Realising Ghana's nuclear power plans: opportunities and challenges

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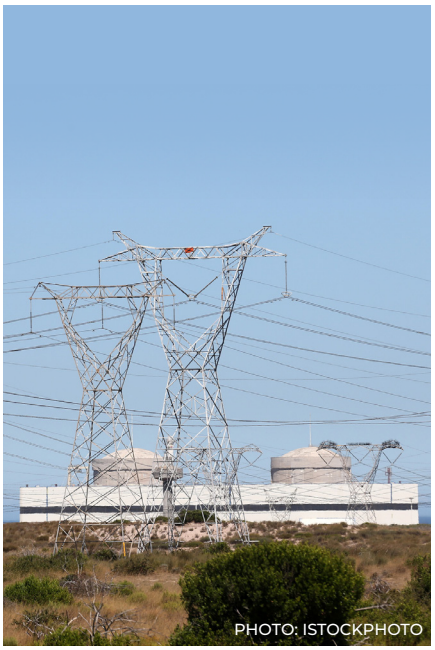
Key Messages

If Ghana wants to realise its ambitions to invest in nuclear power, the following recommendations are important:

- **Continue to adhere to the International Atomic Energy Agency's (IAEA) nuclear development roadmap** to ensure safety, secure financing, and build credibility for Ghana's nuclear programme.
- **Strengthen Ghana's national grid and enhance regional cooperation** within the West African Power Pool to facilitate regional energy trade and export potential.
- **Diversify funding sources and develop strategies to mitigate geopolitical risks** that impact vendor financing capabilities.
- **Maintain the independence and transparency of regulatory bodies** to protect safety standards and financial integrity.

Since nuclear investment is subject to high risks and long timescales, **the Ghanaian government should also pursue a diverse approach to investment** – and also scale up investment in renewable energy technologies. It should ensure that the costs and benefits of nuclear and renewables have been fully considered in power system planning processes.



Koeberg Nuclear Power Station, Cape Town – South Africa

Summary

- Ghana aims to establish a 1 GW nuclear plant by 2030 to diversify the electricity system. The government sees nuclear energy as vital for decarbonisation, enhancing energy security and potentially generating electricity export revenue.
- Financing new nuclear investment is challenging for any country. Ghana has been negotiating with several vendor countries, but increased geopolitical risks and the county's financial situation will substantially affect the costs and risks of Ghana's nuclear plans.
- Ghana faces some technical challenges in its nuclear journey, including grid capacity limitations and uncertainties around which nuclear technologies to adopt.
- It will be essential for Ghana to continue developing its institutional capacity by establishing robust institutional frameworks for nuclear regulation and partnerships with a wide range of stakeholders.
- Since nuclear investment is subject to high risks and long timescales, the Ghanaian government should pursue a diverse investment strategy that also supports renewable energy technologies.

Introduction

Ghana, a rapidly developing West African nation, is exploring investment in nuclear energy to diversify its energy portfolio. In 2012, the government officially announced its commitment to a peaceful nuclear power programme, aiming to install a 1 GW nuclear plant by 2030 [1, 2]. Policymakers see this initiative as crucial for decarbonising Ghana's energy system, improving energy security, while generating electricity export revenue [3, 4]. However, countries across the African continent face substantial challenges related to nuclear technologies in terms of funding, infrastructure, resource availability, and security of nuclear infrastructures [3, 4].

This Policy Brief presents an interdisciplinary analysis of Ghana's technical, economic, and institutional capacity for nuclear development. Due to its aspiration to become the third African nation to acquire nuclear capabilities after South Africa and Egypt, Ghana offers valuable insights for other countries aspiring to develop nuclear programmes in the region. To examine the critical facets of nuclear readiness, the analysis draws on a range of documentary sources and interviews with key stakeholders.

Methodology

This briefing evaluates Ghana's preparedness for nuclear energy adoption building on Jessica Jewell's [5] nuclear feasibility framework, which is particularly useful for analysing nuclear feasibility in applied policy settings in newcomer countries. Jewell's framework focuses on four critical factors influencing nuclear deployment: (1) technical feasibility, (2) financial capacity, (3) institutional readiness, and (4) political stability. **Table 1** illustrates the conceptual framework adopted in this study, which is a revised version of Jewell's framework, tailored to the Ghanaian context. The research explored relevant topics and issues for Ghana including the potential of Small Modular Reactors (SMRs), geopolitical concerns involving vendors in conflict, and debt constraints imposed by the International Monetary Fund (IMF).

***Table 1:** Conceptual framework used to analyse nuclear feasibility in Ghana.*

Financial feasibility	Financing Models
	Vendor options
	Russian finance
	International Monetary Fund (IMF) constraints
Technological feasibility	Grid capacity
	West African Power Pool
	Small Modular Reactors
Institutional capacity	Establishment of institutions
	Legal framework
	Stakeholder engagement
	Human Resources
	Safety

Various data sources were used. First, nineteen documents, including key policy strategies, government reports, grey literature, and academic papers, were analysed to gain insight into Ghana's energy policy landscape. Additionally, eight interviews were conducted with key stakeholders, including government policymakers, utility representatives, academics, journalists, and international experts to gain a wide range of views on key developments and issues surrounding nuclear feasibility (**Table 2**). This approach allowed the development of a nuanced interpretation of

the feasibility of nuclear energy in Ghana. Both the document and interview data were thematically analysed according to a coding tree developed from the nuclear feasibility literature (see Table 1 for the themes used in the coding tree) [3, 4, 5].

***Table 1:** Interviewees by category*

Type of stakeholder	Number	Abbreviation in text
Academics	3	ACS
Utility Company	1	UTI
Civil Servant	1	CIS
Intergovernmental Organisation	1	IGO
Policy Advisor	1	POA
Journalist	1	JOU

Key results

The feasibility of nuclear energy in Ghana is dynamic and rapidly evolving. Ghana's Government has shown commitment to developing a national nuclear programme and has been implementing the International Atomic Energy Agency's (IAEA) 'milestone approach' [6]. This is an internationally recognised framework by which newcomer countries undergo rigorous scrutiny before embarking on an atomic energy programme.

The IAEA milestone approach comprises three phases: Phase 1 focuses on infrastructures, safety, fuel, and environmental protection; Phase 2 on grid capacity, institutional capacity, financing, and site procurement; Phase 3 is concerned with the actual construction of the power plant [6]. In 2012, Ghana formalised its nuclear programme intention, establishing the Ghana Nuclear Power Programme Organisation to oversee infrastructure development, and aligning with the IAEA's infrastructural milestone approach [6]. A roadmap by the Nuclear Power Ghana outlined a plan to have a 1 GW nuclear power plant installed by 2030 [1, 2, 7]. In 2015, Ghana applied for the IAEA's Integrated Infrastructure Review, and transitioned to Phase 2 in 2019 [6]. Currently, site characterisation and evaluation are pending, which would move the country to Phase 3.

Financial feasibility

Finance is one of the major barriers to nuclear investment in any country, due to high capital costs, long construction times, and the history of significant cost over-runs and delays. Direct government funding and/or contracts underwritten by governments are usually required. Ghana is exploring different financing options[1] and funding models to support its nuclear programme, including export credits, commercial loans, bonds, and equity investment [3, 4]. There are an increasing number of vendors engaged in negotiations with Ghana, which is emerging as an attractive partner in atomic collaborations. Notably, the country has been negotiating agreements with key players such as Russia, China, and the United States as part of its Nuclear Power Programme [8, 9].

> *"Considering the seriousness on the part of the vendors to get us [Ghana] to partner with them, I am very optimistic that we will find the financing solution for the project[2] by the end of the year"* (CIS)

The United States is offering the construction of SMRs, which are at a much earlier stage of development than large, pressurised water reactors. Therefore, investing in them is particularly risky.

[1] Ghana has three main financing options available: a) 'finance between governments' which takes the form of a bilateral loan between two state governments; b) 'vendor financing' whereby a vendor, defined as the nation supplying the nuclear infrastructure, offers a loan to the host country to pay for the vendor's nuclear export product; and c) 'Build-Own-Operate' or 'Build-Own-Transfer' whereby the vendor country provides all of the necessary finance to construct the plant but retains ownership of the plant after completion.

[2] 'Project' just refers to any nuclear plant – either a large reactor or small reactors.

Russia is offering the construction of large plants, while others, such as France, China, and South Korea, offer both options. Negotiations have generally been positive, with all countries expressing willingness to provide loans covering up to 85% of the total project cost. However, some participants maintain a degree of scepticism and a careful examination of Memoranda of Understanding (MOUs) documents reveals a lack of explicit discussions on financing terms [8, 9].

In evaluating vendor viability, Rosatom (a Russian state corporation) stands out as possessing the complete nuclear supply chain and expertise to independently execute a nuclear power plant. However, recent terminations of several Russian nuclear contracts and doubts surrounding Russia's financial capabilities due to its invasion of Ukraine have cast shadows of uncertainty.

Ghana's placement under IMF constraints adds another layer of complexity [3, 10]. In 2023, the IMF approved a $3 billion extended credit arrangement to help Ghana overcome debt and fiscal vulnerabilities exacerbated by the Covid-19 pandemic. Although Ghana's IMF constraints do not specifically prohibit loans to finance nuclear projects, they limit Ghana's ability to borrow money and provide sovereign guarantees crucial for project financing.

Technological feasibility

According to previous studies, the technological feasibility of Ghana's nuclear power developments is limited by the nation's generation capacity [3, 4]. The IAEA states a nuclear reactor must be no larger than 10% of national generation capacity. Ghana does not currently meet this standard, as current capacity stands at 5,500 MW. However, Government forecasts predict an increase in generation capacity to 10,000 MW by 2030, which would put Ghana on track to meet these requirements [1, 2, 7]. However, stakeholders express cautious optimism amid concerns about achieving the envisioned capacity due to ongoing project delays and legacy issues related to generation overcapacity, noting that this could hinder Ghana's nuclear programme.

Viewed from a regional perspective, these challenges might be easier to address. The West African Power Pool (WAPP), consisting of 14 interconnected power systems, offers a platform for balancing electricity supply and demand through cross-border transfers. This would enable Ghana to export power and reduce, albeit not eliminate, Ghana's need for national grid capacity [6]. July 2023 marked a milestone with successful grid synchronisation and a unified electricity market among WAPP states. However, interviewees point to important complexities related to inter-regional grid infrastructures, investments, and responsibilities.

Finally, in terms of nuclear waste management, Ghana currently runs one of the few nuclear waste storage facilities in Africa so there would be capacity to meet some of these needs.

> *"The issue of grid capacity means that Ghana would need to look at having regional contracts in place if they went for a large-scale power plant"* (IGO)

In 2022, Ghana entered strategic collaborations with both the United States and Japan to develop SMRs [8, 9]. Supporters highlight SMRs' appropriateness for Ghana's grid due to their potential to make shutdowns more manageable and financing more accessible. However, questions about SMR viability persist because most designs have not yet been built in practice, and therefore costs and performance are uncertain [11]. Further, The safeguarding measures of Western-manufactured SMRs exported abroad have been questioned. Finally, geopolitical risks amid the Ukraine conflict raise inquiries about safe ports and insurance

availability in the context of a Ghana–Russia nuclear agreement.

Institutional and regulatory capacity

In Ghana's pursuit of nuclear energy, the establishment of key institutions, including the Nuclear Regulatory Authority, Nuclear Power Ghana, and partnerships with entities like the Volta River Authority and Ghana Atomic Energy Commission, aligns with global standards [1, 2, 8, 10]. Ghana has solidified its commitment to nuclear energy through a robust legal framework, ratifying international treaties and conventions in compliance with IAEA standards, exemplified by the Nuclear Regulatory Act of 2015 [2, 3, 4, 10]. Notably, support for nuclear endeavours extends across both major political parties, creating a bipartisan stance on the matter.

> *"In terms of political support, or government support, we have two major political parties that both support nuclear activity. We've done a lot of public engagements, community engagement, stakeholder engagements, media engagement"* (CIS)

According to some interviewees, the independent regulator is building its capacity to regulate nuclear activities and exhibits sufficient levels of institutional independence. However, a critical examination reveals that there might a gap in governance, as the official documentation fails to specify the degree of independence these institutions must maintain from the government, as recommended by the IAEA [6]. This raises concerns about safety and protection from potential budget cuts by the government.

Further, while initial assessments revealed shortcomings in the level of stakeholder engagement with industry by key governance institutions, there have been increasing efforts in addressing this gap. For instance, the Association of Industries in Ghana has shifted its perspective, supporting nuclear energy because it sees the potential to augment electricity supply and reduce consumer costs.

Recognising the importance of human resources, Ghana has introduced nuclear energy courses in universities, implemented a programme to train a skilled workforce, and fostered cross-national educational collaborations [1, 2, 3]. This reflects Ghana's commitment to building a knowledgeable workforce capable of steering its nuclear energy ambitions towards success.

Conclusions and recommendations

Ghana has made significant progress in preparing for a potential nuclear energy programme. However, the country's experience underscores the challenges associated with implementing such a programme expeditiously, given the intricate and capital-intensive nature of nuclear infrastructure, the high financial risks involved, and the uncertainties of the global geopolitical landscape. If Ghana wishes to realise its nuclear ambitions, the following recommendations should be considered. Many of these recommendations also apply to other nations contemplating the expansion of their nuclear programmes:

- **Following the IAEA's nuclear energy development roadmap:** Adhering to the IAEA's roadmap for nuclear energy development is crucial for ensuring safety and security, while also serving as a prerequisite for securing financing from vendors. By following this roadmap, Ghana can build credibility and increase the potential for attracting investment. However, even if the roadmap is followed,

attracting investment will be very challenging in current circumstances.

- **Strengthen Grid Infrastructure and Regional Cooperation:** Invest in upgrading Ghana's domestic power generation and grid capacity, while simultaneously enhancing collaboration within the WAPP to facilitate regional energy trade and export potential. This could involve prioritising infrastructure projects to address current limitations and streamlining regulatory processes for inter-regional energy transactions.
- **Diversify Financing Options and Mitigate Geopolitical Risks:** While substantial government funding will be required from national and international sources, Ghana could also explore diverse funding models beyond reliance on single vendors or sources. This could include export credits, commercial loans, and equity investments. Comprehensive risk mitigation strategies will also be required to address geopolitical uncertainties, such as conflict-related disruptions and fluctuations in vendor financing capabilities.
- **Enhance Institutional Independence and Transparency:** Ensure regulatory bodies, such as the Nuclear Regulatory Authority, maintain independence from government influence to uphold safety standards and protect against budget cuts.

Finally, given that investing in nuclear power is subject to a lot of uncertainty, Ghana should pursue parallel strategies to diversify its electricity system. This would involve prioritising investment in other low-carbon technologies, such as wind and solar power, to contribute to energy security, grid reliability and sustainability. This parallel strategy will help to mitigate risks associated with nuclear energy and bolster Ghana's resilience to external political, economic, and technical constraints.

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