Fast Follower Framework for New Nuclear Deployment

Executive Summary

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Revision Table

Revision	Description of Changes	Date Modified	Responsible Person

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Executive Summary

Since the launch of the 'Atoms for Peace' initiative, nuclear technology has significantly contributed to economic growth through commercial energy production. As global demand for clean and reliable energy increases, the interest in deploying new nuclear technologies, such as Small Modular Reactors (SMRs) and rapidly deployable reactors, has grown. These technologies are essential to meet international and national energy goals related to decarbonization, demand growth, and energy reliability and resiliency.

Historically, the global nuclear industry has achieved success with standardized designs for nuclear plants. In contrast, the U.S. has often modified designs for each new project, which, while improving over time, resulted in unique and varied designs. For widespread new nuclear deployment, it is crucial for the industry to demonstrate cost savings through a consistent learning curve, using similar designs and making changes only to meet site-specific requirements or where significant value is added.

The U.S. Department of Energy *Pathways to Commercial Liftoff: Advanced Nuclear Report* outlines potential cost reductions from First-of-a-Kind (FOAK) to Nth-of-a-kind (NOAK) projects.[1] This is based on the premise that repeating tasks can reduce errors and improve productivity, leading to cost reductions through decreased average time per unit. Other perspectives, such as the DOE Office of Scientific and Technical Information's report, acknowledge that while initial units are likely costly, subsequent units built in succession benefit from "learning effects."[2] The serial construction and manufacture of new nuclear technologies must lead to lower costs – if not, resources will be diverted to other technologies to meet national energy goals. Cost and construction duration savings will only be realized under certain conditions that result in a positive overall project learning rate.

To effectively capitalize on learning rates, a project's success depends on several factors. Various components of a project improve at different rates depending on factors (e.g., where the activity is performed, site conditions, level of standardization, people involved, etc.). These learning rates are unique and may or may not be different for each aspect of a project, or from one project to another. For instance, installation costs may decrease substantially, while commodity costs may be unchanged or even more costly as their prices are independent of learning improvements. Achieving Nth-of-a-Kind (NOAK) cost requires implementation of learnings. This requires a disciplined approach to systematically capturing and applying lessons learned to continually refine and enhance project efficiency as it should not be assumed that learning will occur automatically.

Fast Follower Framework

The "Fast Follower Framework" provides guidance to executive decision makers and management staff of nuclear power utilities, nuclear reactor vendors, nuclear plant operators, other vendors and suppliers to transition from FOAK to NOAK. This framework emphasizes a continuous learning culture and applies to various nuclear projects in different jurisdictions. In this framework, we are establishing a set of practices that provides a roadmap for organizations involved in multiple builds of the same technology (with minor site-specific driven changes) to drive learning rates and the benefits therefrom.

[1] Table 15: Categorizations for how nuclear costs could decrease from FOAK to NOAK deployments, DOE *Pathways to Commercial Liftoff: Advanced Nuclear*, p. 19.

[2] Bolisetti, Chandrakanth, Abou Jaoude, Abdalla, Hanna Bishara Hanna, Botros Naseif, Larsen, Levi Morin, Zhou, Jia, and Shirvan, Koroush. *Quantifying Capital Cost Reduction Pathways for Advanced Nuclear Reactors*. United States: N. p., 2024. Web. doi:10.2172/2361138.

The approach focuses on four key steps to successfully navigate follow-on nuclear builds:

1. Identify FOAK Elements: Every project is likely to have some FOAK elements. Projects need to determine which elements of a new project are FOAK, assess their position on the learning curve, and implement risk management strategies. Once identified, a risk assessment and mitigation plan for each element can be put in place to prevent mistakes and recover project performance.

2. Establish a Learning Organization: Successful owners of new nuclear projects will need to establish and maintain a learning organization to identify and act on significant improvements. This includes a set of practices to drive learning rates and benefits across projects.

3. Balance Speed and Risk: The timing between projects affects the learning curve. Too short a gap may not allow enough time for capturing improvements, while too long a gap can lead to loss of knowledge. An ideal time gap ensures labor proficiency and process adjustments.

4. Achieve NOAK Performance: Different project aspects will have varying learning rates. For instance, on a second of a kind fast follower project, installation costs may go down as much as 50% while turbine island equipment may only go down 20%.[3] NOAK is reached when project cost reductions become minimal and further reductions require innovation (design change).

Key Considerations for Fast-Follower Projects

1. **Programmatic Long-Term Vision:** Organizations with a long-term view and commitment to multiple projects have the greatest opportunity to benefit from learning effects. A programmatic approach allows for standardized procedures, bulk procurements, assignment of resources to continuous improvement and a culture of learning. Cooperative commercial agreements (e.g., Integrated Project Teams) facilitate knowledge sharing.

2. **Location Variability:** When a project is replicated in a different location (even with the same owner), new challenges related to site-specific regulations, environmental conditions, and local workforce skills can arise. This may slow down the learning curve and increase costs.

3. **Consistent Team:** Maintaining the same project team across multiple deployments enhances effectiveness by retaining institutional knowledge and experience. Changing team participants not only lose skills and experience, but also contract differences may complicate the learning process.

4. **Different Ownership:** Projects with different owners may experience different learning rates due to differences in organizational culture and practices. Sharing lessons learned across owners can collectively benefit the industry but has intellectual property challenges.

[3] DOE Pathway to Commercial Lift Off: Advanced Nuclear.

Strategic Implications

- **Multi-Unit Planning**: Planning for multiple units from the start allows prioritization of investment in learning from the first unit to inform all subsequent units. This minor higher upfront cost will reap cost and schedule benefits on all subsequent units and projects.

- **Knowledge Transfer Mechanisms**: Effective knowledge transfer is crucial for maintaining continuity when projects transition between teams, locations, or owners. Robust documentation, training, and communication are essential to maintain continuity and embed learnings.

- **Standardization and Modularization:** Standardized designs and modular approaches enhance learning rates and reduce variability, improving efficiency even across different teams or locations.

The framework in this report will help companies to optimize learning rates in new nuclear projects by involving a disciplined approach to capturing and implementing lessons learned. By focusing on consistent designs, maintaining project continuity, and effectively managing knowledge transfer, organizations can maximize the benefits of learning rates and achieve excellence in construction.