African Nuclear Security Landscape and Non-Proliferation

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Abstract

Background:
Africa has developed a dense legal and institutional architecture for nuclear non-proliferation and nuclear security, centred on the Treaty of Pelindaba, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and emerging continental bodies such as the African Commission on Nuclear Energy (AFCONE). Despite this, implementation remains uneven, and long-term sustainability of nuclear security programs is threatened by capacity and funding constraints.[1–3]

Objectives:
To provide a narrative synthesis of: (1) the current African nuclear security and non-proliferation landscape, (2) key enablers and barriers to strengthening nuclear security, and (3) funding models capable of sustaining long-term nuclear security programs in Africa.

Methods:
A narrative review of policy reports, institutional statements, and analytical papers from international organizations (IAEA, AU/AFCONE), regional initiatives (AFRA, FNRBA), and specialized think tanks was undertaken, focusing on governance, capacity building, and financing of nuclear security in Africa. Sources were selected for relevance to African institutions, legal frameworks, and concrete programs or funding initiatives.[1,2,4]

Results:
Africa benefits from strong formal commitments to non-proliferation and disarmament through near-universal NPT membership and the African Nuclear-Weapon-Free Zone (Treaty of Pelindaba), which together prohibit nuclear weapons, mandate IAEA safeguards, and oblige implementation of the Amended Convention on the Physical Protection of Nuclear Material (A/CPPNM). Key enablers include: a robust normative framework; the emergence of AFCONE, AFRA, and the Forum of Nuclear Regulatory Bodies in Africa (FNRBA); and growing regional capacity-building and regulatory-harmonization initiatives. Barriers include gaps in treaty adherence and domestic implementation, under-resourced regulators and continental bodies, and pressure from expanding nuclear energy ambitions and uranium production. Sustainable funding models point toward a mix of national budget lines, AU-anchored regional funds, predictable donor and IAEA support, and innovative initiatives such as the African Nuclear Energy Funding Initiative (ANEFI) that link back-end fuel-cycle revenues to governance and security.[1,2,4–10]

Conclusions:
Africa's nuclear security regime rests on comparatively advanced legal norms, but durable progress depends on strengthening implementation capacity and designing funding architectures that move from project-based assistance to African-owned, multi-decade financing arrangements. Leveraging Pelindaba, AFCONE, and emerging financing partnerships can position Africa as both a beneficiary and shaper of global nuclear security and non-proliferation norms.[3,11,12]

Keywords: Nuclear Security, Non-Proliferation, Africa

Introduction

Nuclear security and non-proliferation in Africa are increasingly salient as more states explore nuclear power, expand radiological applications in health and industry, and engage in uranium mining and trade. At the same time, Africa remains committed to nuclear disarmament and weapon-free zones, having established one of the most comprehensive regional nuclear-weapon-free regimes in the world through the Treaty of Pelindaba. This review examines the African nuclear security landscape, identifies key enablers and barriers to strengthening nuclear security, and discusses funding models for sustaining long-term programs.[2,8,13,14]

African nuclear security and non-proliferation landscape

Legal architecture and norms

The African Nuclear-Weapon-Free Zone Treaty (Treaty of Pelindaba) designates Africa and its adjacent islands as a zone free of nuclear explosive devices. It prohibits the development, manufacture, acquisition, testing, or stationing of nuclear weapons on the continent. It further requires parties to apply full-scope IAEA safeguards to all peaceful nuclear activities and includes a unique provision (Article 11) prohibiting armed attacks on nuclear installations, thereby extending protection beyond that provided by the NPT alone.[8,15,16]

Almost all African states are parties to the NPT, reinforcing global non-proliferation obligations and embedding a commitment to disarmament and peaceful uses. The Pelindaba Treaty obliges its parties to adhere to and implement the A/CPPNM, which is the only legally binding global instrument focused specifically on nuclear security and physical protection of nuclear material. Together, these treaties provide a strong normative baseline for nuclear security, even where practical implementation lags.[2,4,17]

Institutions and continental governance

The Treaty of Pelindaba created the African Commission on Nuclear Energy (AFCONE) as its implementing body, mandated to ensure compliance, promote peaceful nuclear cooperation, and support the development of safeguards, safety, and security across Africa. AFCONE works with the IAEA, AU organs, and member states to advance capacity building and to integrate nuclear science into African development agendas in health, agriculture, energy, and environmental management.[1,3,18]

Complementing AFCONE are regional technical and regulatory platforms, notably the African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) and the Forum of Nuclear Regulatory Bodies in Africa (FNRBA). AFRA focuses on peaceful applications and capacity building, while FNRBA provides a network for regulators to exchange experience, coordinate on safety and security infrastructure, and pursue regulatory harmonization.[1,7,12]

Nuclear activities and risk profile

Africa hosts limited but growing nuclear infrastructure, including South Africa's Koeberg nuclear power plant and Egypt's first power reactor under construction at El Dabaa, alongside numerous research reactors, medical and industrial facilities using radioactive sources, and expanding uranium mining in several countries. These activities create a spectrum of nuclear security risks, ranging from theft or sabotage of nuclear material to illicit trafficking of radioactive sources for malicious use.[2,14,19]

Regional security challenges, including terrorism, organized crime, and porous borders, intersect with nuclear and radiological materials, underscoring the need for robust detection, control, and emergency-response capabilities. Historical legacies—such as colonial nuclear testing in parts of North Africa and unresolved grievances about technological inequities—also shape African states' positions in global nuclear debates.[2,19–21]

Enablers of stronger nuclear security

Normative leadership and political commitment

African states have been vocal proponents of nuclear disarmament, weapon-free zones, and equitable access to peaceful nuclear technologies, often positioning Pelindaba as both a shield against nuclear weapons and a vehicle for development. South Africa's voluntary dismantlement of its nuclear weapons program and subsequent alignment with non-proliferation norms provides a powerful normative example within the continent and globally.[11,21–23]

Within the African Union, decisions have endorsed nuclear energy as part of the continent's development strategy while emphasizing the need for safety, security, and non-proliferation, reinforcing the political legitimacy of investing in nuclear security institutions. This political backing enables regional bodies to advocate for higher standards and to coordinate continental positions in NPT review processes and other multilateral fora.[3,15,18,24]

Institutional and regulatory capacity building

Capacity-building initiatives led by the IAEA, AFCONE, AFRA, and FNRBA constitute a central enabler for translating legal commitments into practical nuclear security measures. IAEA programs support African states

in establishing State Systems of Accounting for and Control of nuclear material (SSACs), strengthening physical protection, improving border detection systems, and developing national nuclear security regimes.[7,9,25,26]

AFCONE has launched a five-year program to "uplift nuclear safeguards in Africa", with support from partners such as Finland and the EU, aimed at enhancing SSACs, legal frameworks, and institutional capacities while consolidating AFCONE's own role as a regional hub. Training, education, and mentorship programs—often targeting regulators, operators, law-enforcement agencies, and judiciaries—help build a cadre of professionals capable of sustaining nuclear security practices.[9,18,27,28]

Regional cooperation and harmonization

Cooperation through FNRBA and AFCONE supports regulatory harmonization, mutual assistance, and peer review, which collectively raise nuclear security baselines. Proposals for a Pan-African Nuclear Regulatory Framework, and ongoing efforts to align national regulations with IAEA standards, aim to reduce gaps and inconsistencies that could be exploited by malicious actors.[7,9,29]

Joint regional workshops, such as AFCONE-led webinars on nuclear security and African regional workshops on implementing the A/CPPNM, create platforms for sharing best practices and developing common approaches to challenges such as source security and emergency preparedness.

Multi-country initiatives like NUCAF (Strengthening nuclear security in Africa), funded by the EU and implemented by European regulators with African partners, illustrate how coordinated projects can strengthen regulatory infrastructure and emergency response across several states simultaneously.[4,9,30,31]

Barriers and implementation gaps

Incomplete treaty adherence and domestic legislation

Despite the strength of the continental legal framework, a subset of African states has yet to sign, ratify, or bring into force the Pelindaba Treaty, leaving gaps in the nuclear-weapon-free zone's legal coverage. Moreover, many states have not fully aligned national legislation with Pelindaba obligations, the A/CPPNM, or IAEA nuclear security guidance, limiting enforceability of security requirements.[2,13,32,33]

Domestic incorporation of treaty obligations into criminal codes, regulatory statutes, and operational procedures is uneven, especially where legislative capacity is limited or nuclear activities are still at an early stage. These gaps hinder the establishment of comprehensive SSACs and coherent national nuclear security regimes.[1,2]

Under-resourced institutions and human capital constraints

AFCONE has struggled with limited and irregular assessed contributions from member states, as well as reliance on extra-budgetary funding, which constrains its ability to conduct verification support, advisory missions, and extensive capacity-building activities. Many national regulators face similar resource constraints, operating with small staff, limited equipment, and inadequate budgets for inspections and training.[1,6,7,12]

Human resource shortages are particularly acute in specialized areas such as nuclear security culture, cyber-security for nuclear facilities, and advanced safeguards analysis, leading to dependence on a small pool of

experts and external consultants. Brain drain and limited career pathways in nuclear regulation further complicate long-term workforce development.[12,25]

Emerging nuclear energy ambitions and material risks

More than 20 African countries are exploring or planning nuclear power programs, including interest in small modular reactors (SMRs), to meet energy security and climate goals. These ambitions outpace regulatory and security capacities in several cases, increasing the importance of early-stage integration of nuclear security into infrastructure planning, site selection, and licensing.[9,14]

Uranium mining and processing in countries such as Niger, Namibia, South Africa, and the Democratic Republic of Congo generate risks of theft, diversion, and illicit trafficking of source material, particularly where governance is weak and security forces are overstretched. The widespread use of radioactive sources in medicine, industry, and research also creates vulnerabilities to orphan sources and radiological dispersal device scenarios if controls are inadequate.[2,19,26]

Funding models for long-term nuclear security

National budget allocations and mainstreaming

A foundational funding model centers on consistent domestic financing of nuclear security through national budgets, integrating it into core functions of regulatory authorities, security agencies, and nuclear operators. Embedding nuclear security in national development, energy, and security strategies allows it to be funded alongside other critical infrastructure and governance priorities, rather than as an externally driven add-on.[12]

Cost-recovery mechanisms—such as regulatory fees, licensing charges, and operator contributions—can supplement state budgets, provided they are structured to avoid undermining regulatory independence. Over time, domestic co-financing can increase as donor-funded projects facilitate initial capacity building and infrastructure development.[9]

Regional funds and continental mechanisms

Analysts and AFCONE documents have proposed the creation of an African Nuclear Development or Governance Fund, managed by AFCONE under AU oversight, to support legal, technical, and institutional development across member states. Such a fund could pool assessed contributions, voluntary payments, and partner resources to finance regional training centers, research institutions, and targeted support for regulators and SSACs.[1,11,12]

AFCONE’s financing model already combines assessed contributions from states parties with extrabudgetary funding, but stabilizing this arrangement requires improved payment discipline, predictable multi-year pledges, and integration with AU financial frameworks. AFRA and FNRBA strategies likewise emphasize cost-sharing and member-state ownership, which can gradually shift the balance from donor-driven projects to African-led programs.[3,6,7,12]

International and IAEA-linked mechanisms

The IAEA supports nuclear security in Africa through its Nuclear Security Fund, Regular Budget, Technical Cooperation Programme, and Peaceful Uses Initiative, all of which can finance training, equipment, and advisory missions. European instruments such as the Instrument for Nuclear Safety Cooperation (INSC) and various development cooperation facilities have also funded projects like NUCAF and regulatory-capacity programs.[10,25,28,31]

However, these mechanisms often operate on short project cycles, creating sustainability challenges once funding ends. Embedding nuclear security components within longer-term energy, infrastructure, and climate finance programs—such as just-transition and green-transformation initiatives—can extend time horizons and stabilize funding.[10,12]

Innovative and blended financing initiatives

Innovative models seek to link revenue-generating nuclear activities, particularly at the fuel-cycle back end, to governance and security funding. The African Nuclear Energy Funding Initiative (ANEFI), a partnership between AFCONE and DeepGEO, aims to support multinational high-level waste repositories and a shared nuclear supply chain, with a portion of proceeds earmarked for regional governance and infrastructure. This approach could create a recurring income stream for AFCONE and associated institutions while supporting African financial institutions' capacity to invest in nuclear projects.[5,6]

More broadly, blended finance mechanisms that combine multilateral development bank loans, climate funds, export credit, and domestic capital can allocate a defined share of project finance to regulatory and security infrastructure as a condition of support. Ensuring that nuclear security is recognized as integral to bankable nuclear and radiological projects is crucial for accessing these wider pools of capital.

Implications and future directions

Africa’s nuclear security landscape demonstrates an advanced normative and institutional framework relative to the scale of its current nuclear activities, but this advantage can erode if implementation gaps and funding volatility persist. Strengthening nuclear security requires consolidating treaty adherence, fully incorporating obligations into national legal systems, and investing in robust, independent regulators supported by regional networks.[1,2,4,7]

Sustainable financing will depend on a strategic mix of national investment, AU-anchored regional funds, long-term partnerships with the IAEA and donors, and innovative revenue-sharing mechanisms associated with nuclear energy and fuel-cycle infrastructure. If effectively implemented, these models can enable Africa not only to secure its nuclear and radiological materials but also to play a more assertive role in shaping global non-proliferation and nuclear security norms.[3,5,10,11,23]

Conclusions

Africa has established one of the most comprehensive regional nuclear non-proliferation and nuclear security frameworks globally, anchored in the Treaty of Pelindaba, near-universal adherence to the NPT, and the emergence of continental institutions such as AFCONE, AFRA, and the Forum of Nuclear Regulatory Bodies in Africa. This normative and institutional architecture provides a strong foundation for nuclear security, safeguards, and peaceful uses of nuclear science and technology.

However, the effectiveness of this framework is constrained by uneven domestic implementation, persistent human and financial resource limitations, and increasing pressures arising from expanding nuclear energy ambitions, uranium mining, and widespread use of radioactive sources in medicine and industry. Reliance on short-term, project-based international assistance further undermines sustainability and institutional continuity.

Long-term nuclear security in Africa will therefore depend not only on maintaining legal commitments, but on strengthening implementation capacity, consolidating regional cooperation, and establishing predictable, African-owned financing mechanisms. If these challenges are addressed strategically, Africa can move beyond a recipient role to become an active contributor to shaping global nuclear security and non-proliferation norms.

Recommendations

1. Strengthening education, training, and nuclear security culture There is a pressing need to institutionalize nuclear security education and training across Africa, targeting both current practitioners and future professionals. Priority areas include: The expanded use of IAEA tools—such as hypothetical research reactor table-top exercises for insider-threat mitigation and nuclear material accounting and control—should be systematically integrated into regional training programs.

- Nuclear security culture for academic institutions and professionals handling radioactive sources
- Training-of-trainers (ToT) programs to ensure long-term sustainability and national ownership
- Specialized training in transport security for nuclear and radiological materials
- Dedicated security training for emerging nuclear power programs, including small modular reactors (SMRs)

2. Institutional development and regional coordination To consolidate gains and reduce fragmentation, Africa would benefit from the establishment of a structured, continent-wide platform for nuclear security qualifications, training, and professional certification. An "African Academy for Nuclear Security", operating in partnership with AFCONE, AFRA, FNRBA, and international partners, could play a central role in: Such an initiative would reinforce regulatory independence, professional mobility, and peer-to-peer cooperation across African states.

- Standardizing competencies for nuclear security specialists
- Harmonizing certification of transport and source-security professionals
- Supporting regulatory authorities with advanced technical training

3. Enhancing transport, source control, and incident reporting Given the widespread use of radioactive sources and expanding cross-border transport, African states should prioritize: Collaboration with international organizations such as NTI and WINS could support the development of a pan-African nuclear security performance and preparedness index, enhancing transparency and benchmarking.

- Harmonized transport security requirements and certification
- Strengthened national and regional registries for radioactive sources, including disused sources
- Development of interoperable incident-reporting mechanisms for nuclear and radiological materials outside regulatory control

4. Sustainable and diversified financing models Sustainable nuclear security cannot rely solely on external assistance. African states and regional institutions should pursue a diversified financing strategy that includes: Embedding nuclear security as an integral component of energy, infrastructure, and climate-finance projects will be essential to securing predictable, multi-decade funding.

- Dedicated national budget lines for nuclear and radiological security
- AU-anchored regional funding mechanisms under AFCONE oversight
- Long-term partnerships with the IAEA and development partners
- Innovative and blended finance models linking nuclear energy and fuel-cycle revenues to governance and security infrastructure

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