U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Accelerating Commercial Maritime Demonstration Projects for Advanced Nuclear Reactor Technologies

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Pathway: Pathway 2 – Advanced Reactor Development Projects

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Abstract

The Department of Energy (DOE) is making major investments in advanced nuclear reactor development and demonstration programs through programs such as the Advanced Reactor Demonstration Program (ARDP). The innovations in these technologies (e.g., "nuclear battery" concepts using microreactors and small modular reactors) have opened the door to a wide range of applications beyond power stations providing electricity to the grid. Transportation applications and process heat/power for applications with industrial operations offer substantial and reliable carbon-free energy to achieve industry decarbonization goals and support important related activities (such as green alternative fuel production, water desalinization, local power for special uses like data centers or microgrids, etc.). DOE recognizes the transformational power of these technologies by investing in foundational research and development as well as reactor demonstration projects. However, unique and significant hurdles exist in each application domain to bring projects into reality beyond just the underlying reactor technology maturation.

This project focuses on addressing those hurdles in the maritime domain so that new reactor technology can be deployed rapidly to transform the industry and create market disruption that will provide unique competitive advantages for U.S. companies that design, build, operate, and support maritime assets associated with ship operations and offshore industrial operations. Advanced nuclear technology is positioned to be one of the strongest tools available to the industry for achieving the aggressive decarbonization goals that are fundamentally changing the shipping and offshore industry's assets and infrastructure. This project will improve drastically the timeline for advanced reactor technology deployment for commercial maritime applications by achieving the following objectives:

1. Building demonstration project pathways and business cases (i.e., scenarios evolving from initial demonstrations onsite at DOE facilities to full-scale testing in maritime environments)
2. Developing models of various advanced reactor technologies integrated with maritime applications to help the maritime industry understand the unique value proposition and realism of nuclear solutions for pressing issues in the maritime industry (e.g., decarbonization goals)
3. Assessing the readiness of DOE for supporting demonstration projects that integrate advanced reactor technology demonstrations with land-based marine systems (e.g., industrial plants and propulsion systems) in a DOE test environment, and outlining opportunities and options for preparing the DOE complex and/or other government facilities to support such demonstrations
4. Publishing guidance for addressing key technical, regulatory, and policy issues for maritime demonstration projects (nuclear-related and maritime-related) for achieving approvals/success

Clean. Reliable. Nuclear.

The key deliverables will be the following:

1. A roadmap for maritime application demonstration projects that will serve as a guide for DOE, industry, academic partners, regulators, and other stakeholders
2. Electronic models for demonstrating advanced reactor technologies integrated with maritime applications
3. ABS *Advisory on Advanced Reactor Technology for Maritime Applications* for the nuclear and maritime industries, regulators, and other stakeholders
4. A readiness report for DOE support of maritime-related demonstration projects of advanced nuclear technology
5. ABS *Guidance Notes for Maritime Demonstration Projects Using Advanced Nuclear Reactor Technology* for the nuclear and maritime industries, regulators, and other stakeholders

The results will be cross-cutting and beneficial for the advancement of a broad set of domestic nuclear reactor designs and technologies. Without this work, reactor developers and maritime operating companies will find it prohibitively expensive/risky to make major investments in commercial maritime applications.

Nuclear reactor technology has been successful with military naval reactors and non-U.S. government-owned icebreakers. Commercial maritime use of nuclear reactor technology has been limited (e.g., the *NS Savannah*) and is now dated. The technical limitations and economics of legacy nuclear technology as well as an assortment of regulatory/policy issues worldwide and social resistance (especially after the Chernobyl and Fukushima incidents) stalled interest in non-government maritime applications.

There has never been a better time for nuclear technology to gain traction with the commercial maritime industry. Today, a combination of (1) advances in reactor technology and (2) strong regulatory-driven decarbonization drivers in the maritime industry are creating renewed interest in nuclear reactors. The variety of emerging small modular reactor and micro-reactor technologies offer drastically different value propositions and operating envelopes compared to legacy technology. The concept of interchangeable “nuclear batteries” for powering ships and barges and/or industrial processes on offshore assets is a game changer for the industry. Equally important, the maritime industry is striving to achieve the highly aggressive decarbonization goal of a 50% carbon reduction by the end of 2030 (and a more aggressive goal of an 70% reduction by 2050). This initiative is pushing the industry to go far beyond energy efficient use of lower carbon fuels/scrubbers to dramatically different options like hydrogen, ammonia, and nuclear-powered operations.

The opportunity is even more important than good economics for maritime companies and decarbonization of an entire industry. The ability to introduce and control U.S.-based nuclear technology options for the maritime industry can expand multiple elements of the U.S. economy. The distinct advantages of advanced reactor technology for maritime applications can (1) revitalize U.S. shipping companies and shipbuilders that have suffered without a competitive differentiator from foreign competitors, (2) create a potential market of hundreds of ships and offshore assets for U.S. nuclear reactor designers, builders, and operators, and (3) develop a supply and logistics support chain for fueling these reactors in the U.S. This technology would be transformative for the U.S. economy and clean-energy job growth, while also supporting the clean power and decarbonization initiatives of the government.

However, none of this can move forward without DOE support for demonstrating how advanced reactor technology can meet the needs of the industry reliably and safely. Much work is ongoing with advanced reactor design that will culminate ultimately in various reactor technology demonstrations. This is important work, but similar attention is required on demonstrating the integration of such technology into maritime applications to gain industry, regulatory, and public acceptance. With investment in this area, demonstration projects onsite at DOE facilities are achievable by 2025 and in the maritime environment within 2028-2030.