



DOE-NE Micro-Reactor RD&D Program
Mission and Objectives

GAIN Micro-Reactor Workshop
June 2019

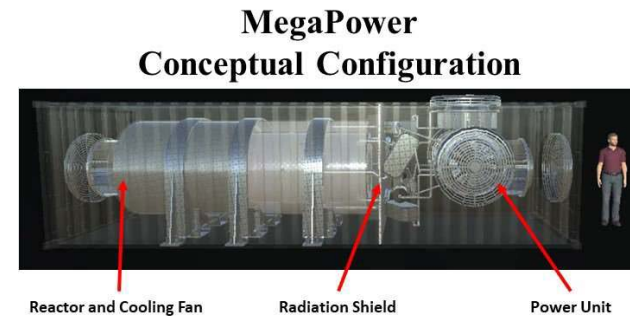
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Presentation Outline

- Background
 - Overview of Micro-Reactor Benefits and Potential Applications
 - FY19 National Defense Authorization Act Micro-Reactor Directives
- DOE-NE Program Mission & Objectives
- Micro-Reactor Demonstration Coordination
 - Department of Defense
 - Industry
- Major Program Technical Areas
- Recent Accomplishments and Path Forward



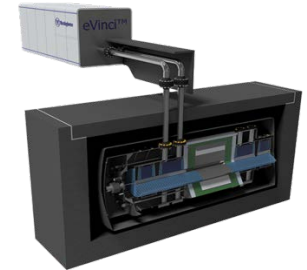
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DOE Views on Micro-Reactor Benefits and Applications

DOE believes micro-reactors have the potential to provide the commercial and defense sectors with a clean, reliable, and resilient energy supply technology

Potential benefits include:

- Enhanced inherent safety characteristics
- Smaller footprints significantly reducing source terms
- Semi-autonomous and remote control operations reducing staffing needs
- High temperature operation for both electricity and process heat production
- Highly integrated and transportable systems reducing on-site construction times



Potential applications include:

- Competitive electricity and process heat supplies for remote and off-grid communities and industrial locations
- Resilient and reliable energy supplies for remote and forward military bases
- Reliable and clean electricity supplies for disaster and emergency relief operations

FY19 National Defense Authority Act (NDAA)

Section 327 of the FY 2019 NDAA directs the Secretary of Energy to develop a report, within 12 months: *Describing the requirements for and components of a pilot program to provide energy resilience to DoD/DOE facilities by contracting with a commercial entity to site, construct, and operate at least one micro-reactor by December 31, 2027*

- The NDAA language describes 9 required sections that the report should cover:
 - Identification of potential locations to site, construct, and operate a micro-reactor at a DoD or DOE facility;
 - Assessments of different nuclear technologies to provide energy resiliency for critical national security infrastructure;
 - A survey of potential commercial stakeholders to construct and operate a licensed micro-reactor;
 - Options to enter into long-term contracting, including various financial mechanisms for such purpose;
 - Identification of requirements for micro-reactors to provide energy resilience to mission-critical functions;
 - Estimate of the costs of the pilot program;
 - Timeline with milestones for the pilot program;
 - Analysis of the existing DOE/DoD authority to permit the siting, construction, and operation of a micro-reactor;
 - Recommendations for any legislative changes necessary for DOE/DoD to permit siting, construction, and operations.
- Report final draft currently undergoing stakeholder review/inter-agency concurrence
- DOE on track to issue report to Congress by August 2019 due date

DOE Micro-Reactor RD&D Program Mission and Objectives

Mission: Enable micro-reactor technology demonstration at a DOE national laboratory and subsequent deployment for commercial and/or defense applications

Objectives:

- Identify technology research and development requirements for micro-reactor concepts
- Perform laboratory-led, early-stage R&D supporting cross-cutting micro-reactor technology development and licensing activities
- Coordinate with NRC, DoD, and industry to demonstrate micro-reactor technology on a DOE national laboratory site

Coordination with Department of Defense

DOE has engaged with the DoD's Office of the Assistant Secretary of Defense for Sustainment and DoD's Strategic Capabilities Office (SCO) to coordinate micro-reactor technology demonstration efforts

- **Office of the Assistant Secretary of Defense for Sustainment**
 - Focused on demonstrating a micro-reactor at a domestic defense installation by the mid-2020s
 - Reactor would be transportable to a site but would then be stationary for its operational lifetime
 - Air Force bases in Alaska potential candidate sites for the initial demonstration
 - Would likely be a second mover following an initial concept demonstration supported by DOE/industry
 - Demonstration would likely be commercially owned and operated and NRC licensed
 - Goals closely aligned with micro-reactor mission defined in the NDAA report



Coordination with Department of Defense

Strategic Capabilities Office

- Interested in ultra-mobile micro-reactor systems
 - Brought in to forward operating positions, operated, and transported back out
 - Provides reliable, high-density energy system with long term fuel supply for remote or forward operating bases – eliminates fuel transport casualties
 - Humanitarian Assistance Disaster Relief (HADR) capability – rapidly deployable power for high-value locations (e.g. hospitals, relief centers)
- Distinctly different mission compared to Office of the Assistant Secretary of Defense for Sustainment
- Would most likely not be NRC licensed



DOE Request for Information on Micro-Reactors (1 of 2)

In support of the NDAA report, DOE-NE issued RFI on Sept. 13 and received responses through Oct. 15, 2018

- Queried industry for information on the various micro-reactor technologies under development and solicited input on how a pilot program should be structured
 - Responses included 16 reactor design concepts from 14 different commercial companies and input from NEI, LES, URENCO USA, Southern Company, BWXT, and Sargent & Lundy
- Submitted reactor concept technologies included:
 - Pressurized water reactor
 - Fast and thermal spectrum gas cooled reactors
 - Liquid fluoride cooled thorium reactor
 - Solid state fast reactor
 - Epithermal spectrum reactor
 - Heat-pipe cooled reactors
- Concepts ranged from 0.2 to 81 MWe
- Majority of concepts plan to use HALEU (5-19.75%)
- Concepts focused on passive safety features, long design life, ease of transport from factory to end-user location, micro-grid applications, and high resiliency features

DOE Request for Information on Micro-Reactors (2 of 2)

- Areas of critical importance identified in the RFI to complete a successful demonstration by 2027 included:
 - NRC licensing
 - Prompt identification of a site
 - Fuel qualification and manufacturing
 - Need for a reliable supply of HALEU
 - Supply chain development
 - Effective contractual mechanisms and public-private partnerships,
 - Appropriate government funding and incentives
 - Strong national laboratory support
 - Continued cooperation among industry, DOE, DoD, NRC, and the National Labs
 - Continued legislative support of advanced reactors through authorizations and appropriations
- Overall, the RFI responses concluded that a pilot program could be implemented by 2027, depending on ability to address deployment challenges above

Major FY19 Program R&D Areas

Industry and DoD stakeholder feedback have formed the basis for FY19 DOE-funded micro-reactor R&D efforts in the following areas:

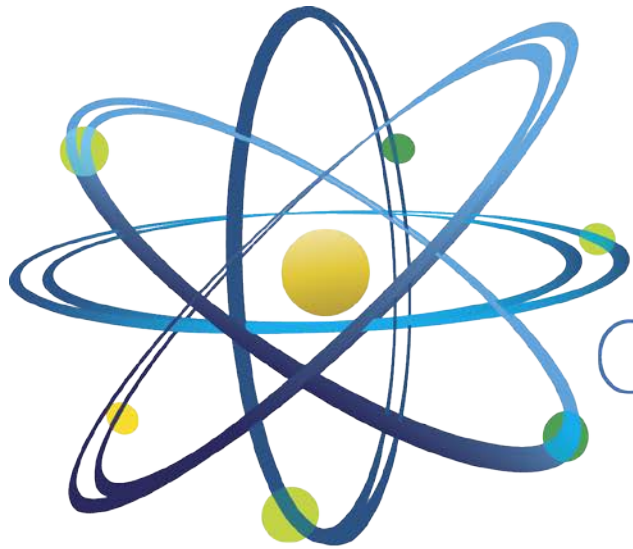
- Accelerating micro-reactor HALEU production and fuel fabrication capabilities
- Preparing potential national laboratory micro-reactor demonstration sites and NEPA analyses
- High fidelity, dynamic analysis of conceptual designs
- Demonstrating innovative cross-cutting micro-reactor technologies such as heat pipes and advanced moderators
- Qualifying advanced high temperature materials and exploring additive manufacturing techniques
- Developing remote monitoring and semi-autonomous control systems
- Assessing potential DOE, DoD, and NRC regulatory pathways for both near-term micro-reactor demonstration and future “nth of a kind” commercial applications

Next Steps

Path forward for FY20 and beyond:

- **Continue R&D supporting commercial/DoD micro-reactor demonstrations at a national laboratory site**
 - Develop non-nuclear test bed to demonstration key micro-reactor components and subsystems
 - Provide technical support for completion of demonstration NEPA siting assessments
 - Develop pathways for HALEU availability and fabrication
 - Address unique micro-reactor licensing challenges (e.g. transportation, semi-autonomous control, AM materials)
 - Provide support for reactor vendor concept development and licensing activities
- **Continue coordination with industry, DoD, and NRC stakeholders to identify and address high-priority R&D needs and regulatory issues**
 - Workshops with stakeholders
 - Technical support for DoD micro-reactor efforts
 - Close engagement with NRC during demonstration/deployment phases

Thank you! Questions?



Clean. **Reliable. Nuclear.**