Integrating SMRs into Africa's Water and Energy Nexus

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Abstract:

Sub-Saharan Africa faces a critical intersection of energy insecurity, freshwater scarcity, and inadequate liquid waste management, all of which undermine sustainable development. Small Modular Reactors (SMRs) present a flexible, low-carbon technology with the potential to simultaneously address these challenges by providing stable baseload electricity and process heat for desalination and advanced wastewater treatment. This paper proposes an innovative deployment framework for SMRs within the African water–energy nexus, integrating technical feasibility, geospatial suitability, and governance readiness. Using a PESTLE-informed geospatial model, the study identifies high-potential zones in Ghana, Nigeria, and South Africa based on political stability, nuclear readiness, water stress, and infrastructural capacity. A comparative institutional analysis assesses the roles of regional bodies such as ECOWAS, the West African Power Pool (WAPP), and the African Union's Agenda 2063 in enabling SMR deployment. Findings reveal that while select regions demonstrate strong technical suitability, fragmented regulatory environments and limited public acceptance remain significant barriers. The paper proposes three policy pathways: harmonized regional nuclear regulations, innovative financing through blended capital and public–private partnerships, and decentralized SMR-powered water–energy hubs aligned with circular economy principles. By reframing SMRs as enablers of integrated water and energy resilience rather than solely electricity generators, this research highlights their potential to advance Africa's climate adaptation and industrialization.

Keywords:

Small Modular Reactors, Water–Energy Nexus, Sub-Saharan Africa, Circular Economy, Regional Integration.