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THE WORLD OF NUCLEAR

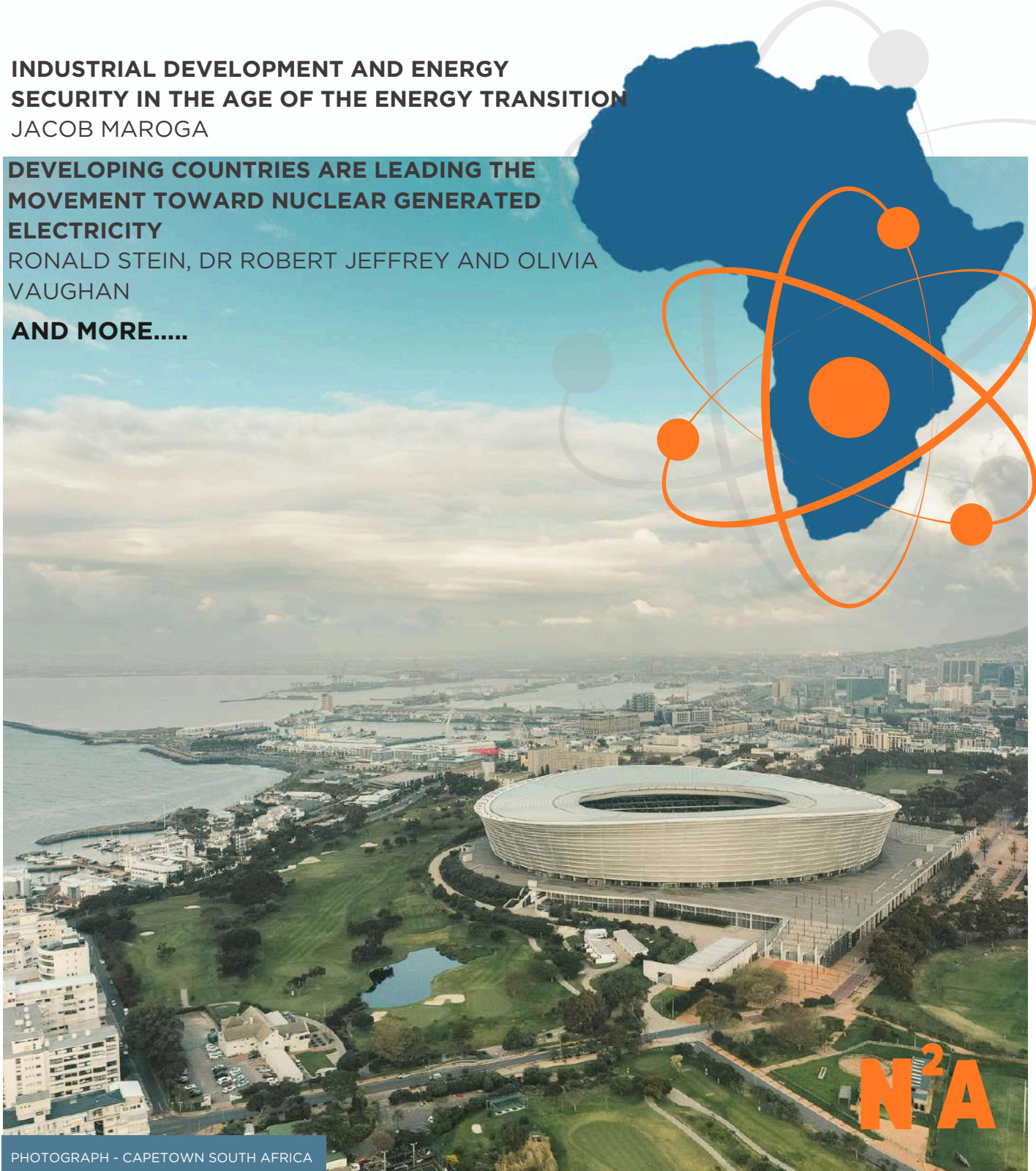
**INDUSTRIAL DEVELOPMENT AND ENERGY
SECURITY IN THE AGE OF THE ENERGY TRANSITION**

JACOB MAROGA

**DEVELOPING COUNTRIES ARE LEADING THE
MOVEMENT TOWARD NUCLEAR GENERATED
ELECTRICITY**

RONALD STEIN, DR ROBERT JEFFREY AND OLIVIA
VAUGHAN

AND MORE.....



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FROM THE EDITOR

Unlocking Africa’s Potential in Nuclear Energy for a Sustainable Future

Welcome to the fourth edition of **N²A**, where we dive into one of the most exciting and critical conversations of our time: the race to develop sustainable energy solutions, with Africa emerging as a key player in nuclear power.

As global energy demand soars, driven by the rapid rise of data centers, AI technologies, and increased digitization, the need for stable and clean energy sources is more pressing than ever.

Africa, uniquely positioned with vast natural resources and a growing commitment to sustainable development, has the potential to lead in the global transition to advanced nuclear energy solutions. Not only could nuclear power provide reliable and efficient energy to support Africa’s infrastructure and industries, but it also aligns perfectly with the continent’s environmental goals.

Data centers, essential for powering the digital economy and the expanding use of artificial intelligence, require significant energy. As AI applications grow, so too will Africa’s energy needs. Nuclear power offers a low-carbon and efficient solution to meet this demand sustainably, making it a cornerstone of Africa’s energy future.

In this issue, we explore the potential of nuclear innovation across the continent, from Small Modular Reactors (SMRs) that could transform rural electrification, to partnerships that bring world-class technology and safety standards to African nations. We’ll also address how strategic investments in nuclear energy can support economic resilience, energy security, and environmental goals for a more sustainable tomorrow.

Africa stands on the cusp of a nuclear renaissance, and with vision and collaboration, the continent can become a global leader in clean energy innovation. Join us as we uncover the opportunities and challenges that lie ahead in building a brighter, more resilient future for Africa.

Thank you for being a part of this journey with **N²A**



Heather Veldhuis
HEATHER VELDHUIS
EDITOR



Engineering, Risk and SHEQ Services

Main Projects:

- France - Nuclear Waste Repository
- Rwanda – Lake Kivu Biogas Power Station - 56MWe
- South Africa and Australia – New Nuclear Pebble Bed Power Plant of 35 MWe



SOMETHING TO BE PROUD OF!




CUTAWAY OF THE HTMR-100 SMALL MODULAR REACTOR (SMR) DEVELOPED IN PRETORIA, SOUTH AFRICA. THIS REACTOR OF 100 MW THERMAL AND 35 MW ELECTRICAL OUTPUT IS THE RESULT OF OVER 30 YEAR'S WORK.

INITIAL WORK ON ITS PREDECESSOR, THE PEBBLE BED MODULAR REACTOR (PBMR), STARTED IN 1994.

THE DESIGN IS CHARACTERIZED BY EXTENSIVE PASSIVE SAFETY SYSTEMS, AND ITS HIGH TEMPERATURE OPERATION.

THE HTMR-100 EVOLVED FROM THIS INITIAL DESIGN, AND IS TODAY A HIGH-TEMPERATURE HELIUM-COOLED SMR WHICH CAN BE PLACED IN ANY GEOGRAPHICAL LOCATION.



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DEVELOPING COUNTRIES ARE LEADING THE MOVEMENT TOWARD NUCLEAR GENERATED ELECTRICITY

RONALD STEIN, DR ROBERT JEFFREY AND OLIVIA VAUGHAN

Countries like France have embraced nuclear power since the 1960s and have for six decades been safely producing electricity with 56 reactors that generate 361 billion kilowatt-hours of electricity annually.

Nuclear accounts for 68% of the annual electricity generation in France, the highest nuclear generation share in the world. France is also the largest net exporter of electricity in Europe.

The French strategy includes building at least six new reactors by 2050.

The French Department of Energy advocates a nuclear power policy including large reactors for bulk electricity production, and Small Modular Reactors (SMRs) for flexible deployment. This approach has recently been updated in the 'Pathways to Commercial Liftoff' report, in which advanced nuclear (small and micro modular reactors) have been cited as having a differentiated value proposition.

The US Navy has had longstanding success with nuclear-powered vessels, emphasizing the safety and reliability of nuclear technology over decades. Nuclear power also stands out as one of the most cost-effective options for electricity generation.

Filmmaker Oliver Stone's documentary, "Nuclear Now," sheds light on the benefits of nuclear power, showcasing its safety record, efficiency, and minimal environmental impact, compared to other electricity sources.

The history of the South African nuclear sector traces back to the mid-1940s, with the formation of the forerunner of the Nuclear Energy Corporation of South Africa (Necsa) in 1948. In 1959, plans commenced for the construction of a research reactor, in collaboration with the US Atoms for Peace initiative. This reactor celebrates its 60th Anniversary of successful operation in 2025.

South Africa is also leading the charge with SMR development, as nuclear expertise moved to the private sector after the PBMR project was shut down in 2010. South Africa is an exporter of nuclear expertise, as evidenced in the Barakah Nuclear Power Station build in the UAE, where over 160 South African professionals are working on the project that has successfully proven that nuclear power plants are both bankable and efficient.

Developing countries are leading the charge towards nuclear-generated electricity, and they include; China, India, Korea, Indonesia, and South Africa, amongst others. South Africa was the first in the world to start work on a commercial SMR in the mid 1990's, viz; the Pebble Bed Modular Reactor (PBMR) project that was unfortunately politically halted in favour of green agendas in 2010.

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There are numerous reasons why developing nations are embracing nuclear energy:

- Electricity poverty leaves people less likely to be responsible custodians of the environment, as people in poorer developing countries survive in a world with inadequate access to goods, services and economic freedoms that are abundantly available in developed economies that were built on the products made from fossil fuels.
- In 2019, about 759 million people could not access electricity, nearly 75% of them (570 million) from Africa, which represents about half of the region's population.
- In 2022 and 2023 some African countries placed nuclear power at the centre of their strategies to reach climate policy objectives.
- The only Helium-cooled Small Modular Reactor in operation in the world, is the High Temperature Gas-Cooled Reactor (HTR-PM) in Shidao Bay in China. The foundation for this technology stems from a collaboration with the Pebble Bed Modular Reactor program in South Africa.

- Based on economic research by Dr Rob Jeffrey, South Africa and many other developing economies, need to move toward nuclear, mixed with High-Efficiency Low Emission (HELE) coal.
- These developing countries face the choice between a dark future of slow economic growth and rising unemployment, or the potential of achieving high sustainable economic growth, addressing poverty, unemployment, and inequality.
- Sustainable economic growth can only be achieved through the rapid development of proven technologies with high Capacity Factors, like nuclear, (HELE) coal, gas and oil for affordable, reliable, continuous, and low emissions electricity.
- It is imperative for countries, including the United States, to adopt nuclear power to ensure electricity security and to alleviate energy poverty effectively. The UK, European Union, Germany, Spain, California and South Australia are examples where the transition to 'renewable' solar and wind has led to higher energy prices, slower growth, and declines in their industrial and mining sectors.

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The Path Forward

The path is clear: any sort of “Just Transition” needs to result in a proportionate increase in units of production, to live to the standards that those imposing the standards would like to live. This is the only way to a true “Just Energy Transition”, one in which the billions of impoverished people can see an improving future

Astonishingly, while hungry countries are pursuing reliable and emissions-free electricity from nuclear and low-emissions technologies, the wealthier countries, with ample goods and services produced by fossil fuel derivatives, are focusing on promoting intermittent wind and solar in those developing countries.

*** This article is an edited version of the full article which can be found here:
https://www.eurasiareview.com/29102024-developing-countries-are-leading-the-movement-toward-nuclear-generated-electricity-oped/#google_vignette

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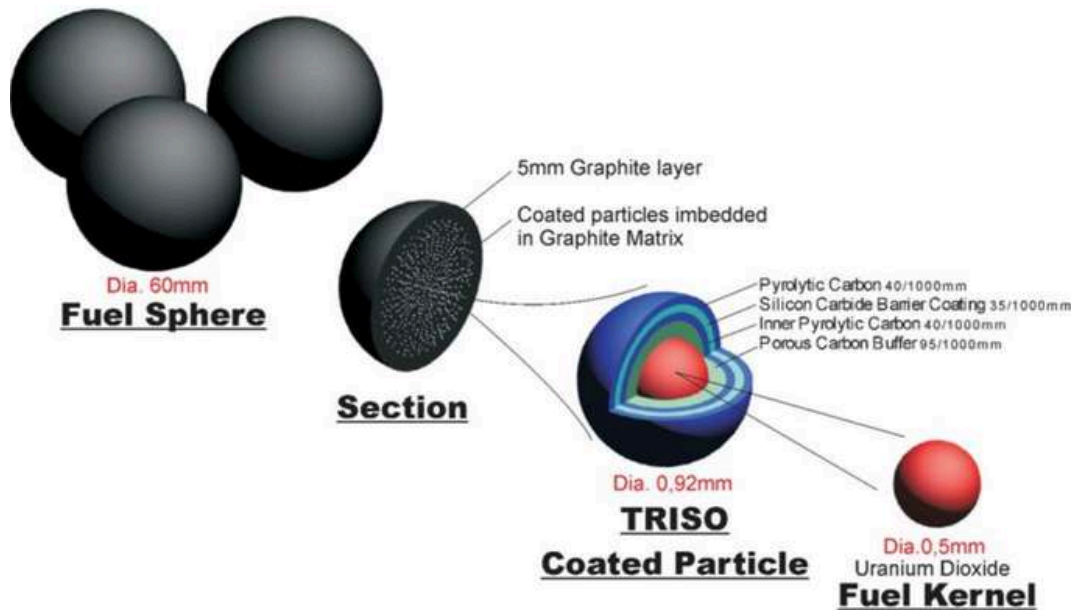
Dr Robert Jeffrey is an economist, business manager and energy expert. He has a master’s degrees in economics and business management and holds a PhD in Engineering Management. He previously served on the economics round table advising the South African Reserve Bank

Olivia Vaughan holds a Bachelor of Commerce in Law and an MBA. She operates across key sectors in the circular economy, with focus on sustainable systems and the built environment. She lives in the Eastern Cape of South Africa.



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THE MAKE UP OF THE TRISO FUEL BALL



TRISO (TRi-structural ISOtropic) fuel is a type of nuclear fuel designed for high safety and efficiency, used mainly in advanced nuclear reactors, including high-temperature gas reactors. Each TRISO particle is composed of a uranium, thorium, or plutonium fuel kernel encased in multiple protective layers, including carbon and ceramic coatings, which act as mini-containment systems. These layers prevent the release of radioactive materials even at extreme temperatures, enhancing the fuel's safety profile. TRISO fuel is also known for its high-temperature tolerance, allowing reactors to operate at temperatures above conventional limits. Its robust structure makes it a promising option for application in nuclear energy.



Justine Burgess holding TRISO Fuel ball fabricated in Pretoria, South Africa

INDUSTRIAL DEVELOPMENT AND ENERGY SECURITY IN THE AGE OF THE ENERGY TRANSITION

JACOB MAROGA



Since the Paris Agreement on climate change in 2015, investments in the so-called ‘clean technologies’ have increased exponentially, as countries aspire to meet their CO2 emissions targets, in keeping with their nationally determined contributions (NDC). It is estimated that global energy investment will exceed \$3 trillion for the first time in 2024, with \$2 trillion going to clean energy technologies and infrastructure. Because electricity is so vital to the well-being of every society, the energy transition is presenting both opportunities and risks to all countries. The transition is opening new frontiers for technological innovation and industrial development, which can propel countries into new areas of growth. But it also presents great risks in escalating energy costs, and declining energy security, that could lead to industrial decline and economic stagnation.

Grid Reliability

Wind and solar are the most supported energy sources for the energy transition. The massive increase in the wind and solar segment, together with the retirements of traditional generation like coal, gas, and nuclear, are presenting challenges to the reliable and secure operation of the power grid in a number of countries. Because of the fluctuating nature of wind and solar, they do not provide a similar reliability contribution to the grid as do traditional large spinning generators. Whilst battery storage can help smoothen the volatility of renewables, the current battery technologies are generally limited to an operating cycle of only four hours, before they require recharging. Therefore, renewables require a full back-up to ensure grid reliability. Also, wind and solar farms are often installed in remote locations far from load centers, thereby requiring long transmission lines which add cost and induce reliability risks.

These reliability limitations of renewables are normally not fully appreciated by policy makers, as they craft environmental legislation. It is then left to grid operators to manage and mitigate these risks, which sometimes result in high costs or decreased reliability. **CONTINUED ON PG 10**

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Loadshedding and the Energy Transition

The recent bout of loadshedding in South Africa, which resumed in 2018 and escalated during the following three years, had its roots in the poor performance of the Eskom coal fleet. However, the efforts to resolve and manage the energy crisis have been complicated by the energy transition. Because of the dominance of coal in the electricity sector in South Africa, there is growing pressure locally and internationally for the country to accelerate the exit from coal. The pressures to exit coal had an influence on the governance structures of Eskom, on how they prioritized and allocated resources to the coal fleet. This resulted in the escalating energy crisis from 2021 to 2024. The leadership changes in 2022, at the board and executive levels of Eskom, resulted in the refocus on the operational turnaround of the coal fleet. This has resulted in the halting of load-shedding which has now lasted for more than six months. There are now indications that the authorities in South Africa are becoming more circumspect about the pace and scale of the proposed coal exit. As a result, the plan to accelerate the coal exit has been reviewed.

De-industrialization of Europe

Europe has been a global leader of the Energy Transition. European countries, like Germany and Spain, have been at the forefront of massive investments in renewable resources. However, lately, concerns about high energy costs and energy security have emerged in Europe. The European Commission has also recently issued a report on the future competitiveness of Europe.

This report has highlighted the reality that Europe’s competitiveness has seriously declined, compared to its trading competitors, the USA and China, largely due to energy policies. Energy-intensive industries in Europe are now facing increasing competitive pressure, primarily due to increased energy costs and the stronger decarbonization efforts required in Europe. The report concluded that de-industrialization in the EU, in some of the energy-intensive sectors, has already started and may accelerate without dedicated policies.

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JACOB MAROGA STATES HIS POSITION

CONT.... FROM PG 10

China, a Superpower in energy

China's approach to the energy transition appears to be focused on industrial development and energy security. China's industrial expansion and economic growth is reported to have lifted close to 800 million people out of poverty, over the past 40 years. China has doubled its electricity output since 2010, as its manufacturing base continued to expand at an unprecedented pace. The country now generates more than twice the electricity production of the USA. From 2008 China focused on the manufacturing of renewable energy systems, particularly solar PV, as a new opportunity for industrial development and growth. The result is that China is now the dominant industrial superpower in all key supply-chains of the energy transition. The country is now by far the largest global supplier of solar panels, batteries, wind turbines and electric vehicles. At home, China is expanding all energy sources; coal, gas, hydro, solar, wind and nuclear. Clearly, China is building a lot of everything, as it asserts its position as an industrial super-power.

The US Shale Revolution

The "Shale Revolution" in the United States, which started in the 2000's, enabled the country to significantly increase its production of oil and natural gas through hydraulic fracturing and horizontal drilling. The United States is now a leading producer of oil and gas, surpassing Saudi Arabia and Qatar. Thanks to the Shale Revolution, the greatest energy transition ever in the US, the switch from coal to natural gas power-generation has been much easier. Natural gas emits less than half of the CO₂ compared to coal. Therefore, the switch to natural gas has allowed the US to significantly reduce its CO₂ emissions, even before the massive rollout of renewables. The added advantage of natural gas power plants is that they are more flexible compared to coal, thus making the integration of variable renewable much easier.

Key Lesson

Whilst trillions of dollars have poured into the energy transition over the past decade, it is becoming apparent that the holy grail of clean, cheap and abundant energy is not yet in sight. Regions like Europe, which have led the pack in the energy transition, are facing a significant deindustrialization, as the real costs and risks of decarbonization begin to emerge.

However, some developing countries, like China, are using the energy transition as an opportunity to expand new trade opportunities for themselves, exploiting new products that have been created by the energy transition philosophy.

The key lesson for South Africa is that the energy transition cannot only be about the exit from coal. South Africa should reframe its energy transition as an opportunity to leverage its national endowments to achieve its developmental ambitions. There is also an opportunity to mobilize other SADC countries to develop an integrated energy transition which can be a catalyzing initiative for the development of the Region.

Jacob Maroga is an electrical engineer (University of the Witwatersrand) who also gained an Advanced Management Program (AMP) qualification from Harvard University. He is a former CEO of Eskom. Jacob is an energy and leadership expert with an extensive track record in the engineering and power sector, spanning over 35 years.



CREDIT: ADRI SENEKAL DEWET

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NUCLEAR POWERED DATA CENTRES FOR AFRICA

DR AYODELE PERIOLA

Nuclear energy has the appeal of having a low-carbon related emissions footprint with the benefit of an environment-friendly operation. Therefore, nuclear power systems are suitable for developing countries seeking to pursue development initiatives and transformation, without compromise on low environmental carbon emissions. Such a profile describes the case of a significant number of developing countries in Africa.

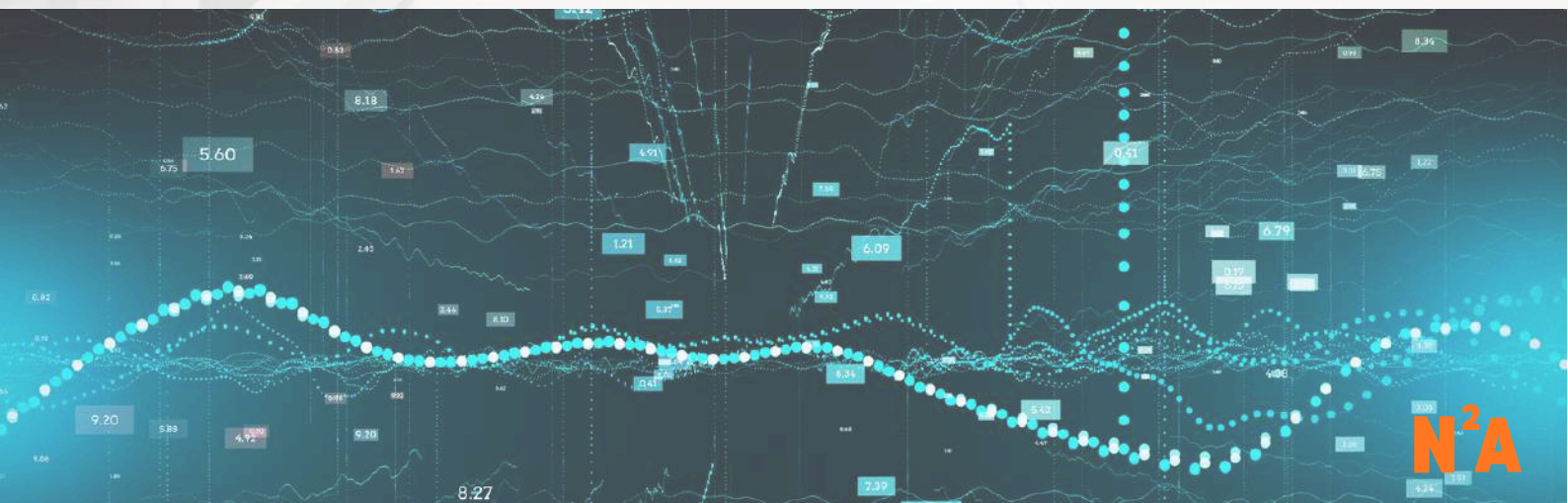
The suitability of nuclear power systems, available in different form factors is beneficial for use in this regard. Nuclear power systems are now available as Small Modular Reactors in different operational configurations. In addition, nuclear power systems are also available in alternative configurations such as Micro Reactors, with even smaller scales such, as Nano Reactors being feasible, depending on the operational context.

The emergence of nuclear power systems has attracted attention from other domains with a notable one being cloud computing. Cloud computing service providers, with an interest in sustainably operating expansive data centre infrastructure, such as Amazon, Microsoft, and Google, are now turning towards the use of nuclear power systems. The adoption of such systems by these global computing players sets a trend for future computing platform service providers in developing countries. The quest to develop data centres and computing platforms in emerging economies, to ensure data security and sovereignty, makes the availability of a suitable power source necessary.

For emerging economies, it is important to embrace the digital technology options presented by cloud computing platforms. This is because the installation of data centres by service providers brings huge new economic opportunities. This is relevant for yet-to-emerge significant economically active African countries. For example Africa's five big economies, comprising South Africa, Egypt, Algeria, Nigeria and Ethiopia, with a combined population of approximately 570 million (2023 estimate) have a total gross domestic product of \$1 445 billion. Africa's other 48 countries which have a combined population of 886 million (2023 estimate) have a total gross domestic product of \$1 372 billion. The five biggest African economies have a significant deployment of cloud computing enabling data centre facilities. This is not true for a significant number of countries in the smaller economies bracket. The high populations concerned, and the appeal of digital technologies, make the comparatively smaller economies attractive opportunities for the future deployment of data centre facilities. These comparatively smaller economies require a low-emission environment-friendly energy source, to operate the potential data centres.

Nuclear power systems have a significant role to play in enabling the realization of the computing platform systems of the future. This makes it important to consider the role of nuclear power in enabling the future of technologies such as generative Artificial Intelligence, and product derivatives for Large Language Model-based solutions, such as Chat GPT.

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The adoption of nuclear power systems in enabling the environment-friendly operation of data centres, located in emerging economy contexts, though beneficial, requires a re-thinking. A new direction and perspective to attune nuclear power systems to the operational demands and requirements of computing platforms needs to be considered. In this case, the computing platforms concerned comprise multiple data centres. Each data centre has multiple installed servers. Data Centres are mostly deployed at ground level and are classified into different Tiers i.e., Tier I, Tier II, Tier III, and Tier IV. Tier IV systems are expected to have the highest availability, and Tier I have the least availability.

The design of nuclear power systems, to meet their expected functionality for powering and enabling each data centre Tier, requires new thinking and perspectives.

Such considerations should also develop standards for An important aspect of a data centre system’s design is the incorporation of module redundancy. The inclusion of redundancy in this case should be done while considering the cost preferences of the data centre operator. This should result in the emergence of standardized nuclear power systems for different operational technologies of the Small Modular Reactors.

Other potential nuclear reactor designs, such as Micro Nuclear Reactors and an hypothetical Nano Nuclear Reactor. The inclusion in this case, is expected to enable the realization of the expected uptime for the postulated data centre Tier. In addition, the deployment of multi-configuration nuclear power systems requires the design of supporting nuclear-computing data exchange and communication interfaces.

Dr Ayodele Periola is a lecturer in the Department of Electrical, Electronic and Computer Engineering at the Cape Peninsula University of Technology. Dr Periola’s research interest is in Computing and Communication Systems which focus on the design of intelligent computing systems that incorporate communication networks. The research conducted in this area has a significant societal impact because of its focus on the design of solutions that enable future internet-enabled applications.



US ELECTIONS - IMPACT ON NUCLEAR ENERGY IN AFRICA

HEATHER VELDHUIS

The outcome of US elections often has wide-reaching implications, way beyond American borders, influencing global politics, trade, and the strategic priorities of various sectors, including energy. For Africa, where several countries are exploring nuclear energy to support economic development and decarbonization, the stance of the US on nuclear energy development could be pivotal. So, how could the recent US elections potentially shape nuclear energy advancements in Africa?

Nuclear Policy Direction

The US government’s policy on nuclear energy can influence African energy strategies, as African nations often look to the US for technological partnerships, funding, and regulatory models. If the new administration prioritizes nuclear energy as a low-carbon solution in the climate debate it may increase investments in nuclear energy research, development, and technology exports. Such a stance could be highly beneficial for African countries looking to adopt Small Modular Reactors (SMRs) and other advanced nuclear technologies, given the historic involvement of the US in developing nuclear systems.

However, a less favourable US stance on nuclear energy could lead to reduced innovation funding, so affecting African nations’ access to emerging nuclear technologies.

Trade and Diplomatic Relations

US-Africa relations have evolved with growing partnerships around energy and infrastructure projects. A US administration that seeks to strengthen these ties could leverage nuclear energy as a key component, expanding programs like Power Africa or Prosper Africa to include nuclear projects. Such support might include not only technology transfer but also funding and regulatory assistance to help African countries establish their nuclear frameworks and safety standards. Conversely, if the new administration focuses less on African relations, African countries may need to seek alternative partners for nuclear energy development, such as Russia and China, both of whom have expressed strong interest in supporting nuclear projects in Africa.

Environmental Goals

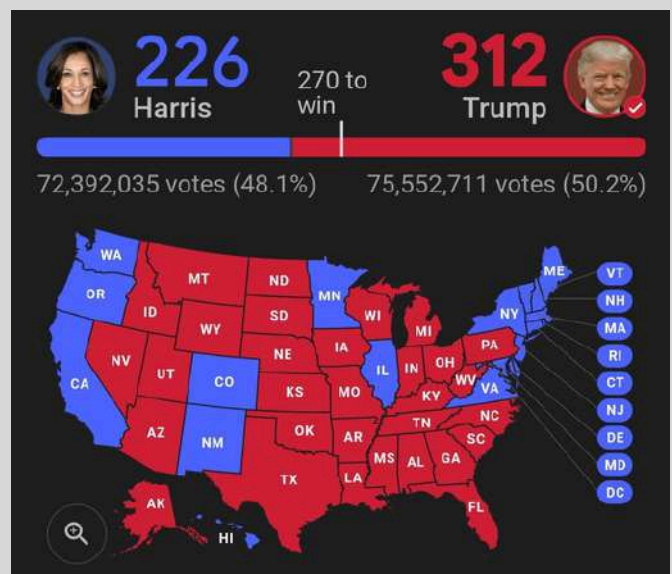
Nuclear energy offers a low-carbon alternative to fossil fuels. An administration that upholds a robust environmental agenda could bolster nuclear energy as a tool for sustainable energy transition, offering Africa a path to energy security without increasing greenhouse gas emissions.

If the US takes a backseat on climate commitments, however, African nations may find it harder to access clean energy funding tied to international climate goals, which could impact the financial feasibility of nuclear projects.

Export-Import (EXIM) and Private Investment

The role of the US Export-Import Bank (EXIM) in financing energy infrastructure can be instrumental in enabling African countries to afford the high initial costs of nuclear power plants. If the new administration increases EXIM support for nuclear technology exports, and Intra-Africa nuclear trade, African nations could benefit from favourable financing arrangements, making nuclear projects more viable.

Private investments could also be impacted, as US-based companies and investors look to government signals to indicate which industries are prioritized for growth. Endorsement of nuclear energy should have the effect of unlocking private sector investment, giving African countries access to both funding and technological expertise. **CONTINUED ON PG 15**



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Global Nuclear Regulations and Standards

The US plays a significant role in setting global standards for nuclear safety and security through its engagement with the International Atomic Energy Agency (IAEA) and other international bodies. An administration actively engaged in a positive nuclear policy could support African countries in meeting safety and regulatory requirements, ensuring that any nuclear energy projects adhere to international safety standards. In contrast, a US engagement which puts the brakes on African nuclear interaction could cause tensions, if African countries see nuclear as their pathway to rapid economic development. The best path is to encourage technology people to work together in pursuing nuclear projects on the continent.



Africa moves how?

The impact of the results of the US elections on nuclear energy development in Africa will depend on the US administration’s commitment to nuclear technology as part of its climate and energy policy. Most important too is its approach to Africa as a diplomatic and trade partner in nuclear technology, and the support offered through financing, standards, and technical assistance. A US administration that embraces nuclear energy as a component of sustainable development could accelerate Africa’s nuclear ambitions, helping the continent to rapidly move toward reliable, clean energy. Alternatively, an attitude of braking or blocking nuclear advancement in Africa may well open opportunities for other global players, thereby shaping Africa’s nuclear energy landscape through alternative partnerships and investments.

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DID YOU KNOW??

THE OLDEST NUCLEAR REACTOR IN THE WORLD IS IN GABON, IN AFRICA

The oldest nuclear reactor in the world is in Gabon, in Africa.

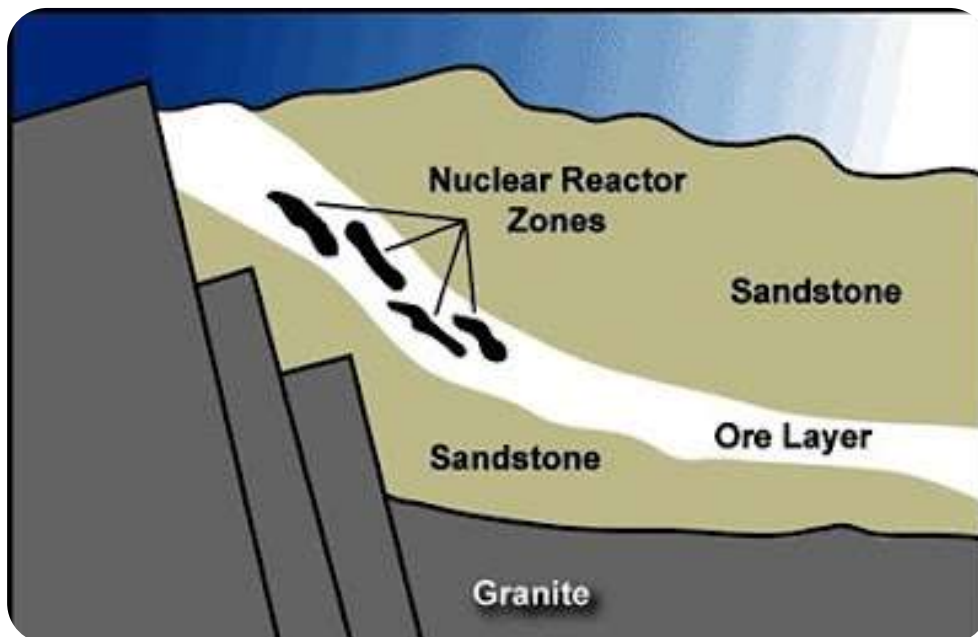
Yes, this is true. It is a natural reactor which arose 1.7 billion years ago due to a set of special circumstances. It is known as, Oklo.

Way back, in the mists of time Oklo was a mudflat. The soil was soft clay with some dilute uranium minerals mixed in it. Then, for some reason, the site started flooding on a regular basis. Each time it flooded, some of the uranium would dissolve in the water and trickle down into underground pools.

Those pools contained algae, or pond scum, and when the uranium water trickled down, the algae pond scum would absorb it—and thereby concentrate it.

When the algae died, they would drift down to the bottom of the underground ponds and pile up—which concentrated the uranium more. Eventually, the uranium grew concentrated enough to reach a critical mass which is the point at which a nuclear chain reaction starts. The reaction ran as long as the ground was wet. But when it dried out, it stopped. Repeated wet-dry cycles meant that the Oklo reactor switched itself on an off continuously for very many years.

These algae were the world's first nuclear engineers.



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Any person who has influence and a role to play in representing any Nuclear-Related Developments to advance nuclear power in Africa. or in any international entity, which can contribute to the development of Africa's nuclear energy capability is encouraged to be part of this great journey.

Any company, ranging in capability from a nut and bolt to the most sophisticated piece of equipment, should join the journey now.

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