ENERGY FOR GROWTH HUB

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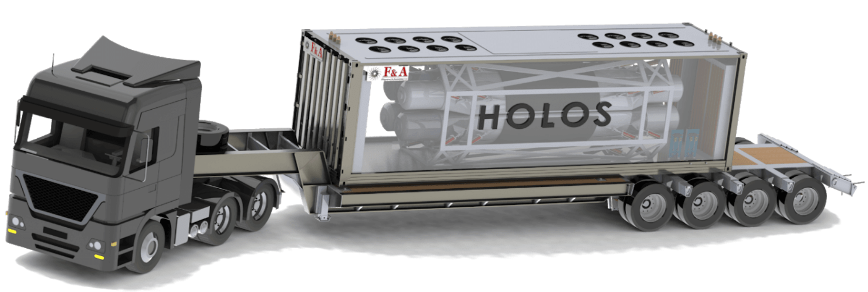
How Advanced Nuclear Technologies Could Accelerate Deployment Across Africa

In early 2020, the United Arab Emirates will start up the massive 5.6 GW Barakah nuclear power plant, the first country in nearly a decade to successfully start a new nuclear power program. A handful of developing African nations are also looking to start their own nuclear power programs, but building *any* power plant at this scale or cost (~$25 billion) on the continent is likely unrealistic. However, a new generation of far smaller and cheaper nuclear technologies may offer more appropriate options for African countries to accelerate deployment of reliable, low-carbon electricity. Here are some of the most promising innovations:

Small Modular Reactors (SMRs) and microreactors

One of the biggest problems with conventional nuclear technology for African countries is their tremendous size. The high upfront cost, extended construction time, long return on investment horizon, and the complex logistics for such a project can make them a non-starter in many markets. Small Modular Reactors are less than one-third the size of today's typical plants (<300 MWe) and will be manufactured at a central facility, rather than constructed on-site, potentially bringing capital costs down dramatically and speeding up construction. Microreactors, a subcategory of SMRs, are even smaller (<10 MWe) and could be an attractive option for off-grid industries in remote locations, such as mining, that want access to reliable electricity. Additionally, some microreactor concepts have fuel that lasts the entire lifetime of the plant, meaning no downtime every few years for refueling and no need for domestic fuel handling or waste storage.

FIGURE 1: An artist's rendering of one such transportable microreactor concept. Credit: HolosGen.com



High-Temperature Gas-Cooled Reactors (HTGRs)

These reactors use gas as the primary coolant instead of water, as in conventional nuclear plants. And while they have advantages in terms of improved safety and efficiencies, their reduced (or eliminated) use of water may be particularly attractive for certain locations. HTGRs could make nuclear power more feasible in inland regions where there are no major rivers to provide a constant cooling source. Low water requirements also make commercial nuclear tech potentially viable in countries where it might otherwise be impossible, like Mali, or easier in different parts of the country, such as inland Nigeria, Kenya, or South Africa. Additionally, HTGRs can produce high-quality heat for industrial applications like fertilizer production or paper mills.

Molten Salt Reactors

These reactors can be either salt-cooled or salt-fueled - where the fuel is dissolved in the reactor coolant - but the overall design is similar. Molten salts stay liquid up to extremely high temperatures, meaning that there is no risk of the coolant boiling off like with traditional water-cooled reactors. This also means that the reactor doesn't need to be pressurized to keep the coolant liquid, which dramatically simplifies the design and reduces costs of equipment. Both of these features make molten salt reactors very safe, but also potentially much cheaper and easier to operate, as they rely more on natural physical properties for safety instead of redundant engineered systems.

Floating and offshore reactors

Russia, China, South Korea and the US are all developing floating or offshore reactor concepts. Similar to SMRs, floating reactors would likely be manufactured in a centralized facility and then transported to their final destination to be connected to an industrial zone or the power grid. Floating power plants can mitigate many challenges in siting nuclear power plants associated with local geology such as earthquakes, flooding, and wildfires, though they face unique challenges such as hurricanes or cyclones. Still, they can be easier to physically secure, especially if they are located farther offshore. But for countries with large populations near the coast, offshore plants could be a fast way to add significant power capacity locally.

Utilizing new business models: Build-Own-Operate (-Remove)

Russia's nuclear vendor Rosatom currently offers Build-Own-Operate nuclear power projects for their large-scale, conventional nuclear technologies, but this deployment model is more feasible with much smaller and factory fabricated reactors. Very small designs should be easier to finance by a wider range of financial institutions, but more importantly, their portability could make it feasible to return the entire reactor to the vendor country at the end of the project's life. This could minimize the need for in-country fuel handling and decommissioning. A Build-Own-Operate-Remove business model with very small, advanced nuclear reactors could accelerate deployment of nuclear power to more countries, while mitigating some challenges around fuel handling, waste disposal, and workforce training for host countries.

Conclusion: New models using advanced technologies soon coming to market may overcome some of the size, price, safety, and complexity barriers to deploying nuclear power in African markets. To prepare, countries should incorporate advanced nuclear designs into their energy policy discussions. They should invite more vendors to present their technology to see which might be a good fit for the local market, workforce, and environmental conditions. There are a greater variety of options that may be available to finance smaller plants, so governments should think creatively about options. Policy-makers should also explore how they could integrate a nuclear plant with other services besides electricity, such as industrial heat or desalination. While countries understandably don't want to pilot untested technology, there may be advantages in partnering early with advanced nuclear companies to be active partners in the first few commercial demonstrations.

TABLE 1: Nuclear vendors closest to commercial viability. For comparison, a standard nuclear power plant being built today produces over 1000MW of power.

COMPANY	TECHNOLOGY
NuScale	A 60MW light-water reactor that will be deployed in 6- or 12-packs, making it ideal to replace existing coal plants on larger power grids. Solves some financing and grid challenges as each reactor comes online in succession.
Oklo Inc.	A 1.5MW microreactor aimed at off-grid application. The reactor has minimal moving parts, reducing on-site staff required. This reactor can also produce heat for industry.
X-Energy LLC	A 75MW high-temperature gas-cooled reactor. Designed to integrate with facilities for industrial heat production or water desalination.
Kairos Power LLC	A 140MW salt-cooled reactor. This design relies heavily on passive and inherent safety to simplify the technology and operations.
Terrestrial Energy USA Ltd.	A 195MW molten salt fueled reactor. The Terrestrial reactor was selected by U.S. and Canadian regulators for the first-ever joint design review.