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Energy

Conclusion: Challenges of achieving a Sustainable Africa Energy Future

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In 2023 Africa only produces 1.5% of its energy from renewables (excluding hydro). The other two developing regions, South Asia and South America produced 3.6% and 5.6% respectively. By 2050 Africa will produce around 16% while the other two regions will produce almost half of their energy from renewables. Africa will trail further and further behind. Expressed as a portion of total energy production, South Asia and South America also produce more nuclear and hydro than Africa. There are significant variations between sub-regions and countries, of course. North Africa is much more dependent on fossil fuels compared to Sub-Saharan Africa. However, because the latter has a poorly developed energy infrastructure, it is less tied to the path dependency of other regions. The result is that Sub-Saharan Africa is well positioned for an energy transition in line with the policies advocated in the UNEP Global Gap report, with the potential to transition to non-fossil energy sources rapidly. North Africa is less so. Should the promise of SMRs come to fruition nuclear is all poised to play an important role in meeting Africa's base load requirement as well as contributing to a lower-carbon trajectory.

Our modelling suggests a **first estimate of a carbon budget for Africa** in the order of 13% of total emissions from fossil fuels by 2050 and 22% by 2063. That would be the share of global emissions from fossil fuels that Africa would require in the Sustainable Africa scenario, i.e. in an ambitious high-growth scenario that includes a host of mitigation policies and efforts to constrain carbon emissions whilst rapidly transitioning away from coal and oil.

In considering these numbers, the reader is reminded that Africa's 2050 population will constitute 25% of the world's total and, in 2063, it will be 28%. Currently Africa constitutes 18% of the world's population. Therefore, Africa's required share of carbon emissions from fossil fuels is significantly below its share of the global population, even on a high-growth forecast. Currently, Africa contributes 4.8% of global carbon emissions from fossil fuels. The Current Path forecast, i.e. on Africa's current modest development trajectory, is 11% and 17%, respectively. Bear in mind that the African population is smaller in the Sustainable Africa scenario, given the reductions in fertility rates that accompany improvements in well-being. The difference in emissions from fossil fuels between the Current Path forecast and the Sustainable Africa scenario is 46 million tons of carbon (169 million tons of CO_2 equivalent) in 2050 and 85 million tons (312 million tons of CO_2 equivalent) in 2063.

In 2023, Sub-Saharan Africa produced 5.5% of its energy from wind, solar and geothermals (6.1% if hydro and nuclear are included), and North Africa produced only 2% with the inclusion of hydro and nuclear. The Current Path forecast is for a rapid increase in renewables to the extent that, by 2050, Sub-Saharan Africa will generate 27.4% of its energy from renewables and 52.5% in the Sustainable Africa scenario. These significant increases reflect the potential for rapid progress in the region, with slower improvements likely in North Africa.

The role that **hydrogen** could play in Africa's energy future is currently unclear. Energy from hydrogen has regularly attracted hype and disillusionment, and its journey towards becoming a ubiquitous fuel is bumpy at best, given the challenges of producing, transporting and containing it. The most straightforward use of large-scale hydrogen is in hard-to-decarbonise areas of the economy, such as heavy industry, with limited application in Africa, given the low demand from these sectors. It is, instead, the potential for export that attracts attention. Thus, with promises of US$10.8 billion investments from Germany, Namibia has the most ambitious plans to produce green hydrogen from its abundant solar and wind resources, turn it into ammonia, and then ship it to Europe.

Chart 17: Renewable energy production in Current Path as per cent of total production, 2023-2063

Renewables refers to all renewable sources of energy excluding nuclear

Source: IFs 8.17 initialising from IEA World Energy Balances

With clear policies and determined leadership, many African countries can embark on an early transition to reduce fossil fuel use, as presented on this page. Large fossil fuel producers, Nigeria, South Africa, Algeria, Egypt, Angola and Libya will be most affected. The future carbon emissions from a handful of African countries are globally significant, namely Nigeria, Egypt, South Africa, Ethiopia, Algeria, the DR Congo, Mozambique, Tanzania, Uganda, Côte d'Ivoire, Morocco, Sudan and Zimbabwe. These are countries with rapidly growing populations and fossil fuel importers or producers. Their success in transitioning quickly to renewables and reducing their carbon footprint will be critical in determining Africa's contribution to global warming and a sustainable global future.

Amongst Africa's coal producers, **South Africa** faces the most significant challenge in meeting the Global Gap report target of eliminating coal production by 2040. In 2023, it depended on coal for almost 95% of total energy production and is one of the largest coal exporters in the world. As a result, South Africa is Africa's largest carbon emitter, the 15th largest carbon emitter of fossil fuels globally and includes some of the most air-polluted areas in the world. According to the Current Path forecast, South Africa will still depend on coal for 74.4% of its total energy production in 2040 while also exporting large amounts. In the Sustainable Africa scenario, South African energy exports will decline to about US$2.7 billion in 2050 (compared to the Current Path forecast of US$12.7 billion), and energy imports will increase by US$29.4 billion. The associated energy transition would be huge but outweighed by the benefits to its economy and the health of its citizens.

Similar to other large coal exporters, the South African government and proponents of a rapid transition away from coal have to contend with a strong coal lobby, including from unions in its mining sector. In the interests of reductions in carbon emissions and in addition to a substantive investment in CCS, there is no alternative to a rapid decrease in coal production and consumption globally.

The transition from coal will also be painful for **Zimbabwe, Mozambique** and **Botswana**. The latter sourced 50% of its energy production from coal in 2023 - Zimbabwe was 71% and Mozambique at 57%. On the Current Path forecast, coal production in Botswana will remain at its current levels until 2050, while production in Mozambique and Zimbabwe is set to increase, implying that these countries could continue mining coal for domestic energy production given the size of known coal reserves, but that they will have to forego export earnings related to their coal assets since they would struggle to find external investors and markets.

Africa's oil exporters, such as Angola and Libya, will also need help reducing production in line with the UNEP target. **Nigeria**, Africa's largest oil producer, will be challenged the most. Oil accounts for over 80% of exports and roughly 50% of the government budget, although production has steadily declined from its peak in 2005. Investments in exploration have also gone down. Many of the larger foreign oil companies such as Shell, TotalEnergies, Chevron, ExxonMobil, Eni and Equinor have either left, are in the process of doing so, or are shifting their investments into offshore waters given high levels of insecurity onshore, particularly in the Niger Delta that harbours most of Nigeria's onshore and shallow-water oil rigs. With the largest gas reserves in Africa, Nigeria will inevitably pivot from oil to natural gas, which currently accounts for just 10% of Nigeria's exports. Increasing its gas exports would require significantly expanding the facilities to cool and liquefy gas, writes the Economist.

On the one hand, our modelling indicates a slow energy transition to renewables, nuclear and hydro in Africa, away first from coal, then oil and, in the second half of the century, from gas. Renewable energy production in Africa is in its infancy, and it will take several years to gain momentum and a decade or more to ramp up to levels at which renewables offer viable alternatives to fossil fuels. Hydro and nuclear projects must also ramp up rapidly.

The hydroelectric project with the most potential, the Grand Inga scheme in the DR Congo, now back on the table after many years, illustrates how new technologies could circumvent infrastructure constraints. Instead of the need for transmission networks to transport electricity to industry in Nigeria or South Africa, the project becomes commercially viable if it uses its vast electricity production to produce hydrogen at the source, then shipped to markets in Asia, Europe and elsewhere by sea.

In thinking about energy, African governments are primarily concerned about cost and speed and less about the choice of technology (nuclear or not). In this context, SMRs could significantly contribute to meeting Africa's energy requirement in high-demand nodes. Rather than the development of traditional national electricity grids, baseload electricity supply needs to be taken to these nodes to create mini or smaller grids. Examples are the provision of energy for industrial or mining demand such as cement and fertiliser production, iron ore smelters, large data centres, and chemical and steel plants, much of which can be done using SMRs with project-specific additions from other energy sources to meet peaking demand. Africa will, however, not invest in technology demonstrators (first of kind) SMRs, implying that the most likely successful approach could either come later in the SMR development path (once demonstrator units are operating effectively elsewhere) or for SMR developers presenting a fleet option to several countries as a package option that resolves energy requirements across a host of higher demand nodes.

Africa has set a path towards industrialisation, regional trade, and integration. These two ambitions inevitably release more carbon than the other eight sectors modelled on this website and are included in the Sustainable Africa scenario. It is, therefore, important that industrial development, such as building fertiliser and cement plants, proceed with the appropriate technologies that keep carbon emissions to a minimum.

Given the fear of stranded assets, the inevitable question is: How and who will finance Africa’s ongoing fossil fuel exploration and production and for which market - for domestic consumption or export? Momentum is growing among wealthy countries to stop new investments in oil and gas ventures, and the risk of stranded investments is growing. Global demand for gas could change rapidly, which is important since much of Africa's gas is for the more lucrative export market rather than domestic consumption. At the same time, Africa’s high levels of indebtedness and punitive risk premiums mean that the continent struggles to attract investment in the best circumstances. With an unreformed global financial system and capital mainly in the hands of the risk-averse private sector, the ability of African countries to borrow money at affordable interest rates is limited. At the same time, the large sums of money promised to help the green transition under the auspices of the so-called Just Energy Transition Partnerships have not materialised, and the result is that polluting coal plants stay open. Mozambique is an example of a country that has to enter into complex arrangements with private actors with only limited revenues flowing to the government towards the end of the project life cycle once the investors have recouped the return on their investment.

A previous section noted the extent to which revenue forecasts for oil and gas resources are regularly overstated, and today, these investments are considered even more risky. Oil and gas ventures often require several decades for governments to realise a reasonable return, underlining the fraught nature of these investments. Even if Africa were to get a reprieve on gas projects, the negative perceptions associated with investments in fossil fuels imply a high level of risk to private or public sector investors if the world were to pursue the UNEP production targets.

Africa would need lots of support from multilateral funding institutions, private sector partners, development agencies and bilateral support from high-income countries to realise a viable carbon emissions pathway, including for selected exploration and production of gas. The call is not new and was prominently made as part of the Bujumbura Declaration of August 2021 that urged the World Bank to scale up investments in energy cooperation in Africa, including the financing of gas-to-power projects beyond 2025. The obvious response would be to introduce a carbon tax on countries with high per capita emissions and those that have historically benefitted from a high carbon growth path, using the associated funds to fund Africa's energy transition, as discussed in the theme on Africa's Climate Futures. In addition to debt relief and suspension, multilateral development banks need to implement the Climate Resilient Debt Clauses (CRDCs) developed in response to the Sustainable Debt Coalition created at COP27 in Egypt and the use of debt-for-nature or debt-for-climate swaps to strengthen recipient countries, allowing them to repay their debts by investing in nature regeneration and climate action as recently proposed by the African Center for Economic Transformation. The recommendations are part of five financial proposals to help African countries finance a just and equitable climate transition at scale.[1]

The future carbon emissions from a handful of African countries are globally significant, namely Nigeria, Egypt, South Africa, Ethiopia, Algeria, the DR Congo, Mozambique, Tanzania, Uganda, Côte d'Ivoire, Morocco, Sudan and Zimbabwe. These are countries with rapidly growing populations and fossil fuel importers or producers. Their success in transitioning quickly to renewables and reducing their carbon footprint will be critical in determining Africa's contribution to global warming and a sustainable global future.

Various estimates have been tabled about the cost associated with tripling renewables by 2030 (the target set at COP28), ranging from US$1.3 to US$2 trillion annually. According to Climate Analytics, investment in Africa needs to grow five-fold to ramp up renewables twice as fast as the global average. These are significant amounts, probably only available within the private sector in the developed world and through a carbon tax on high-income and high-carbon emitter countries to reduce emissions and fund the energy transition in regions such as Africa. Given the small contribution Africa and other areas have historically made to global carbon emissions, their current low emission levels and considerable developmental challenges, it is unlikely that developing countries would agree to a worldwide tax that does not recognise these inequities.

Africa needs vast amounts of energy. Linear, path dependency thinking is that the base load requirements cannot come from renewables given the variability of solar and wind. Unlike fossil fuels, conventional approaches constrain options for nuclear or hydro as they currently offer the required potential without a technological breakthrough with energy storage. Yet scaling up large-scale solar power in North Africa could power Europe, while the associated manufacturing requirements could significantly boost North Africa's economies. Instead, Germany chose gas from Russia and closed its nuclear energy plants until the war in Ukraine ignited demand for gas from America instead of solar energy from the Sahara.

Without 'out of the box thinking', such as green hydrogen from Grand Inga and Namibia and bulk solar from the Sahara, the costs associated with hydro, hydrogen and nuclear energy, including the environmental challenges, appear to limit the feasibility of other options. In addition to wind, solar, geothermal, green hydrogen, and other renewables, Africans must explore local solutions, such as repurposing solid waste and making efforts towards a circular economy.

Similar approaches have worked well in Brazil with ethanol-based biofuels. However, typical biofuels from food crops require agricultural land and water, thus reducing food production, which may enhance food shortages in an already

crop-vulnerable region. Energy availability can also be improved with the location of micro and small modular nuclear reactors closer to demand, such as for heavy industry, such as fertiliser production. It would negate the issue of inadequate infrastructure and transportation. Once micro and small modular nuclear reactors are produced cheaply, safely and sufficiently, Africans can locate low-carbon energy supply closer to demand. Should a group of African countries agree to support a particular small modular nuclear technology and commit to providing a guaranteed market, it could unlock more rapid development in this domain.

Low-carbon liquid fuel security in Sub-Saharan Africa can be improved substantially by small-scale decentralised production of fuels.

The analysis and scenarios presented here broadly align with those of the IEA, including on controversial matters, such as that 'nuclear power will have to expand further worldwide, in part by bringing small modular reactors to market, while overcoming some of its recent difficulties in advanced economies.' Africa will benefit from advancements in nuclear technology, particularly the development of SMRs that could be plugged into national and regional networks to provide clean, reliable baseload capacity, but will not be able to step away from fossil fuels to the extent proposed by UNEP and others.

Technological development will fundamentally change the future of energy and emissions, particularly the 'race to the top' between the US and China, spurring investment and innovation in renewables, carbon capture, storage technology, and nuclear energy. The fracking revolution in the US is an example of how technology, at scale, can disrupt the market to the extent that it is now the largest LNG gas exporter globally. Looking to the future, biomass, renewables such as wind, solar, hydrogen, small-scale nuclear plants, and new technologies such as solid-state battery storage, amongst others, could have similar disruptive effects.

It seems inevitable that renewables and small-scale nuclear will lead to a more distributed energy system, thereby reducing the power of resource-rich countries with lots of coal, oil and gas to lord it over others. Much depends on the policy choices made, however, since the promise of technology as an enabler of the redistribution of political, economic and social power has yet to be realised. There is, instead, for many in the West, the fear that the concentration of the associated manufacturing capacity in China could provide that country with significant leverage in the renewables sector, given the extent to which it has also locked in the required rare earth and other metals in a vertically integrated production chain from mine to shop. Generous state subsidies, rapid domestic demand growth, and intense local competition mean China is responsible for 80% of global solar manufacturing, with batteries and electric vehicle production just a little behind. It is, however, not an issue that concerns Africans much.

Renewables demand extensive critical raw materials (primarily metals), such as copper demand for undersea power cables and lithium and cobalt as key battery technology components. Thus, a typical electric car uses about six times the minerals of a conventional vehicle. Most of these minerals are in Africa, although Canada, Australia, and others are emerging as well-endowed, providing significant development opportunities given the demand for critical minerals indispensable in renewable technologies. 'A renewables-based energy transition', writes IRENA's Francesco la Carema, 'provides a chance to rewrite the script for extractive commodities and ensure their value chains are more inclusive, ethical and sustainable.' The problem, however, is that the extraction of cobalt, lithium, and nickel only accounts for 0.1% of the total value chain, one example of Africans' need to redouble efforts at beneficiation, local production, and manufacturing. Knowledge transfer and domestic investment in exchange for the export of beneficiated raw materials should, therefore, be front and centre in an African strategy to leverage the associated opportunities, with some countries, such as Namibia, already having instituted export restrictions.

The transition to a sustainable world will be gradual. Still, it will consist of several steps, moving steadily from coal to oil, gas, and other fuels and eventually to renewables. There is enormous inertia in the current fossil-fuel energy world and intermediate pathways, such as moving from fossil-based fuels to biofuels and renewables. Meanwhile, Africa is already

starving of investment in producing fossil fuels such as gas and renewables.

An early start to this pathway is particularly relevant for Africa, which could eventually emerge as a significant source of carbon emissions from fossil fuels on its current development trajectory.[2] Given the low levels of heavy industry and manufacturing, we have also seen that the contribution CCS can make in Africa is limited, as well as the limited effect of a carbon tax on carbon emissions from Africa.

Additional savings could come from implementing stricter building codes and energy standards, greater industrial efficiencies in cement, steel, and chemicals, efficiencies in existing vehicles, the promotion of fuel-efficient modes of transport, and the Continental Power System Masterplan.

Determined and early action is required to forestall the global damage that will follow a situation where Africa proceeds along its current fossil-fuel-dependent growth path. The theme of Climate Futures starkly presents the irony that the continent will suffer more than any other region, given its limited coping (or adaptive) capacity.

Because Africa is currently only responsible for a small portion of global carbon emissions from fossil fuels (4.4% of the worldwide total in 2023), a revolution in Africa's energy production away from fossil fuels will not change the global climate trajectory for several decades. But, because of the increase in Africa's carbon emissions over time, the energy decisions taken by Africa in the years ahead will significantly impact global carbon emissions and climate change in the long term. International support for a just and orderly African energy transition to renewables needs to be aware of these considerations. For its part, the continent needs to focus its efforts on climate adaptation instead of mitigation.

Though slower than elsewhere, the transition to a low-carbon African economy will require careful planning to meet the just energy transition criteria. For example, the closure of coal mines will have a substantial environmental and social impact. In contrast, the move from platinum to green metals required for a low carbon economy, including manganese, copper, vanadium and rare earth metals, also has its effects. Many of these mines are in vulnerable areas with low alternative employment opportunities but offer the chance to swap out the current dirty coal generation units with an alternative power source, most likely nuclear.

The challenge is, of course, even more significant than presented in this theme. Africa should pursue energy self-sufficiency with energy production roughly equal to its energy demand, implying a 39% increase in domestic energy production by 2050. That goal, not examined in this theme, could increase Africa's carbon emissions, but in an ideal world, it should not markedly increase global emissions.

Chart 18: Recommendations

Recommendations

- States must rapidly reduce fossil fuel production and consumption globally.
- Transition to renewables to reduce Africa’s commodity dependence and vulnerability to commodity price swings.
- On top of determined mitigation, Africa needs a growing carbon emissions budget.
- Exploit gas reserves while constraining greenhouse gas emissions.
- Africa needs international support for the realisation of exploration and production of gas, and a long-term transition plan to accommodate current investments and a low- carbon aspiration.
- Implement carbon tax high per capita emissions countries to fund the loss and damage fund and Africa's energy transition.
- MDB's must implement the Climate Resilient Debt Clauses (CRDCs) and use debt-for-nature swaps to strengthen recipient countries.
- Africa must contribute to carbon mitigation through land and forest management.
- Africa can achieve reductions in electricity demand through energy and material efficiency measures, implementing stricter building codes and energy standards.
- Industrial development must proceed with the appropriate technologies that keep carbon emissions to a minimum.
- Africans need to redouble efforts at beneficiation, local production, and manufacturing of global means to achieve a low carbon economy and leverage the associated opportunities.

Endnotes

1. 1. Debt relief and suspension for low- and middle-income countries, including innovative debt swaps and Climate Resilient Debt Clauses. 2. Extend below-market-rate, or concessional, capital to EMDEs. 3. Use credit enhancement and credit guarantee schemes to incentivize private sector participation. 4. Establish a foreign exchange guarantee mechanism. 5. Create a turbocharger facility for climate action projects and entrepreneurs in Africa.
2. Because of the current low demand for energy per person in Africa, and because energy efficiency is low, energy demand in Africa will overtake other regions and countries several years later than the point at which its carbon emissions from fossil fuels is larger. Thus Africa's energy demand only overtakes the EU27 in 2043, the US in 2052, India in 2066 and China in 2080, but its carbon emissions from fossil fuels is already larger in 2033 (EU27), 2052 (US), 2060 (India) and 2066 (China).

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Dr Jakkie Cilliers is the ISS's founder and former executive director. He currently serves as chair of the ISS Board of Trustees and head of the African Futures and Innovation (AFI) programme at the Pretoria oce of the Institute. His 2017 best-seller Fate of the Nation addresses South Africa's futures from political, economic and social perspectives. His three most recent books, Africa First! Igniting a Growth Revolution (March 2020), The Future of Africa: Challenges and Opportunities (April 2021), and Africa Tomorrow: Pathways to Prosperity (June 2022) take a rigorous look at the continent as a whole.

Ms Alize le Roux joined the AFI in May 2021 as a senior researcher. Before joining the ISS, she worked as a principal geo-informatics researcher at the CSIR, supporting various local and national policy- and decision-makers with long-term planning support. Alize has 14 years of experience in spatial data analysis, disaster risk reduction and urban and regional modelling. She has a master's degree in geographical sciences from the University of Utrecht, specialising in multi-hazard risk assessments and spatial decision support systems.

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