Feasibility Analysis of Introducing Innovative SMR (i-SMR) in Developing Countries (Kazakhstan, Indonesia)

Byungjoon Jung*, Sin Jung Chang
SMR Development Group, Korea Hydro & Nuclear Power Co., Ltd, 70, Yuseong-daero 1312beon-gil, Yuseong-gu, Daejeon 34101, Republic of Korea
**Corresponding author: joon7826@gmail.com*

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1. Introduction

In response to climate change and the need for energy security, there has been a growing global interest in Small Modular Reactors (SMRs). Korea's Innovative SMR (i-SMR), currently under development, is recognized as an efficient alternative for developing countries due to its low carbon emissions and high installation flexibility. This study analyzes the feasibility of introducing i-SMR in developing Asian countries, focusing on Kazakhstan and Indonesia. Based on each country's energy mix, this paper evaluates the advantages and challenges of i-SMR deployment. Based on these findings, the study seeks to propose the optimal strategy for adopting i-SMR in each country.

2. Energy mix and the necessity of SMR deployment

2.1 Kazakhstan

Kazakhstan's energy mix is dominated by coal, which accounts for 70% of total energy production, followed by natural gas (20%), hydropower (5%), and other energy sources (5%). The country's heavy reliance on coal poses challenges in achieving carbon neutrality. Introducing SMRs could be a viable solution to increase the proportion of clean energy while ensuring a stable power supply. Moreover, the adoption of i-SMR could help Kazakhstan reduce carbon emissions, enhance its energy export capacity, and advance its nuclear technology sector.

2.2 Indonesia

Indonesia's energy mix is dominated by coal, which accounts for 60% of electricity production, followed by natural gas at 20% and hydropower and other sources at 20%. As an archipelagic nation, Indonesia faces challenges in providing stable electricity across its vast and dispersed territory. Large-scale power plants are not always viable, making SMRs an attractive option for decentralized energy production. Deploying SMRs in Indonesia could significantly improve electricity access in remote areas and strengthen the country's energy independence.

3. Analysis of advantages and disadvantages of i-SMR adoption

The advantages and challenges of adopting i-SMR are analyzed in terms of economic feasibility, safety, environmental impact, and energy security as follows.

Table I: Advantages and challenges of i-SMR

Aspect	Advantages	Challenges
Economic Feasibility	Lower initial investment than traditional NPPs	Higher unit electricity generation cost compared to large-scale plants
Safety	Reduced accident risk with advanced safety features	Need for regulatory adaptations due to new technology
Environment Impact	Reduced carbon emissions and air pollution	Management of radioactive waste
Energy Security	Decreased reliance on imported fuel	High initial technology adoption costs

The potential benefits and challenges of introducing i-SMR in each country have been analyzed.

Kazakhstan could diversify its energy mix and expand energy export opportunities by adopting i-SMR. However, the high initial investment cost poses a financial burden.

Indonesia, with its numerous islands, could benefit from independent power generation using i-SMR, particularly in remote areas. However, the lack of a well-established nuclear infrastructure may hinder its adoption.

4. Proposed optimal strategies for i-SMR deployment

Considering each country's specific conditions, the following strategies are proposed for the optimal adoption of i-SMR.

For Kazakhstan, integrating SMRs with existing large nuclear power plants and coal-fired plants would be a viable approach. The country could collaborate with Russia and South Korea for technology transfer while gradually replacing its coal-based energy sources with SMRs to maintain a stable energy supply and achieve carbon reduction goals.

In Indonesia, deploying SMRs in remote island regions could be an effective way to build a decentralized power grid. The government could initiate

pilot projects before expanding SMR deployment nationwide, ensuring technical and economic feasibility.

5. Conclusion

The introduction of i-SMR in developing countries presents a promising solution for energy transition and carbon neutrality. However, economic, technological, and environmental factors must be carefully considered to ensure successful implementation. This study has assessed the feasibility of adopting i-SMR based on the energy mix of two target countries and has proposed tailored implementation strategies. By providing these insights, the research aims to contribute to future policy discussions and technological advancements in the field of nuclear energy.

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