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# Small modular reactor deployment: Learning from the past and the present

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ABSTRACT

The success of SMR technology will depend on the initial projects' ability to demonstrate economical construction without falling victim to the large cost overruns of nuclear projects both past and present. The remarkable tool and process evolution of recent years suggests a very favorable outlook for building SMRs on time and within budget. However, challenges remain, as evidenced by difficulties with current nuclear construction projects.



## 1. Introduction

Global net generation from nuclear power is projected to increase by 91% between 2012 and 2040. However U.S. nuclear generation is expected to increase by only 8%.

Nuclear power emits no greenhouse gas or other atmospheric pollutants.

The U.S. once led the world in nuclear power generation. However, new nuclear facility deployment in the U.S. has stalled. Seven operating nuclear plants are scheduled to close by 2025, due primarily to market rules. The plants that are closing represent over 32 million metric tons of carbon emission increases per year (the equivalent of 6.9 million cars in the U.S.).

Despite all their benefits, solar and wind generation can't be expected to supply the growing demand for electricity without other sources such as nuclear. Some herald Small Modular Reactor (SMR) technology as an attractive driver for deploying safer, cost-effective and financeable nuclear plants in the U.S. and abroad. The success of SMR commercialization and deployment will be significantly measured by the early deployments. Consider, however, that new nuclear build projects have a reputation for extended schedules and overrun budgets.

This paper will assess the outlook and challenges facing (SMR) deployment. It will draw from historic and recent research; and near fifty years of personal first-hand involvement with the nuclear power industry, including current experience with state-of-the-art best practices.

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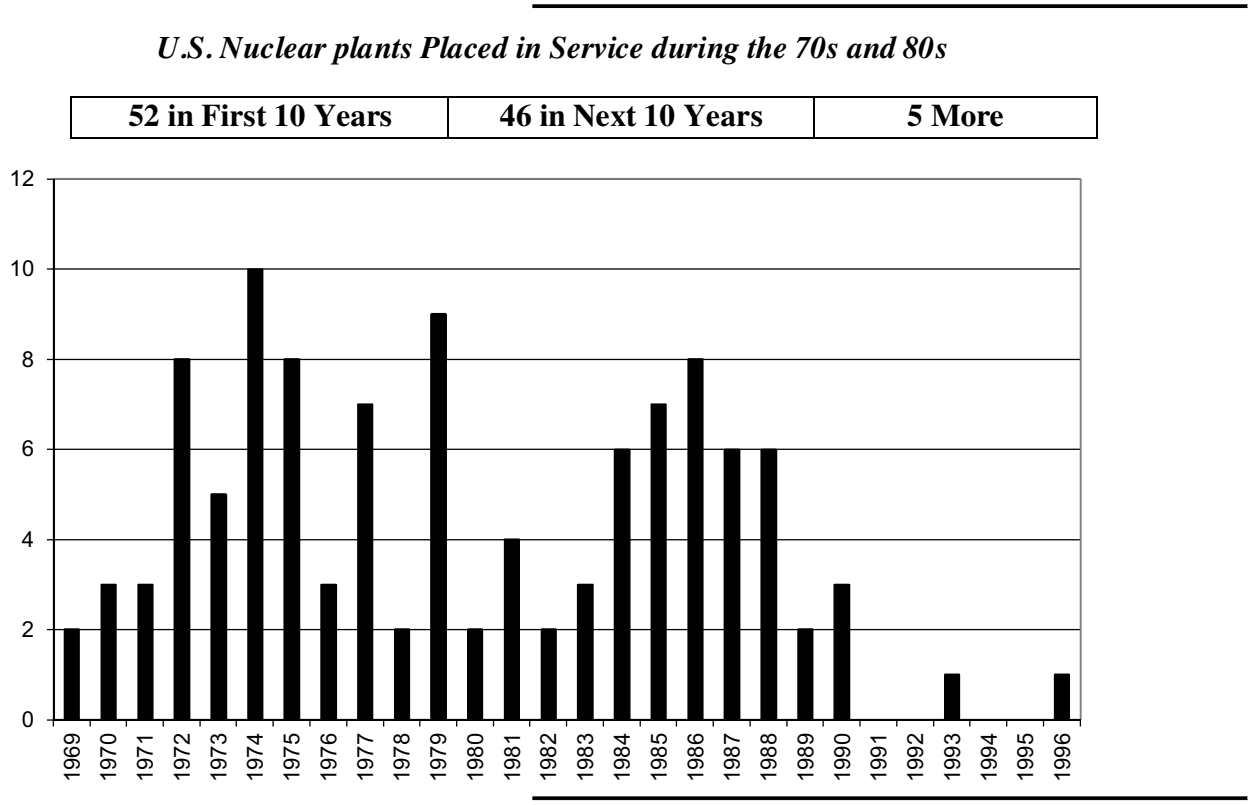
## 2. Background




The last domestic nuclear build period spanned 25 years. During that period, over 100 units were placed in commercial operation. **Fifty-two were put online in the first 10 years.** Consider a point in the late 60s and compare it to our present situation. In the 60s, we essentially started with nothing! Only a cloudy blank sheet of paper, some early prototypes, and some ideas! Here's a look back at the situation during early stages of the U.S. commercial nuclear power industry:

1. No nuclear component manufacturing infrastructure.
2. No prior commercial nuclear experience.
3. No proven commercial design (experimental and naval reactors, yes; but nothing of the commercial scale and design.). Without prior proven designs, numerous problems or concerns raised at one plant required evaluation and changes on others in a cascading manner.
4. Drawings were pencil on mylar and were manually reproduced in wet-solution reprographic machines.
5. Codes, Standards and regulatory mandates were new and evolving. Changes impacted efforts to design and build within budget and schedule.
6. Document review was conducted by manually developing notes or annotating on hard copies.
7. Composite drawing and physical models were manually prepared to detect interferences in the design layout.
8. An industry that was familiar with building fossil steam plants, but not the complex nuclear plants with the rigorous and newly developed (developing) quality standards.
9. A well-intended two phase licensing process that prompted numerous design changes.
10. During this period the U.S. experienced double digit inflation, double digit interest rates and three economic recessions!!!
11. Word processing was by typewriters with correction tape and white-out.
12. Schedules were hand-drawn logic sheets with main frame data reports that did not logically reflect reality in the field.
13. Engineers relied on slide rules.
14. Computerized engineering tools were just coming into use, requiring manually-punched key card decks and main frame computers. Programs had to be queued in the mainframe schedule and took time before output was available. Often programs had to be re-run as input errors were detected and corrected.
15. Project management processes were limited and project leadership was often substandard.
16. A proclamation that nuclear power offered electricity "too cheap to meter" and a population expecting that result.

Notwithstanding the above challenges, these very complex plants actually worked. They worked well and continue to work very well, despite the challenges and rigorous demands for operational excellence. Many people did their jobs and they did them well!

Today's design, construction and project management tools and processes are much more advanced than in the last nuclear build period.

1. The industry has years of experience successfully operating and maintaining nuclear plants. This has contributed significant Operating Experience to inform new designs and theoretically reduce design changes as new issues are reduced.