Advanced Nuclear Commercialization Model

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Purpose

The purpose of this document is to articulate SMR Start's views on a commercialization model for advanced nuclear technology. Light water SMRs are the most mature of the advanced nuclear technologies, and industry continues to make progress toward their deployment in the mid-2020s. In a policy statement on public-private partnerships, SMR Start identified the benefits of additional government investment in SMRs and the policies to support their commercialization. The focus of this paper is to identify the roles of government and industry in commercializing advanced nuclear technologies from basic research and development all the way through the first-movers deployments.

Rationale for Government Role in Developing New Technologies

The U.S. Government has a long history of supporting the research, development, demonstration and deployment of new technologies. This support for new technologies has accelerated scientific advancements that improve the standard of living, quality of life, national security and economic well-being of the people. The government is able to fund development of valuable technologies where the financial risks are so high that they discourage sufficient private investment. Public-private partnerships are also valuable in leveraging each other's resources to accelerate the development of new technologies.

For most technologies, including other energy technologies, it is sufficient for government to limit its role to basic R&D, and allow industry to more efficiently advance the technology and products to the maturity needed by the market. However, nuclear is unique in that there are several large barriers to entry that increase the risk profile of commercializing new technologies, including large up front capital, long development timeframes, and an uncertain regulatory environment. Nuclear is also unique in that it is not only a critical technology for a reliable low-carbon energy system, but it is also important to national security. Furthermore, U.S. nuclear companies are competing against state-backed enterprises in the international markets, where the agreements to provide new nuclear power plants are often government to government.

The result is a scarcity of private investment sufficient to develop new nuclear technologies to the point of maturity the market and customers need. It also represents a risk to the U.S. national security if the government does not appropriately align programs to commercialize advanced nuclear technologies consistent with nuclear energy role as a national strategic priority. Therefore, government support for new nuclear technology development must include a focus on ensuring that these technologies are able to make it to the market over these long timeframes.

Commercialization Attributes

- Key Objectives

  - Accelerate U.S. advanced nuclear technology innovation to assure availability in time to meet domestic needs and compete internationally
  - Ensure U.S. advanced nuclear technologies are cost competitive, have features and benefits important in the future energy markets, and have high performance and safety levels
  - Accommodate high numbers of technologies and designs in the early stages of development and rely on the market to provide down selection of technologies
  - Promote US manufacturing development and domestic supply chain

- Stages of commercialization, for example:
  - Research
  - Development
  - Deployment
- Commercialization activities, for example:
  - Testing (materials, components, separate effects and integrated systems)
  - Modeling and simulation
  - Design (conceptual, preliminary, final, ready for manufacturing, ready for construction)
  - Component development (building manufacturability into the final design)
  - Manufacturing process development for domestic supply chain (FOAK and NOAK)
  - Regulatory approval (design, site, construction, operation)
  - Procurement
  - Construction
  - Start-up
- Decision points and key inputs, for example:
  - Begin conceptual design (basic science supports concept and concept has merit)
  - Begin preliminary design (initial testing and conceptual design indicate technical and potential commercial viability)

  - Submit for regulatory approval (sufficient funding to complete regulatory process, expected commercial viability)
  - Begin design finalization (necessary design details beyond that necessary to support license submittal, expected commercial viability)
  - Design for manufacturing (key suppliers identified, initial parts produced, design changes approved to improve overall economics based upon manufacturer's feedback)
  - Design for construction (engineering completed, including changes to improve cost/schedule, to facilitate efficient assembly and construction in the field)
  - Begin site engineering
  - Begin site preparation
  - Customer decision to proceed (need for facility, cost competitive, sufficient funding to complete)

- Philosophical role for industry and government
  - Basic/fundamental R&D – exclusively government
  - Applied R&D – mostly government
  - Technology development (design and licensing) – roughly even industry and government
  - Component development and testing - roughly even industry and government
  - Domestic manufacturing development – mostly industry
  - First Mover Deployment – mostly industry
  - Sustained deployments – exclusively industry
- DOE Technology Readiness Levels (TRLs)
  - TRLs (1 through 9) generally align with stages of commercialization; however, it is possible for different aspects of a design to be at different TRLs
  - SMRs still have a number of components and systems that need to get from TRL 6 to 9.
  - Component and supply chain development are elements of design finalization, that ensure manufacturability and constructability are factored into the final design

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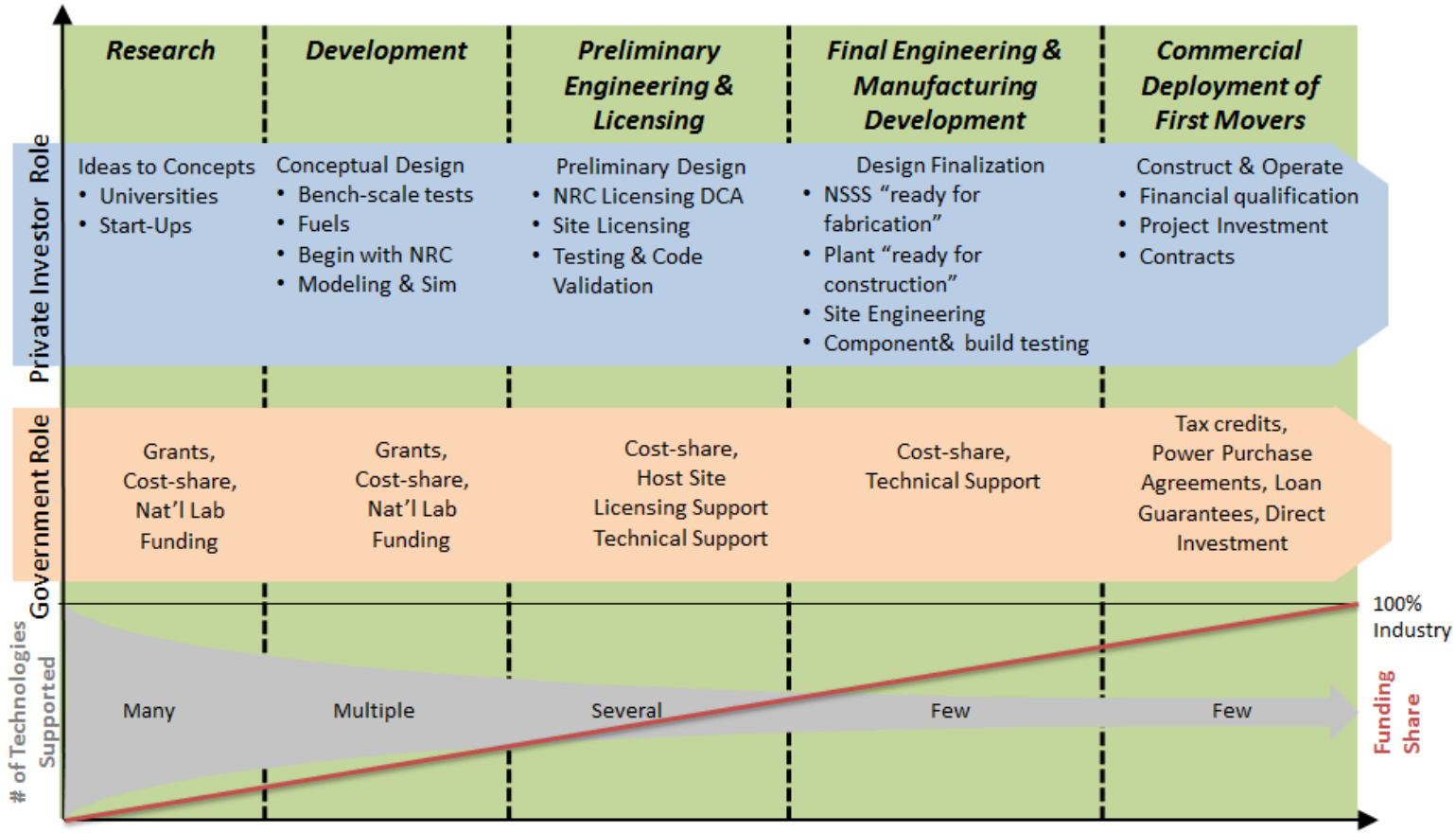
Conceptual Illustration of Public-Private Partnerships Roles and Investment Levels



Note: Does not include test or demonstration reactors, which may be necessary to support early phases for some technologies.

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DOE Technology Readiness Levels