THINK BIG WE DO℠

Mechanical Engineering Capstone Design

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Where ingenuity and invention converge

Team 01- Coal to Nuclear

Members: Owen Horiagon, James Russell, Thomas Scorpio, Nathan Segar
Advisors: Dr. Bahram Nassersharif, Mr. James L. Little

Abstract and Introduction

This project focuses on repurposing the retired Brayton Point coal plant into a next-generation clean energy facility by integrating a small modular reactor (SMR) to power a 250 MW AI data center. The purpose is to demonstrate a sustainable and technically sound solution that addresses both the rising demand for computational power and the need to decarbonize legacy infrastructure. Our objectives include designing and validating the NuScale SMR process, ensuring reliable integration with existing site assets, maintaining strict safety and licensing standards, and achieving zero net carbon emissions. The scope of work encompasses the complete system design, site retrofit planning, power distribution analysis, and evaluation of the data center's operational demands, paving the way for a scalable and job-generating energy transition model ine of this project is a proven design process of integrating a SMR based nuclear power plant into a retired coal site to power the grid and a AI data center.

Project Requirements and Demands

Or main requirement for our project was to produce 308 Mw of electricity using six Nuscale reactors. This electricity would be supplied to an AI data center. Our design would have to accommodate load swings of up 10%. Grid integration would be an essential requirement for our project. This would allow us to supply electricity to the AI data center and supply the surrounding area with any excess power produced.

Conclusion and Future Work

Our integrated SMR module design will provide a combined total of 308 MW to a data center and the grid. We have designed for excess capacity and sequential refueling/shutdown to ensure the data center is always being supplied with power. Safety of reactor design is verified by NRC licensing.t.Based our site analysis, engineering calculations, and information gathered and analysis completed on Nuscale SMR technology and data center schematics, a retired coal plant can be converted to a SMR based nuclear plant that supplies energy to both a 250 MW data center and the grid. **Next Steps and Further Work**: Project development, state licensing, acquiring data center customer, and a market and construction risk assessment.

Contact Information

Owen Horiagon: owen_horiagon@uri.edu; 401-4874078
James Russell: james_russell@uri.edu; 401-484-2088
Thomas Scorpio: thomas_scorpio@uri.edu; 401-575-0637
Nathan Segar: nathan_segar@uri.edu; 860-936-1026

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NuScale SMR Power Module

The NuScale Power Module is a small modular reactor developed by NuScale Power to provide scalable, carbon-free nuclear energy. Each module is a fully factory-fabricated pressurized water reactor. Designed with enhanced safety features, the NPM uses passive cooling systems that operate without the need for external power or human intervention, significantly reducing the risk of accidents. Its modular design allows for flexible deployment and scalability, making it ideal for a range of applications from remote locations to industrial and data center support.

Containment

The NuScale Power Module features a robust and safety-focused containment design. It is constructed below grade and housed within a stainless steel-lined pool, enhancing both structural integrity and radiation shielding. Classified as Seismic Category 1, the containment is built to withstand significant natural events. Its compact footprint allows for flexible site placement, while the incorporation of passive safety systems and multi-layer containment ensures protection without the need for active intervention. Each module operates independently, allowing for modular deployment and enhanced operational resilience.

AI Data Center Schematics

The Brayton Point SMR-powered AI data center in Fall River, Massachusetts, will deliver 200-300 MWe to meet the demands of a high-performance facility, utilizing NVIDIA GB200 GPUs (20 petaflops, 141 GB HBM3e) and AMD EPYC 9005 CPUs (192 Zen 5 cores), with a CPU:GPU ratio of 1:8, consuming 130-160 MWe. Cooling systems, including circulated water (50-100 kW, PUE 1.1-1.2), immersion (100-500 kW, PUE 1.03-1.1), and hybrid methods (50-200 kW, PUE 1.1-1.3), manage thermal loads. Power infrastructure, supported by a VOYGR 12-pack SMR, provides ~308 MWe with high-amp distribution (>2500A), 54V DC grids, and ~10 MWe UPS. Networking leverages NVIDIA's InfiniBand (800 Gb/s) with 100-200 Tb/s bandwidth, while storage uses NVMe SSDs (100 TB/drive, 1 petabyte/rack) and Ceph clusters for 10-20 MWe capacity, supporting 10-1 zettabytes. The 1,000,000 sq ft facility, built on a 50-100-acre brownfield site, features pod-based modularity (20 MW, 100 racks/pod), creating over 5,000 jobs (engineers, technicians) and 2,000 temporary roles, revitalizing the blue-collar community.

Market Analysis

The NuScale SMR project at Brayton Point targets the $1T+ AI data center market by 2030, delivering 300-308 MW of clean, 24/7 power for 200-300 MW data center needs. Using 6 US460 reactors, the $3-4B project leverages Brayton Point's grid and cooling, funded by private capital, DOE loans, and IRA incentives. It aligns with Massachusetts' net-zero 2050 goals, offering >90% reliability, 300-400 construction jobs, and $10M+ annual tax revenue. Compared to retrofitting coal plants ($4B+), it avoids trillions in decarbonization costs, focusing on future emissions reduction (~1M tons CO_2/year displaced). Hyperscalers like Microsoft drive demand, while NuScale's NRC-approved design ensures scalability. Risks include high costs and regulatory delays, but incentives and demand mitigate these. The project outshines fossil fuel alternatives, positioning Brayton Point as a leader in clean energy for AI growth.

Political Analysis

The Brayton Point coal-to-nuclear SMR project engages diverse stakeholders, including federal, state, and local governments, regulatory agencies, local residents, environmental and activist groups, NuScale, National Grid, plant operators, construction firms, technology companies, data center operators, and financial backers. Support comes from local, state, and federal governments and pro-nuclear residents, driven by the project's promise of economic growth, revitalization, and job creation (300-400 construction, 100-200 permanent). It offers cleaner, reliable energy, displacing ~1M tons of CO_2 annually, while fostering greater investment and enhanced training and education opportunities for residents, aligning with Massachusetts' net-zero 2050 goals.