
- Mapped aggressive projections for nuclear deployments rates to component production targets
- Surveyed 20+ companies on abilities to meet production targets
- Initial findings:
  - We have an initial US capacity
  - Supply chain can ramp up with caveats...



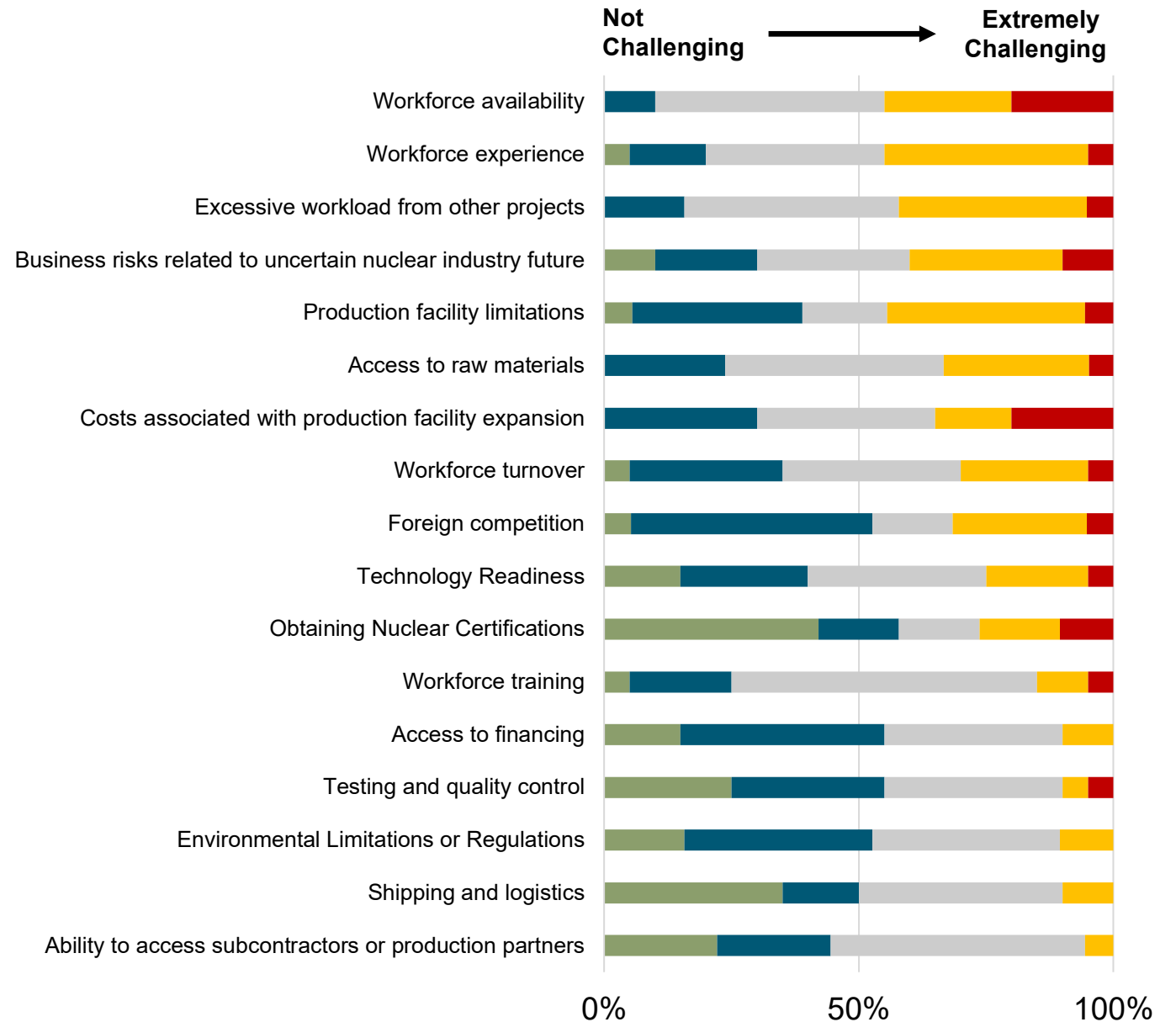
<https://www.osti.gov/biblio/1973747>

# Some Concerns Noted

- Largest concerns are related to **workforce** issues:
  - Availability
  - Experience
  - Turnover
- Additional concerns include:
  - Uncertainty of demand
  - Other non-nuclear commitments
  - Production facility limits
  - Access to raw material
  - Cost of expansions/upgrades

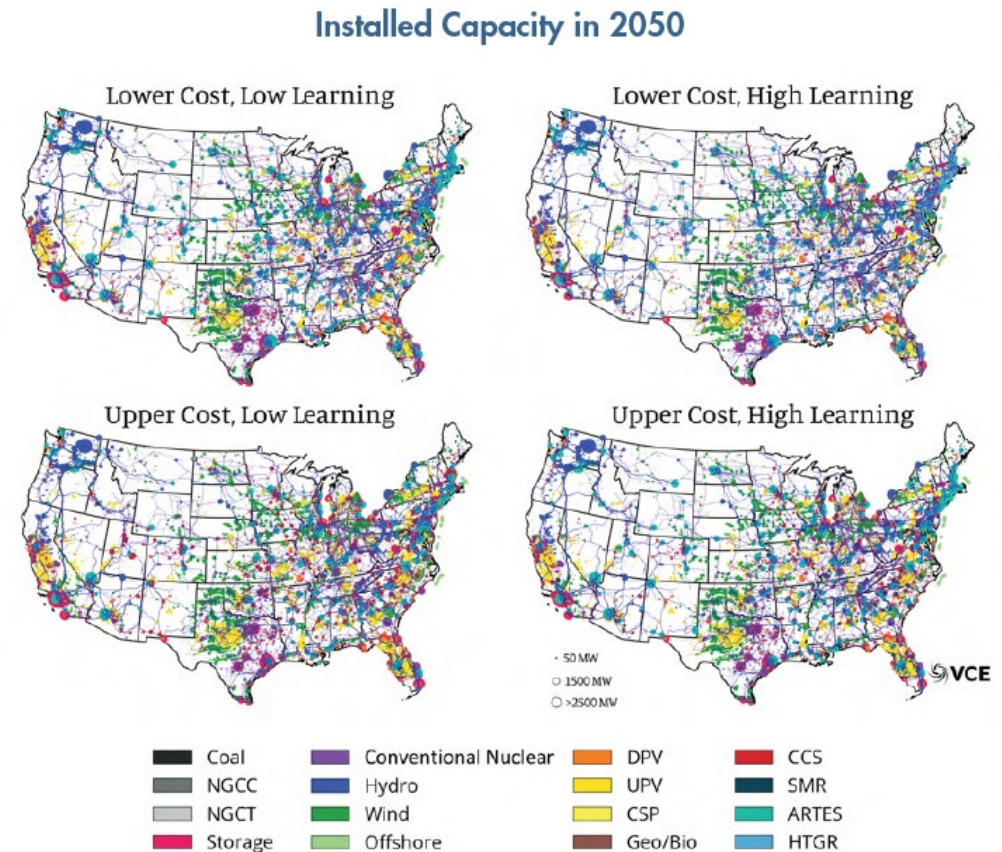


Workforce

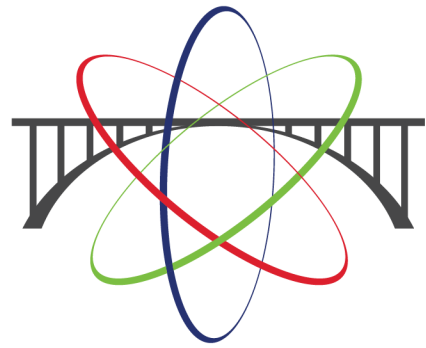


# Reactor Costs for Energy System Modeling

- Energy models are trying to predict the future energy mix
- Many different examples based on assumptions
- One important issue for nuclear is cost information
- NIA Held Workshops to discuss path forward
- GAIN has picked up the effort







# GAIN

Gateway for Accelerated  
Innovation in Nuclear



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