Deployment Pathways of Small Modular Reactors in Electric Power and Industrial Markets to Achieve Cost Reductions and Widespread Use

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ABSTRACT:
Declining wholesale prices, increasing wind and solar penetrations, and rapid diffusion of competing technologies are undermining nuclear generator's reliance on power market revenues. To succeed given shifting market conditions, small modular reactors (SMRs) can leverage two of their key value propositions: (1) participation in small and large power and industrial markets and (2) cost reductions via mass fabrication. This proposal will explore how to leverage these two value propositions to achieve widespread SMR deployment. We will accomplish 3 objectives.

> **Objective 1:** Advance electric power system modeling to quantify current and future SMR revenue streams from and value to power systems.
> > *Research Gaps:* Deterministic power system models poorly forecast prices and SMR revenues
> > *Major Tasks:* Develop stochastic operational and capacity expansion models; include SMRs within those models; forecast future prices and SMR value to the grid
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> **Objective 2:** Optimize SMR design and operations with thermal storage to maximize revenues from power and industrial markets.
> > *Research Gaps:* Market analyses cover few locations and neglect thermal storage
> > *Major Tasks:* Develop optimal design and operation model for SMR coupled with thermal storage; generate SMR net revenue curves that capture spatial and temporal heterogeneity
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> **Objective 3:** Couple heterogeneity in SMR revenues with SMR cost reductions from deployment to generate SMR deployment pathways.
> > *Research Gaps:* Market analyses ignore feedbacks between deployment and cost reductions
> > *Major Tasks:* Gather potential SMR learning curves from literature; couple SMR net revenues with learning curves to create SMR deployment pathway model

This proposal will generate new methods, datasets, results, and insights actionable by developers, policymakers, and other SMR stakeholders. We will publish methodological improvements for quantifying the value and net revenues of SMRs in power and/or industry markets, augmenting future research. By applying these improved methods to three U.S. regions, we will estimate near- and long-term SMR market potential across the largest geographic area to date. We will also determine the value of thermal storage in unlocking industry markets for SMR participation, which could be a key component for future SMR economic viability. To capture positive feedbacks between capital cost reductions and deployment, we will publish SMR deployment pathways across space and time, which will help developers and policymakers target regions and industries for near- to mid-term deployment. Our deliverables include a publicly accessible dataset of hourly electricity prices for complementary SMR market analyses, documentation of developed models, publications on our methodological improvements and results, and presentations at the American Nuclear Society and other conferences.