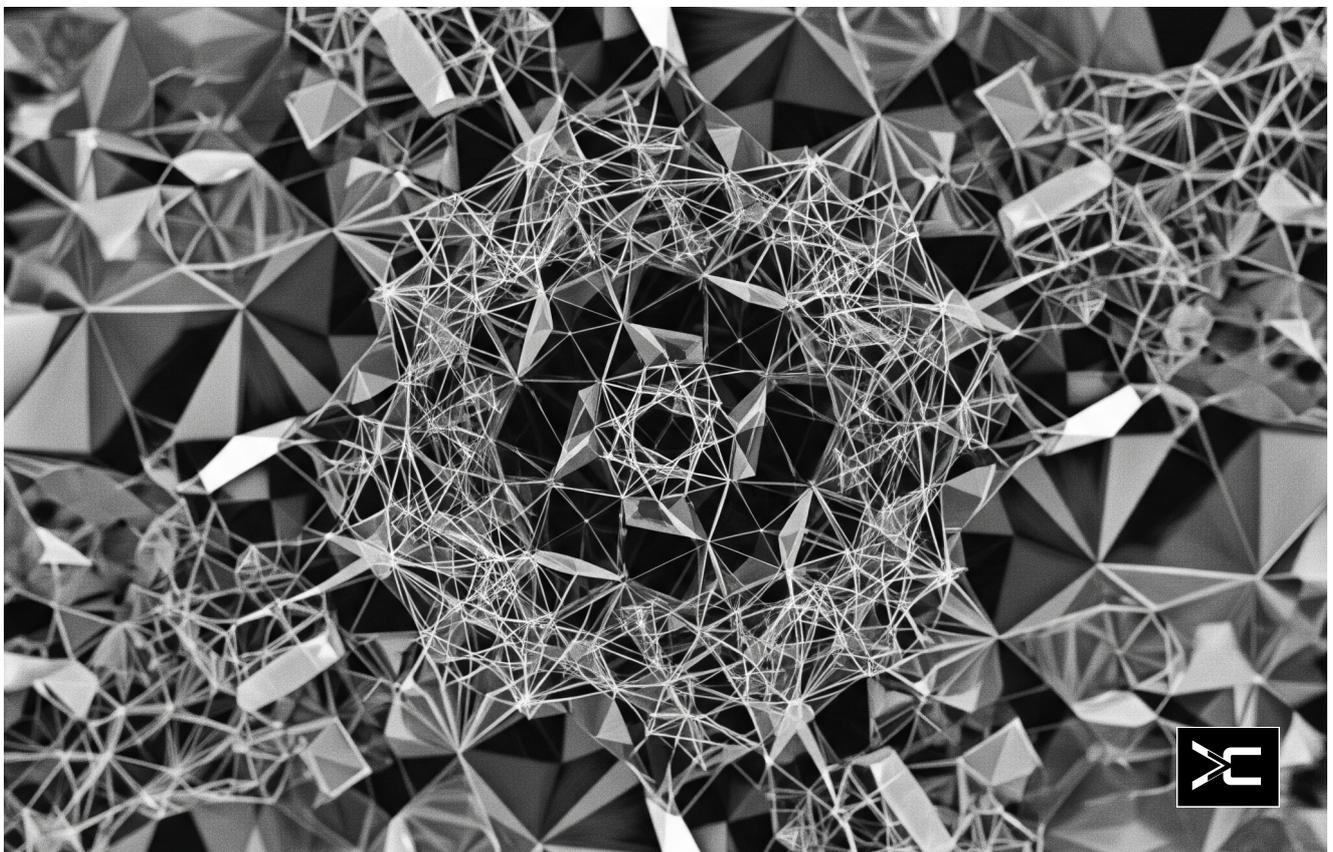


DEPLOYMENT OF A 300 MWE PWR SMALL NUCLEAR MODULAR REACTOR (SNMR) IN DHOLERA, GUJARAT



Project Information Modelling & Infrastructure Optimisation (PIMIOS)

Date: 16 July 2025

1. Executive Summary

This proposal outlines the strategic deployment of a 300 MWe Pressurized Water Reactor (PWR) Small Nuclear Modular Reactor (SNMR) in the Dholera Special Investment Region (DSIR), Gujarat. In the context of India's rapid economic growth and commitment to energy transition, SNMR technology offers a clean, reliable, and scalable solution to meet the futuristic energy demands of DSIR. The project will leverage Project Information Modelling & Infrastructure Optimisation (PIMIOS) to ensure efficient planning, execution, and long-term operational excellence, contributing significantly to Dholera's vision as a sustainable and smart industrial hub.

2. Introduction: Energy Transition and India's Growth Trajectory

The global energy landscape is undergoing a profound transformation driven by climate change concerns, energy security imperatives, and technological advancements. India, as a rapidly developing economy, faces the dual challenge of meeting escalating energy demand while simultaneously decarbonizing its energy mix. The nation's ambitious targets for renewable energy integration are commendable, but the intermittent nature of renewables necessitates a stable, baseload power source to ensure grid reliability.

Nuclear energy, particularly advanced SNMR technology, presents a compelling solution. SNMRs offer inherent safety features, reduced construction times, lower capital costs per unit, and enhanced flexibility compared to conventional large-scale reactors. Their modular design allows for phased deployment, aligning well with the incremental growth patterns of emerging industrial regions.

Dholera Special Investment Region (DSIR) is envisioned as a global manufacturing and trading hub, characterized by smart infrastructure, sustainable development, and high-tech industries. Realizing this vision requires a robust, secure, and environmentally responsible energy supply.

3. Project Overview: 300 MWe PWR SNMR in Dholera

3.1. SNMR Technology: 300 MWe Pressurized Water Reactor (PWR)

The proposed project centers on a 300 MWe PWR-based SNMR. PWRs are a mature and globally proven reactor technology, representing the majority of operational nuclear power plants worldwide. The SNMR variant miniaturizes this technology, offering:

Compact Footprint: Requires significantly less land area compared to conventional large reactors.

Enhanced Safety: Incorporates passive safety systems that rely on natural forces (gravity, convection) for cooling in accident scenarios, reducing reliance on active components and human intervention.

Modular Construction: Components can be fabricated off-site and transported for assembly, leading to faster construction schedules, improved quality control, and reduced on-site labor requirements.

Load Following Capability: Modern SNMR designs are being developed with greater flexibility to integrate with variable renewable energy sources, providing grid stability.

Reduced Capital Investment: Lower upfront costs per unit, making financing more manageable.

A 300 MWe capacity is well-suited to the initial and evolving energy needs of a developing industrial region like DSIR, allowing for scalable expansion as demand grows.

3.2. Location Rationale: Dholera Special Investment Region (DSIR), Gujarat

Dholera, strategically located in Gujarat, has been identified as an ideal site for this SNMR deployment due to several factors:

Planned Industrial Hub: DSIR is a greenfield industrial city with significant planned infrastructure development and projected high energy demand from manufacturing, commercial, and residential sectors.

Economic Growth Corridor: Situated within the Delhi-Mumbai Industrial Corridor (DMIC), Dholera is poised for substantial economic and industrial growth.

Infrastructure Availability: The region is being developed with modern infrastructure, including transportation networks, water supply, and land availability suitable for a nuclear facility.

State Support: Gujarat has a progressive industrial policy and a track record of supporting large-scale infrastructure projects.

Coastal Proximity: Access to a large body of water (Gulf of Khambhat) is crucial for cooling purposes, a key requirement for PWRs.

Energy Security: Diversifying Dholera's energy portfolio with a baseload nuclear source enhances energy security and resilience against price volatility of fossil fuels.

3.3. PIMIOS Integration: Project Information Modelling & Infrastructure Optimisation

The successful execution of a project of this scale necessitates advanced project management and digital tools. PIMIOS will be integrated across the entire project lifecycle:

Design & Engineering:

3D Modelling & Simulation: Create a comprehensive digital twin of the SNMR plant and its surrounding infrastructure, enabling detailed design review, clash detection, and optimization before physical construction.

Performance Simulation: Model reactor performance, thermal hydraulics, and safety systems to validate design parameters and predict operational behavior.

Construction & Assembly:

Modular Assembly Planning: Optimize the sequence and logistics of module fabrication, transport, and on-site assembly, minimizing delays and costs.

Progress Tracking: Real-time monitoring of construction progress against the digital model, identifying potential bottlenecks early.

Supply Chain Management: Integrate supply chain data into the PIMIOS platform for efficient procurement and delivery of components.

Operations & Maintenance (O&M):

Digital Twin for O&M: The digital twin will serve as a living model for the operational plant, facilitating predictive maintenance, asset management, and training.

Remote Monitoring & Diagnostics: Enable remote monitoring of plant parameters and performance, allowing for proactive intervention and optimized maintenance schedules.

Decommissioning Planning: Incorporate decommissioning strategies into the PIMIOS model from the outset, streamlining future processes.

Infrastructure Optimisation:

Site Layout Optimisation: Optimize the placement of the SNMR within the DSIR master plan, considering connectivity, safety zones, and future expansion.

Integration with DSIR Utilities: Model the seamless integration of the SNMR with Dholera's smart grid, water supply, and waste management systems.

Environmental Impact Assessment (EIA): Use PIMIOS to model and analyze environmental impacts, supporting robust mitigation strategies.

PIMIOS will ensure data-driven decision-making, enhance collaboration among stakeholders, reduce risks, and improve overall project efficiency and cost-effectiveness.

4. Energy Transition Analysis: India's Path to Decarbonization

India's energy transition is characterized by a rapid expansion of renewable energy capacity (solar, wind) alongside a continued reliance on fossil fuels for baseload power. While renewables are crucial for decarbonization, their intermittency poses challenges for grid stability and reliability.

- **The Need for Baseload Power:** Nuclear power provides a non-intermittent, high-capacity factor baseload electricity source that can complement renewables effectively. It operates 24/7, ensuring a stable supply regardless of weather conditions.
- **Carbon Emission Reduction:** Nuclear power plants produce virtually no greenhouse gas emissions during operation, making them a vital tool in achieving India's climate commitments and Net Zero targets.
- **Energy Security and Diversification:** Reducing dependence on imported fossil fuels enhances India's energy security and insulates the economy from global energy price fluctuations. Nuclear energy contributes to a diversified energy mix, reducing reliance on any single source.
- **Technological Advancement:** Investing in SNMR technology positions India at the forefront of advanced nuclear innovation, fostering domestic capabilities and creating high-skill jobs.

The SNMR in Dholera will serve as a cornerstone for a balanced and sustainable energy portfolio, supporting the transition away from fossil fuels while ensuring energy reliability for industrial growth.

5. Futuristic Needs of Dholera Special Investment Region (DSIR)

DSIR is being developed as a smart, sustainable, and globally competitive industrial city. Its futuristic needs demand an energy solution that is:

- **High Energy Demand:** As a manufacturing and industrial hub, DSIR will have a consistently high demand for electricity to power factories, data centers, commercial establishments, and residential areas. A 300 MWe SNMR provides a substantial and reliable power source.
- **Reliability and Stability:** Critical industries require an uninterrupted power supply. Nuclear power's baseload nature ensures grid stability, preventing blackouts and brownouts that could disrupt economic activity.
- **Sustainability and Green Footprint:** Dholera's vision emphasizes environmental sustainability. The SNMR, being a zero-emission power source during operation, aligns perfectly with this goal, contributing to a cleaner industrial ecosystem.
- **Water Security (Potential for Desalination):** PWRs produce significant amounts of waste heat. This heat can be harnessed for co-generation applications, including large-scale desalination of seawater. Given Gujarat's coastal location and potential water stress in the future, integrating a desalination plant with the SNMR could address Dholera's long-term water needs, providing a dual benefit.
- **Attracting High-Tech Industries:** The availability of reliable, clean, and potentially low-cost energy is a significant draw for energy-intensive, high-tech industries, enhancing Dholera's attractiveness as an investment destination.
- **Resilience:** A localized, secure power source like an SNMR enhances the energy resilience of DSIR, making it less vulnerable to external disruptions affecting the broader grid.

6. Benefits of the SNMR Project for Dholera and Gujarat

The deployment of a 300 MWe SNMR in Dholera offers multifaceted benefits:

- **Clean Energy & Decarbonization:** Provides a significant source of carbon-free electricity, contributing to India's climate goals and Dholera's green city aspirations.
- **Grid Stability & Reliability:** Delivers consistent baseload power, stabilizing the grid and ensuring uninterrupted supply for industrial operations.
- **Economic Growth & Investment:** Attracts energy-intensive industries, creates high-skill jobs during construction and operation, and stimulates local economic development.
- **Technological Leadership:** Positions Gujarat and India as leaders in advanced nuclear technology deployment and innovation.
- **Water Security:** Potential for integrated desalination facilities to address future water needs of DSIR.
- **Reduced Land Footprint:** SNMRs require less land, preserving more area for other developmental activities within DSIR.
- **Enhanced Safety Profile:** Inherently safer designs with passive safety systems reduce operational risks.

7. Challenges and Mitigation Strategies

While SNMRs offer significant advantages, their deployment involves certain challenges:

Regulatory Framework: Establishing a clear and streamlined regulatory pathway for SNMR licensing and deployment in India.

- **Mitigation:** Proactive engagement with regulatory bodies (e.g., AERB) to develop specific SNMR licensing guidelines and ensure adherence to international best practices.

Public Perception & Acceptance: Addressing concerns related to nuclear safety, waste management, and security.

- **Mitigation:** Comprehensive public awareness campaigns, transparent communication about safety features, waste management plans, and community engagement initiatives.

Financing & Investment: Securing substantial upfront capital for the project, despite lower costs per unit than traditional reactors.

- **Mitigation:** Exploring diverse funding models, including public-private partnerships, international collaborations, and green financing mechanisms. Government incentives and policy support will be crucial.

Supply Chain Development: Building a robust domestic supply chain for SNMR components and services.

- **Mitigation:** Fostering local manufacturing capabilities, technology transfer agreements, and skill development programs.

Waste Management: Ensuring safe and secure long-term storage of nuclear waste.

- **Mitigation:** Adhering to national and international standards for spent fuel management, exploring advanced fuel cycles, and investing in research for waste minimization and recycling.

8. Conclusion and Recommendation

The deployment of a 300 MWe PWR SNMR in Dholera, integrated with PIMIOS, represents a forward-thinking and strategic investment in India's energy future. It aligns perfectly with the nation's energy transition goals, the specific futuristic needs of the Dholera Special Investment Region, and the imperative for sustainable industrial development.

This project offers a clean, reliable, and scalable energy solution that will:

- Ensure energy security and stability for DSIR's burgeoning industrial and urban landscape.
- Significantly contribute to decarbonization efforts, reducing reliance on fossil fuels.
- Attract high-value industries and foster economic growth in the region.
- Showcase India's commitment to advanced nuclear technology and sustainable development practices.

Recommendation: We strongly recommend proceeding with a detailed feasibility study and site characterization for the proposed

300 MWe PWR SNMR in Dholera, Gujarat, with a clear roadmap for PIMIOS integration from the project's inception. This initiative will be a cornerstone of Dholera's success as a smart, green, and globally competitive investment region.

Sign-offs:

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