Revitalizing America's Nuclear Future: Lessons Learned in History and Steps Forward

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About the Author

Joshua A. Tolbert, Ph.D., P.E., is a seasoned engineer with four engineering degrees, including a doctorate in mechanical engineering. He has extensive experience in power generation, including coal, natural gas, biomass, and nuclear, as well as leadership roles such as CTO and VP of Engineering for a commercial developer of small-scale nuclear power plants. Dr. Tolbert has worked with nuclear regulators domestically and internationally, including the UK ONR, Poland's PAA, Argentina's ARN, Romania's CNCAN, and Turkey's NDK.

In the private sector, Dr. Tolbert has identified the major obstacles to nuclear power development, including regulatory, technical, and economic challenges. He has a deep commitment to participating in the revitalization of the nuclear industry by implementing practical solutions to these obstacles.

His technical expertise includes the full design of a small-scale pressurized water reactor (PWR), encompassing the primary loop, secondary loop, and auxiliary systems, all utilizing advanced modularization techniques to enhance constructability and reduce costs. This hands-on experience positions Dr. Tolbert to offer unique insights into the challenges and opportunities facing the nuclear industry today.

Introduction

America once led the world in nuclear technology — not only in innovation, but in construction, operation, and fleet performance. The early decades of the U.S. nuclear program demonstrated what is possible when engineering excellence, regulatory clarity, and national purpose align. Yet for more than forty years, nuclear development in the United States has stalled. New plants are rare, construction timelines unpredictable, and costs persistently high. The U.S. went from global leader to global cautionary tale.

While political, regulatory, and economic explanations abound, the core drivers of decline are not mysteries. They are well-understood structural failings: loss of standardization, regulatory drift, erosion of the supply chain, and a strategic retreat from the practical engineering principles that once made nuclear buildable.

This paper examines the real roots of America's nuclear stagnation and lays out a pragmatic path to restore nuclear power as a cornerstone of U.S. energy policy. Revitalizing nuclear power is not a matter of inventing new reactor types or waiting for technological miracles — it is a matter of applying lessons we have already learned and rebuilding the institutional, regulatory, and engineering foundations that once enabled rapid, cost-effective deployment.

A Look Back: How the U.S. Once Built Nuclear Plants Quickly and Economically

The extraordinary performance of the early U.S. nuclear buildout is often forgotten. Between the late 1950s and the mid-1970s, utilities constructed dozens of commercial reactors with impressive speed, cost discipline, and engineering rigor. Designs were smaller, simpler, and standardized enough to allow utilities, vendors, and regulators to build expertise through repetition.

These plants — the early pressurized water reactors and boiling water reactors — were not stripped-down or reckless. They were robust, well-understood machines built using the same industrial supply chains that supported fossil power and large-scale manufacturing. Containment structures were conservative. Safety systems were straightforward. And importantly, design variation was limited.

The result was an ecosystem where:

1. utilities could plan construction with confidence,
2. vendors could build predictable manufacturing pipelines,

3. and the AEC could license reactors through an orderly, consistent process.

These conditions created a virtuous cycle: the more plants were built, the more efficient the industry became. The U.S. achieved overnight costs equivalent to $1–$2 million per megawatt in today's dollars — a level that now seems almost unthinkable.

This success was not an accident. It was the product of design discipline and an integrated industrial approach that today's nuclear sector must rediscover.

Where the Industry Lost Its Way

The decline of U.S. nuclear development was not caused by one event. It was the result of compounding structural shifts.

Loss of Standardization

As utilities moved away from proven designs and pursued larger, more complex reactors, the industry sacrificed repeatability. Each plant became a bespoke engineering effort, eliminating the efficiencies of scale that once underpinned success.

Regulatory Fragmentation

When the Atomic Energy Commission was dissolved and its regulatory functions transferred to the NRC, the industry lost a critical balancing mechanism. Without a mandate to consider deployability or economic impact, regulation increasingly focused on idealized safety targets divorced from construction or operational realities.

Supply Chain Contraction

As nuclear-specific requirements expanded, many suppliers exited the space entirely. Components that were once commodity industrial items now required boutique qualification, dramatically reducing the number of available vendors and driving up cost and lead times.

Escalating Project Complexity

Projects began incorporating new design features, new safety philosophies, and new analytical tools in the middle of construction. The result was rework, redesign, and delay — outcomes magnified by large reactor scale and tight regulatory coupling.

By the time the Three Mile Island accident occurred, the industry was already weakened. The event did not cause the decline — it solidified it.

The Core Lesson: Buildability Matters More Than Novelty

For decades, the nuclear sector has been driven by the pursuit of "advanced reactors" — systems that promise superior economics, reduced waste, or novel operational advantages. But none of these innovations can compensate for the fundamental problem that defines U.S. nuclear development today: we cannot build reactors on time and on budget.

This is not a technical limitation. It is a structural and institutional one.

Restoring nuclear power requires a return to the principles that made early deployments successful:

1. Start with proven technology.
2. Standardize and iterate.
3. Use risk-informed regulation.
4. Leverage the existing industrial supply chain.
5. Anchor safety in robust containment.

New reactors are valuable. But without a framework that enables buildability, they will remain experiments on paper rather than assets in service.

A Path Forward: Rebuilding the Foundations of Nuclear Deployment

The revitalization of nuclear power begins not with a new reactor design, but with a new deployment philosophy — one that looks much more like the early era of nuclear success and far less like the one-off megaprojects of the last forty years.

Re-embrace Proven Reactor Architectures

Modernized versions of early PWRs and BWRs provide a technically mature platform on which to rebuild. These reactors have decades of operational data, well-characterized failure modes, and deep supply chain familiarity. Innovation should enhance — not replace — this foundation.

Standardize a Fleet Model

The U.S. must adopt the strategy that enabled South Korea and France to deploy large fleets: repeat the same design. Standardization turns each project into a derivative of the last, reducing engineering hours, construction risk, and regulatory uncertainty.

Restore the Role of Containment

A strong containment structure reduces dependence on extreme CDF targets and simplifies PRA. It allows plant designers to avoid unnecessary component qualification and keeps plant architecture grounded in practical engineering rather than idealized prevention.

Reintegrate Nuclear With the Industrial Supply Chain

Industrial-grade components — qualified through risk-informed classification — should be used wherever appropriate. Section III should be applied where safety significance is high, not as a default for the entire plant.

Align Regulation With Real-World Risk

Part 53 offers a promising foundation for performance-based, technology-inclusive licensing. It must be implemented pragmatically, with early demonstration through concrete projects (such as a generic plant design reference).

Why This Approach Works

This path forward is not theoretical — it is historically validated. The nations that deploy nuclear power successfully today use standardized designs, proven technology, and supply-chain-driven construction models. They deploy reactors not as isolated megaprojects, but as products.

By returning to these fundamentals, the U.S. can:

1. sharply reduce capital cost
2. stabilize construction timelines
3. expand the supply chain
4. simplify licensing
5. restore investor confidence
6. and create a platform for long-term innovation in fuels, materials, and reactor types

The result is not just a revival of nuclear power, but a restoration of America's capacity to build.

Conclusion

Revitalizing nuclear power in the United States is not a matter of discovering new physics or inventing radical technologies. It is a matter of rediscovering the engineering discipline,

regulatory alignment, and strategic focus that once enabled the country to build an entire fleet of reactors in a single generation.

America can lead again — but only if it rebuilds nuclear power on a foundation that values practicality over perfection, standardization over reinvention, and proven engineering over speculative promise. The path forward is clear, grounded in history, and immediately actionable.

The United States does not need to wait for the future of nuclear energy.
It needs to decide to build it.