

A Just Transition Framework for Oil Rich Sub-Saharan Africa Countries

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Abstract

This paper narrates the complexities presented to Oil Rich Sub-Saharan Africa countries endowment by the ongoing global energy transition. There is a global call for transition from fossil fuel to renewable energy to curb climate change. It is noted in literature that Global North who has developed their economies using fossil fuel and currently emit much more than the Global South mainly champion this call. For a just transition to occur (where the transition process is fair and does not cause unnecessary hardship to a people), there is need to consider the complexities of the process on ORSSA countries. ORSSA countries heavily rely on fossil fuel for economic growth and are energy poor which hinders their ability to diversify their economy. Gas is viewed to be have less environmental impact than coal but still contributes to climate change. Furthermore, many Global North countries still depend on gas for energy security due to the intermittency of renewable energy and its inability to power some energy intensive sectors such as cement and steel. ORSSA countries house about 40% of new gas discoveries in the last few years. This paper argues for continued use of gas as a transition fuel in ORSSA countries in their energy transition journey. It uses narrative enquiry to tell the story of this case study, provide better understanding, provide justification for the use of gas as a transition fuel for the ORSSA countries and make recommendation on how to better position their oil and gas to avoid stranded asset.

Keywords: Just Transition, Sustainable energy Transition, Transition fuel, Oil Rich Sub-Saharan Africa

1. Introduction

Access to energy is a catalyst for development anywhere in the world. In Africa, energy poverty has been a major constraint not just for economic development but also increasingly to trade. These constraints can only be addressed if there is access to energy, and the energy gap is closed. More than 600 million Africans have no access to energy, resulting in diminished industrialisation. The acceleration of the global momentum towards sustainability and away from fossil fuel is well recognised as demonstrated in COP26's explicit reference [1]. What is not well understood nor supported is the need to ensure that the world's poorest citizens, many of

whom live in resource rich countries, are not left behind.

Most Oil Rich Sub Saharan African (ORSSA) economies are highly exposed to the global energy transition, as their economies depend on oil and gas revenues. Nigeria and Angola for example get 90 percent of government revenue and up to 70 percent of foreign exchange from the oil and gas sector; therefore, the industry cannot be banned suddenly. The energy mix of renewables and non-renewables will help boost Africa's industrial base, helping achieve a just energy transition, but it is noted that the transition to clean energy must not be at the expense of Africa's economic development. Furthermore, African governments are spending between 5-11 percent of their GDPs to adapt to climate impacts [2]. With the increasing rate of famine, drought across regions and rising conflict borne out of the climate crisis as neighboring communities fight for scarce resources, African development is at risk. The continent's commitment, despite a historical and current carbon emissions contribution below 3 percent, to reducing carbon emissions is commendable, but Africa faces a unique challenge in access to modern energy to fulfill its development needs, including building climate resilience. A just energy transition for Africa means the continent gets its space to develop. The transition must be just, fair and equitable. Africa needs the energy to close the gap in terms of income and welfare, between the region and the rest of the world for global convergence. African resources should be used for developing African economies and growth, unlike in the past, when the bulk of the resources were taken and used to develop the Global North. A just energy transition will not be uniform across the continent owing to different resource endowments and differentiated economic power and needs of individual nations. Hence, this paper focuses on the ORSSA countries. There is growing recognition that achieving just transitions requires widespread, inclusive and democratic deliberation due to the trade-offs required, and the diversity of objectives, views and pathways involved. Yet traditional models of participatory decision-making and transition options often draw on experiences of Global North were the key assumption do not apply in Global South. The key assumptions include the existence of a strong and well-resourced state able to provide retraining and compensation, an engaged and responsive private sector, a well-organised labour movement, and spaces where

informed and capacitated civil society can meaningfully engage without fear of violence. Few ORSSA countries meet such requirements. Yet the fundamental shift in their economic and development models implied by energy transitions will not be possible without an active and informed debate between citizens and policymakers: a reimagining of just transition through open and inclusive dialogue. This paper aims to provide a qualitative case study narrative inquiry as an instrument to construct and communicate meaning, impart knowledge and provide an in-depth insight into the ORSSA countries complex dynamic struggles with the energy transition and how this could occur in a just a fair manner.

2. The Concept of Justice in Sustainable Energy Transition

The historical responsibility of different countries for climate change is at the heart of debates over climate justice and is deeply rooted in the United Nations Framework Convention on Climate Change. Article 3.1 states that “The Parties should protect the climate system for the benefit of present and future generations of humankind, based on equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.” This also means that adherence to the principle of a just energy transition requires consideration of past emissions and how they shape future emissions trajectories.

Energy justice is defined “as a global energy system that fairly distributes both the benefits and burdens of energy services, and one that contributes to more representative and inclusive energy decision making” [3, p. 677]. Energy justice also refers to the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system [4]. The concept of energy justice is concerned with decisions and agreements on who bears the cost and burden of energy transition. It has emerged as an agenda to include more social science related disciplines within energy research [5]. [6] argues for a refocus of energy discussions on people rather than resources, technology, or prices. The author argues that this can reveal how much the energy intensity of communities, and lifestyles vary. Energy justice has predominantly been framed in terms of access to affordable energy and fuel poverty, as well as the politics of energy infrastructures [7]. However, [8] argue that a true energy system transition requires thinking and operating differently in terms of new technology as well as proactive and collaborative decision-making processes.

The issue of energy justice is of inherent concern to Global South (GS), especially Africa, compared to Global North (GN) countries [9]. The call for all green energy may be viewed as a form of energy injustice to Africa (especially ORSSA) due to the enormous financial implications and insufficient energy structure of the region. It is argued that with countries like China and India using coal to increase their energy production, the United State of America allowed to pull out of Paris agreement and the use of nuclear by Japan, Taiwan and South Korea, Africa should be allowed to use their natural endowment for energy development [10]. [11] argue that an alternative energy must not be renewable, but has to be sustainable and a better substitute to fossil fuel in terms of cost and environmental impact; natural gas fits into this description. [12] argue that currently, Africa has the least financial and technical ability as well as market incentive for renewable energy investment and these present key limitations to achieving the United Nations SDGs within the stipulated period. This paper therefore supports the notion for ORSSA countries to convert flared gases from waste to significant economic fortune for achieving its energy transition goals while developing strategies for possible all green energy future.

Another type of justice argued for is the environmental justice. This embodies distributive, procedural and justice as recognition. Distributive justice focuses on the distribution of environmental goods, costs and benefits [13]. [14] notes that as much as direct environmental burden or benefit are important, other intersecting dimensions such as vulnerability, need, and responsibility are also to be considered. Distributional justice also addresses questions of access to resources and opportunities that are deemed to be critical to redress social injustices [14]. Procedural justice, on the other hand, is about inclusion and exclusion in decision-making processes around environmental and social issues [14]. Procedural injustices occur when environmental information is unavailable, as well as when there is exclusion and inequity in relation to public participation in policy, decision-making, and access to the formal justice system. This calls for the need for the GS to be included as key stakeholders in climate change and transition global policies as well as inclusion of the society in the development of energy policies at regional and national level.

Climate change has the capacity “to compound existing vulnerabilities such as poverty, loss of biodiversity or degradation” [15] as seen in GS. However, climate change responsibility and vulnerability are not equally distributed, and vulnerability relates to political-economic processes. The author argues that policies to mitigate or adapt to climate change may create unfair outcomes, further exacerbating, maintaining, or ignoring inequalities as seen in ORSSA. Therefore, there exists the potential

of climate change challenges to impact governance and decision-making processes from a sustainability perspective [16]. It is argued that pursuing climate justice intra and inter generationally, in a socially just way in a highly unequal world will mean having to address ‘energy justice’ for the 1.6 billion people worldwide without access to electricity that is so essential to development. It will also mean the energy injustice that characterises the distribution of harm and benefit within the current fossil fuel dependent global economy.

3. Energy, Development, and a Just Transition in Africa

Energy transition in much of ORSSA is less about moving to renewables than about providing electricity where currently none exists. During the last decade, a larger share of the world's population gained access to electricity than ever before, except in sub-Saharan Africa, where it actually decreased [17]. The global access to electricity deficit is increasingly concentrated in Sub-Saharan Africa with over half of the region's population without access to regular electricity and a significant proportion of households continue to rely on conventional forms of energy as their primary source of energy for cooking [18] (see Figure 1). Africa is home to one-sixth of the global population, yet the continent accounts for less than 6% of global energy consumption and produces only 2% of global emissions [19]. Moreover, since the 1980s, the rate of population growth has outpaced the growth of installed electricity capacity and connections, with roughly 140 million more people without access to electricity in 2019 than in 1990. The continent faces a parallel imperative of providing electricity access to millions of citizens currently deprived of it, and the need to align with the global transition to a net zero future. Therefore, ORSSA policy-makers face a challenging dilemma.

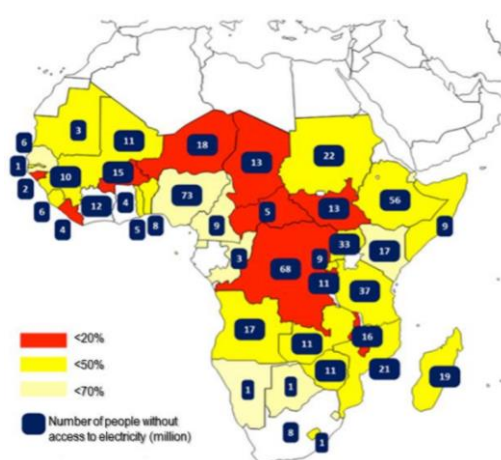


Figure 1. Number of People without Electricity Access in Sub-Saharan African Countries

It is an established fact that modern energy holds a pivotal role in facilitating the speed and degree of structural transformation. In advanced economies (GN), average per capita consumption levels have surged to unprecedented heights, propelling their industrialisation and ultimately helping achieve high levels of prosperity. A strong correlation exists between GDP per capita and modern energy consumption in the form of electricity across a wide range of countries. India and China (emerging economies) have driven most of the energy growth of the last 15 years, while some GN countries have witnessed a peak on per capita and even total energy demand. Energy use follows a linear path during the lower stages of economic development then plateaus as countries achieve higher affluence. However, the global move to electrification of energy systems is changing this pattern [20]. The shift to enhanced digitalisation of enduses technologies and transport based on electricity is bound to drive up electricity consumption. There is therefore the complex challenge of expanding electricity provision to all as well as building a sustainable energy system based on a highly efficient and resilient power sector in ORSSA economies. Energy is an important contributor to human development and key for achieving the Sustainable Development Goals (SDGs). Electricity consumption is highly correlated with the HDI, with a notable exponential slope, suggesting that electricity is particularly important for attaining broader socioeconomic development. The positive relationship between electricity consumption and development is strongly correlated at low levels of energy use as seen in ORSSA countries with an HDI score of less than 0.8. The relationship levels off at an HDI score of higher than 0.8 (mainly GN) because these countries tend to minimise energy intensity and maximise energy efficiency, suggesting that even small increments in energy services amount to proportionately more significant impact on well-being. The HDI on the one hand, show a strong association with climate vulnerability, readiness, and climate resilience, on the other [8]. Climate vulnerability scores and HDI scores generally have an inverse relationship, while the climate readiness score is positively associated with HDI score.

Most ORSSA countries still rely heavily on traditional and inefficient biomass to meet their energy needs despite the continent being rich and diverse in primary energy resources (renewable and non-renewable) [21]. ORSSA countries remains energy poor, unable to harness its enormous energy potential to meet its socioeconomic development challenges. Sub-Saharan Africa's per capita consumption of modern forms of energy is much lower than that of any other global region (see Figure 2). While its per capita consumption was on a par with China's in 1970, it was less than a fifth of China's in 2019. Energy consumption inequality has fallen for

every global region except Sub-Saharan Africa, as primary energy consumption in industrialised economies remained largely the same over the past five decades. Electricity production, a critical part of modern energy systems, is severely lacking in Africa. In 2018, Africa had an installed power generation capacity of 244 gigawatts (GW) for a population of 1.2 billion people, just slightly above Germany's 211 GW for a population of 83 million. In 2019, 47 countries in Africa accounted for about 70 GW of installed capacity (less than the installed capacity of Turkey). The average expansion of installed capacity has been roughly on a par with population growth since 1990 across Africa, while installed capacity per million inhabitants grew fourfold in India and Southeast Asia.

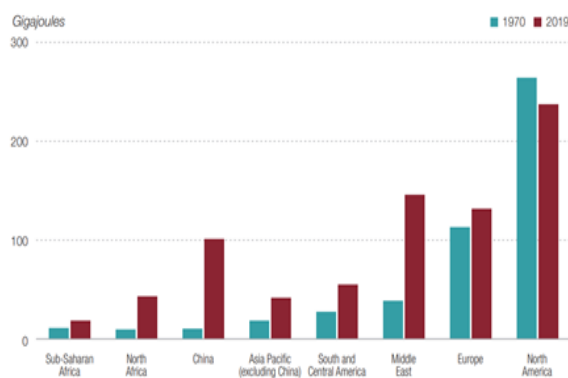


Figure 2. Per capita primary energy consumption of modern forms of energy by global region (1970 and 2019) (World Bank, 2020)

Beyond electricity generation, ORSSA countries' transmission and distribution infrastructure is weak, averaging 200 kilometers of high-voltage transmission lines for every million inhabitants. For example, Nigeria has roughly 30 to 40 km per million. This is less than a quarter of the coverage for the United States (800 km per million), France (720), and Chile (680). This is due to economic viability, independence of utilities, technical and nontechnical losses, regulatory environment, and electricity generation capacity. Per capita electricity consumption in SSA remains very low, at around 370 kWh (without North Africa and South Africa) compared with 920 kWh in India and 2,300 kWh in Asia [22]. Both the cost of being connected, equipped and energy used are higher in ORSSA than elsewhere in the world. The unit cost of electricity to consumers in many ORSSA countries is more than double that of high-income countries such as the United States (\$0.12/kWh) and far higher than in many emerging markets such as India (\$0.08/kWh) (see Figure 3). In ORSSA countries, utilities do not receive cost-reflective electricity tariffs because of low tariff collection rates; high transmission, distribution, and nontechnical losses; and poor financial and technical

management. Low rates of access to electricity and inadequate supply and infrastructure affect households, social and productive sectors. Public health centres and schools lack reliable electricity supply [23]. Furthermore, around 80 percent of businesses in ORSSA experience outages, and power outage durations tend to be far longer. The energy access of power productive sectors is an enduring problem in Africa.

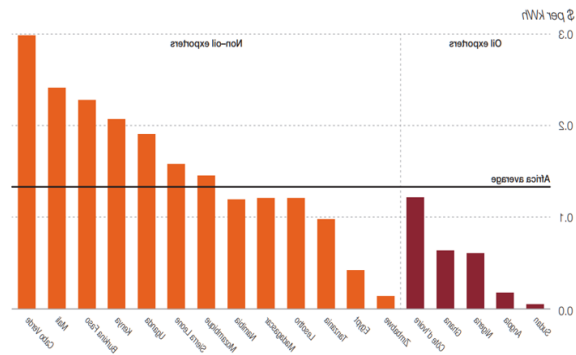


Figure 3. Indicative electricity prices in selected African countries, June 2021 (United Nations Economic Commission for Africa electricity tariff statistics)

Bridging Africa's energy deficit is crucial to the economic well-being of the continent and its people, yet the impacts of climate change are likely to fall more heavily on Africa than other global regions. Africa's historical and current carbon emission share is below 3 percent of global emissions, but the burden of climate change on economies and livelihoods across the continent is disproportionately high - a climate injustice. Additionally, Africa is also the least climate-resilient region in the world, with high vulnerability to climate change and a low readiness for its impacts. Climate change is already threatening to derail development gains and impose further economic costs and social disruption, with adaptation alone projected to cost the continent at least \$50 billion annually by 2050.

African policy-makers argue that since Global North countries developed using fossil fuel emissions, these countries should lead the way in reducing their GHG emissions to offset the impact of the Global South's quest for economic growth and greater prosperity. The principle of a just energy transition in Africa must consider past emissions and how they shape future emission trajectories. Africa contributed little to the buildup of historical emissions and should therefore not be denied the "carbon space" to develop its economies. True climate justice suggests that Africa is owed almost 10 times as much as the global climate finance that it received in recent years. In addition, GN countries should provide technology transfers and financial support necessary to help grow Africa's clean generation capacity. The recent COP26

Climate Change Conference in Glasgow focused on the mobilisation of public and private finance to produce clean energy in the GS. However, the relevant Sustainable Development Goal 7 (SDG7) goes beyond just cleaner energy, it embodies access to affordable, reliable, sustainable and modern energy for all. In ORSSA, more progress has been made towards improving access to energy services than in ensuring the reliability of energy supplies and the sustainability of energy production. Transitions to more sustainable forms of energy are charged with political questions about how to balance these different goals. Careful country-level analysis of such competing interests and working with entire energy systems are therefore key.

Countries' resource endowments should be the point of departure for support. Countries with few commercially viable fossil-fuel resources, has successfully developed renewable energy, as seen in Kenya. Concerns over energy security and a focus on developing indigenous sources of energy can be observed in many countries, but their outcomes differ from one country to another. Resource endowments have hitherto decisively influenced the potential for energy transitions. There is a remarkable correlation between the availability of fossil-fuel resources and the choice of energy technologies. Countries like Nigeria, Ghana and Tanzania, which have significant commercially viable oil, gas and/or coal resources, have included little non-hydro renewable energy in their energy mixes, while Ethiopia and Kenya that lack fossil-fuel resources have shown a greater interest in developing their renewable sources of energy. Support strategies should therefore reflect the particular country's own resource endowments. If a transition to more sustainable forms of energy is the goal, continued support to the development of non-

hydro renewable energy is required, as are diversified approaches and a willingness to work across energy sources and technologies. The access agenda provides a window of opportunity for promoting non-hydro renewable energy.

4. Sub-Saharan Africa's Energy Resources: A Narrative of the Paradox

Sub-Saharan Africa is blessed with renewable and non-renewable energy resources. The non-renewable sources focus on gas endowment given that gas is now a recognised bridge fuel as detailed in Cop 27 proceedings. The SSA natural gas sector emerged in the late 1990s when the first LNG plant came on stream in 1999 in Nigeria, followed by Equatorial Guinea (2007), Angola (2013) and Cameroon (2018), finally connecting the region to the global gas market [24]. In 2019, Nigeria's production accounted for about 7% of globally traded LNG and ranks the country among the world's top five producers. Although the presence of gas has been known in Mozambique and Tanzania since the 1960s, it was from 2009 that a huge series of natural gas discoveries were made (3000 to 5000 billion cubic metres (bcm) in Mozambique, and 1000 to 1700 bcm in Tanzania. Significant discoveries were also made offshore in Senegal and Mauritania from 2016 (500 to 1000 bcm) and in South Africa in 2019, which collectively accounted for over 40% of global gas discoveries between 2011 and 2019 (Table 1). These official figures of the proven reserves have not taken into account all the recent giant gas discoveries made offshore Mozambique and Tanzania in East Africa, and in Senegal and Mauritania in West Africa.

Table 1. Natural Gas Proved Reserves and Production and in Sub-Saharan Africa (Enerdata,2020)

Countries	Proved Reserves (in Mb)	Share of Global Reserves (%)	Production (in 000 bpd)	Share of Global Production (%)
Nigeria	5761	2.82	47.90	1.20
Mozambique	650	0.32	4.21	0.11
Angola	343	0.17	7.28	0.18
Congo-Brazzaville	284	0.14	0.70	0.02
Cameroon	179	0.09	2.38	0.06
Ghana	53	0.03	2.77	0.07
Senegal	52	0.03	0.01	0.00
Mauritania	50	0.02	-	-
Equatorial Guinea	39	0.02	6.19	0.15
Tanzania	35	0.02	0.88	0.02
Gabon	26	0.01	0.48	0.01
Sudan	25	0.01	-	-
Ivory Coast	12	0.01	2.28	0.06
SSA TOTAL	7631	3.74	74.86	1.87

Unfortunately, the lived experience of ORSSA countries over the past several decades tells a story which differs radically from the promise of petroleum. There are dramatic development failures and lack of economic growth and poverty which have been

argued to be exacerbated by oil and gas endowment [25]. Long-time African oil producers such as Nigeria, Angola, Congo-Brazzaville and Gabon, have been largely unable to convert their oil wealth into broad-based poverty reduction. These countries have

not been able to diversify their economies or prepare for a post-oil future either. On the contrary, petroleum has become a magnet for conflict and, in some cases, civil war. African oil-producing countries exhibit all classic oil-related patterns. Initially, oil development seems to work at the beginning, where positive outcomes such as increase in per capita income (as seen in Gabon and Equatorial Guinea), but these positive outcomes are undermined by greater rent-seeking. The huge profit margins from the oil rents generally overwhelm all other revenue sources [25].

Growing reliance on oil and gas rent replaces and disrupts healthy pre-existing economic activities as it becomes easier to import food or consumer goods than to produce and to buy technological knowhow than to develop it [26]. Thus, the fiscal advantage of petroleum can actually serve as a handicap, hindering the development of other productive activities. The oil windfalls push up the real exchange rate of these countries' currencies and the tendency to render most other exports non-competitive. The decline of the agriculture and manufacturing sectors of oil countries create a vicious cycle where ORSSA countries become more dependent on oil, thereby exacerbating other problems of dependency, leading to a permanent loss of competitiveness [26]. The oil and gas sector being an economic enclave and a highly capital-intensive activity, provides little employment and relatively few linkages with the rest of the economy therefore unable to make up for the shortfall. Oil and gas therefore, continues to be the main source of revenue and foreign exchange, and as a consequence, the economic basis of these countries. This dependence on oil and gas revenues negatively affects the capacity of states and their ability to govern. There is a vicious circle in which the more governments spend, the more they need oil revenues. As a consequence, oil dependence is today overwhelming. Taking Nigeria as example, (with over 200 million inhabitants), oil rent account for more than 50% of federal government revenue and more than 80% of export earnings, although it only accounts for 10% of GDP [27]. Likewise, Angola's oil and gas account for about two-third of government revenue, more than 90% of its export earnings and approximately 30% of its GDP [28]. Although this situation is repeated in a way in many other oil producing countries around the world (including Venezuela, Russia, etc.), it is particularly putrid in SSA. This is as result of the state institutions being weak and unable to tackle the problem in order to broaden its productive base and not fall into the pitfall of the resource curse, as Norway or Dubai managed to do. The challenge of this dependency includes high vulnerability to oil revenues that makes planning and projection of government spending levels difficult. Furthermore, the volatility of oil prices makes planning extremely difficult and undercuts efforts to turn oil wealth into other more permanent forms of sustainable

development [29].

5. Discussions and Analysis

The call for acceleration of global energy transition places ORSSA oil and gas endowment at a high risk of stranded asset. The active consideration of a blanket ban on fossil fuel infrastructures by several high-profile financiers would also harm the regions ability to export their endowment. Although this moved is hailed as a good environmental policy as burning natural gas emits carbon dioxide (CO₂), a long-lived greenhouse gas and facilities that produce, transport and consume natural gas sometimes leak methane, a short-lived but even more potent greenhouse gas. However, blocking money for new gas pipelines, gas-fired power plants, or gas-consuming industries in ORSSA would bring hardship and hinder development for the already energy poor regions therefore presents unjust transition. Furthermore, as gas has a pivotal role to play in Africa's transition to clean energy, a ban now could slow the adoption of renewables and reinforce a global energy double standard.

Banning gas in ORSSA does not represent effective way of fighting climate change. This is because the continent is starting from such a low energy use and emissions base that there are few gains from eliminating gas. Currently, Africa's contribution to Green House Emission (GHG) is historically negligible (apart from South Africa). As at 2019, the continent accounted for less than 4 percent of global GHG emissions [30]. While this is expected to increase over time as access improves, it will very likely remain less than Europe, America and China (see Figure 4).

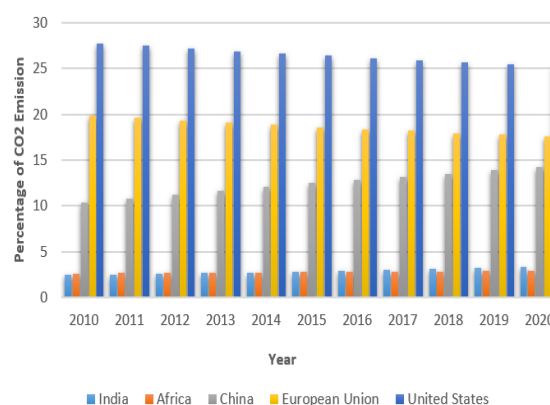


Figure 4. Annual Carbon Dioxide Emission from Fossil Fuel by World Region [30]

Measured by CO₂ emissions per capita, the difference between Africa's contribution to climate change and that of other regions and countries is stark (see Figure 5) [31]. If all of Sub-Saharan Africa

tripled its current electricity consumption overnight using only natural gas, the additional CO₂ would be equivalent to just 1% of global emissions. While electricity demand may be plateauing in the Global North, in ORSSA, electricity demand is most likely to triple resulting from rising incomes, growing populations and rapid urbanisation. Therefore, barring financing for all fossil fuels would have the very concrete effect of slowing poverty reduction, raising energy costs on the most vulnerable people, and suppressing incomes and job creation.

Ruling out gas would constrain ORSSA countries as they try to adapt to the major impacts of climate change like droughts, floods and soaring temperatures. Gas is particularly well-suited to energy-intensive adaptation technologies, such as steel and concrete for resilient infrastructure, desalination for expanded freshwater supply, and cold storage and air conditioning [30].

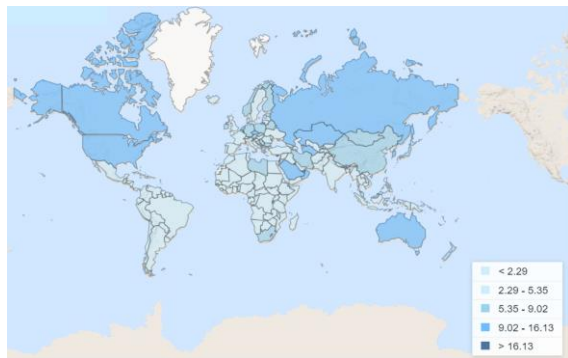


Figure 5 Carbon Dioxide Emissions (Metric Tons per Capita) [31]

Gas-fired power plants are modular and inexpensive compared to coal, geothermal, nuclear and hydro power stations which incur huge upfront capital investments. They are also less polluting than the default modular energy source in emerging markets – the diesel generator. Natural gas is a valuable feedstock for making fertilizer or other petrochemicals and an efficient source of process heat for high-energy industries like cement or steel production. For African countries with industrial ambitions, gas will be an indispensable input.

Given that ORSSA countries have significant natural gas resources that they are already developing, any suggestions to leave this resource in the ground and forego income, or to export all their gas to richer regions, seems indefensible. This is especially given that Global North countries are expanding use of gas as core component of their energy future as seen with the United States, China, and large parts of Asia and Europe. Closing off gas consumption to ORSSA countries just because they are late adopters with more limited financing options for building out domestic gas infrastructure is a politically and ethically fraught

stance. Although renewable energy is essential, their intermittency is a major issue. Wind and solar have become much more competitive due to steep price reductions. However, African countries that are rapidly increasing renewable capacity are facing challenges managing intermittency. Kenya, for example, is already suffering from severe voltage instability at only about 15% of installed capacity from wind and solar [30]. With currently available storage technologies, it is impossible for African countries to greatly expand power supply without complementary new investments in gas or other dependable backups. Gas pairs especially well with wind and solar as a technology and a financial model. Gas turbines can start and stop quickly to balance renewable sources affected by local weather variability. Also, the low-fixed-cost/high-variable-cost character of gas-fired power means that – unlike coal, hydro, nuclear or geothermal – it can remain financially viable even when wind and solar are meeting energy demand much of the time.

Furthermore, due to rapid urbanisation in ORSSA, the greatest demand for electricity comes from cities, where space constraints can make it difficult to install new solar and wind turbine facilities. In addition to this, Africa’s power system’s transmission and distribution grids is developed around central generation nodes. While these might be redeveloped over the course of a century to accommodate more local renewable energy facilities, it would be difficult to implement this as a short- or even medium-term solution.

The most immediately visible environmental and health problem in emerging market cities is outdoor air pollution, which causes around 3 million premature deaths a year. Natural gas unlike coal, burns cleanly and makes a negligible contribution to air pollution. Although gas-fired generation does emit GHGs, burning gas generates fewer local pollutants (SO_x, NO_x and particulates) than coal and diesel and roughly half as much CO₂ per unit of energy (see Figure 6).

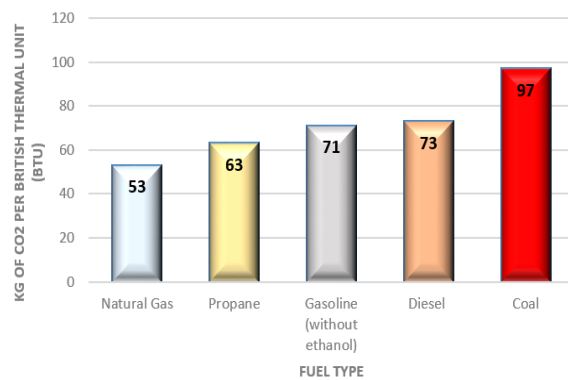


Figure 6. Carbon Dioxide Emission of various Fuel Types

In ORSSA, piped gas or imported LNG could keep coal out of the future energy supply while displacing existing dirty generators that run on diesel or fuel oil. In countries that produce oil, a functional local gas market would also reduce environmentally harmful gas flaring. Innovation can also position gas to support a future zero-carbon energy system. Monitoring methane leaks by satellite could potentially address a serious environmental concern about gas. Emerging technologies for carbon capture and storage (CCS) might also allow gas-fired power plants to operate with a low or zero carbon footprint.

6. Sustainable Framework for Building Just Energy Systems for the Future

The energy transition presents a unique opportunity for redefining Africa's energy systems to deliver on the African Union's Agenda 2063, the Paris Agreement, and the SDGs. This paper agrees with the African common position on energy access and just transition which stipulates that Africa should continue to deploy all forms of its abundant energy resources, including renewable and non-renewable energy, to address energy demand. Natural gas, green and low-carbon hydrogen, will play a crucial role in expanding modern energy access in Africa both in the short to medium term, while enhancing the uptake of renewables in the long term for low carbon and climate-resilient trajectory on the continent.

The energy technological design must be technically adequate, cost optimal, and viable, now and in the future. The energy system must deliver maximum value for sustainable development in ORSSA by strengthening local capacity, resources, and knowledge. Natural gas as a transition fuel will need to be part of Africa's future energy mix, given that ORSSA countries have over 600 trillion cubic feet of proven natural gas reserves, in Nigeria, Algeria, and Mozambique, with new reserves discovered in Senegal, Mauritania, and Tanzania. Furthermore, natural gas power plants will be needed to support the baseload, provide reserves, and balance the grid in ORSSA countries. Additionally, the opportunity exists for ORSSA countries to potentially strengthen the resilience and sustainability of their resource bases and build robust positions in the new energy businesses of the future. The speed and the urgency of the actions required, and what strategies to adopt will depend on the level of reliance that each country has on oil and gas revenues and their position on the global hydrocarbon cost curve. However, it is worth noting that in Sub-Saharan Africa, more than one-third of gas is produced as a by-product of crude oil production (associate gas) and therefore the resilience of gas production in Africa is linked, at least partially, to the resilience of the continent's crude oil production.

Electricity systems and markets must adapt and be re-optimised to incorporate large proportions of variable renewables generation. Identifying an optimal energy mix over the next decades is equally necessary to determine the best contribution of renewables and natural gas in Africa. This focus needs to consider fuel availability, transmission infrastructure for greater country and regional interconnection, fuel cost, technology advancement, and a carbon price subject to change due to policies of non-African and African countries. In fact, new technologies, management systems, and finance will be needed to develop and integrate energy resources, including gas, to drive the industrial transformation.

Renewables are Africa's cheapest generation options. Utility-scale solar photovoltaic (PV) and onshore wind systems are now firmly established as the cheapest sources of electricity generation. According to the latest figures from IRENA and from Lazard, solar PV and onshore wind electricity costs levelized [32] & [33] over their lifetime have fallen to \$0.03–\$0.06 per kWh.⁴², 90% fall since 2001). These costs are far below the average fossil fuel levelized cost of electricity of \$0.055–\$0.145. Solar PV auctions have produced winning bids of \$0.025–\$0.06 per kWh in some African countries, in a strong falling trend [34]. The first few solar PV and wind projects in a country can commonly be added to the grid without much change in the grid's structure. However, as their share grows, several options for compensating daily and seasonal supply intermittencies of solar and wind power should be included in the system to balance supply and demand, yielding what is sometimes referred to as "clean energy portfolios." Yet, while the potential of such portfolios for Africa is very promising, its feasibility is highly dependent on whether there is enough upfront finance and how quickly renewables and various balancing options can be ramped up, including energy storage and increased interconnection, due to high initial cost. Hence, attaining high shares of solar and wind power requires that African countries strongly commit to such pathways and that they are decisively supported financially by the international community and the private sector. The private sector is becoming increasingly important for closing Africa's energy gaps, but governments will remain vital players. Historically, around 80 percent of Africa's installed capacity has come from state-owned projects, with private IPPs accounting for 13 percent of installed capacity in 2019. However, the number of IPP projects has grown steeply in the last decade. Over 80 percent of financially closed projects since 2010 have been renewable energy-based, although at considerably smaller scale than fossil fuel-based IPPs, which have dominated IPP installations from a capacity perspective since the 1990s and offer promise for large-scale industrial uptake. Generation capacity in Africa, with state ownership has dropped

to roughly one-third. However, many IPPs, especially public–private partnership plants, have failed in the past, suggesting the need to improve policy and finance support for this category.

Flexible generation on the grid, different storage technologies, interconnectivity, sector integration and demand-side measures, and use of decentralized off-grid energy are needed to balance the supply and demand in integration of renewable energy [35]. Flexible generation on the grid can quickly react to and balance out differences in supply and demand. Certain conventional electricity generation technologies such as open-cycle natural gas turbines can be dispatched flexibly on short timescales to cover electricity shortfalls during prolonged periods of low availability of sunshine and wind. Interconnectivity will increase trade and reliability and decrease end-user costs. The more regionally interconnected an energy system is, the more potential it offers. Africa should continue to seek to make interconnectivity a reality through the Continental Power System Masterplan and the accompanying African Single Electricity Market. Sector integration, which aims to meet energy demand in sectors in which demand is currently not met by electricity (such as transport, cooking, agriculture, and some industries), helps to balance the grid and, perhaps more important, is driving sustainable development and supplying energy services beyond energy as a commodity. Demand-side measures include both improved energy efficiency (reducing demand while keeping service levels constant) and sector integration. This leads to smoother demand profiles because parts of these sectors' energy demand occur at (or can be shifted to) times of the day when renewable energy are abundant. Both measures lower overall unit energy costs.

Diversification strategy is tremendously important for resilience. Given the importance of diversifying ORSSA economies, it is critical to recognise how various dimensions of diversification can have different implications for the different policy options. Economic diversification for ORSSA region should embrace structural transformation from lower to higher productivity sectors that contribute to employment and production (gross domestic product (GDP) diversification), international trade or exports diversification and fiscal diversification. The fiscal element should involve expanding government revenue sources and public expenditure targets and play a central role in helping to catalyse broader economic transformation through the expansion of activity in specific industries and sectors. It is also important to note the role of quality of governance in both economic growth and diversification. Natural gas should be used to develop other sectors of the economy and seen as a bridge fuel rather than a mainstay for economic growth.

The levers to strengthen the cost competitiveness of ORSSA resources, such as addressing sources of

cost premium (for example, insecurity), and improving the ease of doing business should also be put in place. This will increase investor confidence and attract foreign investors in the sector. The ORSSA countries could further strengthen the resilience of their resources by considering initiatives to decarbonise their existing oil and gas operations and encouraging investment in lower-carbon energy infrastructure such as gas pipelines. Investment in lower-carbon-energy infrastructure projects, especially gas pipelines, processing infrastructure, and liquefied petroleum gas (LPG), could enable African countries to promote intraregional trade and boost global exports of ORSSA energy products, while also helping to strengthen regional energy access and reduce the risk of stranded gas resources.

Policies to achieve climate resilience and a just energy transition in ORSSA should be inclusive. This transition requires close consideration of the equity implications and challenges associated with prevailing energy poverty, low energy consumption and energy needs for economic growth and transformation.

7. Conclusion

The adoption of energy transition strategies and policies are designed to move the global energy sector away from fossil fuels towards zero-carbon energies by 2050 as determined by the Paris Agreement. There is universal acceptance of the need to transition in order to reduce energy related CO₂ emissions and limit climate change. However, there also needs to be recognition that whilst aggressive energy transition programs are being pursued in developed countries and by the international oil companies, many developing countries, and especially those with hydrocarbon-dependent economies such as ORSSA, require a more gradual and flexible approach to energy transition. Therefore a “Ban all fossil fuels, everywhere” (although an intuitively appealing position), will amount to energy injustice when applied to energy-deprived regions like Africa. The ruling out of natural gas will do far more harm than good on environmental, health, and development fronts. This paper therefore concludes that to avoid stranded asset, increase energy access and enable economic diversification, the ORSSA countries must be allowed to use all forms of energy sources and continue using gas as a bridge fuel whilst gradually incorporating renewable energy into the energy profile.

8. References

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