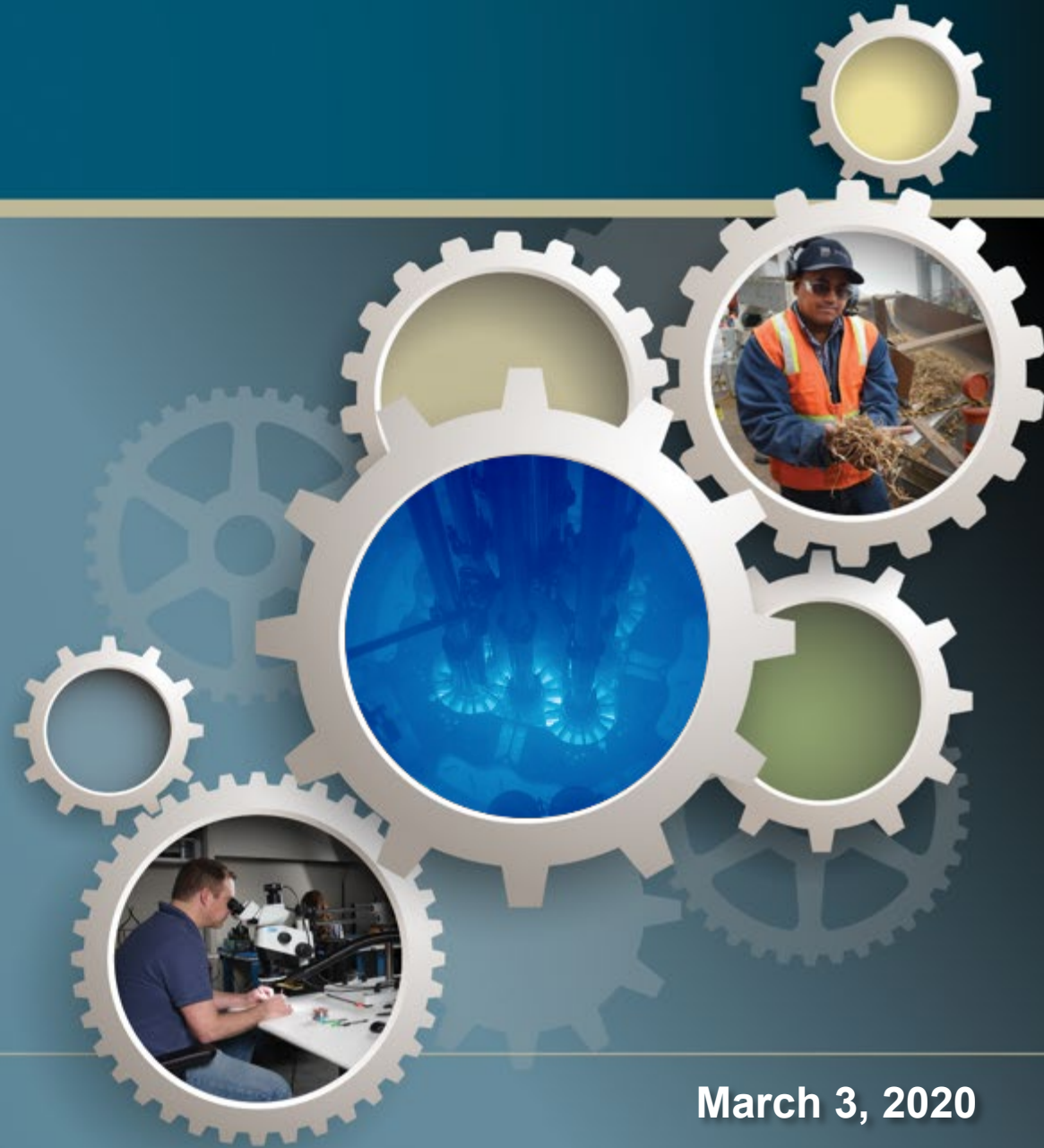


# Nuclear Science & Technology

## *Advanced Reactor Safety & Deployment*

**Dr. Corey McDaniel**  
*NS&T Chief Commercial Officer*



**March 3, 2020**

[www.inl.gov](http://www.inl.gov)



# Strong Interest in Clean Energy Driving Renewed Interest in Nuclear

- Unprecedented bi-partisan support
- Favorable appropriations
- Several new authorizing legislation
- NEICA signed into law Sept. 2018
- NELA re-introduced, Mar. 2019
- NRIC launched, Aug. 2020



*"I'm thrilled that senators from both sides of the aisle have come together to support advanced nuclear. This is exactly the kind of leadership our country needs to both solve the climate challenge and reassert our leadership in this important industry"*  
Bill Gates, Mar. 2019

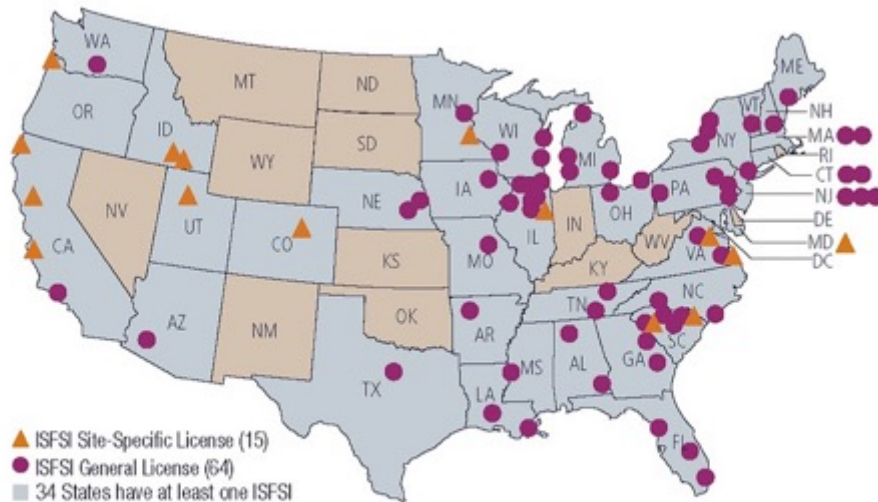




# Political Indecision/Inaction, but the Industry Continues to Manage Spent Nuclear Fuel Safely and Securely

**"We have to find a solution;" leaving the hazardous nuclear waste scattered around the country "is not an appropriate solution."**

U.S. House Committee on Appropriations Energy and Water Development Subcommittee March 26, 2019



**U.S.NRC**  
United States Nuclear Regulatory Commission  
Protecting People and the Environment  
As of July 2018

## Inaction Results

SNF inventory 80,000 MT, increasing 2,000 MT/yr.  
Suboptimal storage at utilities, double in the last 20 yrs.  
Tax payer's liability of \$2.2 M per day



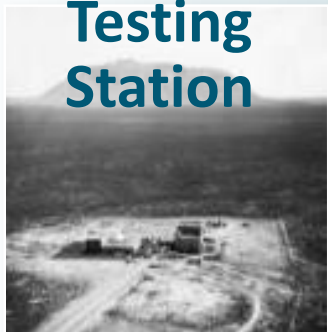
***YMP - Stalemate to date, no consensus between the Administration and Congress***

- 2010** – DOE stops license application; BRC established
- 2011** – NRC suspended licenses review process
- 2012** – BRC issued recommendations
- 2013** – DOE new strategy; NRC resumed licenses
- 2015** – NRC reported YMP satisfies regulations
- 2015** – Interim Storage Partners, LLC and Holtec
- 2016** – International submitted applications to NRC for building a CISF
- 2019** – Budget Request of \$116 M for YMP regulatory activities and initiating interim storage

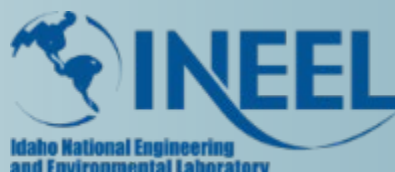
# Idaho National Laboratory

## *Evolving to Meet the Nation's Needs*

**National  
Reactor  
Testing  
Station**



Energy Mission –  
Reactor Science,  
Safety and  
Sustainability  
Solutions



Environmental  
Management  
Mission



INEEL & ANL-W combined  
to create the new Idaho  
National Laboratory

**Nuclear Energy**

**National and Homeland  
Security**

**Energy and  
Environment**



**Advancing  
Nuclear Energy**

**Securing &  
Modernizing Critical  
Infrastructure**

**Enabling Clean  
Energy Systems**

1949

1974

1997

2005

2019



# *Strategic S&T Initiatives Address Grand Challenges and Advance Energy and Security Goals for the Nation*

## **Nuclear Reactor Sustainment and Expanded Deployment**



## **Integrated Fuel Cycle Solutions**



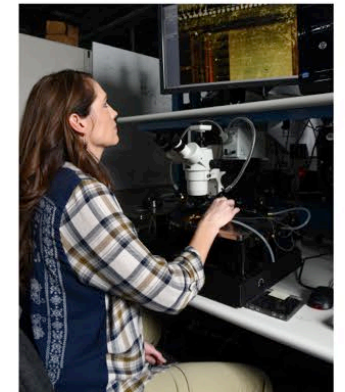
## **Advanced Materials and Manufacturing for Extreme Environments**



## **Integrated Energy Systems**



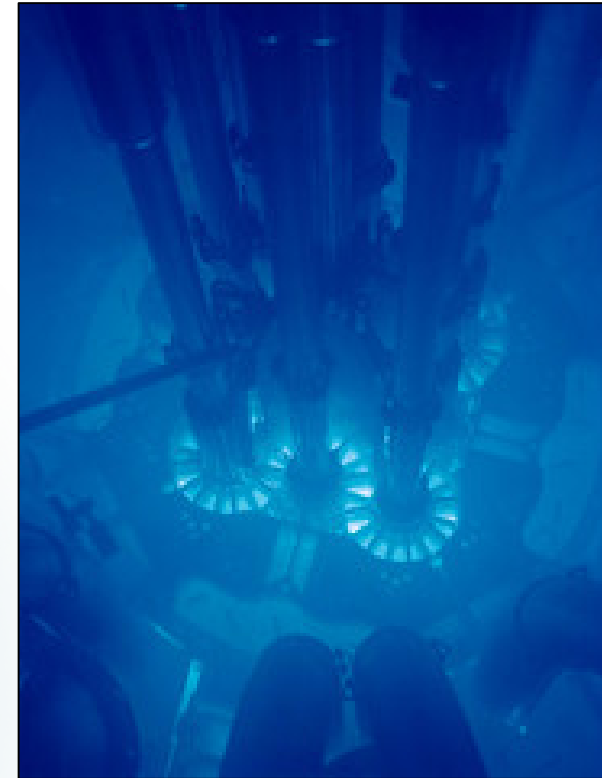
## **Secure and Resilient Cyber- Physical Systems**



## Vision for INL Nuclear

INL is the laboratory that:

- Challenges conventional thinking and approaches and leads a paradigm shift in developing and licensing new nuclear materials, concepts, and technologies.
- Provides – both directly and through collaborations – the technology breakthroughs, technical solutions, and capabilities, across the entire nuclear fuel cycle, that preserve and expand the use of nuclear systems.
- Develops solutions that enable:
  - continued operation of the existing fleet
  - replacement and expansion of existing fleet
  - management and disposition of spent fuel



# Nuclear RD&D Team at INL

**1400** staff working to revive, revitalize, and expand nuclear energy, enabled by unique research facilities, infrastructure & capabilities

## Nuclear Science & Technology

Change the world's energy future by advancing nuclear energy.

- Nuclear fuels and materials
- Nuclear systems design and analysis
- Fuel cycle science and technology
- Nuclear safety and regulatory research
- Advanced Scientific Computing

**398 Employees** • **149 Ph.D.** • **94 Bachelor** • **13 Postdocs**  
**90 Master** • **4 Associates**

## Materials & Fuels Complex

Experiments and engineering that drive the world's nuclear energy future.

- Transient testing
- Space nuclear power and isotope technologies
- Analytical laboratories
- Fuel Fabrication
- Post-irradiation examination
- Advanced characterization

**614 Employees** • **39 Ph.D.** • **187 Bachelor**  
**65 Master** • **84 Associates**

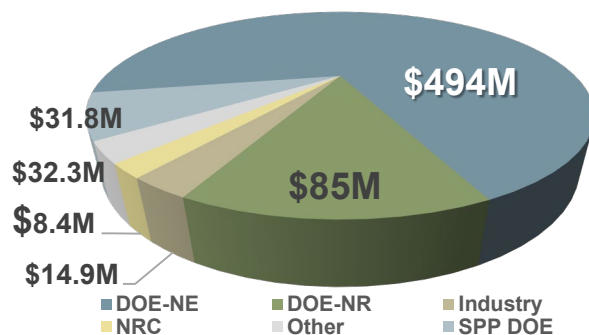
## Advanced Test Reactor

Provide unique irradiation capabilities for nuclear technology research and development. Steady-state neutron irradiation of materials and fuels

- Naval Nuclear Propulsion Program
- Industry
- National laboratories and universities

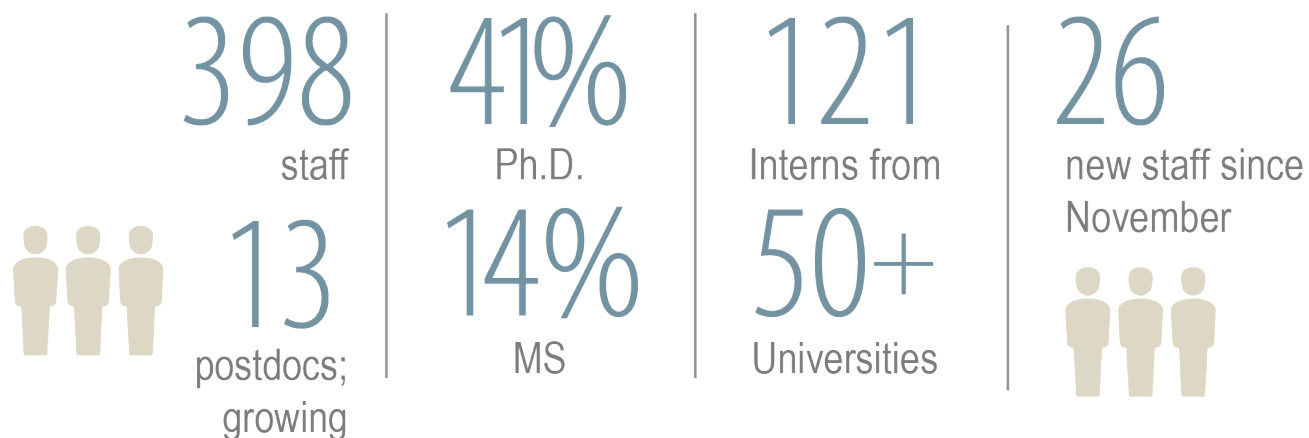
**388 Employees** • **2 Ph.D.** • **121 Bachelor**  
**36 Master** • **43 Associates**

FY-18 Budget Authority - \$666M

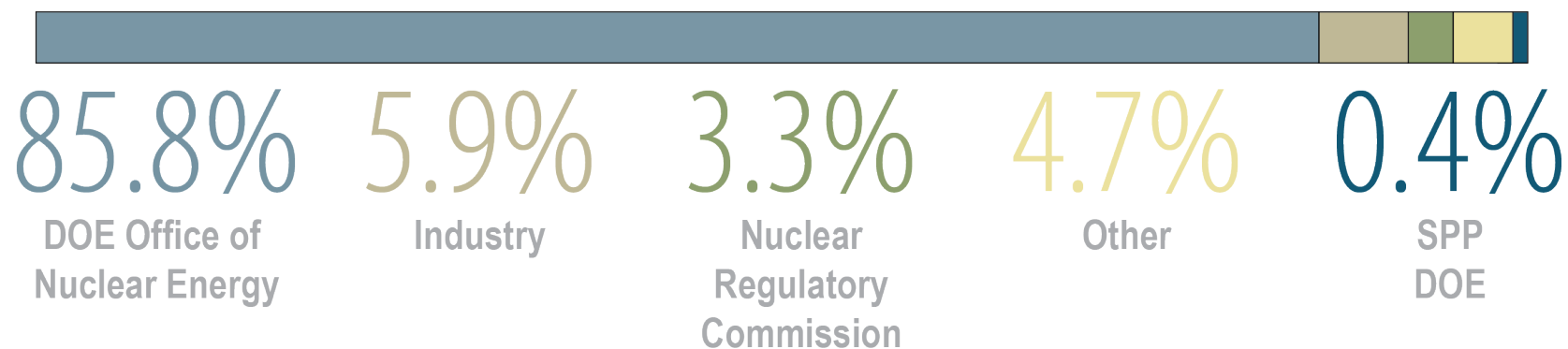




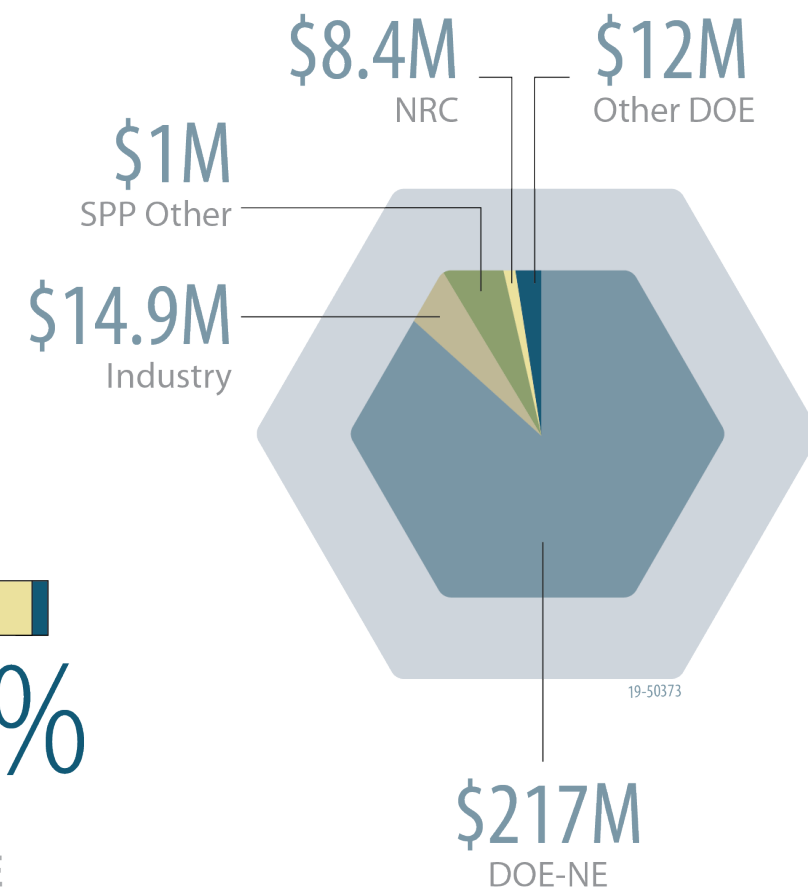
# Nuclear S&T Directorate



## SPONSORS



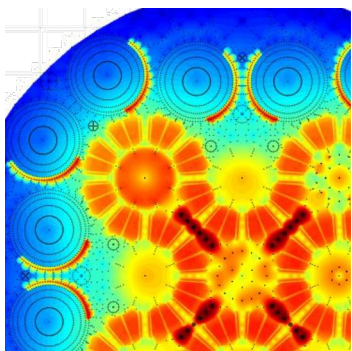
## FY18 Budget Authority \$253M





# Nuclear S&T Directorate

Reactor Systems Design  
& Analysis



Nuclear Safety &  
Regulatory Research



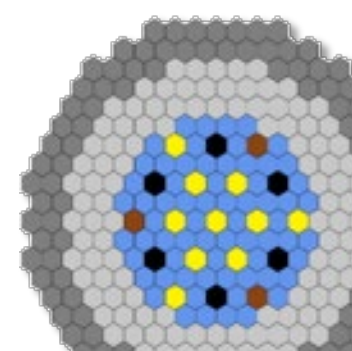
Advanced Scientific  
Computing



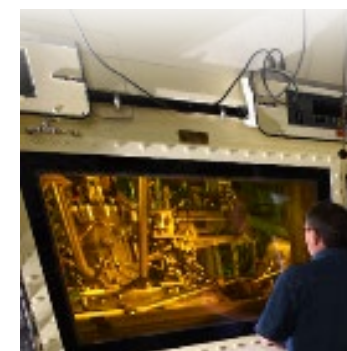
Fuel Cycle Science &  
Technology



Advanced Nuclear  
Facilities R&D



Nuclear Fuels  
& Materials



## Leadership Positions in Major DOE-NE Initiatives/Programs

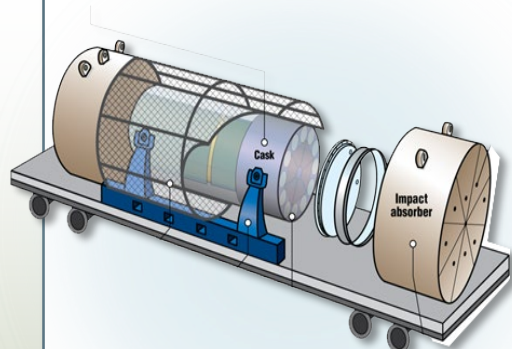


Creating the Next-Generation National Reactor Testing Station:

# Advanced Reactor Pipeline Vision at Idaho National Laboratory

## Microreactor (<10MW) demonstration by early 2020s

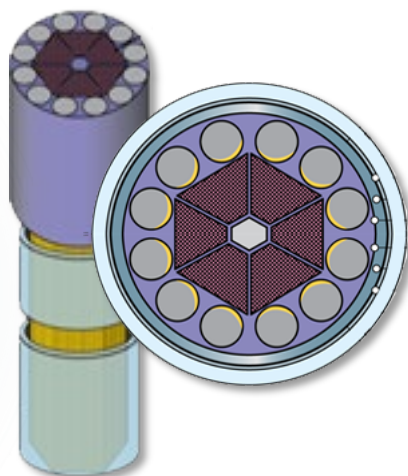
- Resolve key advanced reactor issues
- Open new markets for nuclear energy
- Provide a 'win' to build positive momentum



2023

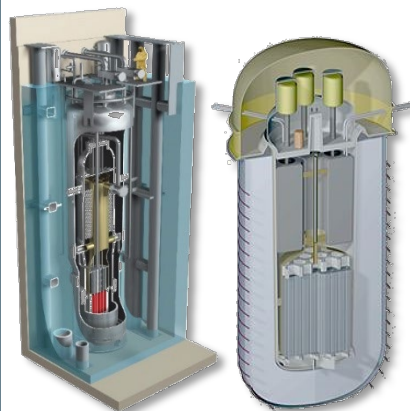
## Commercial microreactors deployed

- Support deployment of micro-reactors for key remote site power and process heat customers



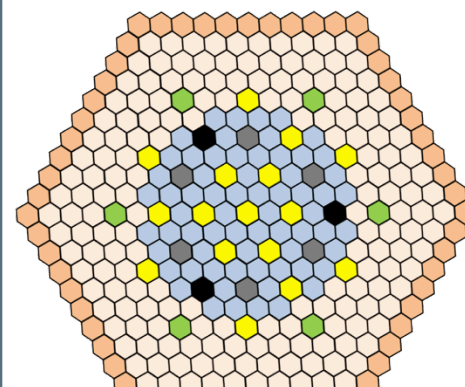
## SMR(s) operating by 2026

- Enable deployment through siting and technical support
- Joint Use Modular Plant leased for federal RDD&D



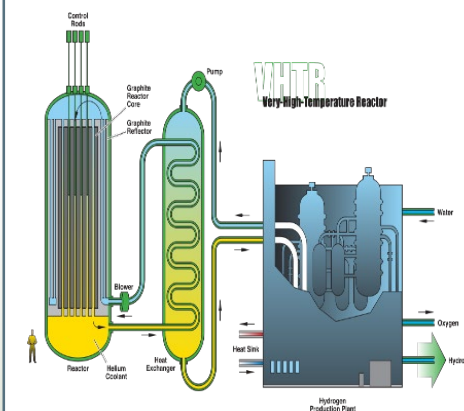
## Versatile Test Reactor (VTR) operating by 2026

- Establish fast-spectrum testing and fuel development capability
- Support non-LWR advanced reactor demonstration



## Non-LWR advanced demonstration reactor by 2030

- Demonstrate non-LWR technology replacement of US baseload clean power capacity



2030



Enabling the future of nuclear energy systems:

## Vision for Effective, Integrated Fuel Cycle Solutions

### Address interim HALEU supply-chain

- Recover and down-blend HEU from irradiated fuels utilizing Hybrid-ZIRCEX and electrochemical processes
- Provide HALEU to support advanced reactor start-up cores
- Inform HALEU transportation



### Develop and demonstrate real-time instrumentation

- Interrogate SNF treatment processes
- Monitor back-end fuel and canister integrity



### Support management and treatment of SNF

- Demonstrate decrease in proliferation risk by SNF immobilization processes
- Demonstrate dramatically simpler integrated SNF treatment process, potentially reducing cost and waste



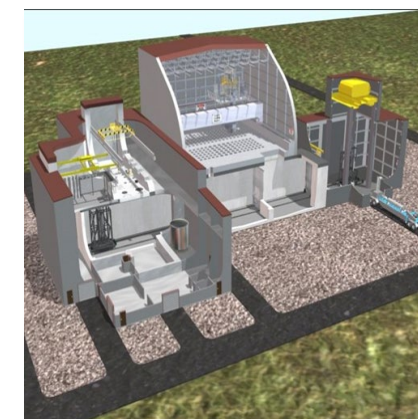
### Support disposition of SNF

- Develop process flowsheets for predicting all waste streams and SNF generated from non-LWR-based advanced reactors
- Inform storage, transportation, disposition, and safeguards requirements for current and future SNF



### R&D facilities to support SNF long-term challenges

- Upgrade and expand relevant site facilities to provide data needed to support safe and secure management and treatment of SNF and high-level waste



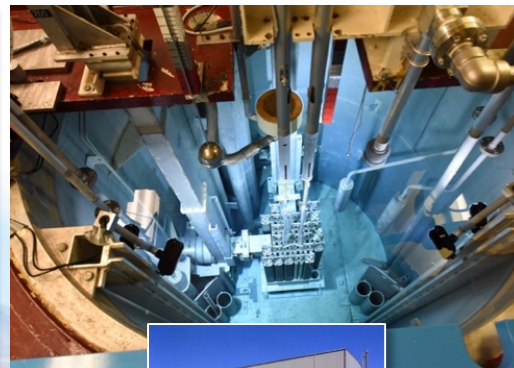
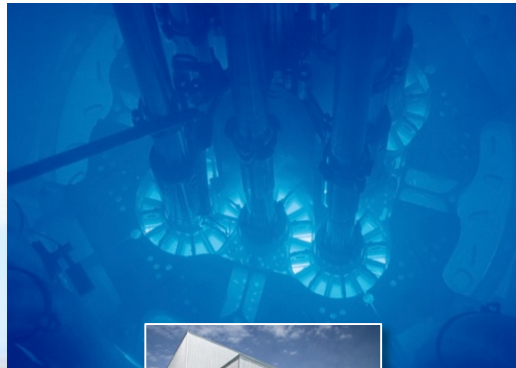
2024

2027

2030



# *National Reactor Innovation Center Will Provide Capabilities to Accelerate Technology Readiness From Proof-of-concept Through Proof-of-operation*



## **NEICA**

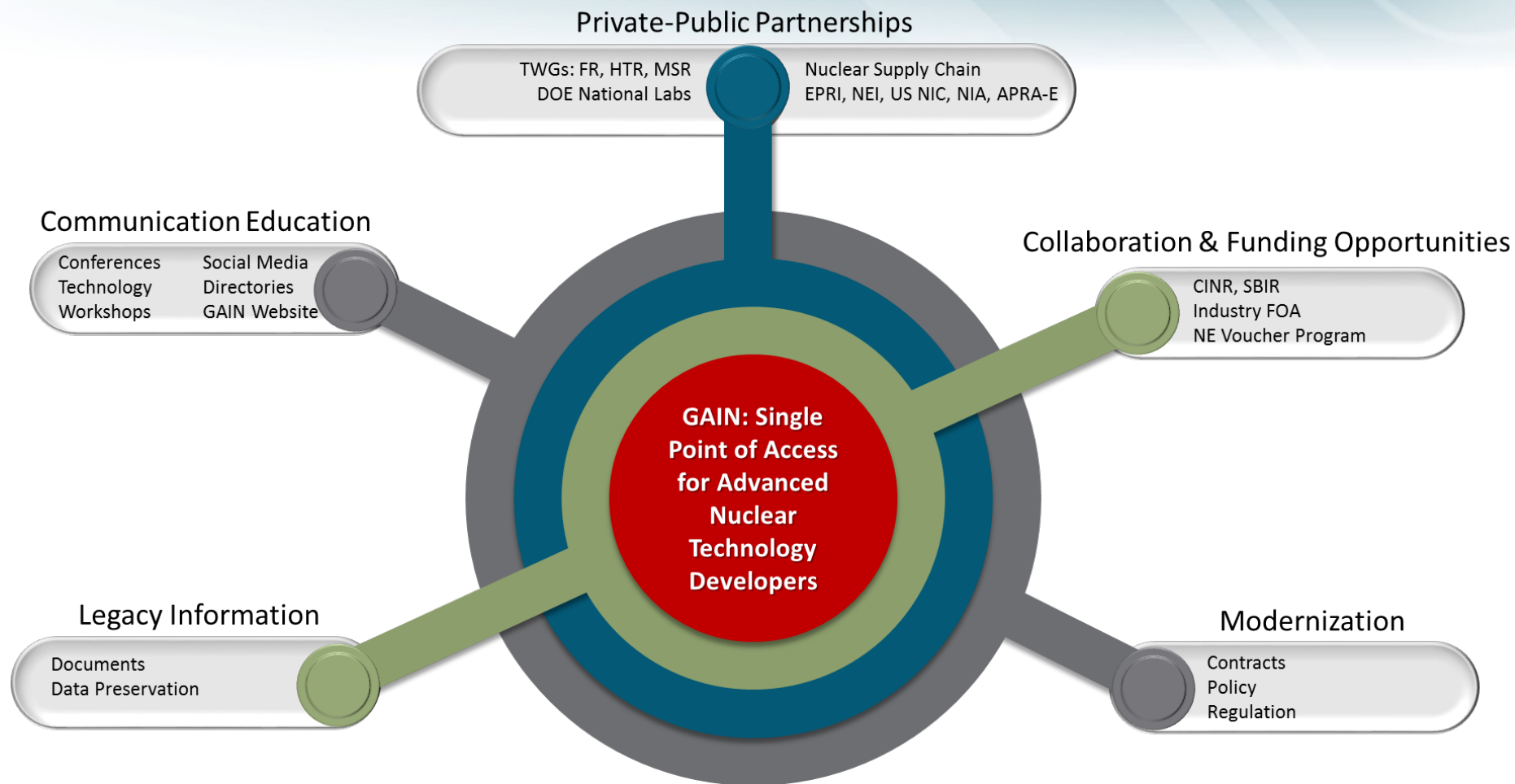
### **Nuclear Energy Innovation Capabilities Act**

*Signed into law September 2018, NEICA calls for the creation of a **National Reactor Innovation Center** to support demonstration of cost-shared private reactors.*

## **NRIC**

### **National Reactor Innovation Center**

*NRIC is a place where government and private companies can test and demonstrate new reactor designs, as well as materials, fuels, and other nuclear energy technologies.*

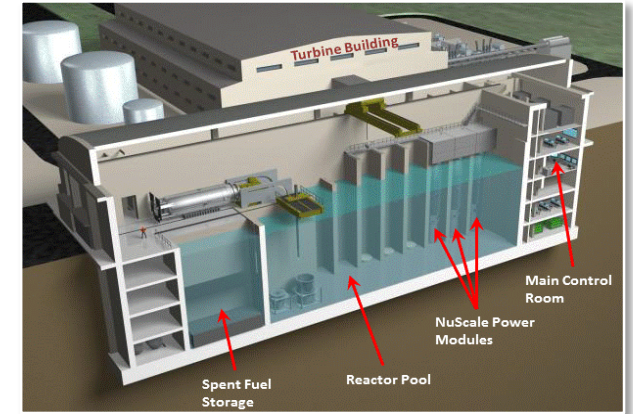




*Looking Ahead:*

## ***Continued Challenges for Nuclear Energy, but Reasons for Optimism***

- Funding (federal budget, private industry)
- Political support
- TREAT completely restored
- Research Collaboration Building, Sample Prep Laboratory
- SMR demonstration and JUMP
- Versatile test reactor
- Microreactor demonstrations
- INL Scientific Computing Strategy; Collaborative Computing Center
- Improved MFC and ATR operations and output/reliability
- NEICA, NEIMA, NELA ...



***3-D view of Six NuScale Modules***



***Collaborative Computing Center (C3)***

## ***Establishing the National Reactor Innovation Center***



**INL-Alaska  
Building a Better  
Future TOGETHER**



***Questions?***