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"Nuclear Powered Artificial Intelligence (AI): Small Modular Reactors as an Emerging Power Source for AI Data Centers"

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Andrew P. Stevens

MEDIA CONTACT

Wendy M. Byrne
wbyrne@shumaker.com

AI is advancing at extraordinary speed due to development of large language models relying on complex, GPU-powered compute clusters. The rapid advance of AI is creating unprecedented electricity demand, with projections showing data center energy consumption doubling by 2028.[1] This strain on an already fragile electric grid is leading technology companies to explore a once-unlikely solution: powering AI data centers with small modular nuclear reactors (SMRs).

The Emerging AI Power Crisis

Modern AI infrastructure consumes extraordinary amounts of power, with full AI campuses increasingly demanding 100 MW to over 500 MW of power.[2] For perspective, a 100-MW data-center load is comparable to the electricity consumption of a small city, while a 500-MW campus can rival the power demand of a large industrial complex or a metropolitan district.[3]

Electric utilities in states like Virginia, Oregon, and Texas are already warning that the surge in large AI data-center loads is beginning to outpace planned generation and transmission capacity, creating stress points in regions that have historically been able to absorb steady cloud-computing growth. In Northern Virginia, utilities have cautioned that existing substations and high-voltage lines are approaching their limits, forcing delays or reconfiguration of major AI projects.[4] Similar concerns are emerging in Oregon's data-center corridor and across rapidly growing Texas markets, where utilities are grappling with how to integrate multi-hundred-MW AI campuses into grids not designed for such dense, continuous demand.[5] Compounding the

issue, interconnection queues in many regions now stretch five to 10 years, meaning that even when utilities are willing to build new capacity, hyperscalers cannot count on timely access to reliable transmission infrastructure.[6]

This supply-demand imbalance has revived interest in on-site, carbon-free energy sources.

What Are SMRs?

SMRs are a new generation of nuclear reactors designed to be smaller, safer, and more flexible than traditional nuclear plants. Unlike the massive gigawatt-scale reactors that require large facilities, SMRs are typically 5–300 MW in size and are engineered to be quickly manufactured in factories and transported to their final location.[7] Once delivered, they are installed on site, often on a much smaller footprint than conventional reactors, and are connected to the grid or directly to an industrial facility, such as a data center.[8] SMRs also incorporate advanced safety features, such as passive cooling systems, that operate without external power or human intervention, reducing both operational complexity and risk.[9]

Because of their size and design, SMRs offer several advantages over both traditional energy sources and large-scale nuclear plants. Compared with natural gas, SMRs do not depend on volatile fuel markets, and unlike wind and solar, they produce around-the-clock, carbon-free power that is not affected by weather or time of day. SMRs also require significantly less land and infrastructure than large nuclear facilities and can be installed in a wider range of locations, including remote or grid-constrained areas. Their modular construction allows developers to add capacity incrementally, deploying a single unit initially and expanding to multiple units as energy demand grows.

These characteristics make SMRs a strong potential match for the energy demands of AI data centers. On-site SMRs may allow operators to bypass long grid interconnection queues and secure a dedicated, non-stop power supply to meet the continuous, high-density electricity demand of AI workloads. And because SMRs can be deployed in modular increments, they can scale alongside AI campuses as compute demand increases. Together, these attributes allow SMRs to directly address the reliability, safety, scalability, and proximity challenges facing today's AI data centers.

Why Technology Companies Are Exploring Nuclear

Major technology companies are already exploring nuclear power to sustain AI growth. Microsoft has publicly advertised for a global SMR strategist, and Amazon Web Services has entered into agreements to explore nuclear-powered cloud campuses.[10] Beyond these early movers, industry analysts report that more than 40 GW of SMR capacity is already being positioned globally for industrial users, including hyperscalers and large digital-infrastructure operators.[11] These moves signal a broader industry trend toward evaluating nuclear energy as one of the technologies capable of meeting the uninterrupted, high-density electricity demands of large-scale AI.

Regulatory and Legal Considerations

Companies exploring SMRs must navigate a rigorous regulatory framework. The Nuclear Regulatory Commission (NRC) maintains comprehensive authority over reactor licensing, construction, and operation, and approval depends on navigating detailed requirements impacting timeline, cost, and project structure.[12] While the NRC is working to modernize its approach, significant challenges remain. These include the agency's limited historical experience regulating next-generation reactor designs, high application and review fees, and questions surrounding how factory-built modules will be certified and monitored once deployed.[13]

Beyond federal licensing, companies must prepare for a multi-layered environmental and siting review process. SMR projects trigger obligations under the National Environmental Policy Act, along with state-level nuclear-siting requirements, water-use assessments, and analyses of ecological impacts.[14] Nuclear projects also involve a unique liability regime under the Price-Anderson Act, which establishes industry-wide indemnification but requires careful allocation of responsibilities for operations, emergency planning, waste handling, and eventual decommissioning.[15] Finally, companies must be aware of supply-chain constraints, particularly the limited availability of fuel for certain advanced SMR designs, which may affect procurement and long-term planning.[16]

Organizations evaluating SMR-powered AI data centers should begin by conducting early feasibility studies that examine siting options, licensing pathways, potential interconnection alternatives, and environmental review obligations. Second, they should engage with reactor developers and utilities to understand technology readiness levels, fuel requirements, and realistic deployment timelines. Third, companies should map out risk allocation from the outset, identifying who will assume responsibility for licensing, operations, emergency planning, waste management, and decommissioning. Given the complexity and novelty of these issues, companies should seek experienced legal guidance to support them in this process. Engaging knowledgeable counsel at the outset can help organizations avoid costly delays, navigate evolving regulatory requirements, and make informed decisions about integrating nuclear energy into their AI development roadmaps.

Conclusion

AI is transforming global industry and, in doing so, is also transforming global energy demand. As data-center loads soar, companies are looking beyond traditional grid solutions. While significant challenges remain, SMRs represent a potential option for delivering the reliability and scalability that AI infrastructure requires. For enterprises considering their long-term energy strategy, understanding the opportunities and complexities of SMRs is a critical step in preparing for the next decade of AI growth.

If you would like more information on navigating the regulatory, technical, and strategic considerations of SMR-powered AI infrastructure, please contact Andrew Stevens.

Whether you are evaluating next-generation energy solutions, assessing feasibility for nuclear-supported data-center operations, or planning long-term AI growth, Shumaker's Technology, Data Privacy, Cybersecurity & AI Service Line provides forward-thinking, practical guidance to position your organization for the future of high-density compute.

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[3] *Id.*

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[12] https://nuclearinnovationalliance.org/sites/default/files/2024-10/Nuclear%20Reactor%20Licensing%20101_0.pdf

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