Transactions of the Korean Nuclear Society Autumn Meeting
Changwon, Korea, October 30-31, 2025

Regulatory Perspectives for Deploying Small Modular Reactors (SMRs) in Nigeria

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**Keywords: Small Modular Reactors (SMRs); Nigeria; IAEA Safety Standards; US NRC*

1. Introduction

The worldwide drive for clean and resilient energy systems has renewed focus on nuclear power, especially SMRs, which blend the advantages of modular design with enhanced safety features. With capacities typically under 300 MWe per unit, SMRs offer greater flexibility than conventional large-scale nuclear power plants and are suited for remote regions, industrial applications, and distributed energy systems [1].

Countries such as the United States, Canada, South Korea, and Russia have advanced SMR projects, with deployments ranging from land-based to floating and hybrid energy systems. The strategic potential of SMRs resides in addressing both energy security and decarbonization objectives. However, regulatory readiness, financing mechanisms, and public perception remain major challenges for SMRs deployment [2].

At present, Nigeria's electric generation capacity (below 7,000 MWe) falls significantly short of the estimated country's energy demand, which ranges from 28,000 to 31,000 MWe [3]. Therefore, Nigeria has embarked on a Nuclear Power Program (NPP) to address this gap by adopting the International Atomic Energy Agency's (IAEA) Milestones Approach. The country is currently advancing through Phase 2, which emphasizes institutional and regulatory preparedness [4]. The Nigerian Atomic Energy Commission (NAEC) oversees development strategy, while the Nigerian Nuclear Regulatory Authority (NNRA) regulates licensing and safety.

Under these circumstances in Nigeria, this present study aims to provide regulatory perspectives for SMR deployment, focusing on the regulatory framework, financing SMR projects, target applications, and capacity building for nuclear regulation.

2. Research Method

In identifying relevant regulatory perspectives for SMR deployment in Nigeria, key documents from international nuclear and energy organizations (IAEA, OECD/NEA, OECD/IEA, WNA) and from nuclear-experienced countries such as Korea and the United States were carefully reviewed. In addition, the Nigerian national regulatory framework was reexamined. Finally, a Nigeria-specific regulatory perspective for SMR deployment was derived for several areas.

3. Analysis Results

3.1 Regulatory Framework

The IAEA safety standards could provide a flexible framework for SMR deployment, but it was identified that additional provisions are necessary to address modular construction, accelerated timelines, and passive safety systems features for SMRs [5].

Through the gap analysis between existing regulations for large-scale commercial reactors and newly coming regulations for i-SMR, several regulatory gaps that need to be resolved were identified [6].

The US has taken a different approach for SMRs by the 2024 ADVANCE Act and proposed draft 10 CFR Part 53, which emphasizes risk-informed, performance-based licensing. These reforms enable graded safety requirements, probabilistic risk assessment (PRA), and flexible licensing pathways for advanced reactors [7].

In Nigeria, since regulations were designed with large light-water reactors in mind, the above observations on international moves on SMR regulations highlight the need for the introduction of innovative approaches for the SMR regulatory framework. For example, the NNRA's current licensing processes do not include modular deployment or non-electric SMR applications. Implementing a performance-based, risk-informed licensing approach while adhering to IAEA standards would enable Nigeria to adapt more effectively to SMR technologies.

3.2 Financing SMR Project

Nuclear projects with large reactors are capital-intensive, requiring 8 - 12 years of investment to make a profit. On the other hand, SMRs mitigate this challenge by enabling shorter construction periods (3 – 5 years), lower initial costs, and modular scalability [8].

However, Nigeria's high borrowing costs and limited sovereign guarantees pose financing challenges even for the SMR project.

Therefore, innovative financial mechanisms, such as public-private partnerships, green bonds, and regulated

asset base models, would be essential. Government-backed Power Purchase Agreements (PPAs) and concessional financing could further enhance bankability and improve prospects for sustainable SMR deployment in Nigeria.

3.3 Target Applications

While large-scale reactors mostly focus on power generation, SMRs could have different applications other than electricity. SMRs could significantly enhance a country's energy mix by offering diverse applications beyond conventional electricity generation. They can provide industrial heat and cogeneration, reducing reliance on fossil fuels in heavy industries, while also supporting desalination to address freshwater shortages.

SMRs can enable clean hydrogen and synthetic fuel production through high-temperature processes, contributing to the development of a sustainable fuel economy. In addition, they are well-suited for district heating, off-grid or remote power supply, and specialized marine transportation, such as powering icebreakers [9].

Importantly, SMRs also offer load flexibility, enabling the dual use of electricity and heat depending on grid conditions and demand, making them a potential versatile solution for Nigeria's future energy needs.

3.4 Capacity Building for Nuclear Regulation

Effective deployment of SMRs in Nigeria will highly depend on strengthening regulatory and institutional capacity, which is currently limited by inadequate training centers and insufficient R&D initiatives to support advanced nuclear technologies. To bridge these gaps, Nigeria should actively participate in international programs such as the IAEA's Nuclear Harmonization and Standardization Initiative (NHSI) and the World Nuclear Association's CORDEL program [10], which provide opportunities for regulatory benchmarking and alignment with global best practices for SMRs as well as large-scale reactors.

In addition, bilateral partnerships with SMR vendor countries, including Korea, the US, and the UK, could facilitate licensing collaboration and accelerate knowledge transfer on specific SMR designs.

Finally, Nigeria could assume a leadership role in West Africa by fostering regional regulatory cooperation, positioning itself as a hub for nuclear governance and capacity building across the continent [4].

4. Discussion

Nigeria's nuclear regulatory landscape is progressing but remains insufficient for SMR-specific perspectives. While the NNRA has adopted elements of IAEA standards for its nuclear regulatory framework, significant gaps exist in licensing modular fabrication, managing phased deployment, and overseeing non-electric applications of SMRs.

Lessons from the US NRC risk-informed, performance-based licensing strategy could guide Nigeria's implementation of flexible, safety-focused regulation on SMRs.

Financing an SMR project bears significant challenges. Although SMRs reduce cost overruns compared to large reactors, Nigeria's macroeconomic conditions, including high interest rates and limited creditworthiness, pose a threat to their viability. International financing partnerships, concessional loans, and sovereign-backed PPAs are necessary for SMR project feasibility.

Applications beyond electricity, such as desalination, industrial heat supply, and hydrogen production, provide Nigeria with opportunities for industrial development and regional energy security. However, public acceptance and waste management strategies must be prioritized at the same time to ensure sustainable deployment.

Finally, capacity building and international collaboration are essential. Nigeria's long-term success on SMR deployment will depend not only on adopting international best practices but also on developing domestic expertise. Participation in global harmonization initiatives and regional collaboration could accelerate readiness and position Nigeria as a leader in Africa's nuclear governance landscape.

5. Conclusion

SMRs represent a transformative opportunity for Nigeria to address electricity shortages, diversify its energy mix, and advance low-carbon development. Through the present study, several key factors for SMR deployment in Nigeria were identified in terms of a robust regulatory framework, innovative financing mechanisms, and sustainable capacity building, including tailor-made target application identification other than power generation.

By addressing those challenges identified, Nigeria can not only deploy SMRs effectively but also emerge as a regional leader in advanced nuclear energy solutions.

ACKNOWLEDGEMENTS

This work was supported by the nuclear safety research program through the Korean Foundation of Nuclear Safety (KOFONS), granted financial resources from the Nuclear Safety and Security Commission (NSSC), Republic of KOREA (Grant No. 2106002).

REFERENCES

[1] International Atomic Energy Agency. *Milestones in the Development of a National Infrastructure for Nuclear Power* (Rev. 2). Vienna: IAEA, 2024.
[2] U.S. Congress. *Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act (ADVANCE Act)*. Public Law 118–56, July 2024.

[3] Nigerian Atomic Energy Commission (NAEC). *Strategic Plan for Nuclear Power Development in Nigeria*. Abuja: NAEC, 2023.
[4] Nigerian Nuclear Regulatory Authority (NNRA). *Licensing and Safety Oversight Framework for Nuclear Power Projects in Nigeria*. Abuja: NNRA, 2024.
[5] International Atomic Energy Agency. *Applicability of Safety Standards to Small Modular Reactors and Advanced Reactor Designs*. IAEA Safety Reports Series No. 123, 2023.
[6] KHNP, *Regulatory Gap Analysis for I-SMR*. IAEA SMR Conference, Vienna, Austria, 2024.
[7] United States Nuclear Regulatory Commission. *Proposed Rule: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (10 CFR Part 53)*. Washington, DC: NRC, 2024.
[8] International Energy Agency (IEA) & OECD Nuclear Energy Agency (NEA). *Financing Nuclear New Build: Challenges and Opportunities for SMRs*. Paris: OECD, 2022.
[9] OECD Nuclear Energy Agency. *Small Modular Reactors: Unlocking Future Energy Markets*. Paris: NEA, 2023.
[10] World Nuclear Association (WNA). *Economics of Nuclear Power and Small Modular Reactors*. London: WNA, 2023.