IAEA
International Atomic Energy Agency

Outlook for Nuclear Energy in Africa

G20
SOUTH AFRICA 2025

FOREWORD

The global energy landscape is changing as countries strive for energy security, economic development and prosperity, and ways to mitigate and adapt to climate change. Africa, vast in potential, is at a crucial juncture in its energy transition. Nuclear energy offers a proven, scalable and low-carbon path towards energy security. The IAEA is supporting countries across the continent that are looking to introduce nuclear energy, while putting safety, security, safeguards, the welfare of people and the environment first.

The timing is fortuitous. Africa is able to benefit from the growing global momentum behind nuclear energy. In 2023 at COP28, all 198 signatory countries of the United Nations Framework Convention on Climate Change (UNFCCC) agreed that investment in nuclear energy, among other low carbon energy sources, should be included in the Global Stocktake on the Paris Agreement. Dozens of countries have since joined a pledge to work towards tripling global nuclear capacity by 2050, and the IAEA's high case outlook now sees nuclear capacity expanding by more than 2.5 times compared with 2023 levels, to 950 gigawatts electric by mid-century.

With the growing interest in nuclear power in Africa and the recent decision by the World Bank to re-engage with nuclear energy for development, in partnership with the IAEA, countries now have a critical opportunity to access an expanding pool of global resources and support for their nuclear power ambitions. Drawing on the operating experience of South Africa, as well as several African countries that are actively embarking on new nuclear power programmes, this publication examines key considerations for integrating nuclear energy into national energy strategies.

Today, 31 countries operate nuclear power plants. They produce 9% of the world's electricity, meaning almost a quarter of global low carbon power comes from nuclear energy.

More than 30 other countries, most of them in Africa and the developing world, are considering or already introducing nuclear power, working with the IAEA to develop the necessary infrastructure to do it safely, securely and sustainably.

With its long history of cooperation with African countries, the IAEA is centrally positioned to support the continent during its energy transition.

Nuclear energy provides continuous baseload power, enhancing grid stability and resilience. Reliability is essential for sectors such as infrastructure, agribusiness, healthcare, tourism and manufacturing, and the livelihoods they support. Nuclear power itself is a source of high-skilled employment and stimulates investment across the broader economy. Able to adjust to changes in electricity demand, it enables greater integration of intermittent renewable energy sources such as solar and wind.

This forward-looking publication outlines the collaborative efforts between the IAEA and African countries in harnessing the full potential of nuclear energy for sustainable growth. I am confident this publication will help decision makers, policymakers, stakeholders and investors deepen their understanding of the transformative impact of nuclear energy.

IAEA Director General

RAFAEL MARIANO GROSSI

EXECUTIVE SUMMARY

Around 500 million people in Africa lack electricity, with the continent heavily relying on fossil fuels. To improve energy security and reduce emissions, many African countries are turning to nuclear power.

South Africa is the only African country with an operational nuclear plant. Egypt is building a four-unit plant, expected to be ready by 2028. Ghana, Nigeria and Kenya plan to adopt nuclear technology, and ten other countries are considering it.

By 2050, Africa's electricity capacity is expected to rise significantly. In a high case scenario, nuclear capacity could triple by 2030 and increase tenfold by 2050, requiring over US$100 billion. In a low case scenario, it could double by 2030 and grow fivefold by 2050.

The IAEA is assisting African countries in developing nuclear power infrastructure.

South Africa's 2025 G20 Presidency requested that the IAEA support the G20 Energy Transition Working Group with a publication on nuclear energy in Africa. This publication addresses the opportunities and challenges of deploying nuclear power throughout Africa, including financing, energy planning and infrastructure development. It also highlights the potential role of small modular reactors, which are suitable for small electricity grids and have lower capital costs.

1 operating NPP in South Africa

1 under construction in Egypt

13 African countries considering nuclear energy programmes

The IAEA is assisting countries in Africa to develop nuclear programmes.

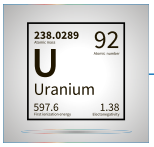
By 2050, Africa's total electrical generating capacity is expected to increase significantly.

< **IAEA Director General Rafael Mariano Grossi and Ambassador Matilda Aku Alomatu Osei-Agyeman, Permanent Representative of Ghana to the United Nations and Chairperson, at the Board of Governors Meeting held at the IAEA headquarters in Vienna, Austria, June 2025.**

Countries in Africa meaningfully contribute to the global uranium production (an indispensable raw material in the generation of nuclear energy), which can be leveraged for energy security. Moreover, South Africa's established nuclear supply chain could be used as a model for other African countries. Innovative financing methods and regional cooperation also are essential for attracting investment in nuclear projects. International monetary agencies such as the World Bank and African Development Bank could support infrastructure and project financing.

On 26 June 2025, the IAEA Director General Rafael Mariano Grossi signed a landmark agreement with World Bank Group President Ajay Banga to formalize a partnership in support of the safe, secure and responsible use of nuclear energy for development. This milestone marks the World Bank's first formal reengagement with nuclear power in decades and reflects growing global recognition of its role in supporting inclusive and resilient growth, particularly in countries seeking to meet rising energy demands.

The IAEA will continue to provide integrated support to African countries in their nuclear power development efforts. This support includes assistance with addressing infrastructure development, energy planning and financing challenges. The goal is to help African countries to safely achieve their nuclear power ambitions and improve energy security across the continent.



African countries are important producers of uranium.

> **IAEA Director General Rafael Mariano Grossi and World Bank Group President Ajay Banga during the signing of the agreement between the IAEA and the World Bank to support the safe, secure, and responsible use of nuclear energy (courtesy of the World Bank Group).**

> **IAEA Director General Rafael Mariano Grossi and HE Dr Kgosientsho Ramokgopa, Minister for Electricity and Energy of South Africa, during a bilateral meeting at the IAEA 68th General Conference held at the IAEA headquarters in Vienna, Austria, September 2024.**

CONTEXT

Most countries in Africa continue to experience shortages of energy, as approximately half a billion people lack access to electricity [1]. The continent currently is heavily reliant on fossil fuels for electricity production. As African countries make efforts to increase access and production of electricity, they continue to express their interest in using nuclear power and are working to integrate this technology into their energy mix. This integration could help to achieve energy security, reduce emissions and improve reliability and sustainability. Nuclear power is a proven technology that offers a clean, reliable, affordable and modern energy solution and has generated global interest, including in African countries.

Currently, South Africa is the only country on the continent operating a nuclear power plant (NPP). Egypt is constructing an NPP with four large units, and the first unit is expected to be operational in 2028. Other countries, such as Ghana, Nigeria and Kenya, have conducted their pre-feasibility studies and have made a firm decision to use nuclear technology for electricity production. Ten more countries are at various stages of consideration.

By 2050, the global landscape of nuclear energy capacity could be radically transformed. The projected total electrical generating capacity in African countries projects an increase of 47% by 2030 and an almost sevenfold increase by 2050 [2]. In the high case scenario, the nuclear electrical generating capacity is expected to more than triple by 2030 and to increase more than tenfold by 2050 compared with the 2022 total capacity. In terms of investment, reaching the high case scenario is likely to require more than US $100 billion. Alternatively, for the low case scenario, the nuclear electrical generating capacity is expected to approximately double by 2030 and to increase fivefold by 2050 compared with the 2022 capacity [2]. Despite this large projected growth, nuclear power is expected to contribute only 1.4–3.3% of the total electricity production in Africa compared with the current world average of 9.2% and with projections of 2–4.1% by 2050.

In support of African countries' renewed interest in nuclear power, the 2025 G20 Presidency (which is held by South Africa) requested that the IAEA develop a publication to support the G20

Energy Transition Working Group. This effort is a continuation of the IAEA's engagement under the 2024 Brazilian Presidency that reflected the unique role that nuclear energy plays in the energy transitions of African countries.

The publication presents an overview of the growing interest of African countries using nuclear energy to address energy security and mitigate climate change. It should be noted that about half of the newcomer countries that the IAEA is assisting are in Africa. The publication discusses the opportunities and challenges involved in deploying nuclear power in African countries (including the challenge of financing projects) and elaborates on the IAEA's technical assistance to these countries under the IAEA Milestones Approach [3]. Energy planning and specific infrastructure issues to be considered for an informed national position, financing mechanism options and approaches to human resources development are highlighted. In addition, the publication discusses the role of nuclear power as part of the national and regional energy planning activities across Africa, as well as the potential role of small modular reactors (SMRs) in the deployment of nuclear power in African countries, given the unique features of SMRs, such as suitability to small electricity grids, lower overall capital cost and multiple applications. An analysis of the associated nuclear supply chain with a focus on African countries is also presented. The publication is expected to also benefit other emerging markets and developing economies outside Africa.

Aerial view of Cape Town, South Africa

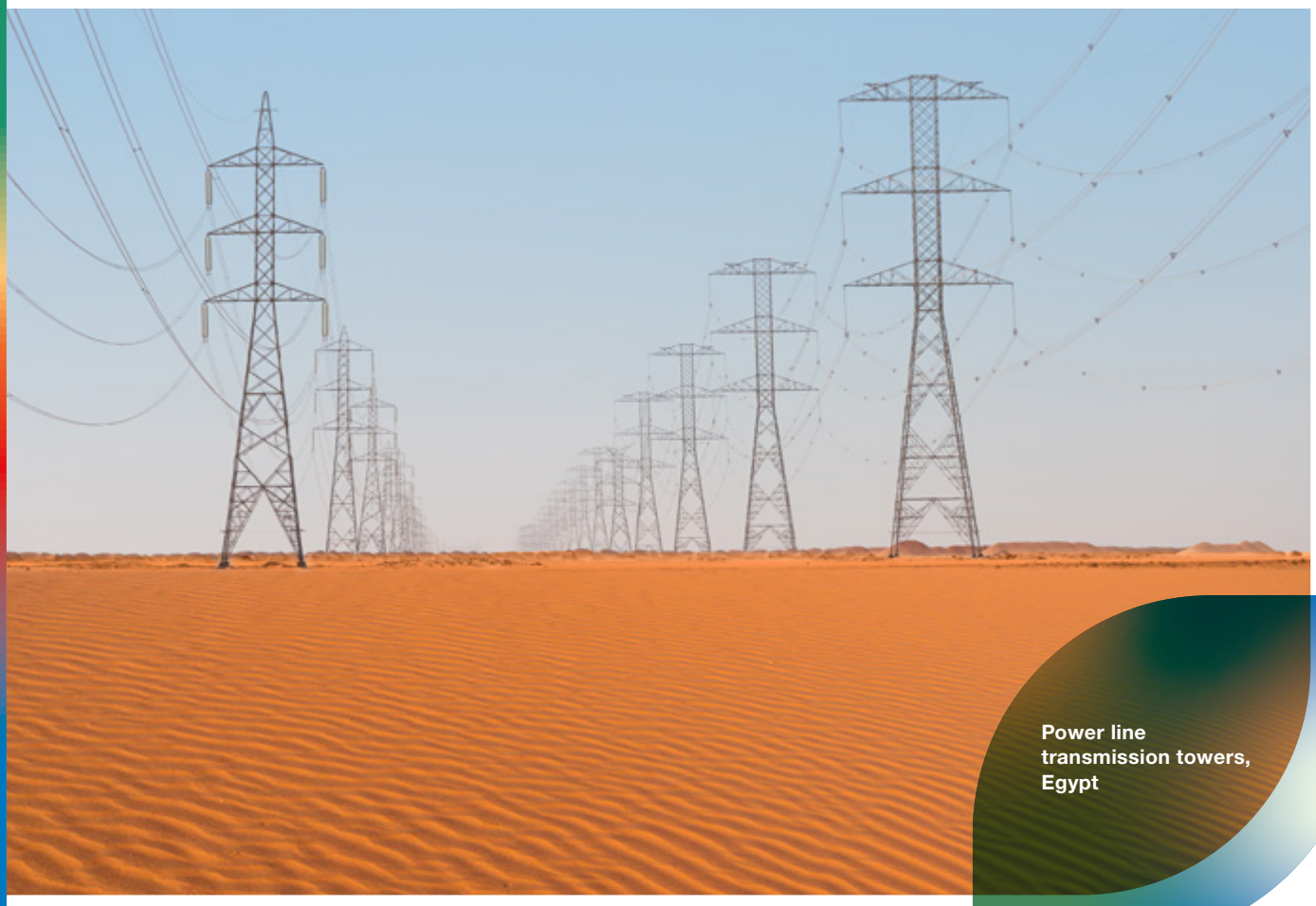
As countries in Africa make efforts to increase access and production of electricity, they look to integrating nuclear power into their energy portfolios, which would enhance energy security, reduce emissions and improve reliability and sustainability.

ENERGY SITUATION AND ENERGY PLANNING

Challenges on the Energy Horizon in Africa

Rapid population growth, urbanization and economic development are driving the future increases in energy demand on the African continent. The development of the energy sector to serve the increasing demand faces multiple, interwoven challenges. Access to electricity remains a significant challenge, with millions lacking reliable electricity supply [1]. Expanding electricity access while ensuring sustainability is complex, especially as countries balance energy sector requirements with other competing priorities. Affordability is another major challenge, as high costs of electricity and fuels hinder both individual consumption and industrial competitiveness. Infrastructure development and financing present critical obstacles, with insufficient investments in power generation, transmission and distribution networks. Many energy projects struggle to secure funding, further leading to delays and inefficiencies. Integrating and connecting energy systems across the continent remains challenging, and could limit access to diversified, affordable energy sources and hinder energy security.

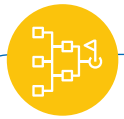
Sustained economic growth depends on overcoming these challenges and ensuring that power supply meets demand without compromising affordability or sustainability.



Power line transmission towers, Egypt

Enhanced Energy Planning Capabilities — A Step Towards Addressing Challenges

Data driven, functional and structured energy planning processes are indispensable tools for policy and decision makers in charting the futures of the energy sectors of African countries. Many countries in Africa need to alter their energy planning processes so as to address these challenges and identify viable and implementable solutions. A sound energy planning framework has the following components:



Data collection, statistics and energy balances:

Effective energy planning starts with high quality and up to date data on electricity access, demand patterns, resource availability and infrastructure conditions. Strengthening national energy information systems, leveraging geospatial mapping and promoting transparency in data sharing across agencies and regional institutions can support data collection.

Energy demand analysis:

Future energy needs are assessed using driving factors such as demographic trends, urbanization rates, economic and technological advancements and lifestyle changes. Bottom-up modelling approaches are used to estimate sector specific demand (residential, commercial, industrial, agricultural) and incorporate climate change impacts on energy consumption.

Energy supply analysis:

A balanced energy mix — integrating various types of power plants, can enhance energy security and sustainability (e.g. off-grid and mini-grid solutions could be used for initial electrification in rural areas, alongside centralized grid expansion). Investing in energy storages and flexible power systems could improve resilience of supply.

Infrastructure development and financing:

Large scale investments in power generation, transmission and distribution require mobilization of all types of public and private financing, blended financing models and regional funding mechanisms. Regulatory frameworks need to be attractive to private sector investment while ensuring affordability and reliability.

Integration of national and sub-regional power markets:

Strengthening regional power pools could improve efficiency and reduce costs by enabling cross-border electricity trade. Governments can harmonize policies, standardize grid codes, adjust market rules and invest in interconnection infrastructure.

Integrated planning with other sectors:

Energy strategies can be aligned with national development strategies and goals, ensuring that energy investments support education, healthcare, water supply, agriculture and industrialization. Holistic planning could optimize resource allocation and drive economic growth.

Improving energy planning through data driven decision making, diversified energy investments, regional cooperation and integrated development strategies could help African countries to achieve a sustainable, affordable and resilient energy future.

IAEA SUPPORT FOR ENERGY PLANNING IN AFRICA

The IAEA plays an important role in supporting African Member States in energy planning and nuclear power development. The IAEA offers a comprehensive capacity building programme through distribution of energy system assessment tools, technical expertise, policy guidance and tailored training programmes to help countries to identify their own energy strategies and develop the necessary infrastructure for the deployment of various energy options, including nuclear power.

The IAEA provides energy modelling tools that cover the overall energy planning cycle. The main tools include the following [4]:

- EBS (Energy Balance Studio): A software tool for the organization of data collection, energy statistics and compilation of energy balances.
- MAED (Model for Analysis of Energy Demand): A model used to analyze energy demand on the basis of economic, social, demographic and technological parameters.
- MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact): A modelling framework for energy supply analysis and scenario development.
- FINPLAN (Model for Financial Analysis of Electric Sector Expansion Plans): A tool used to analyze and assess the financial viability of power generation assets.

These and other tools from the IAEA's suite allow policymakers to compare different energy scenarios and determine the relative competitiveness and roles of energy options, including nuclear power.

The IAEA provides training programmes, fellowships and technical support to build and strengthen national expertise in energy planning. It collaborates with universities and research centres to enhance educational programmes. The IAEA continues to promote regional cooperation, including through the African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA).

For more than two decades, the technical cooperation (TC) programme of the IAEA has been supporting African Member States through national projects and a series of regional AFRA projects. The current regional project focuses on enhancing development through sub-regional cooperation and on achieving sustainability goals at lower costs and lower environmental impacts, by expanding large scale energy sources and quantifying benefits of sub-regional cooperation. Support in this area will continue in the future.

URANIUM RESOURCES

Uranium is a naturally occurring radioactive element and among the most common elements in Earth's crust. Uranium ore is mostly mined from open pits or underground excavation sites, which requires the ore to be crushed and refined to separate uranium from other elements. This method has been gradually replaced by 'in situ leaching', which involves leaving the ore in the ground and pumping liquids through it to recover the minerals out of the ore by leaching.

Examples of Uranium Exploration and Mine Development in Africa

An increase in uranium prices in 2023 led to a significant surge in exploration and development activities across the continent, with several projects advancing towards the final investment decision (FID) [5]. Thus, expenditures on uranium exploration and mine development in Africa made up approximately 9% of the global expenditure in 2023.

Historically, uranium production in **South Africa** has primarily been a by-product of gold mining and to a lesser extent, copper mining. Currently, uranium is obtained by processing reef material from the Moab Khotsong gold mine. The Moab Khotsong underground mine, located in northern South Africa, holds one of the largest gold and uranium reserves in the country, with total identified recoverable resources of 8360 t U.

In **Namibia**, exploration and development activities were undertaken between 2020 and 2023 both at existing mine sites and at new uranium mine sites. The previously idled Langer Henrich mine was reopened in 2024, with mining scheduled to resume in 2026. In addition, a new project under the operation of Bannerman Mining Resources Namibia is estimated to start uranium production in 2028.

In the **United Republic of Tanzania**, identified uranium resources of 58 500 t U (47 900 t U reasonably assured resources and 10 600 t U inferred resources) have been confirmed. In 2020, Mantra Resources of the United Republic of Tanzania decided to construct a pilot processing plant to initiate a small scale open pit mining and processing pilot operation for extraction by in situ leaching. By 2022, Mantra Resources had obtained all necessary approvals for construction by 2023, construction was completed, and the pilot processing complex equipment was installed. The commencement of operations is pending final regulatory approval.

Uranium Production in Africa

In 2022, **Namibia** ranked third among countries that produced the world's uranium (see Fig. 1) [5]. **Niger** and **South Africa** are ranked seventh and tenth, respectively. The countries with the largest uranium production are Kazakhstan, Canada, Namibia, Australia, Uzbekistan, the Russian Federation, Niger, China, India and South Africa, by order of production.

14%

of global uranium production is from countries in Africa.

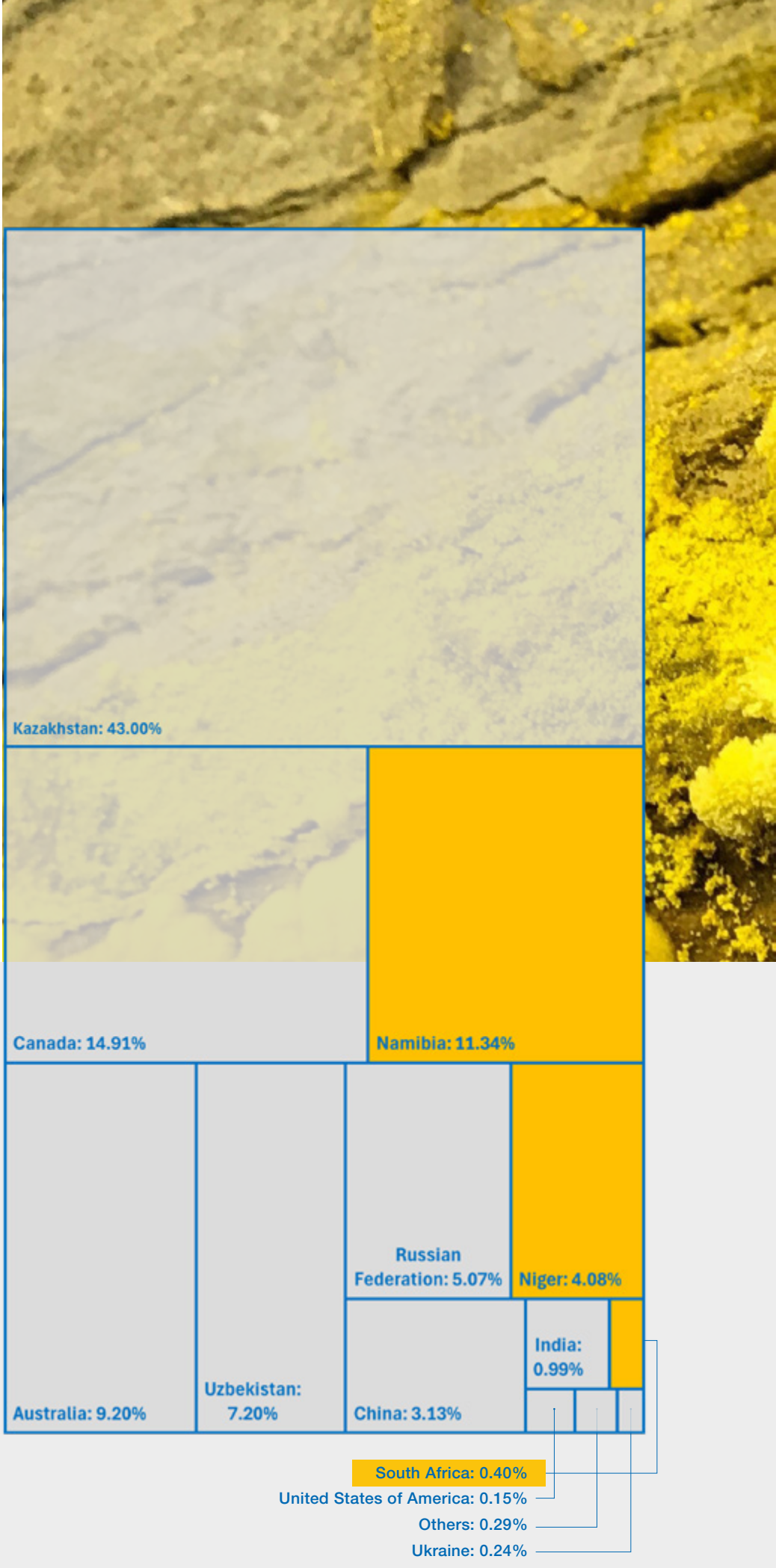


Fig. 1. Global distribution of uranium production [5].

IAEA SUPPORT IN URANIUM PRODUCTION IN AFRICA

The IAEA provides assistance to Member States that are considering exploring uranium resources in their countries through the IAEA Milestones Approach to develop a national infrastructure for the uranium production cycle. Using this approach, the IAEA has supported many countries, including African countries, in the development of the needed infrastructure to support their uranium exploration and production cycle.

In May 2024, the IAEA conducted an Integrated Uranium Production Cycle Review mission in Uganda to assess Uganda's Milestone 1 infrastructure readiness for uranium production. The mission proposed some recommendations, suggestions and good practices for Uganda, as the country considers uranium exploration. In December 2024, the IAEA also organized under the TC Project RAF2014 (Enhancing Regional Capabilities for Sustainable Uranium Exploration and Mining (AFRA)) a meeting to determine the level of uranium production cycle development of African Member States and to discuss and coordinate project activities for 2025 and beyond. Furthermore, the IAEA provided some technical training workshops during 2023 and 2024 in various African countries that covered topics ranging from uranium exploration to nuclear fuel cycle best practices. A fifth hands-on workshop about uranium exploration techniques was held in June 2025 in Lusaka, Zambia.

Uranium Demand in Africa

Nuclear capacity has remained constant in Africa, with the region's only operational nuclear power plant located in South Africa. However, prospects of the use of nuclear power in other African countries look promising, as governments plan to include nuclear power in their energy mix. Egypt is currently constructing a four-unit NPP facility, with the first unit projected to be commissioned in 2028. Several countries have expressed interest in recent years in developing nuclear power for electricity generation and desalination, including Algeria, Ghana, Kenya, Morocco, Namibia, Niger, Nigeria, Rwanda, Senegal, Tunisia, Uganda, the United Republic of Tanzania and Zambia. The demand for uranium on the continent is projected to increase in the coming decade.

NUCLEAR POWER PROSPECTS

As of May 2025, 417 nuclear reactors are operational worldwide, with a total net installed capacity of 377 221 MW(e). The IAEA publication Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 [2] provides comprehensive estimates and projections for energy, electricity and nuclear power trends up to 2050. It includes data and analysis at global and regional levels, considering various high and low case scenarios to account for uncertainties in future developments. The analysis shows that by 2050, nuclear power capacity is projected to increase, with new reactors being constructed and existing ones undergoing life extensions.

Nuclear Power Prospects in Africa

The nuclear power prospects of African countries are gaining momentum, as several countries explore the nuclear power option to meet their growing electricity demands, diversify their energy mix, achieve energy security, reduce carbon emissions and support sustainability and energy affordability, which drives industrial growth. Almost half of the newcomer countries seeking to add nuclear power to their generation mix are African countries. Some recent nuclear power programme developments on the continent based on both large NPP and SMR technologies are shown below.

The IAEA continues to support its Member States that are considering nuclear power as part of their energy mixes. The diagram shows various African countries and the nuclear programme phases that they are currently in according to the IAEA Milestones Approach [3].

Major Nuclear Programme Developments in Africa

South Africa

Currently, South Africa is the only African country with an operational nuclear power plant. The Koeberg Unit 1 Long Term Operation licence was granted in 2024, allowing the Koeberg Nuclear Power Station to extend the unit's operational life by 20 years. In addition, South Africa's Department of Mineral Resources and Energy (DMRE) Integrated Resource Plan of 2023 aims to add 2500 MW(e) of new nuclear capacity including SMRs after 2030, which has been approved by the National Energy Regulator of South Africa (NERSA).

Egypt

The Government of Egypt is constructing a four-unit, 4.8 GW NPP. Following the issuance of construction licences, work is underway on all four units. The first concrete pouring for Unit 4 was completed during the first quarter of 2024. In 2023, the core catchers for both Unit 1 and Unit 2 were installed. Construction of the inner containment building for Unit 1 is ongoing, while work on the inner containment building of Unit 2 began in 2024. In 2025, the regulatory authority granted permission to establish a spent fuel storage facility. The first unit of the four-unit NPP facility is expected to be completed by 2028.

The phases of nuclear programmes according to the IAEA Milestones Approach.

The completion of each phase is marked by a milestone.

	OPERATING	South Africa
Activities to implement the first NPP have been done.	**PHASE 3**	Egypt
Preparatory work for the contracting and construction of an NPP after a decision has been taken.	**PHASE 2**	Ghana • Kenya • Nigeria
Considerations before a decision to launch a nuclear power programme is taken.	**PHASE 1**	Algeria • Ethiopia • Morocco • Niger • Senegal • Rwanda • Sudan • Tunisia • Uganda • Zambia
	PRE-PHASE 1	Burkina Faso • Cote d'Ivoire • Djibouti • Guinea • Madagascar • Namibia • United Republic of Tanzania • Togo • Zimbabwe

Kenya

In 2012, Kenya established the Nuclear Energy Programme Implementing Organization (NEPIO) to evaluate the potential introduction of nuclear energy to meet the country's national development objectives. In 2020, the Kenyan Nuclear Regulatory Authority (KENRA) was established as an independent regulatory body, responsible for regulating nuclear and radiological material in the country. In 2022, Kenya re-evaluated its roadmap and announced that the commercial operation of the first NPP would start in 2038. The country has resolved to also explore SMRs in response to the lower than expected electricity demand and financial constraints. The country is seeking to establish the future owner/operator organization soon.

Ghana

Ghana established the Ghana Nuclear Power Programme Organization (GNPPO) under the Ministry of Energy in 2012 as the country's NEPIO to study the possibility of introducing nuclear power. The GNPPO is supported by the Nuclear Power Institute of the Ghana Atomic Energy Commission. Subsequently, in 2015, Ghana established the Nuclear Regulatory Authority (NRA), the regulatory body with the responsibility for nuclear safety, security, safeguards and civil liability.

In 2018, Ghana established Nuclear Power Ghana, which has been designated as the future owner/operator for the first NPP.

Nigeria

Nigeria's NEPIO is represented by the Nigeria Atomic Energy Commission (NAEC). The Nigerian Nuclear Regulatory Authority (NNRA), which was established by the amended Nuclear Safety, Physical Security and Radiation Protection Act 19 of 1995, is empowered to regulate all practices related to safety, security and safeguards for nuclear power.

SMALL MODULAR REACTOR TECHNOLOGY

Small Modular Reactors Introduce Innovation to the Nuclear Industry

Small modular reactors typically have a power capacity of up to 300 MW(e) per unit and can be shop fabricated and transported as modules to be assembled on site. SMRs can rely on a variety of technologies, from proven water cooled reactors to more innovative metal cooled, gas cooled or molten salt reactors. Some reactors that are not water cooled use fast neutrons. The IAEA 2024 SMR catalogue [6] states that there are 68 active SMR designs (see Fig. 2).

The innovation of SMRs comes from the novel approach to rely on mass-produced systems and components, thus reducing their costs and the construction risks compared with a traditional construction site. The idea is to compensate for the loss of economies of scale due to their small sizes by achieving economies of series by producing SMRs on an assembly line, similarly to what is done for cars or aircraft.

Potential Benefits of SMRs

SMRs can bring the following potential benefits, which are especially appealing to African countries:

- **SMRs are easier to finance by mobilizing smaller amounts of upfront capital when compared to large NPPs.**
- **The smaller outputs of SMRs make them more suitable for smaller grids.**
- **The modular designs of SMRs have the potential to enable quicker deployment.**
- **In the series roll-out of smaller modules, the first module could be operational and start earning revenue to reduce the financing costs of subsequent SMRs.**
- **SMRs are generally designed to be more flexible and could serve remote areas with no grid infrastructure or serve mining operations while also providing process heat or cooling, in addition to power generation.**
- **The SMR infrastructure may not be as extensive as that of large NPPs, which could be desirable for a host country that still needs to establish a nuclear infrastructure.**

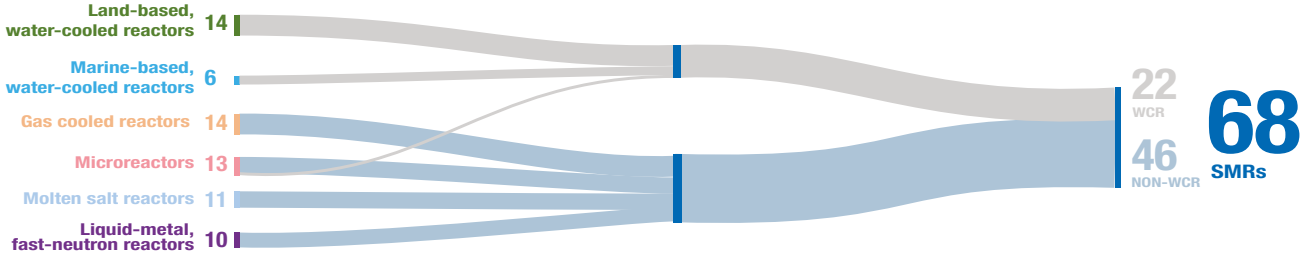


FIG. 2. SMR designs with active development projects as of October 2024 (WCR is water cooled reactor).

SMRs have generated a high level of interest in both expanding and embarking countries. This is reflected in the high number of SMR designs under development. Figure 3 shows the status of development and deployment of SMRs.

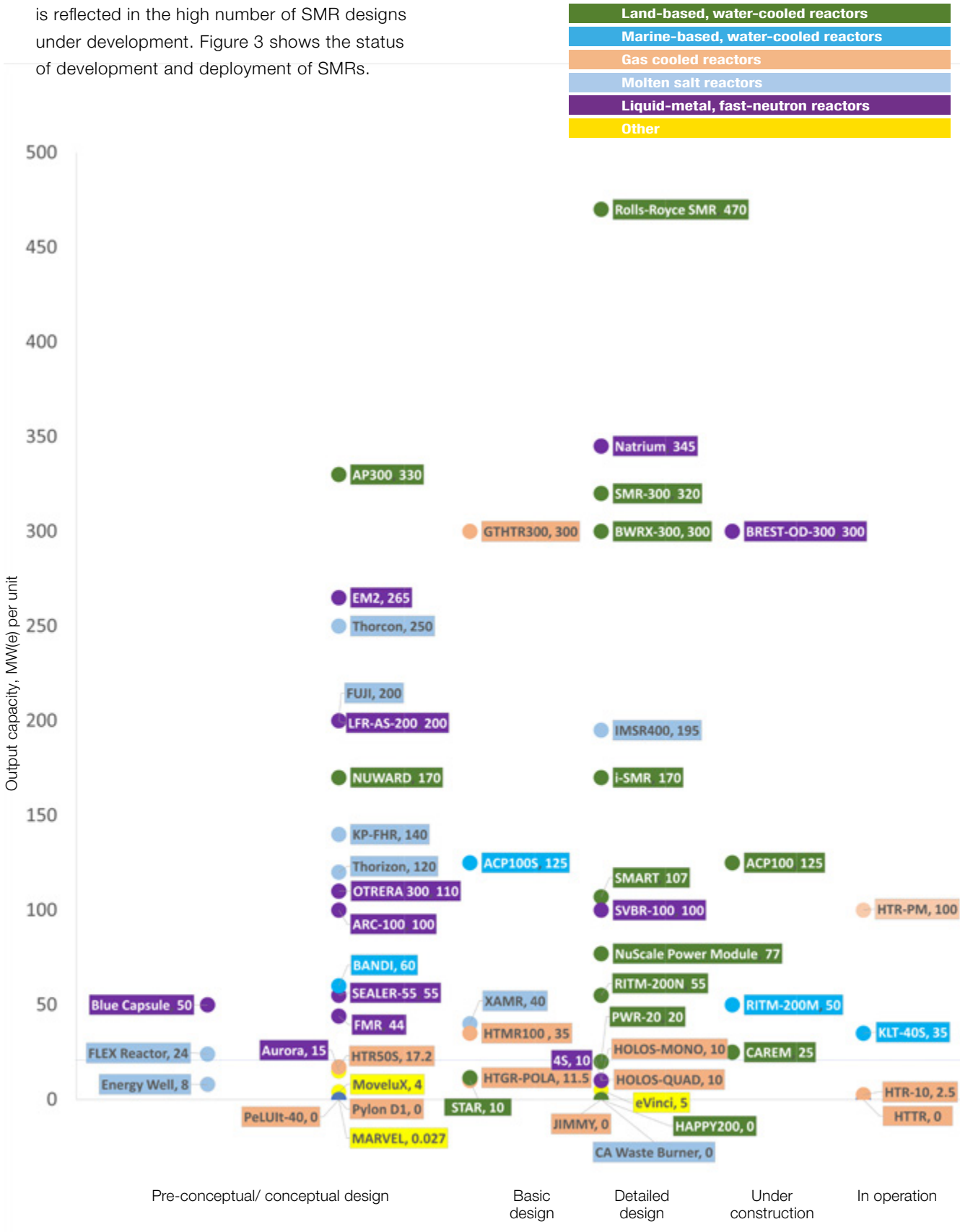


FIG. 3. Status of development and deployment of SMRs. Note: The value displayed with the design refers to the output capacity in MW(e) per unit.

As shown in Fig. 3, currently only two SMR designs are in operation in addition to two high temperature test reactors.

- In the Russian Federation, the Akademik Lomonosov floating NPP with two KLT-40S reactors of 35 MW(e) each was connected to the grid in December 2019 and began operation in May 2020 in the Chukotka region.
- In China, the two-unit demonstration HTR-PM at the Shidaowan site was connected to the grid in December 2021 and started commercial operation in December 2023.

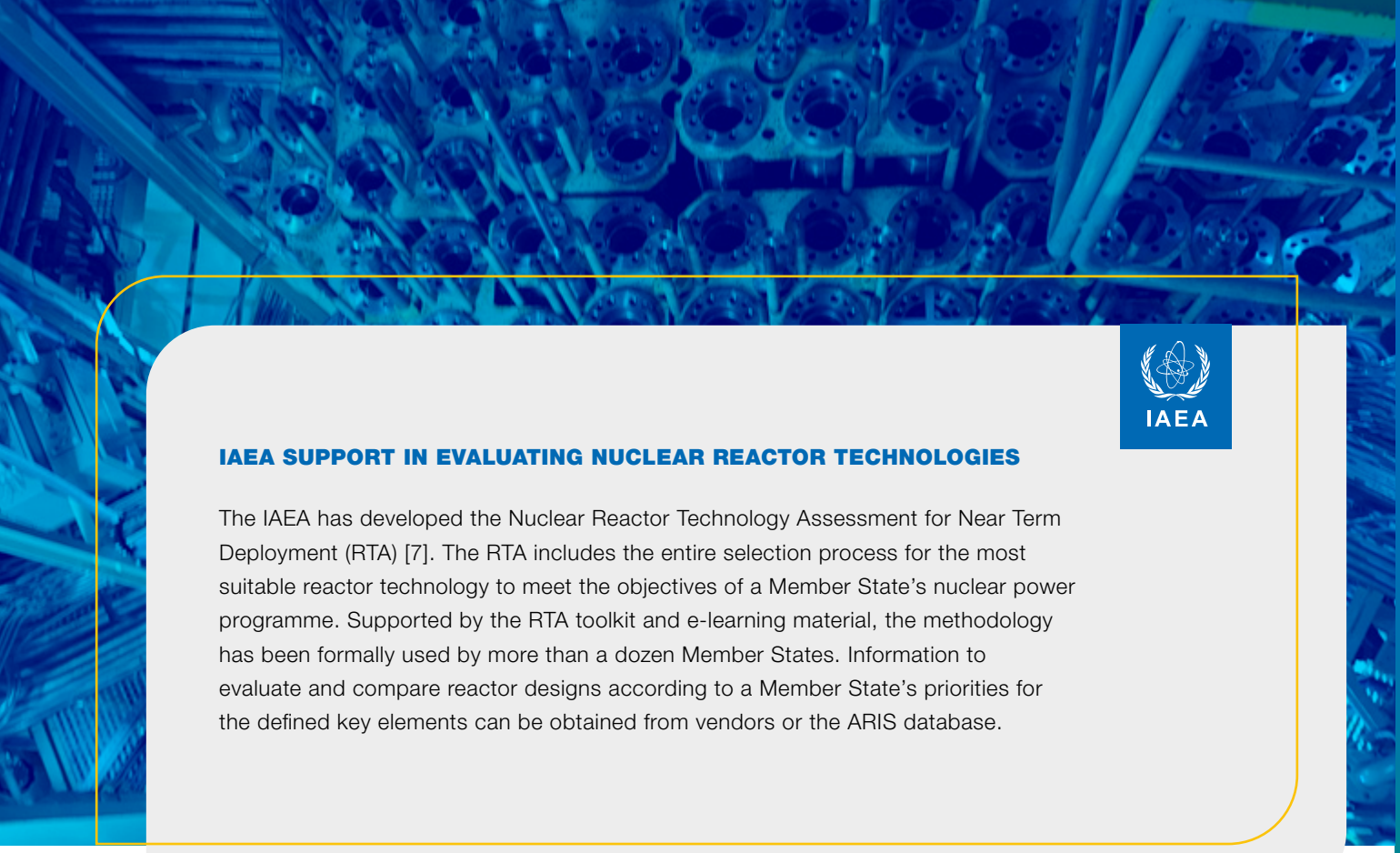
Both designs are in operation as commercial demonstration plants. It should also be noted that Japan has been operating a High Temperature Test Reactor (HTTR) since the late 1990s that generates a thermal power of only 30 MW. The HTTR is used to prove the concept of SMRs with high temperature gas cooled technology for nuclear hydrogen production.

There are several competing designs that are expected to be commissioned at the end of this decade or at the beginning of the next.

The IAEA's Advanced Reactor Information System (ARIS) database contains descriptions of nuclear reactor designs from around the world, including evolutionary technologies and innovative new models, and contains detailed descriptions of the leading SMR designs.

Access the Advanced Reactor Information System (ARIS).

IAEA Director General Rafael Mariano Grossi delivered remarks at the International Conference on Small Modular Reactors (SMRs) held at the IAEA headquarters in Vienna, Austria, October 2024.



IAEA SUPPORT IN EVALUATING NUCLEAR REACTOR TECHNOLOGIES

The IAEA has developed the Nuclear Reactor Technology Assessment for Near Term Deployment (RTA) [7]. The RTA includes the entire selection process for the most suitable reactor technology to meet the objectives of a Member State's nuclear power programme. Supported by the RTA toolkit and e-learning material, the methodology has been formally used by more than a dozen Member States. Information to evaluate and compare reactor designs according to a Member State's priorities for the defined key elements can be obtained from vendors or the ARIS database.

SMRs can be expected to be deployed in large numbers after the mid-2030s, when the first of a kind units are commissioned and operated, and a global supply chain is established.

The main challenges of adopting SMRs for newcomer countries are identified as follows:

- Establishing the regulatory body in the host country and licensing SMR technology creates challenges that cannot be solved without support from a regulatory body with a licensing experience. Hence, first of a kind units need to be built in experienced countries first.
- For SMRs to be competitive, some level of harmonization of regulatory requirements is needed to minimize design modification on a project by project basis, thus enabling reliance on mass production of modules.

In response to these challenges, the IAEA has launched the Nuclear Harmonization and Standardization Initiative (NHSI)[1] to foster international pre-licensing of SMR designs and to document how a regulatory body can leverage the information from other regulatory bodies that have licensed similar SMRs in their own countries. Work with the industry is also ongoing and focused on identifying processes and establishing common approaches that facilitate the deployment of SMRs to foster a global ecosystem that supports the accelerated, sustainable and safe deployment of SMRs.

[1] https://nucleus.iaea.org/sites/smr/SitePages/Nuclear-Harmonization-and-Standardization-Initiative.aspx

NUCLEAR POWER INFRASTRUCTURE DEVELOPMENT

The IAEA Milestones Approach

A nuclear power programme is a major undertaking, and the development of a sound infrastructure that provides the basis for a safe, secure, peaceful and sustainable programme is required. Therefore, introducing nuclear power in the national energy mix needs to be in parallel with a commitment to develop the associated infrastructure for NPPs — from 'hard' infrastructure, such as NPP site supporting facilities and grid enhancements, to 'soft' infrastructure, such as adequate legal, regulatory and institutional frameworks.

To support countries interested in nuclear power, the IAEA published the **Milestones Approach** [3], a comprehensive and phased management guide for developing the national infrastructure for a nuclear power programme, which is relevant whether a country is considering large NPPs or SMRs.[2] The publication describes 19 issues to be considered when developing the national nuclear power infrastructure, three phases to be completed for developing this infrastructure and three milestones to be reached at the end of each phase.

IAEA Support for Nuclear Power Infrastructure Development

The IAEA supports Member States with their plans to introduce nuclear power and to develop an adequate infrastructure to this end, on the basis of the IAEA Milestones Approach. The following chart shows how infrastructure support is provided through modalities in addition to guidance materials and tools[3].

IAEA infrastructure support modalities

- **Integrated Nuclear Infrastructure Training (INIT),** which is a comprehensive programme of training courses and workshops offered to embarking countries under the IAEA interregional TC[4] projects addressing the 19 infrastructure issues, including SMRs.[5]
- **National infrastructure support activities,** such as scientific visits, fellowships, national workshops and expert missions for all infrastructure issues. For countries having hosted an Integrated Nuclear Infrastructure Review (INIR) mission, these activities are coordinated through the Integrated Workplan mechanism. These activities are primarily funded through national TC projects.
- **Integrated Workplan,** which is a strategic planning framework jointly developed by the IAEA and the Member State that defines the IAEA's integrated activities to support the country's nuclear power infrastructure development.
- **Integrated Nuclear Infrastructure Review Service** [8], which is an IAEA peer review service to assist Member States in evaluating the status of their national nuclear infrastructure on the basis of the IAEA Milestones Approach and the associated 19 infrastructure issues.

[2] The 2024 revision of the Milestones Approach includes an Annex on Infrastructure Considerations for SMRs.
[3] https://www.iaea.org/topics/infrastructure-development/bibliography
[4] https://www.iaea.org/services/technical-cooperation-programme
[5] For the 2024–2025 TC cycle, these projects are INT2024, "Supporting Member States Introducing or Expanding Nuclear Power Programmes to Develop a National Infrastructure for a Safe, Secure and Peaceful Nuclear Power Programme", and INT2023 "Supporting Member States' Capacity Building on Small Modular Reactors and Micro-reactors and their Technology and Applications as a Contribution of Nuclear Power to the Mitigation of Climate Change".

The IAEA's assistance is tailored to each country's respective phase and priorities for infrastructure development. Since 2007, in order to cater to the needs of the increasing number of countries expressing interest in nuclear power for the first time, the IAEA's cooperation has also focused on enabling an early engagement with these countries. These tailored activities have proved very effective in accelerating preliminary considerations and initial steps, such as awareness and understanding of the IAEA Milestones Approach, national coordination, and the establishment of NEPIO to conduct the activities and studies needed during Phase 1. A dedicated project funded through the **Peaceful Uses Initiative**[6] (PUI) provides the framework for supporting Member States that do not yet have a national TC project.

[6] https://www.iaea.org/services/key-programmes/peaceful-uses-initiative/

IAEA SUPPORT AND INIR MISSIONS TO AFRICAN NEWCOMER COUNTRIES

Of the approximately 55 countries that have expressed interest in nuclear power and that are at various stages of considering or embarking in their first nuclear power programmes, twenty two are in Africa. According to the IAEA Milestones Approach and its evaluation methodology [9], ten African countries can be considered to be in the decision making phase regarding a nuclear power programme, while four have already made the decision to embark on such a programme or are actively preparing for it. Furthermore, eight countries in the region are in the preliminary stages of considering nuclear power. The IAEA is actively working with African newcomer countries, as reflected in the following details:

- During 2018–2024, there were 1105 participants from 25 African countries in INIT events.
- In the 2024–2025 TC cycle, eight African countries have national projects focusing on nuclear power infrastructure development.
- Fifteen Integrated Workplan meetings were held with African countries during 2022–2024.
- As of March 2025, 11 INIR missions have been conducted in nine countries in Africa, with two other INIR missions planned for 2026.
- The IAEA's support activities have been implemented or are planned for seven African countries under the PUI project.

Phase 1 INIR missions have been conducted in the region in the following countries: Ghana (2017), Kenya (2015), Morocco (2015), Niger (2018), Sudan (2018) and Uganda (2021). Other Phase 1 INIR missions on the continent are planned for 2026 after receipt of official requests from Rwanda and Zambia.

Phase 2 INIR missions have been conducted in the region in the following countries: Egypt (2019), Nigeria (2015) and South Africa (2013). These INIR missions [10] identified some of the political, financial and technical considerations that could have impacts in achieving progress in developing national nuclear infrastructures and that could cause delays in the planned timelines for implementation of nuclear power programmes. Maintaining a national position for the nuclear power programme amidst political changes, developing a financial strategy that makes the programme interesting for investors, addressing grid capacity limitations and establishing mechanisms for retaining trained staff are among the factors and challenges identified.

No Phase 3 INIR missions have been conducted in Africa. However, with NPP construction having started in Egypt, important experience for the region on Phase 3 activities is likely to be obtained in the near future.

IMPORTANCE OF GOVERNMENT POLICIES

Providing National Leadership to Ensure Coordination and Broad Political and Public Support

The benefits of nuclear power are particularly compelling for countries with increasing energy demands, costly or unpredictable alternatives, and significant concerns about energy security, climate change and environmental protection.

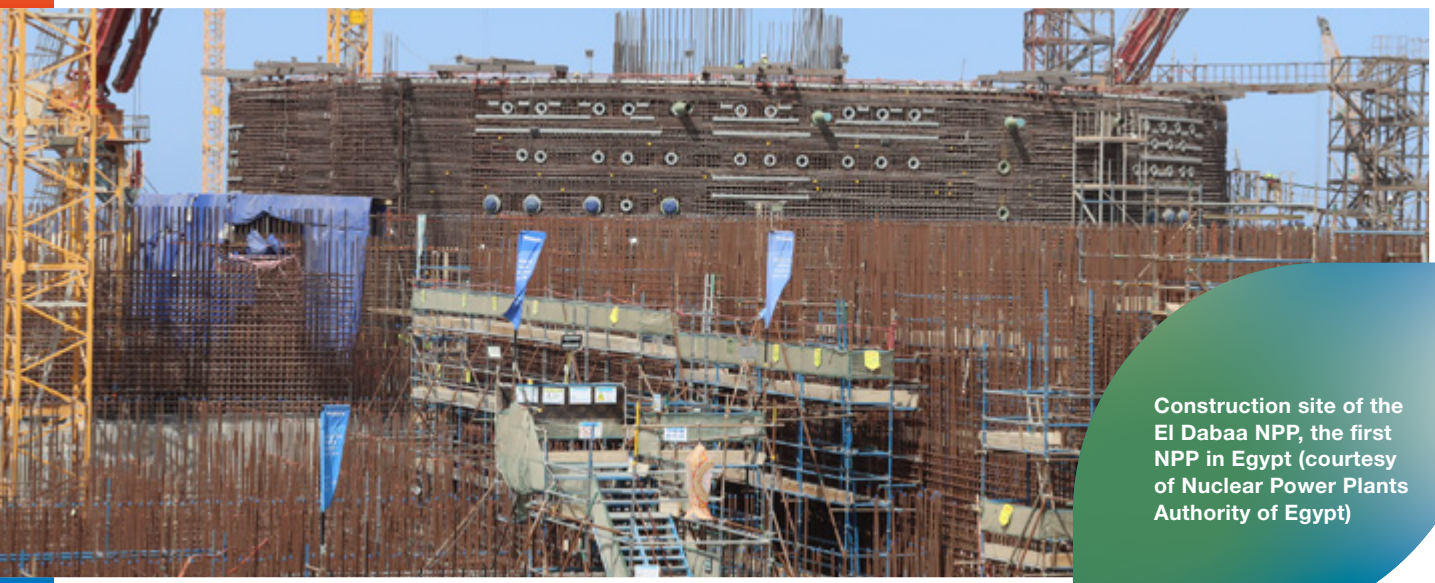
National leaders must present the case for nuclear power to the public, industry and stakeholders for it to be successful [11]. They should effectively communicate the benefits of nuclear energy and outline how governments will ensure safety, security and non-proliferation.

A successful nuclear power programme demands a national commitment spanning at least 100 years. Establishing the necessary infrastructure and constructing the first NPP requires robust national leadership to ensure coordination and widespread political and public support, as interruptions and restarts can be highly detrimental.

Establishing National Policies to Provide Directions to the Implementing Organizations

Nuclear energy has proved to be a dependable, sustainable and eco-friendly source of energy, capable of providing affordable energy even for future generations. Its utilization could be advantageous and sustainable, with due consideration for the safety of people and the environment, non-proliferation and security.

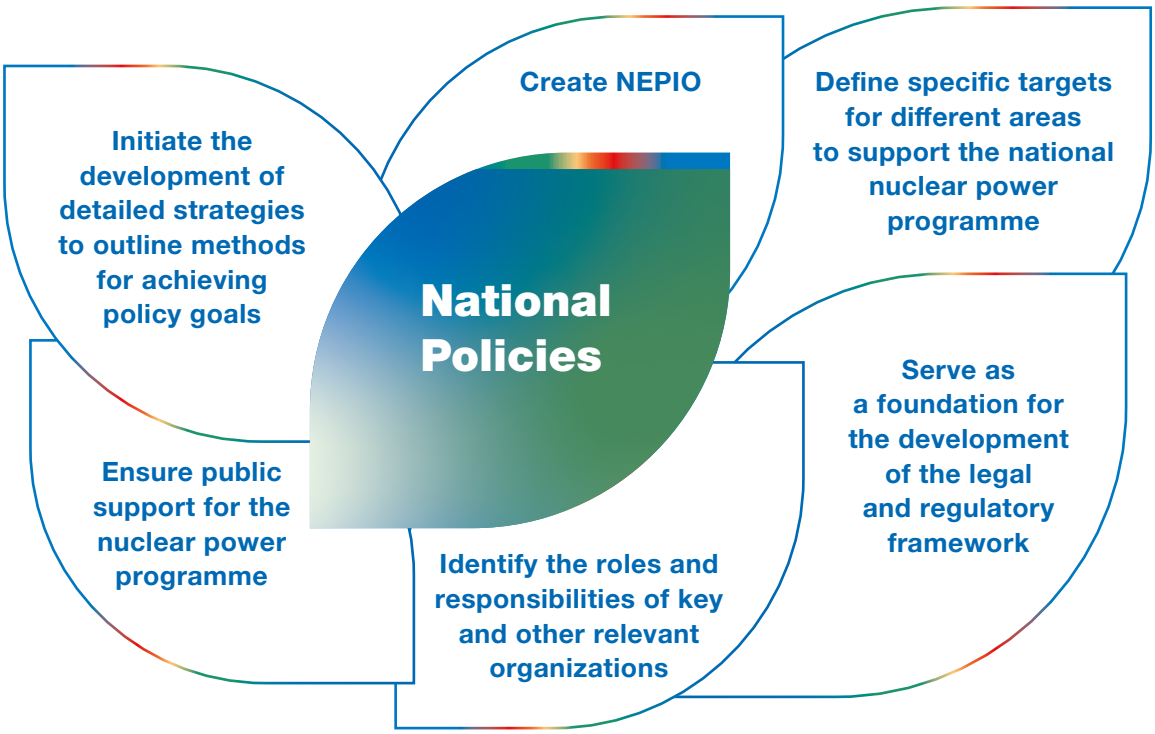
Maximizing the benefits, minimizing the costs and environmental impacts, and ensuring sustainability requires following sound policies and strategies set by the government at national level. The government needs to establish an overall nuclear power policy to inform all organizations about the objectives of the nuclear power programme and guide them through the implementation of the nuclear programme. The directions given in the national nuclear power policy will then be used to establish supplementary policies and strategies in different areas such as nuclear safety, nuclear security, radioactive waste management, nuclear fuel cycle including spent fuel management, industrial involvement and human resources development.



Construction site of the El Dabaa NPP, the first NPP in Egypt (courtesy of Nuclear Power Plants Authority of Egypt)

Role of National Policies

National policies across various areas can establish the goals necessary to support the overarching objectives of the nuclear power policy. These policies can be employed to support several activities, as displayed in the figure.



Important Attributes of National Policies

National policies need to align with the objectives of the nuclear power policy, contributing to its justification and ensuring the programme's sustainability. As examples, these policies should address the following:

SAFETY AND SECURITY	Facilitate participation in global nuclear safety and security regimes, thereby enhancing the programme's credibility on the international stage.
HUMAN RESOURCES DEVELOPMENT	Support the enhancement of national educational capabilities to create a pipeline of engineers and technicians for the nuclear sector.
RADIOACTIVE WASTE MANAGEMENT	Ensure the long term management of radioactive waste without imposing undue burdens on future generations.
NUCLEAR FUEL CYCLE	Aim to efficiently utilize national resources, if available.
INDUSTRIAL INVOLVEMENT	Attract local industries to participate in the NPP project's supply chain, thereby boosting the country's economic benefits.

REGIONAL APPROACH TO NUCLEAR POWER DEVELOPMENT

African Power System and Market Size

It is assumed that developing a single electricity market can accelerate the various nuclear power programmes, as there is a huge demand to be met. African power systems are broadly divided into five sub-regions or power pools based on economic blocs. The most advanced power pool operations are in the southern area of Africa (SAPP). The northern part of the continent also has relatively large, stable and interconnected systems.

The Africa Single Electricity Market (AfSEM) is a targeted intervention aimed to facilitate sustainable development of the African electricity sector through the integrated continental electricity market [12]. The initiative started in 2015 by the European Union through the Africa Union programme on Harmonisation of Regulatory Frameworks for the Electricity Market in Africa.

The AfSEM is designed to bring greater energy security, sustainability and competitiveness to the African Union Member States. The AfSEM will be the largest single electricity market in the world, covering a continent with a total current population of over 1.3 billion [13]. The development of a single market and the integration of power systems at the continental level will enable the integration of large scale power generation projects, which can be a deciding factor for countries to choose nuclear power.

One of the biggest technical challenges in terms of nuclear power integration into a national power system is the size and strength of the national grid. Relatively large production units, such as NPPs, require stable system operation and various backup options and redundancies at transmission and generation levels.

Creation of a single electricity market coupled with increased interconnectivity and strong electricity demand will catalyze the deployment of all available and sustainable power supply options in Africa. An interconnected African system of the future will be able to integrate large scale units, and nuclear power can provide stable generation and support system reliability. In contrast, the expected availability of SMR technologies could be beneficial for smaller systems, both in terms of logistics and securing necessary funding and financing for these projects.

Ocean view of Koeberg NPP near Melkbosstrand, South Africa

IAEA SUPPORT IN DEVELOPING STRATEGIC PLANNING THROUGH EDUCATIONAL PROGRAMMES

Nuclear energy programmes should have long term commitment involved, with obligations that extend well beyond 100 years. The IAEA assists Member States in developing capacity in strategic planning for nuclear energy programmes. Furthermore, several universities offer high quality programmes in nuclear science and engineering, covering the fundamental and technical aspects of nuclear energy. However, to effectively utilize nuclear energy, studies must also address areas such as economics, infrastructure, environment impacts, safety and waste management. The IAEA has developed a model curriculum for university level courses covering topics related to strategic planning for sustainable nuclear energy. The introduction of courses based on the model curriculum in the educational process will contribute to the expansion and deepening of knowledge about the long-term sustainability aspects of nuclear energy systems in newcomer countries.

Regional Cooperation

The decision to deploy nuclear power and start a nuclear power programme is a sovereign right of a country. This decision also means responsibility and engages all parts of the society on a journey that will last for generations.

Regional cooperation could help countries to share costs by developing joint NPPs while maximizing infrastructure benefits across multiple countries. Additionally, stronger bargaining power as a result of regional cooperation can enable African countries to negotiate better financing terms with international partners, ensuring more favourable conditions for development. Regional integration is crucial for large scale energy transformation, as organizations such as the West African Power Pool and Eastern Africa Power Pool are working to reduce electricity costs. By working together, African countries can accelerate the deployment of nuclear power, making it more accessible and sustainable for the future.

Regional cooperation in developing a nuclear power project in the context of African countries could be an important accelerator. While the main tasks and regulatory responsibility remain within the control of the project host government, collaboration in various aspects of the nuclear power deployment can be shared among neighbouring countries or within a sub-region. This encompasses development of human resources, power system integration, joint funding and financing, power take-off agreements, regulatory alignments, cooperation on safety and security topics, industrial involvement, emergency planning and public acceptance campaigns. Several African Member States have previous experience in joint development of larger scale projects, such as the shared hydropower potential of certain river basins, swap contracts for physical assets and energy, or construction of transmission lines, among various countries. This experience and practice can be reused to upscale generation capabilities in African countries through nuclear power.

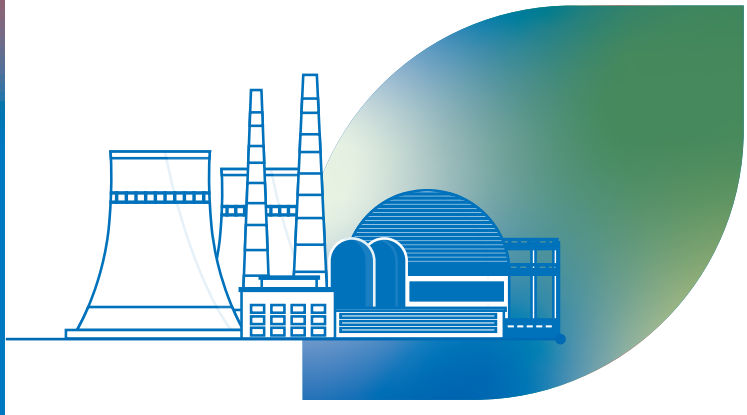
FINANCING NUCLEAR POWER

Nuclear energy projects, like other large infrastructure projects, must prove bankability by mitigating financial risks and taking proactive steps to ensure cost effectiveness.

De-risking Nuclear Power Projects

The commitment to build multiple NPPs within a single country or as a shared effort across a region can help lead to predictable construction schedules and costs. A strong government-led commitment to a pipeline of nuclear reactors can help to build robust supply chains and a skilled nuclear workforce, all contributing to lowering both capital costs and the cost of capital over time. Furthermore, including nuclear energy in sustainable taxonomies and fiscal policy can also catalyze commercial bank involvement, with multilateral development banks playing a supportive role. Additionally, securing power purchase agreements with high volume energy users can also guarantee revenue streams over extended periods, enhancing project bankability.

Unlocking private sector capital is essential, and multilateral development banks can help to mitigate perceived financial risks by the private sector to increase the financing available to nuclear energy projects. Several financial mechanisms could provide additional risk mitigation to make nuclear projects more attractive to private sector capital. These include loan guarantees that could come from project sponsors or multilateral financing institutions and insurance coverage from export credit agencies or the private insurance market (e.g. with political risk insurance).



Financing Clean Energy

Clean energy investments on the continent account for approximately 2% of the global total [14] and are constrained by rising debt burdens and low sovereign credit ratings. Scaling up clean energy investment requires substantial external financial support to overcome economic risks, debt burdens and structural constraints that limit private investment. It requires concessional financing, risk mitigation strategies and increased international support, along with clear national policies and strong climate commitments. In addition to existing funds and commitments from the World Bank and the African Development Bank, innovative financial solutions are needed to avoid excessive debt.

World Bank and other Multilateral Banks' Policies

On 26 June 2025, the IAEA and the World Bank Group formalized a landmark partnership to support the safe, secure and responsible use of nuclear energy for development. This new collaboration reflects the World Bank's first formal engagement with nuclear power projects since 1959. Through this partnership, the World Bank aims to contribute to the life extension of existing nuclear reactors and help support grid upgrades and related infrastructure. It will also work to accelerate the potential of SMRs. The agreement will alter and influence the influx of direct financial resources into the nuclear power sector. The agreement could also serve as a catalyst for broader engagement by other multilateral banks opening new avenues for African countries to access financing for their nuclear power programmes. This would make more resources available to fiscally constrained economies in Africa to finance nuclear power programmes.

Financing Nuclear Energy Projects

Financing nuclear power projects in African countries remains a major challenge. African countries are exploring diverse financing models such as the utilization of state loans. SMRs particularly could provide a flexible and cost effective solution requiring lower upfront investment. Additionally, the adaptability of SMRs could make them ideal for remote areas, where grid expansion is impractical, and for repurposing decommissioned coal fired power plants to reduce the costs of new nuclear sites. Another IAEA publication, scheduled for release in October 2025 to support the G20 Presidency, will focus on the macroeconomic, socio-economic and technical aspects of repurposing coal fired power plant sites for SMRs. Strategic partnerships, policy reforms and diversified financing sources will be key to developing sustainable nuclear power programmes across the continent.

Currently, Egypt is the only nation in Africa constructing a large four-unit NPP. Similar to other nuclear power projects in other emerging markets and low to middle income countries, Egypt's El Dabaa project receives significant concessional loans from its supplier, the Russian Federation, with a favourable interest rate and a favourable repayment period. Such vendor financing, if available, would further the development of nuclear energy in African countries, where both clean energy and climate investment are much needed [15].

In addition to commercial and concessional loans from vendor countries, other enablers of nuclear financing in Africa include loan guarantees, political risk insurance and financial grants for capacity building. As low sovereign credit ratings, high debt to GDP ratios and lack of cost reflective electricity tariffs still hinder several countries in the region, investors would need substantial support from multilateral development banks and other development financial institutions (such as the Climate Investment Funds) to de-risk their nuclear projects [16].

Recently, the Just Energy Transition Partnership (JETP) has been set up between South Africa and the International Partners Group (IPG), committing US $8.5 billion, including US $329.7 million in grants and US $5.325 billion in sovereign concessional finance, for clean energy transition in coal dependent South Africa. Other African countries, such as Senegal and Nigeria, have also expressed their interest in such financing mechanisms, which can enable investments in the development of nuclear energy in African countries and thus accelerate the deployment of nuclear power on the continent.

Creating 'Order Books' for SMR Deployment

Due to their significant power rating, large NPPs of 1000 MW(e) or more are not suitable for the overall grid capacity in numerous African countries, so developing SMRs may be preferable for generating capacity and investment scale reasons. Mirroring regional cooperations to create cross-country power transmission and distribution systems in Africa, such as the West African Power Pool, neighbouring countries with similar needs for nuclear energy can organize a consortium of potential nuclear energy users to not only increase the SMR order volume, and thus the feasibility of such orders, but also to synergize the human and financial resources necessary for project implementation, while distributing the investment risks between users [17].

In addition, African countries have been among the leading producers of natural uranium in the world and have been witnessing rapid growth in the mining sector and other energy heavy industries. Traditionally relying on coal and other fossil fuels for their energy supply, these major energy users can commit to investing in multiple reactors within a single country or region to assuage their power needs, while contributing to decarbonizing the energy system. These potential offtake opportunities can help to socialize the costs of first of a kind units across multiple projects and later achieve economies of scale for nuclear energy development.

SUPPLY CHAIN

Nuclear energy production relies on a network of suppliers who provide essential products and services throughout a reactor's life cycle, including design, construction, commissioning, operation and decommissioning. Ensuring effective and efficient oversight of this global supply chain is vital for both new nuclear projects and existing facilities. As the development of SMRs progresses, there is the need for the nuclear community to also consider and address the issue of supply chains, as most SMRs are projected to be modular and will require factory fabrication. This is important to the success of SMR implementation, as most countries, including African countries, are interested in SMR technology.

Global State of the Nuclear Supply Chain

Following the initial NPP construction boom of the 1960s and 1970s, the nuclear supply chain has become increasingly complex and global in its scope. The accident at the Three Mile Island Nuclear Generating Station in 1979 led many countries and operating organizations to cancel planned NPP construction projects. This moved the focus of the supply chain towards maintenance and long term operation of the existing nuclear fleet. Recent delays of NPP projects have further aggravated the supply chain situation. Even though this situation holds true, other nuclear power countries (i.e. China, France, India, Republic of Korea and the Russia Federation) have made significant efforts in establishing or re-establishing and maintaining their supply chains.

The slow growth in the nuclear industry in many countries has caused many suppliers of nuclear grade or nuclear safety related components and services to leave the nuclear industry because of the rising costs associated with meeting nuclear quality assurance requirements or maintaining the related certificates. The loss of many original equipment manufacturers and obsolescence of components have presented several challenges for the nuclear supply chain.

Increased use of commercial grade items (i.e. products and services based on good industrial quality without a nuclear quality programme) and updating the regulatory and technical requirements to allow for their use in safety related applications has had its own challenges. However, usage of commercial grade items through the process of commercial grade dedication has allowed licensees to overcome the challenge posed by obsolescence and to maintain a more diverse supplier base.

Another challenge due to loss of original equipment manufacturers and the globalization/localization of the nuclear supply chain is the possible introduction of counterfeit, fraudulent and suspect items (CFSIs) into the supply chain. The complex supply chain increases the reliance on sub-suppliers and has the potential to increase the risk of introducing CFSIs, especially if spare parts are procured in a hurry from brokers and such entities. There are other challenges, including digital technology and non-reported design changes.

MSCQ
Management, Supply Chain and Quality Network of Excellence as Resource for African Countries

The Nuclear Supply Chain in Africa

The existing NPPs and the planned projects in African countries will also be impacted by the current nuclear supply chain. The current operating units in South Africa have been able to maintain safe and reliable operation through the reliance on proven reactor technology and its long established supply chain. Establishing the necessary infrastructure and supply chain from the beginning continues to present a significant barrier for many embarking countries seeking to deploy nuclear reactor technology. Starting with balance of plant and other non-nuclear quality items may be part of the solution, as acquiring safety related items only represent a small part of the supply chain.

SMR technology can reduce the necessary infrastructure required to be built because of their compact size and ability to be more easily integrated into existing infrastructure. Increased use of commercial grade items or serially manufactured items substantiated by safety and risk analyses may help with challenges typically associated with low quantity custom orders that have strict nuclear quality requirements. This would allow embarking countries to have the flexibility to utilize existing suppliers that have nuclear experience and to develop or utilize local suppliers simultaneously.

Harmonizing the Supply Chain Through the Nuclear Harmonization and Standardization Initiative

The Industry Track Topical Group (TG) 2 of the IAEA's NHSI seeks to highlight best practices used in Member States related to the oversight and acceptance of commercial grade items and compare quality and technical requirements across jurisdictions to find common approaches and simplify the deployment of SMRs.

The work of the TG2 includes mapping exercises of nuclear and non-nuclear codes and standards. The idea is to highlight areas where harmonization can be achieved and enable the deployment of more standardized SMRs across different jurisdictions and regulatory frameworks. This would greatly reduce the potential cost of deployments, as economy of series is the business model required for sustainable SMR projects.

The IAEA has developed a dedicated management, supply chain and quality (MSCQ) network for excellence to facilitate and encourage enhanced cooperation and the exchange of knowledge and experience on management systems, project management, quality and supply chain management in the nuclear industry.

It is a useful resource for all related questions, as MSCQ includes recent and historical meeting, webinar and training course materials since 2012.

Members get regular updates via the MSCQ newsletter.

There are three related toolkits that pertain to supply chains:

- **Supply Chain Management**
- **Regulations & Standards** (for safety related component manufacturing)
- **Contracting**

The IAEA supports and provides advice regarding the related activities in African countries.

Link to request MSCQ membership

Contact: MSCQ.Contact-Point@iaea.org

DEPLOYMENT CASE STUDIES AND SUCCESS STORIES

Because of growing energy demands and the need to support sustainable development, more than twenty African countries are either considering or actively embarking on new nuclear power programmes. As African countries experience rapid population growth and industrialization, nuclear energy is increasingly viewed not only as a reliable and low-carbon solution but also as a means of supporting socioeconomic development and long term energy independence.

Success Story

Egypt is currently constructing a nuclear power plant at the El Dabaa site, located on the Mediterranean coast. This project, developed in cooperation with the Russian Federation, will become Africa's largest nuclear facility. The El Dabaa NPP is expected to provide over 4.8 GW of electricity to the national grid, supplying around 10% of the country's energy needs. Beyond electricity generation, the project is also generating thousands of jobs and advancing nuclear science and engineering expertise in the country.

In support of this project, Egypt has hosted several IAEA Peer Review Missions, including a Phase 2 INIR mission, a site and external events design review mission, and a technical safety review (safety requirements). Additional missions and activities are planned to take place prior to the beginning of commercial operations, which is expected in 2028.

Ambassador Mohamed El-Molla, Permanent Representative of Egypt to the United Nations (Vienna) (left) and Mr Mikhail Chudakov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, at the IAEA headquarters in Vienna, Austria, September 2020.

A meeting during the Phase 1 INIR Mission in Niamey, Niger, April 2018.

A roadmap meeting with a delegation from Burkina Faso at the IAEA headquarters in Vienna, Austria, May 2025.

Case Studies

Ghana, **Kenya** and **Nigeria** are all progressing through Phase 2 of the IAEA's Milestones Approach, which involves the preparatory work for the contracting and construction of an NPP after a decision has been taken. In this phase, the key organizations are established, and the country develops the appropriate infrastructure as it prepares to invite bids or negotiate the contract for the first NPP.

In **Ghana**, the future owner/operator, Nuclear Power Ghana, is currently considering initiating negotiations with two vendors for the construction of a large NPP as well as an SMR after a request for information exercise. The country's independent regulatory body, the NRA, is working to prepare the regulatory framework needed to license the first NPP. The country has cooperated closely with the IAEA throughout the development of its programme, hosting both a Phase 1 INIR mission in 2017 and a Phase 1 INIR follow-up mission in 2019.

In **Kenya**, the Nuclear Power and Energy Agency (NuPEA) together with KENRA recently published a five year strategic plan that identifies six areas of focus for the nuclear power programme: nuclear infrastructure development, stakeholder engagement and advocacy, energy research and innovation, energy capacity development, a research reactor programme and institutional sustainability. The country has also hosted both a Phase 1 INIR mission in 2016 and a Phase 1 INIR follow-up mission in 2021.

In **Nigeria**, the Nigerian Atomic Energy Commission and the Nigerian Nuclear Regulatory Authority are continuing their efforts to further develop the country's nuclear power infrastructure. In 2022, the Government of Nigeria opened a commercial bidding process for a 4000 MW(e) NPP. Nigeria has signed several cooperation agreements with potential vendors and conducted a Phase 1 INIR mission in 2015.

Several other African countries are also making progress towards introducing nuclear power. **Morocco**, **Niger**, **Sudan** and **Uganda** have all hosted Phase 1 INIR missions to support their national nuclear infrastructure development and are working to implement the IAEA's recommendations. In addition, numerous other African countries are considering or actively preparing for the introduction of nuclear power, positioning the continent as an emerging player in the global nuclear energy landscape.

A delegation from Kenya at the Paks NPP in Paks, Hungary during a meeting hosted by the IAEA in May 2025.

CONCLUSIONS

Africa remains the leading recipient region of IAEA support, as there is a growing level of engagement from African countries with the IAEA in the development of infrastructure to establish a nuclear power programme, thus mirroring their increased interest in nuclear energy. The IAEA has been assisting African countries in nuclear power infrastructure development for many years, with the first INIR mission conducted in Africa in 2013, and experience has been gained in the region about the IAEA's Milestones Approach and the associated actions for infrastructure development. Developing the nuclear power infrastructure in a timely manner and addressing associated challenges in line with a country's NPP project schedule will be a key factor for African countries to achieve their nuclear power goals.

Energy planning sets the stage for incorporating a generating technology into national energy strategies. Thus, all energy options including nuclear energy can usually start with energy planning; furthermore, the outcome can be incorporated into the national energy strategy. The IAEA provides technology-blind analytical tools together with training that allows countries to perform their own energy assessments. Countries are also encouraged to use these tools in their future energy assessments. Energy planning sets the stage to use indigenous energy sources as strategic options for energy security.

African countries contribute a meaningful quantity of the global uranium production. Having such resources can be a stepping stone to achieving energy security in the region, as about 500 million of the population in Africa are without electricity. Even though the uranium resources in African countries can be used as fuel to provide electricity and achieve energy security, there is currently no known fuel cycle technology present on the continent. The uranium resources of African countries can be harnessed together with new investments in fuel cycle management to present a strong backbone for the promotion of new technology on the continent.

The IAEA will continue to provide support to countries in their efforts to establish and sustain nuclear power programmes.

Koeberg NPP near Melkbosstrand, South Africa

As nuclear technology evolves, African countries with small electrical grids or smaller economies can consider SMRs, as this technology promises smaller amounts of upfront capital, smaller electrical output and quicker deployment, which make the SMR technology ideal for most of these countries. Even though SMRs are attractive, the SMR technology is not commercially available, as there are only two operating reference plants (one in China and one in the Russian Federation). It is projected that more reference plants, for a variety of SMR technologies, will be available before the end of the decade.

In the case of either large NPP or SMR deployment, financing is a challenge for most countries. African countries wanting to adopt nuclear power as part of their energy mix should consider innovative ways of financing their nuclear power projects. De-risking a project is key to attracting the needed project financing. In addition, creating regional pools where the order books of a technology can be filled and executed is a sure way to attract and pool financing for projects. International monetary agencies, such as the World Bank and the African Development Bank, should be engaged to support the African countries in developing the necessary infrastructure and project financing.

Supply chains often face challenges, and supply chains in African countries are not immune to these challenges. Currently, South Africa is the only country in Africa that has an established supply chain for its nuclear industry. As other African countries develop their nuclear programmes, African countries can use the South African experience as a springboard for establishing stronger supply chains for the African nuclear power industry.

The IAEA provides the necessary assistance to Member States in all the areas of interest and will continue providing integrated support to African newcomer countries in their efforts to establish nuclear power programmes.

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Editorial note

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