The Integration of Small Modular Reactors into a National Nuclear Power Programme
A SWOT Analysis of Nigeria INIR Mission

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Introduction

The International Atomic Energy Agency (IAEA) conducted an Integrated Nuclear Infrastructure Review (INIR) Mission for Nigeria in June 2015. The Member State requests an INIR mission. The INIR mission is performed by a team of experts to peer review, using a transparent evaluation methodology, a member State's nuclear power infrastructure development status. The INIR mission evaluated the IAEA's 19 infrastructure elements for deploying large nuclear reactors. Through the lens of strength, weaknesses, opportunity and threat (SWOT), this paper examines the suitability of adopting the result of the 2015 INIR mission for a large nuclear reactor when considering the option of a Small Modular Reactor (SMR). The SWOT analysis shows that the infrastructures required for large nuclear reactors are similar to those for SMRs. Hence, it can be concluded that SMR integration into the Nigerian nuclear power programme is achievable with good planning and an effective implementation strategy.

Materials and Methods

The SWOT analysis used in the study was the method of [1] Ishola *et al.,* (2019) and [2]Phadermrod *et al.,* (2019). It is a decision-making tool investors have accepted for planning purposes in the energy sector. Researchers who used similar SWOT as an analytical tool to conduct their studies include [3]Jaber *et al.,* (2015)[4] Kamran et al., (2020) in the renewable energy sector and [5] Agyekum *et al.,* (2020) in nuclear energy.

Results and Discussions

The 19 infrastructure issues (Table 1) developed by the IAEA that were subjected to the INIR process were for large nuclear reactors. Preparation for the INIR Mission created an environment that enabled practical cooperation and partnership among national stakeholders. The INIR report recommendation and suggestions can serve as a guide in deploying SMRs if the problems and issues that will hinder the massive SMR deployment are overcome. These problems and issues include technology choice; supply chain and trained human resources; public perception and acceptance; finance, investment, and political support; proliferation risks (safeguards and security) and; nuclear fuel cycle and approach to spent fuel remediation.

Table 1: IAEA Infrastructure issues

National Position	Radiation Protection	Environmental Protection
Nuclear Safety	Electrical Grid	Nuclear Security
Management	Human Resource Development	Emergency Planning
Funding and Financing	Regulatory Framework	Nuclear Fuel Cycle
Legal Framework	Stakeholder Involvement	Radioactive Waste Management
Safeguards	Site and Supporting Facilities	Industrial Involvement
Procurement		

The SWOT analysis of the activities in Table 1, based on the recommendations, suggestions, and current status of the 2015 INIR report, is presented in Table 2

Table 2: Result of the SWOT analysis for 2015 IAEA INIR Missions to Nigeria

Strengths	Weaknesses	Opportunities	Threats
National Position	Management	Funding and Financing	Legislative Framework
Safeguards	Site and Supporting Facilities	Electrical Grids	Regulatory Framework
Radiation Protection	Nuclear Safety	Environmental Protection	Procurement
Human Resources	Nuclear Fuel Cycle	Stakeholder Involvement	Industrial Involvement
Emergency Planning	Radioactive waste management		
Nuclear Security			

The SWOT approach is a flexible, easy-to-use and understandable tool that evaluates the internal factors of strengths and weaknesses and the external aspects of opportunities and threats that affect the strategies for developing and managing a project [2][5]

Strength

With its effort to add nuclear energy to its energy mix, Nigeria has the prospect of achieving the set objective. Nigeria has agreed to the establishment of the Joint Stock Company. It has also agreed with ROSATOM to build a nuclear power plant [6] based on the financing model of Build Own Operate and Transfer (BOOT). Nigeria has commenced the development of Integrated Management Systems (IMS) for relevant organizations. Human resources and domestic technical capabilities are two factors required to manage nuclear reactors [7]. Nigeria has conducted a comprehensive national human resources development analysis. Nigeria has developed the necessary competencies needed for communicating information relevant to safeguards and facilitating IAEA in-field activities. The National Nuclear and Radiological Emergency Plan have been developed. Nigeria developed a fuel cycle and radioactive waste management strategy to produce a draft Radioactive Waste and Fuel Cycle Policy.

Weakness

Nigeria has confronted the nuclear safety issue by completing the capacity building programme for site licensing as it concerns nuclear safety. A national programme on radiation protection has yet to be implemented because of inadequate capacity. The nuclear fuel cycle and approach to radioactive waste management is a challenging topic for countries embarking on developing and deploying nuclear energy [8]. Nigeria has identified sites for low and intermediate level waste. The following activities have yet to be done: updated site selection information, complete site characterization, and plan for site construction, including on and offsite infrastructure. An impractical environmental impact assessment could impede the adoption and successful implementation of nuclear energy programmes [6]. Nigeria has yet to conduct and send an environmental impact assessment report for the preferred sites for approval.

Opportunities

Lack of adequate financing and investment is a challenge for projects in Africa. The initial costs associated with nuclear power plants are considerable and a greater part of the financing requires long-term upfront investments [6]. A robust and efficient electrical grid is needed to evacuate power from the nuclear power plant [9]. Nigeria has begun capacity-building activity for grid integration but has yet to conduct detailed grid studies and develop implementation plans for grid enhancement and associated funding. Nigeria has developed a stakeholder involvement strategy and plan to improve the public perception and acceptance of nuclear energy. However, the national Public Information and Communication Strategy and communications action plan are not yet developed.

Threats

A functional regulatory framework is the anchor upon which a successful nuclear energy deployment rests [7]. The different laws establishing NAEC and NNRA had been reviewed by the IAEA and forwarded to the national legislature for their consideration. Nigeria has yet to develop a comprehensive plan for developing NPP regulations. The role of nuclear technology in facilitating industrial non-power generation activities [9] must be considered by newcomer countries. Nigeria has drafted a strategy for industrial involvement. Nigeria is developing a stakeholder-based procurement plan.

Conclusion

The SWOT analysis shows that the infrastructures required for large nuclear reactors are similar to those for SMRs. Hence, it can be concluded that SMR integration into the Nigerian nuclear power programme is achievable with good planning and an effective implementation strategy.

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