Energy Review

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Adviser's Note

Green Hydrogen: The Time has Come

The dramatic fall in the cost of renewable power brings within reach energy abundance through hydrogen – a proven fuel – from the electrolysis of water. For India and other developing economies in Asia and Africa, this holds out the prospect not only of clean energy but also of energy security and import reduction through indigenous production of fuel.

Hydrogen has long been produced for fertilizer production and oil refining, among other industrial uses. The problem is that most of it is produced from natural gas, oil, and coal via highly CO2-intensive processes, thereby negating the environmental benefits of this fuel and exacerbating import dependency. In contrast, electrolysis - a totally clean process that can be completely localized - can enable a dramatic expansion of hydrogen supply and bring the fuel into mainstream transportation, residential and commercial applications. Moreover, the local manufacture of electrolysers will open up a new line of industrial activity.

Ajay Singh
Founder, Global Energy

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Energy Review Team

The Political Economy of Electricity Access in Mozambique: Supporting Sustainable and Inclusive Investment

Daniela Salite, Joshua Kirshner and Matthew Cotton

The Indian Ocean nation of Mozambique has a wealth of energy resources through a combination of hydropower (20GW), solar (23TW), and wind (1.1 GW) capacity at coastal locations, as well as considerable fossil fuel reserves, including natural gas in the provinces of Inhambane (estimated 3.5 trillion cubic feet) and Cabo Delgado (128 trillion cubic feet). Mozambique is currently developing one of the largest gas fields in Africa, situated off the coast of the northernmost province of Cabo Delgado. The total project cost is estimated between US$50-$100 billion over a decade, making it one of the largest investment projects in Africa. The U.S. oil company Exxon Mobil heads the consortium developing the gas resources in areas operated by France's Total and Italy's ENI, with stakes held by Indian and Chinese oil and gas firms.

Despite the abundance of resources, however, Mozambique continues to face entrenched energy poverty, and electricity access is one of the primary policy concerns. Currently, only 32% of Mozambique's 30 million inhabitants have access to electricity – one of the lowest rates in the world. This falls to 6% in rural areas. Major cities, such as the capital Maputo, have, at least on paper, reached almost 100% electrification, with Matola (which recently became the largest city by population, and is a growing satellite of Maputo province), Nampula (the third-largest city) and Beira (the fourth largest city) achieving 80%, 89%, 88% electrification capacity, respectively. Yet, inequalities in electricity access are also noticeable in urban areas where population growth has outstripped the pace of domestic grid connections, or where supply problems and lack of maintenance lead to poor connection reliability.

Although the headline figures suggest progress towards meeting the Sustainable Development Goal SDG7 to ensure access to affordable, reliable, sustainable, and modern energy; the grid network itself is unevenly distributed, with the antecedents of unequal access formed in the colonial era. Electricity systems have developed into three distinct path-dependent systems: the first in the south (around Maputo); the second in the centre, associated with the city of Beira; and the third consisting of dispersed urban centres. These systems remain largely disconnected from one another, with significant impacts on business and community development as a result. The grid network still bypasses extensive rural areas, where a combination of low population density and low-income communities makes it both technically and logistically challenging and costly to build 'last mile' access from centralised grid systems to dispersed rural communities. This creates structural energy injustice. The central and northern provinces depend largely on a single, ageing transmission line each, such that a single line failure is enough to cut electricity to a vast area. Yet historically, the private sector was excluded from investing in electricity projects. User tariffs have therefore remained non-cost-reflective – income generation is insufficient to sustain operations and fund rural grid expansion, as well as maintenance and repair without government subsidy, and so construction of

badly-needed transmission and distribution infrastructure, and its repair, is stymied by under-investment.

Poor private investment and government subsidy not only contribute to low electricity access rates and negative social development and wellbeing impacts on the rural poor, but it also politicises electricity access. Though grid extension to rural regions is ostensibly motivated by social development concerns, promising access through grid extension is a key election campaigning tool used to maintain ruling party dominance. This political economy of electricity explains why tariffs are still not cost-reflective, and why EDM faces ongoing financial challenges since the government stopped subsidizing tariffs a decade ago. However, tariffs registered since 2015 have increased rapidly to reflect increased operational costs, but that, in turn, leads to growing energy poverty. At the national level, the Government of Mozambique has set a policy framework to reach 50% access in 2013, and eventual universal access by 2030. In 2018, the government approved the national electrification strategy, which encloses the Energy for All Program (PROENERGIA), with funding from World Bank Group. The program aspires to cover 80% of the population through on-grid connections and 20% through off-grid connections, though public and private revenue-raising for this level of infrastructure investment remain a steep challenge. The decision to focus on grid expansion prioritises centralised renewable and non-renewable energy generation 'mega-projects' such as hydro-dams and gas-fired power plants, which have stimulated rapid GDP growth, but created few jobs and few local linkages. Moreover, domestic energy projects and resources remain export-focused, either for electricity (e.g. export to South Africa) or gas (to global commodities markets) with little concern for rural energy-poor communities.

Off-grid energy for rural communities remains a 'niche' element of Mozambique's energy system, with an estimated less than 1% of the population having access to micro-renewable systems (e.g. domestic solar photovoltaics). Off-grid solar, in particular, is promoted in rural areas by both public and private institutions. Private sector involvement in off-grid renewable transitions, however, is still limited, and they are currently serving around 15,500 users of stand-alone photovoltaic systems. The high costs and lack of incentives (e.g., exemption on import taxes) to implement off-grid projects contribute to the low coverage and high prices. Thus, the market has been dominated by low-quality products imported from South Africa and China traded mostly within informal (i.e. untaxed and unregistered) markets. Household connections commonly fail due to operational failures, and this negatively affects consumer confidence in solar equipment and systems.

The Government of Mozambique plans to incentivise and increase private sector participation in the off-grid sector to support the country's Energy for All programme whilst simultaneously reducing the burden of infrastructure provision on public finances. It is clear, however, that the public institution, FUNAE (Energy Fund) will continue as the principal promoter of solar PV standalone systems and mini-grids, mini-hydropower, and biomass. Although FUNAE's focus has mostly been on electrifying schools, hospitals, administrative offices, and pumping stations with solar panels, they are now expanding their

scope to cover more households in order to fulfill the government plans of energy for all by 2030.

Conclusion

Mozambique, like many least developed countries and economies in transition, struggles to capitalise upon domestic resource availability to meet the socio-economic development and wellbeing needs of its citizens. Energy policy is both diverse and contradictory. The prioritisation of export markets for energy resources exacerbates rural community energy injustice, and the emphasis on centralised grid connections to urban centres politicises electricity access with attention paid to large urban voter blocs. The lack of public investment and rapid rises in tariffs to meet growing operational costs further divide the country in terms of access and electricity availability. In meeting the Government of Mozambique's own universal electricity access policy strategy, greater domestic revenue-raising from resources such as wind, gas, solar, and hydropower needs to be redirected to social benefit programmes, creating last-mile grid access and long-term investment in centralised infrastructure, combined with islanded micro-grids where electricity access to centralised systems is impractical. Tariff subsidy to support EDM investment across rural, peri-urban and urban networks is necessary, and so creating strong domestic political-economic structures for effective utilisation of available renewable and non-renewable energy resources is a vital priority for state-supported and inclusive socio-economic development with strong civic buy-in.

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Strengthening Nuclear Energy Programmes in Sub-Saharan Africa

Simbarashe Mangena

Access to plentiful, secure, and environmentally benign energy is both paramount and fundamental to the development of Africa. According to global energy and utility firm ENGIE, currently, only 37 percent of Africans have access to electricity, with the rural access rates substantially lower than the urban areas. The African Development bank postulates that the electricity access rate in the region ranges slightly above 40 percent and is the lowest in the world.

With the exception of South Africa, the energy consumption per capita is a paltry 180kWh against 13000kWh and 6500kWh per capita of the United States and Europe respectively. This significantly large energy deficit, coupled with a high vulnerability to climate change, is a grotesque impediment to the sustainable growth and development of the continent. In this vein, the advent of nuclear energy becomes a key component in the portfolio of energy technologies that will catapult Africa in the trajectory of sustainable economic development.

According to the World Nuclear Association Information Library, 16 countries out of the 48 countries in Sub-Saharan Africa are embarking on nuclear power programmes. Despite the fact that current nuclear power plants on the market operate at a capacity of 1GW and above, thus exceeding sustainable capacities for many African countries, small modular reactors and advanced nuclear technologies have the potential to significantly improve the feasibility of adopting the technology on the continent. Notwithstanding the fact that the 16 embarking countries have sourced for reactor designs in compliance with what is currently available on the market, the latter presents an opportunity for the establishment of new nuclear energy programmes in Africa in the not too distant future. Through smaller reactor sizes and modest designs, these new nuclear technologies could be economically and technically feasible.

The establishment of a nuclear power plant is inherently a subset of a nuclear energy programme. This implies that a nuclear energy programme encompasses a plethora of applications of nuclear science and technology with benefits such as:

Employment Creation: According to the Rosatom Overseas online brochure, construction and operation of nuclear power plants provide economic growth and creates new jobs: 1 job in nuclear power plant construction creates 10–15 jobs in related sectors.

Energy Efficiency and Reliability: Richard Rhodes opines from statistics in the US in 2016, the average capacity factor of a nuclear power plant is 92.3%, this implies that they can be operated at full power for 336 days out of 365 days in a year. The remaining 29 days will be periodically spread for maintenance. In contrast, hydroelectric systems have an average capacity factor of 38.2 % (138 days per year), wind turbines 34.5% (127 days per year), and solar electricity arrays only 25.1% (92 days per year). Thermal and natural gas plants generate electricity about half the time for reasons such as fuel costs and seasonal and nocturnal variations in demand. This analysis clearly shows the

capabilities presented by nuclear as a steady baseload power source that will enable optimal production and indeed sustainable development.

Carbon-free Power Generation: Nuclear energy generation will significantly reduce the carbon footprint of the continent consistent with the global consensus regarding climate change.

Enhancement of Applications of Nuclear Science & Technology: Nuclear energy programmes have the potential to strengthen the use of radiation in the health sector by promoting the establishment of radiopharmaceuticals industry on the continent. Africa is hard hit by the global cancer scourge with most of her countries incapacitated and under-resourced to meet the growing demand for medical radioisotopes. In the agricultural sector tsetse/pest control, food irradiation for increased shelf life, plant mutation breeding using radiation can also be strengthened. In the consumer product sector, manufacturing of radiation sources for mining and industry will be established within the region, creating employment opportunities. Capacity building in the education sector and deed economic development are also required. All these technologies and expertise are currently being imported. It is important to note that whilst these applications can be established without NPPs, the implementation of a nuclear power program is the pinnacle of radiation technologies, thus providing credible assurance and confidence of the commitment towards radiation safety and security to the international community thereby paving the way for the development of these technologies.

Complementing the massive strides that have been made in the continent towards non-proliferation, as evidenced by the ratification of the Non-Proliferation Treaty by almost all the countries and more than half have ratified the Additional Protocol, the establishment of a sustainable nuclear energy programme in Sub-Saharan Africa is definitely on the table.

(Simbarashe Mangena is an Inspector at the Radiation Protection Authority of Zimbabwe.)

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China's Energy Engagement in Africa

Meghna Ria Muralidharan

Energy is considered one of the five essential elements for the survival of mankind and is important for social development and national security. In the last few decades, countries across the globe have been emphasizing on energy security. With the growing population, energy consumption has witnessed an upward trend thereby pushing countries to diversify their energy basket. The continent of Africa has emerged as a major resource destination for countries to fulfill their energy needs. Among the many actively engaged players, China has emerged as one of the top economic partners of the African continent. Despite the challenges, the relationship between China and Africa has undergone tremendous transitions and the two continue to look for common areas of cooperation. Energy continues to be an important factor in China's cooperation with Africa and is also one of the important elements used in the international system

China's Energy Requirement

A remarkable change has been witnessed in China's energy sector and the energy sector is moving into a new direction following President Xi's call for an "energy revolution". He has emphasized on curbing pollution and adopting a service-based economic model. China is the world's largest consumer of energy, the largest producer and consumer of coal, and also, the largest emitter of carbon dioxide.

In the last half-century, China's large manufacturing-based economy has been solely fueled by coal. China has been the largest consumer of coal as compared to the rest of the world. From 1990 to 2018, China's coal consumption has surged up from 0.99 billion tons to 4.64 billion tons. According to the sources, China has aimed to reduce the percentage of coal in its energy mix below 58 percent by the end of 2020. Though the energy consumption of China has remained robust, the forms of energy continue to diversify. Along with coal, China's energy mix also shows reliance on hydrocarbons, and consumption of oil is predicted to reach by 6.2 million tons in the coming time.

The rapid economic growth of China has increased the energy demand thereby putting pressure on the domestic sources of supply. Domestic production is comparatively low than its overall consumption. Thereby, to compensate for the underproduction of domestic energy resources as well as anticipating a further rise in energy consumption, Beijing has framed an energy security strategy based on three main pillars. First, it seeks to expand domestic energy production and to attract foreign direct investment. Second, China is reducing its dependency on fossil fuels and increasing its reliance on a clean source of energy. Third, Beijing is diversifying its energy basket to avoid dependence on a single region or country.

China's ambition of "energy diplomacy" has kept its diplomats engaged throughout the globe and this diplomacy is considered to be part of China's soft power agenda. However, China's activities have raised security concerns for many countries, which worry that China's energy diplomacy will impact their own energy security. China has been

engaging with various countries in the international system and Africa is considered as China's primary destination.

China-Africa Energy Cooperation

China's growing engagement with Africa is linked to the Chinese need for oil. In other words, China's foreign policy towards Africa is described as "getting resources to fulfill its economic development and taking its quest to lock down sources of oil and raw materials". Africa is China's second-largest source of oil, after the Persian Gulf. In the last few years, Chinese firms have expanded their presence in Africa's oil-rich countries such as Angola, Algeria, Egypt, Mauritania, Gabon, Libya, Nigeria, and Tunisia. Among these, Angola is the largest exporter of oil to China. The bilateral engagement between China and Angola has grown tremendously and huge infrastructure investments are made in the country. The African continent is of strategic interest as an international development field for Chinese oil companies aiming to become global players. Moreover, the African market has been a potential hub to produce Chinese goods and services.

China's energy diplomacy in Africa has made Beijing deeply involved in providing aid and assistance to the region. The number of private Chinese firms has also increased in the African continent. Dominating their presence in Africa has been the China National Petroleum Corporation, Sinopec, and China National Oil and Gas Exploration and Development Corp. Furthermore, the revamping of the Egina fields in Nigeria is said to increase the production volume from Africa.

Along with the positives, there are certain challenges that impact China's energy diplomacy in Africa. Like the West, the Gulf of Guinea is considered to be of geostrategic importance for China as many countries along the coast are resource-rich and most of the imports are carried through the sea but piracy remains to be a major challenge. Secondly, Africa provides China with a challenge to decide what kind of global power it aspires to be and to determine the factors that will help in enhancing the cooperation. Taking these factors into consideration, China has been carefully weighing its actions and has continued to follow the policy of non-interference while engaging with the African countries. Though the role of Chinese NOCs seems to be expanding in Africa, western oil companies continue to dominate the oil market both in terms of production quantity and asset holding.

What is in Store?

China and Africa have been cooperating primarily in hydrocarbons and Africa continues to be dependent on fossil fuels to meet its energy needs while on the other hand, China has been at the forefront of climate diplomacy and policy. It has emphasized reducing the use of fossil fuels and is installing the largest amount of renewable energy capacity in the world. The cooperation has been comparatively low in the clean energy sector. Therefore, plausible cooperation in this regard will be beneficial as Africa provides a great asset base for renewable energy mainly wind and solar. China can enter in this scenario by providing infrastructure assistance.

Thus, if China and Africa cooperate in the clean energy sector, China can rise as a global leader of climate governance and the structural development will help Africa in sustaining energy

thereby creating a "win-win situation" for both. To add to this, the global pandemic has severely impacted progress on energy access and lockdown measures have put off-grid developments at risk. Therefore, it will be interesting to see how China and Africa continue to cooperate in terms of energy and the impact of the pandemic on long-existing cooperation.

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We thank Mr. Ajay Singh for joining as the Guest Adviser for the October 2020 issue of Energy Review. Mr Singh is a Tokyo-based energy expert and management advisor. He is the founder of Global Energy, a venture that promotes green hydrogen.

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