



Reactor Fleet and Advanced Reactor Deployment

Dirk Cairns-Gallimore
Office of Nuclear Energy

Office of Reactor Fleet and Advanced Reactor Deployment Mission

- **Vision** – Be a catalyst for the commercialization of NE-sponsored research, development and demonstration products
- **Mission** – Integrate NE’s research investments to achieve a productive and balanced portfolio of competitive and crosscutting research, development, and demonstration (RD&D) and research infrastructure to enable expansion of the U.S. commercial nuclear industry
- **Objectives**
 - Full and effective integration of NE RD&D planning, execution and oversight
 - Systematic management of NE investments in research capabilities
 - Alignment of NE’s RD&D programs with industry-identified technical and regulatory needs
 - Accelerate the introduction of innovative technologies into the marketplace through multiple mechanisms

Overview of Office of Reactor Fleet and Advanced Reactor Deployment

- Programs in the Office of Nuclear Reactor Deployment (NE-52)
 - Advanced Small Modular Reactor Research and Development (R&D)
 - Advanced Reactor Technologies
 - Microreactors
 - Light Water Reactor Sustainability
- Programs in the Office of Nuclear Energy Technologies (NE-51)
 - Crosscutting Technology Development
 - Advanced Sensors and Instrumentation, Advanced Methods for Manufacturing, Integrated Energy Systems, Cybersecurity
 - Nuclear Science User Facilities
 - Advanced Modeling and Simulation
 - Transformational Challenge Reactor

U.S. Advanced Reactor Landscape

- Over 60 companies and research institutions are working on advanced nuclear projects for a wide array of capabilities to meet the energy needs of the future
 - e.g., sodium-, gas-, lead-, molten-cooled reactors (versus LWR-cooled)
 - Significant levels of private sector investment
- Motivation for advanced reactor development
 - Potential for improved safety and
 - Various options for future commercial (civilian), limited-grid and military applications
 - Potential for improved nuclear resource utilization and reduced nuclear waste
 - Flexible operation to support the national grid of the future containing many energy-source options
 - Application of advanced manufacturing and modeling techniques to bring nuclear into the 21st century
- DOE Advanced Reactor Demonstration Program
 - \$230 million initial year funding to establish a program to demonstrate multiple advanced reactor designs at various stages of technological maturity
 - Construction of two demonstration reactors within five to seven years
 - Solicitation under way; awards to be announced in fall 2020

Goal of the ARDP

- Focus DOE and non-federal resources on the construction of real demonstration reactors and supporting activities for commercial use
- Congress funded DOE to establish a program to demonstrate multiple advanced reactor designs
- Technology agnostic – all advanced technologies are eligible, including LWR-based designs
- Construct and demonstrate several advanced reactors with beneficial capabilities, such as:
 - Inherent safety features
 - Superior reliability
 - Lower waste yields
 - Proliferation resistance
 - Greater fuel utilization
 - Improved thermal efficiency
 - Ability to integrate electric & non-electric applications

Demonstration Structure

Three tier structure based concept maturity and deployment timeline

- **Advanced Reactor Demonstrations (Demos)**
 - Closest to commercialization
 - Deployment and operation 5-7 years following award
- **Risk Reduction for Future Demonstrations (Risk Reduction)**
 - Substantial risks remain to be addressed before designs can be demonstrated
 - Commercial horizon approximately 5 years later than the Demos
- **Advanced Reactor Concepts-20 (ARC-20)**
 - Design maturity is lowest Technology Readiness Level (TRL) scale
 - Commercialization horizon in the mid- 2030's

Other DOE Activities and Capabilities Supporting Industry in Advanced Reactor Development

- National Reactor Innovation Center (NRIC)
 - Addresses key gaps & barriers to enable developers to demonstrate nuclear reactor concepts supporting commercialization
 - Provides well-characterized locations to site reactors, access to key resources, and promotes collaboration with laboratory experts in nuclear science and engineering to support technology development
- Gateway for Accelerated Innovation in Nuclear (GAIN) Initiative
 - Allows industry access to DOE lab RD&D infrastructure to achieve faster and cost-effective development of innovative nuclear technologies toward commercial readiness
 - Nuclear and radiological testing facilities, e.g., thermal-hydraulic loops, control systems testing
 - Computational capabilities along with state-of-the-art modeling and simulation tools
 - Information and data through knowledge and validation center
 - Land use and site information for demonstration facilities
- US Industry Opportunities for Advanced Nuclear Technology Development FOA (Industry FOA)
 - Currently 3 application review cycles per year
 - Cost shared cooperative agreements with industry (Requires between 20% – 50% industry contribution)
 - Project funding aligned with NE programs with same goals
- Advanced Small Modular Reactor (SMR) R&D Program
 - Focuses on cost-shared, private-public R&D partnerships to address technical, operational, and regulatory challenges specific to SMRs

Advanced Reactor Potential Advantages

- Construction timelines for advanced designs expected to be shorter than the current generation of LWRs
- Advanced designs will take advantage of advanced manufacturing techniques and modular construction capability
 - Hands-on labor costs significantly reduced
 - Most work done in a controlled factory environment vs. field
 - Increased repeatability and quality, reducing component inspection times and rejection rates
- Simplicity of design reduces system and component complexity
- Reduced commodity and labor costs (steel, concrete, and rebar) due to smaller systems and lower pressures

Importance of Codes and Standards to Advance Reactors

- Standards provide the basis for efficiency, standardized products, improved trade and commerce, and safety and quality objectives
- Incorporate the evolving technical advancements and lessons-learned from real world use to ensure the standard continues to be relevant
- Set minimum requirements to protect health, safety, general welfare & affordability
- They set an understandable and reliable basis that reduces vulnerability to a wide range of hazards.
- Serves as a common language in increasing interconnected industrial complex

DOE Role in Codes and Standards

- Providing technical experts to key working meetings and as coordinators
- Accelerating the identification of gaps in the standards development process and the methods to close the gaps
- Providing support for international standards meetings
- Supporting research and development activities needed for standards development
- Supporting the codes and standards adoption process.
- Integration

Topography Considerations

- Currently there is a unique moment at DOE
 - Examples:
 - The ARPD program will award projects at multiple technology levels with their associated timeline.
 - DOE Advanced Manufacture Program is refocusing to deployment readiness of technology.
- Current Congressional support for reactor deployment
- Codes and standards efforts will need to be prioritized and integrated given the current landscape.
- Need to consider the push of Data driven/risk based decision making
 - This is an evolving process that considers discrete risk events and integrated effects of multiple risk internal and external to efforts.

Potential Path Forward

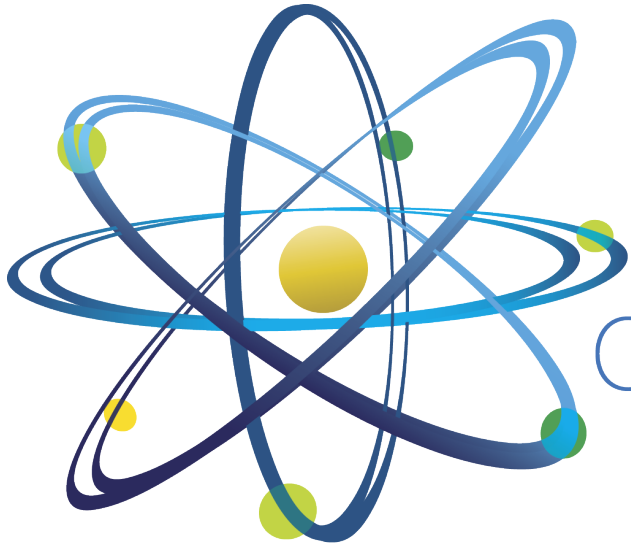
- Evaluate the ARDP awards, other demonstration projects, and future concepts .
- Understand the risks (opportunities and consequences) of current standards, potential changes or new needs.
- Begin to prioritize efforts and determine potential road map

The key will be establishing a multi-organization working group that represents the stakeholder community. That can effectively reach a consensus priorities and road map

Summary

- DOE-NE provides sustained investments to supports codes and standards develop
- The Advanced Reactor Demonstration Program provides a unique opportunity to advance the development and application of new standards
- DOE-NE investments in Advanced Manufacturing increase stakeholder participation (Industry, DOE offices, Standards, NRC, National laboratories etc.)
- Consensus priorities need to be established and road mapped.

Questions?



Clean. **Reliable. Nuclear.**