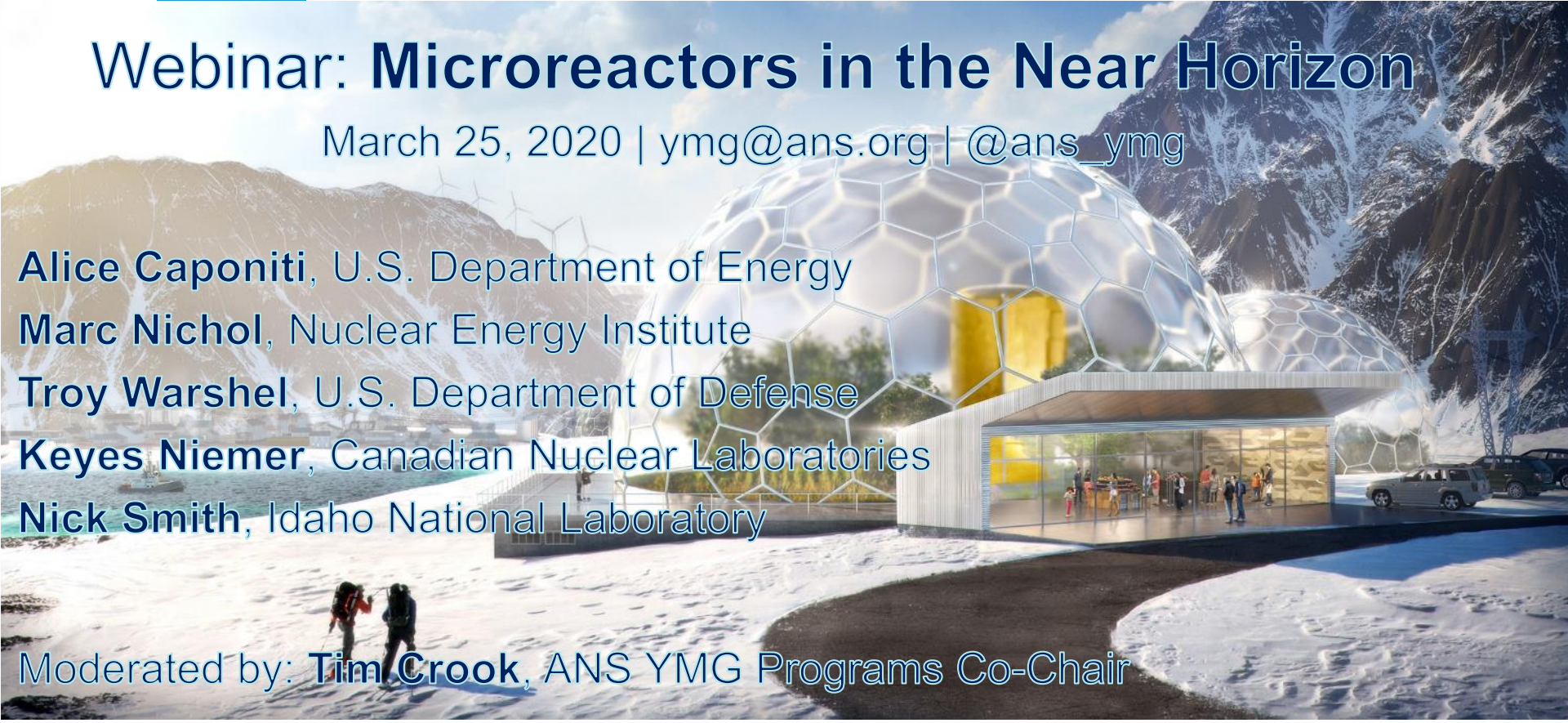
Webinar: **Microreactors in the Near Horizon**

March 25, 2020 | ymg@ans.org | @ans_ymg



Alice Caponiti, U.S. Department of Energy

Marc Nichol, Nuclear Energy Institute

Troy Warshel, U.S. Department of Defense

Keyes Niemer, Canadian Nuclear Laboratories

Nick Smith, Idaho National Laboratory

Moderated by: **Tim Crook**, ANS YMG Programs Co-Chair

American Nuclear Society Young Members Group

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Alice Caponiti

Deputy Assistant Secretary,
Reactor Fleet and Advanced Reactor Deployment
U.S. Department of Energy

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Microreactors for Specialized Applications

Small, transportable reactors able to produce 2 – 40 megawatts of thermal energy that can be used directly as heat or converted to electric power

Benefits:

Small Size

Fits on the back of a semi-truck and can be deployed to remote locations and military bases for reliable heat and power.

Simple Design

Fail-safe and self-regulating designs that require fewer components, maintenance and operators.

Fast On-site Installation

Can be connected and generating power within a week of arriving on site.

Courtesy of Third Way #NuclearReimagined

Marc Nichol

Senior Director, New Reactors

Nuclear Energy Institute

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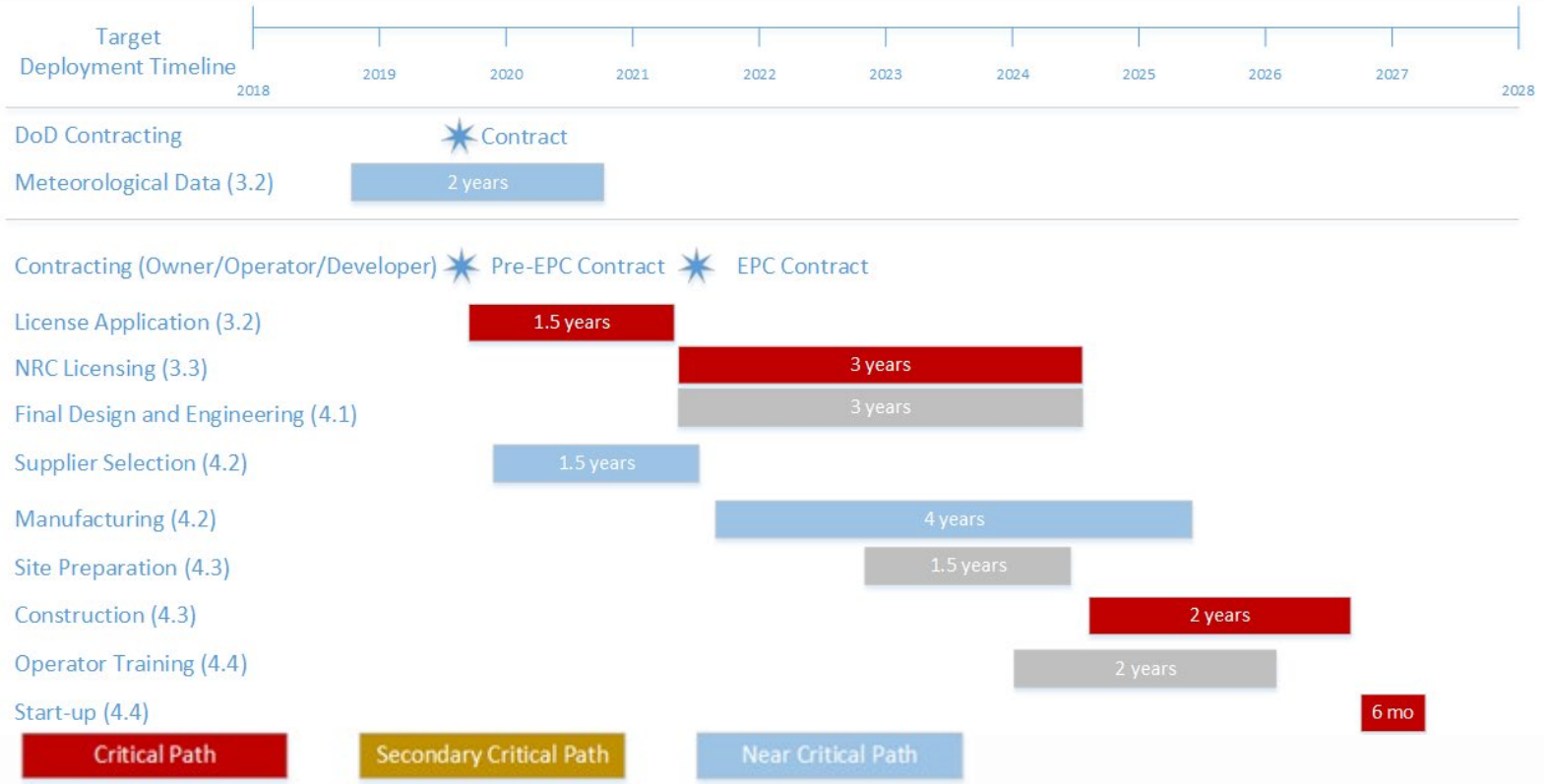
Market Opportunities

Deployment Timeline

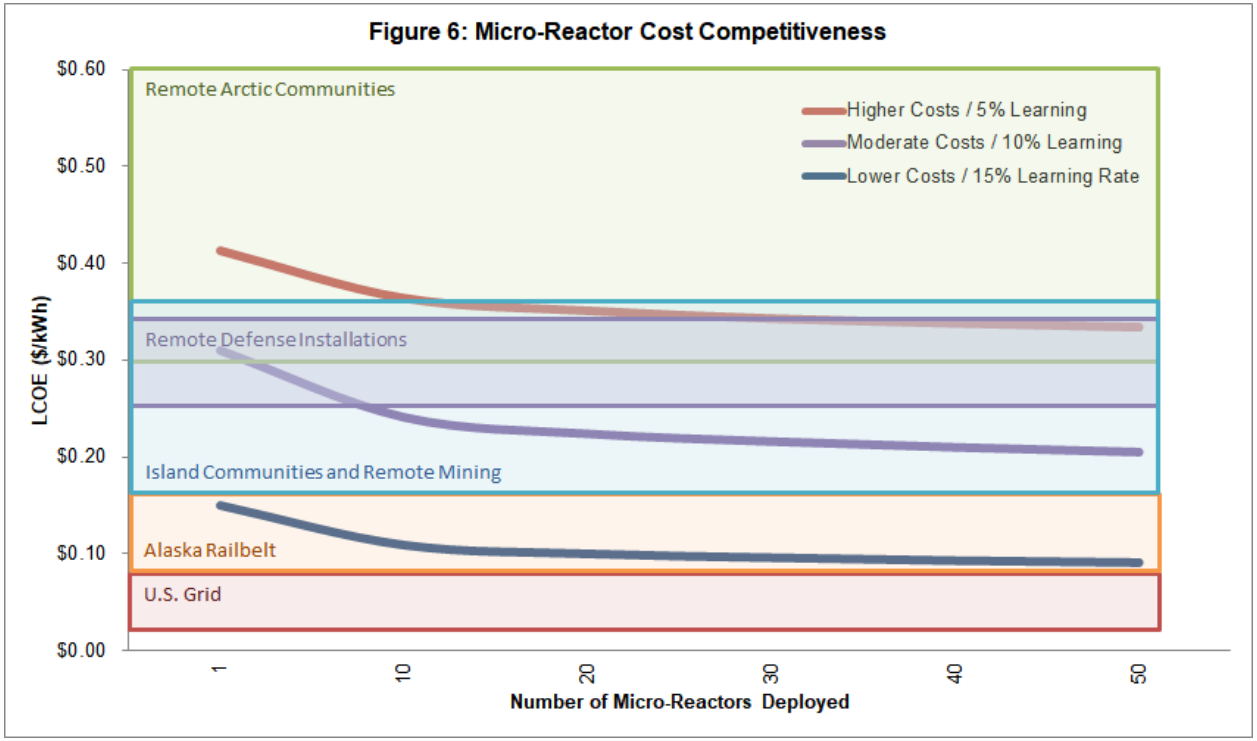


NEI: *Roadmap for the Deployment of Micro-Reactors for U.S. Department of Defense Domestic Installations*, October 2018

Fuel Timeline

NEI: *Roadmap for the Deployment of Micro-Reactors for U.S. Department of Defense Domestic Installations*, October 2018

Micro-Reactor Cost Competitiveness



NEI: *Cost Competitiveness of Micro-Reactors for Remote Markets*, April 2019

Reference Micro-Reactor

- First of a kind
- 10 MWe

Moderate Costs

- $150 million capital cost
- 5¢/kWh operating cost
- < 24 month construction

Micro-Reactor Regulatory Issues

Priority Issues	Addressed in Broader Efforts	Non-Urgent
1. Review Scope, Duration, Level of Effort 2. Operator licensing 3. Resident Inspector 4. Emergency Preparedness 5. Physical Security 6. Aircraft Impact	• Siting • Environmental Reviews	• Transportation • Annual Licensee Fees • Fuel • Generic License • PRA • QA

No issues identified to-date

- Liability Insurance
- Decommissioning Funding

NEI: *Micro-Reactor Regulatory Issues*, November 2019

Troy Warshel

Director of Operational Energy Resilience,
Office of the Assistant Secretary of Defense for Sustainment

U.S. Department of Defense

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Chalk River Laboratories is the single largest science and technology laboratory in Canada

9,100 acres with 200 acres of lab complex

17 nuclear facilities, 70 major buildings

2,800 employees (500 PhDs & Masters)

1,600 engineering, scientific & technical staff

Advanced nuclear fuels and materials research

Radiobiology, radioecology and dosimetry

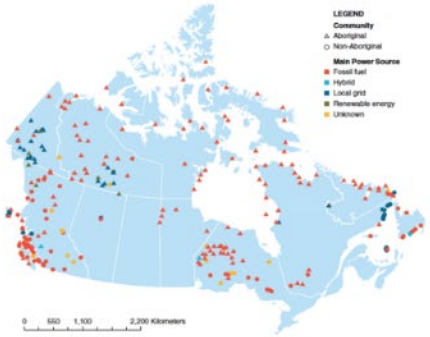
Hydrogen and hydrogen isotopes management

Nuclear safety, security and risk management

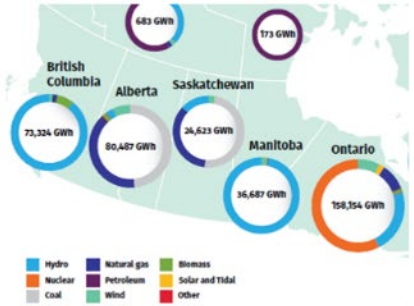
Nuclear and systems engineering

Nuclear chemistry applications

Canadian Market Potential



Sources: The Conference Board of Canada; Arriaga, Doctor Plotta



Northern Canada

- Over 200 communities, largely Indigenous, reliant on diesel generation.
- Health & well being, climate, and financial advantages from energy independence and energy empowerment

Resource extraction

- Hydrogen production for oil sands bitumen upgrading
- Power for in-situ and surface extraction sites
- SMR for mineral mining sites

Low Carbon Energy

- Larger, grid-sized SMR designs could enable a significant shift away from coal-fired generation, as demonstrated in Ontario

Path to a Demonstration SMR at CNL

- Market Survey (2017)
- Invitation to Site a Demonstration SMR (2018):
  - 4 applications received in 2018, 2 in 2019, more anticipated
  - Technology and project developers serious and progressed to site the first demonstration unit
  - GFP submitted its licence application to prepare site in 2019

Stage 1: Pre-qualification → Stage 2: Due Diligence → Stage 3: Negotiation of Land Arrangement and Other Contracts → Stage 4: Project Execution

UBATTERY Local Modular Energy

TERRESTRIAL ENERGY

STARCORE NUCLEAR

GLOBAL FIRST POWER

www.cnl.ca/SMR

Canadian Nuclear Research Initiative (CNRI)

- Seven CNRI proposals were received from 5 companies in the first up-take in the following areas:

Feasibility Study

Reactor Physics

SMR Component Degradation

Safety, Security and Licensing

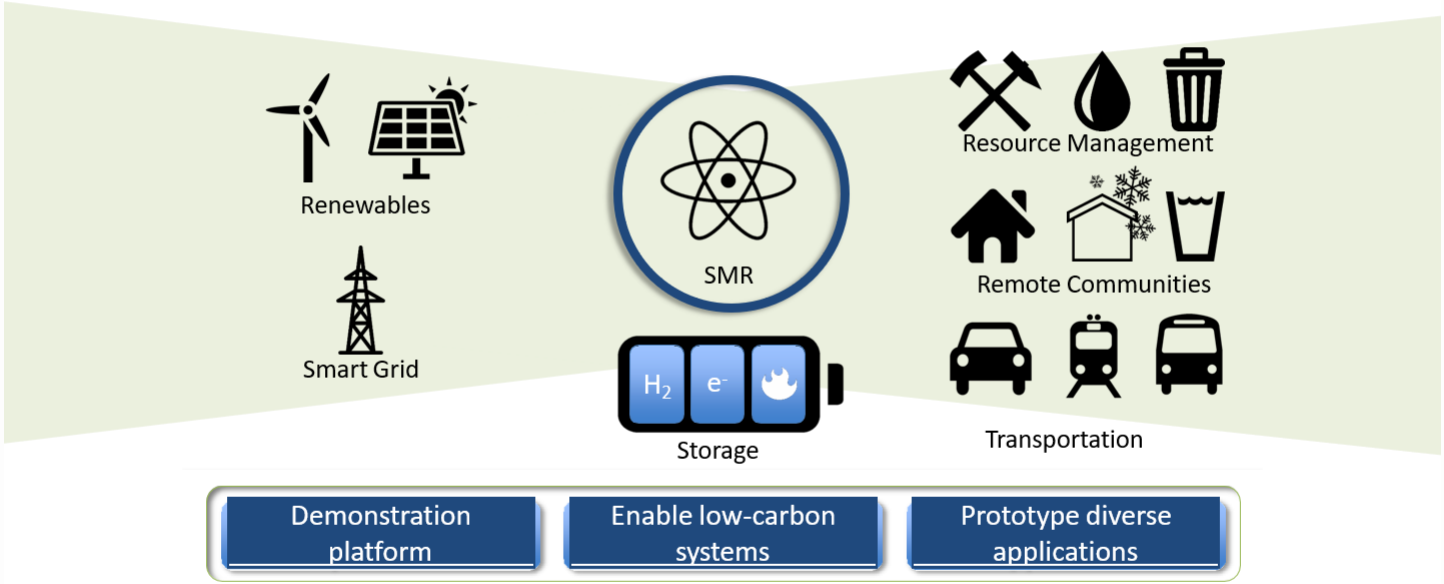
Economics

Thermalhydraulics

- Four projects have been selected for negotiations.

Clean Energy Development Innovation and Research (CEDIR) Park

Advancing the readiness of low-carbon hybrid energy systems with SMRs



Nick Smith

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DOE Launched NRIC on August 15th, 2019

- **Authorized by the Nuclear Energy Innovation Capabilities Act to provide innovators with necessary support to test and demonstrate their reactor concepts and assess their performance.**
- **NRIC is led by INL, coordinating with other national labs**

NRIC provides capabilities to enable the construction and operation of innovative ***demonstration reactor concepts***

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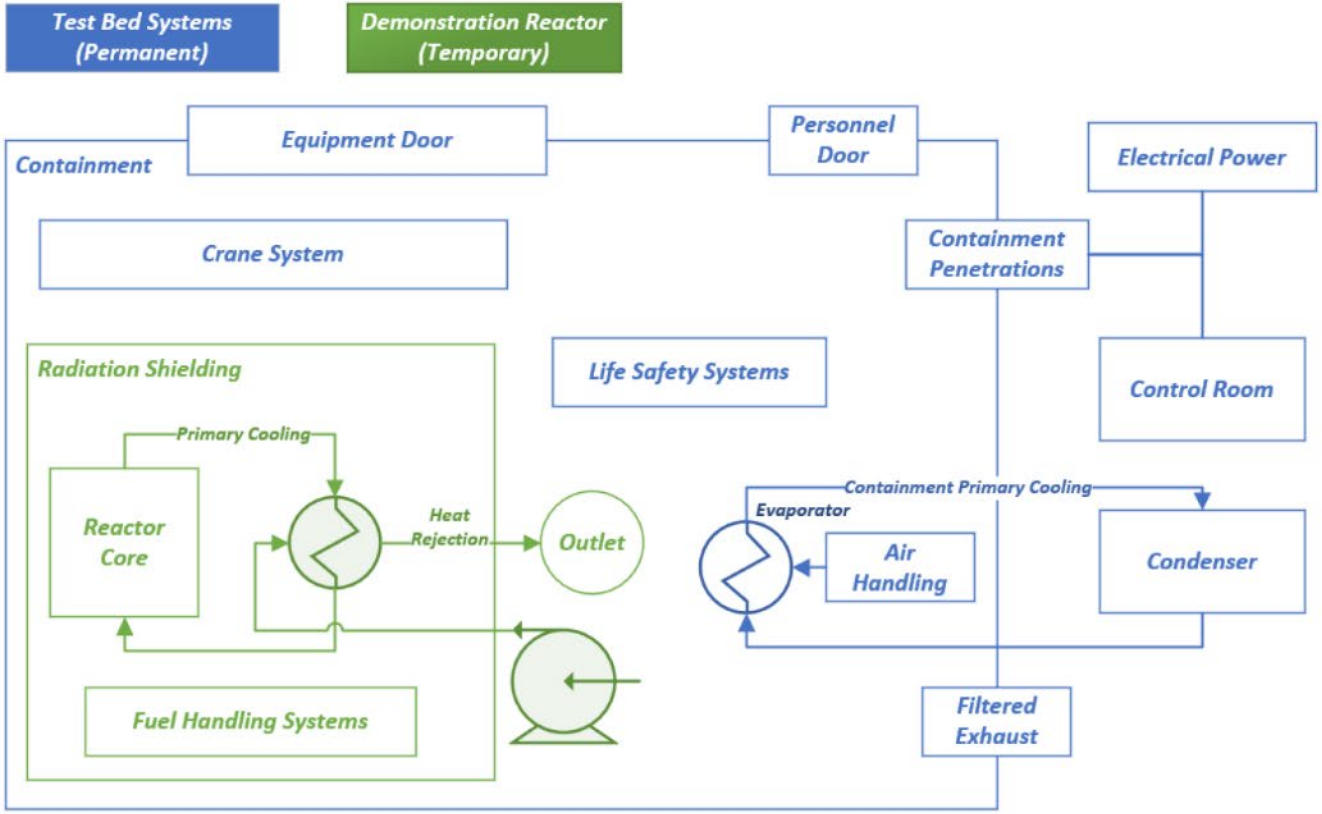
Establishing NRIC in FY'20

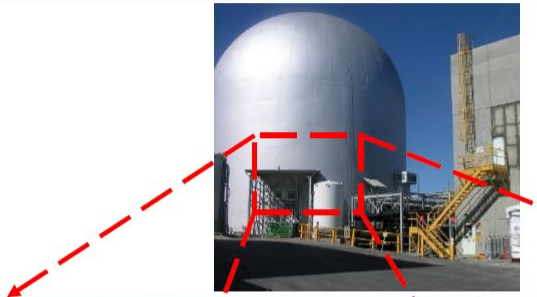
- **Staffing needs to support the development and execution of NRIC projects**
- **Strategic planning to enable:**
  - Successful demonstration reactor projects on a routine cadence
  - Efficient communication and collaboration across multi-year projects
  - Alignment of efforts across multiple organizations
  - Optimized resource commitments and programmatic efforts
- **Development of industry partnerships on demonstration reactor projects**
- **Engagement with NRC on demonstration reactor projects**
- **Address fuel transportation, spent fuel disposition, and demonstration reactor decommissioning**

Demonstration Reactor Test Bed Concept



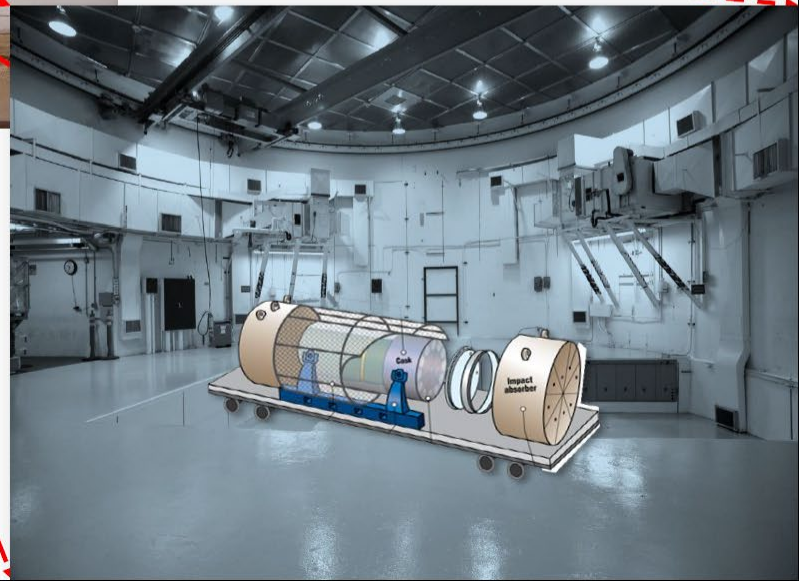
Concept for EBR-II Dome as a Demonstration Reactor Test Bed

- Safety significant containment structure
- Safeguards Category 2 Facility (HALEU or LEU)
- 10MWt heat rejection with option to increase to 20MWt if necessary
- Equipment hatch and entry platform to accept trailer mounted Conex containers (8’ x 8’ 6” x 20’)
- Repairs to existing personnel door
- Containment penetrations and installation of utilities
  - Electrical, Communications, Instrument Air
- Repairs to existing crane system
- Installation of fire protection, radiation monitoring, and security systems



Concept for ZPPR Cell as a Demonstration Reactor Test Bed

- Pre-Conceptual Design Currently Underway
- Working with industry to define facility requirements
- Safeguards Category 1 Facility (HEU or Pu)
- 500kWt heat rejection with option to increase to 1MWt if necessary
- Improvements to roof allowing installation and removal of reactor systems
- Installation of fire protection, radiation monitoring, and security systems



Additional projects to enable rapid demonstration of reactor concepts proposed by industry

- **Risk reduction in DOE authorization process for demonstration reactors**
  - Utilize generic, enveloped, demonstration reactor parameters to initiate DOE facility authorization process
- **Risk reduction in NEPA process for demonstration reactors**
  - Utilize generic, enveloped, demonstration reactor parameters to initiate NEPA process
- **Preparation of new fuel production infrastructure**
- **Provision of satellite office space for on-site collaboration with industry partners**
  - Meeting space enabling industry to work and host events for potential customers, investors, and others

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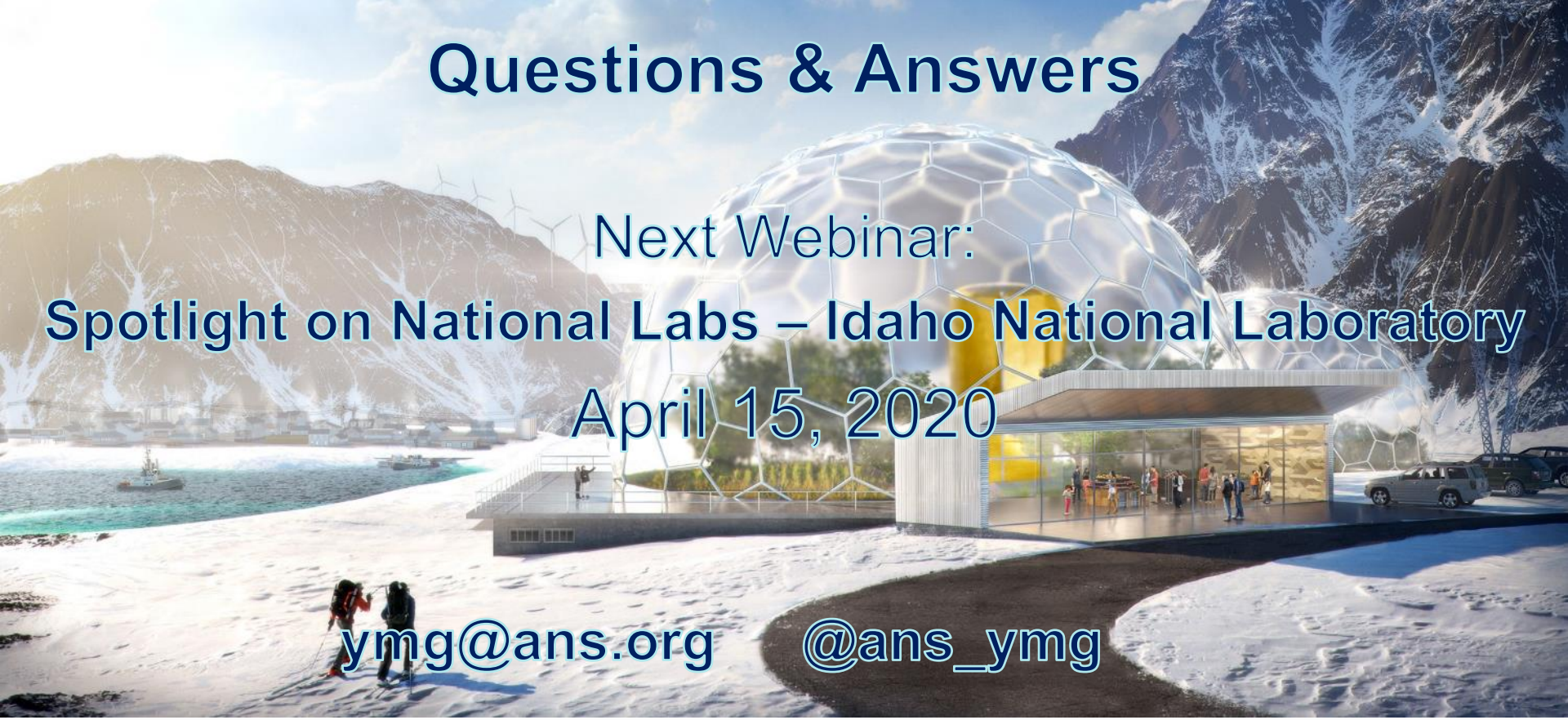
Questions & Answers

Next Webinar:

Spotlight on National Labs – Idaho National Laboratory

April 15, 2020

ymg@ans.org @ans_ymg



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