



Energy and the Economy in Sub-Saharan Africa

Philippe Copinschi

“Sub-Saharan Africa is rich in energy resources but very poor in energy supply.” So began the Africa Energy Outlook published by the International Energy Agency (IEA) in 2014, underlying the fact that *“making reliable and affordable energy widely available is critical to the development of the region”*. Five years later, in the 2019 edition of the Africa Energy Outlook, this remains globally unchanged: while Sub-Saharan Africa is home to around 15% of the world’s population, the region only accounts for 4.3% of the global energy demand and less than 1.75% of the world’s electricity consumption (Enerdata 2020).

Sub-Saharan Africa embodies a paradox. On one hand, the region has long attracted the energy industry and represents a significant part of the major international oil and gas companies’ activities, thanks to its endowment in natural resources combined with attractive fiscal regimes. On the other hand, the majority of the one billion people lack access to energy, especially electricity, which hinders their economic and social development.

For decades the dominant discourse, from governments as well as international development agencies and economic actors, has considered that the exploitation of its energy resources would prompt the economic growth of the continent by giving the countries the financial means to undertake development strategies. Unfortunately the reality seems more complex. On the contrary most energy producing countries in Sub-Saharan Africa seem to underperform in terms of economic development.

As the process in which the exploitation of energy resources leads to misdevelopment is being better understood, a new approach has emerged which focuses on the development of access to energy for the population. As a

P. Copinschi (✉)

SciencesPo—Paris School of International Affairs, Paris, France

e-mail: Philippe.copinschi@sciencespo.fr

consequence all over the continent new national, regional and international initiatives have been put in place to boost access to energy for the local population, eventually acknowledged as a key driver for economic development.

This chapter will start by drawing a quick panorama of the oil and gas scene in Sub-Saharan Africa, which remains the main energy sector in the region. I will then analyse the impact of this industry on the economic situation of the producing countries, and end with a presentation of the new challenges of developing access to reliable and affordable energy for the population.

1 AN ENERGY SCENE DOMINATED BY FOREIGN ACTORS

1.1 Oil Production and Reserves

Although Sub-Saharan Africa is blessed with natural resources, especially energy, the continent made its appearance on the oil and gas map relatively recently when compared with other hydrocarbon-producing regions like North and Latin America, the Middle East and North Africa. It was only in the 1960s that oil production started, after discoveries were made around the Gulf of Guinea, in Angola (in the Cabinda enclave) in 1955, followed by Nigeria and Gabon in 1956, and Congo-Brazzaville and Cameroon in the early 1970s. The oil production in the region substantially got underway in the 1970s, after the end of the Nigeria Civil War (1967–1970) during which the oil-producing region of Biafra tried to secede.

Production boom was helped by the sharp increase in oil price after the 1973 and 1979 oil shocks and by the wave of nationalisations in OPEC countries. By raising the oil price, the two successive oil shocks opened new exploration and production opportunities everywhere in the world. This was especially so in Sub-Saharan Africa where governments, keen on attracting foreign investors to boost development, offered favourable fiscal regimes to international oil companies who, after having been kicked out of OPEC countries, were very happy to invest in Sub-Saharan Africa in order to diversify their portfolio of activities. Indeed, reflecting on the weakness of the State in Africa, none of the oil-producing countries in Sub-Saharan Africa ever nationalised their oil industry. Although OPEC used to encourage its members to nationalise their oil industry to further their economic independence, Nigeria (which became a member of the cartel in 1971) never took control of operations through its national company; neither did Angola nor Congo ever nationalise the foreign private companies' interests, even after having established Marxist regimes in the 1980s. This explains why Sub-Saharan Africa was one of the oil and gas regions—along with the North Sea, the Gulf of Mexico and Alaska—that benefited the most from the nationalisations in OPEC countries in the 1970s.

The region experienced a second oil boom in the 1990s with a series of huge discoveries made offshore. At the same time, exploration expanded throughout the continent, both offshore and onshore, and new producers appeared,

including Equatorial Guinea, Ghana, Chad, Niger, Mauritania, Sudan and so on. As a consequence, Sub-Saharan oil production rose from about 400,000 barrels per day (bpd) in the late 1960s to 2.5 million bpd (Mbpd) in the mid-1970s (essentially from Nigeria), before reaching 4 Mbpd by the late 1990s and 5 Mbpd in 2019 (with Nigeria and Angola contributing about 2.1 and 1.5 Mbpd respectively). During the same period, oil reserves in Sub-Saharan Africa rose from about 10 billion barrels in 1970 to 20 in 1980, 40 in 2000 and more than 60 in 2019 (Enerdata 2020).

Even if some countries, like Cameroon and Gabon, are gradually nearing the end of their oil era as their reserves are rapidly declining and no new discoveries have recently been made, Sub-Saharan Africa is now home to more than a dozen oil producers, although only a few (mainly Nigeria and Angola) do really have a significant production. Several other countries may soon be joining the list as almost all the governments across the continent have granted exploration licenses. Although the Gulf of Guinea remains the central point of focus for oil and gas players in Sub-Saharan Africa, exploration and production have spread out since the 1990s across the whole continent, with discoveries made both offshore (in Mauritania, Ghana, Ivory Coast, Senegal, Sao Tome and Principe, Tanzania, Mozambique, South Africa, etc.) and onshore (Uganda, Niger, Chad, etc.) (Table 34.1).

All together, Sub-Saharan Africa produces about 5 Mbpd of oil. On a global scale, this doesn't seem to account for much: the current production of the continent represents less than 5% of the global oil production and the oil reserves only just 3.5% of the world's total. The importance of the continent is

Table 34.1 Oil production and proved reserves in Sub-Saharan Africa 2020

	<i>Proved Reserves (in Mb)</i>	<i>Share of global reserves (%)</i>	<i>Production (in 000 bpd)</i>	<i>Share of global production (%)</i>
Nigeria	36,890	2.13	1743	2.09
Angola	7783	0.45	1220	1.46
Congo-Brazzaville	2882	0.17	310	0.37
Gabon	2000	0.12	216	0.26
Chad ^a	1500	0.09	127	0.15
Sudan ^a	1500	0.09	92	0.11
Equatorial Guinea	1100	0.06	126	0.15
Cameroon ^a	309	0.02	71	0.09
DR Congo ^a	278	0.02	22	0.03
Ivory Coast ^a	154	0.01	38	0.05
Mauritania ^a	154	0.01	2	0.00
Niger ^a	147	0.01	18	0.02
Ghana	23	0.00	195	0.23
South Africa	23	0.00	99	0.12
TOTAL Sub-Saharan Africa	58,711	3.39	4883	5.85

Source: Enerdata

^a Production of 2019

elsewhere: because of it always being very open to foreign investors, Sub-Saharan Africa has generally been viewed by the oil industry as one of the world's hotspots for oil production and exploration and one of the leading deepwater offshore oil production centres. Today, all major energy companies (Shell, BP, Total, ExxonMobil, Chevron, ENI, etc.), as well as many independent and junior companies and even some public (mostly Asian) companies are involved in oil and gas exploration and production in Sub-Saharan Africa, often in cross-partnerships. Far beyond its importance in the global energy production, the region accounts for a quarter to a third of the activities of the major international energy companies.

1.2 Natural Gas Production and Reserves

While Sub-Saharan Africa is key for private international oil and gas companies, the continent also remains dependent on those companies for the development of its hydrocarbon resources, as no country has ever managed (or even attempted) to play a central role in the local oil and gas industry, leaving the entire sector to foreign (mostly private) companies. As a consequence, the development of the oil and gas industry in Sub-Saharan Africa has always depended on the interests of the international oil business, which explains why the gas sector stayed marginal for so long (Copinschi and Smedley 2016).

Until quite recently, international oil companies operating in Sub-Saharan Africa showed no real interest in developing gas production. Very little exploration was targeted specifically at gas, and associated gas (unavoidably extracted with crude oil) has long been considered an unwanted by-product of oil. The gas was (and still is) mostly vented or flared on site (some part being re-injected in the fields to enhance their productivity), despite the serious direct and indirect impacts of flaring on human health, soil, vegetation and the atmosphere. From the companies' point of view, the local markets were too small and the distances to major market centres (Europe, North America and Asia) too great to make gas production and its associated transportation infrastructures (pipelines and liquefaction plants) economically viable. For example, oil fields in Nigeria are generally scattered, and the associated gas collected from these fields must first be piped to a common collection point, compressed and transported to a processing unit before being available for economic purposes, all of which increase production costs.

Long restricted by the lack of infrastructure to monetise natural gas being flared, the Sub-Saharan African natural gas sector eventually 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. In 2019, Nigeria's production accounted for about 7% of globally traded LNG and ranks the country among the world's top five LNG producers behind Qatar, Australia, Malaysia and the United States. In the other oil production countries (Congo,

Gabon, etc.) most of the natural gas production is re-injected into oil fields or flared, with only a small part of it being commercially used, mostly in gas-fuelled power plants.

On the other side of the continent, East Africa has been virtually ignored by international oil and gas players for decades. The presence of gas has been known in Mozambique and Tanzania since the 1960s, but at the time, oil companies were exclusively looking for oil and few geologists believed in the region's potential. A new era began in the late 2000s when some oil companies were awarded exploration blocks in the offshore Rovuma Basin, straddling the maritime border of Mozambique and Tanzania. From 2009 onwards, a huge series of natural gas discoveries, large enough to support LNG projects, were made and changed the oil and gas industry's interest in the whole region. Given the size of the discoveries (3000 to 5000 billion cubic metres (bcm) in Mozambique, and 1000 to 1700 bcm in Tanzania), licence-holders (ENI, Total, Shell, ExxonMobil, Equinor, etc.) are now moving ahead on plans to build LNG trains, especially in Mozambique where the first LNG production is expected by 2023. As oil companies tend to work by imitation, more offshore exploration was subsequently carried all around the continent, leading to significant discoveries made offshore in Senegal and Mauritania since 2016 (500 to 1000 bcm) and in South Africa in 2019, just to name a few (Table 34.2).

Note: These official figures of the proven reserves don't take 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 34.2 Natural gas production and proved reserves in Sub-Saharan Africa 2020

	<i>Proved Reserves (in bcm)</i>	<i>Share of global reserves (%)</i>	<i>Production (in bcm)</i>	<i>Share of global production (%)</i>
Nigeria	5761	2.82	47.90	1.20
Mozambique ^a	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 ^a	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 ^a	35	0.02	0.88	0.02
Gabon	26	0.01	0.48	0.01
Sudan	25	0.01	–	–
Ivory Coast ^a	12	0.01	2.28	0.06
TOTAL Sub-Saharan Africa	7631	3.74	74.86	1.87

Source: Enerdata

^a Production of 2019

2 A REGION PLAGUED BY THE RESOURCE CURSE

Until the COVID-19 pandemic and the collapse of the oil price in early 2020 that obliged the companies to drastically reduce their investments, Sub-Saharan Africa was considered as one of the hottest spots for major oil companies. All of them were carrying out huge projects all around the continent, especially in Mozambique, Nigeria, Angola and Senegal/Mauritania. Although the 2020 slump in world oil and gas prices has led many developers to scale back projects and rein in costs, the resources in the above-mentioned countries are probably important enough to consider that their development is only a matter of time.

The flow of foreign investment into the African oil and gas sector that has been generated over the last three decades, and that is still expected in the future thanks to new projects, is usually presented as a great opportunity for the economic development of poorer countries. Especially since foreign aid to Africa from industrialised countries has been falling and gradually being replaced by an emphasis on trade as a means for African countries to escape poverty, the promise that oil and gas will boost the standard of living of Africans echoes repeatedly throughout the continent, raising popular expectations to sometimes-soaring heights. Today (in Mozambique, Senegal, Mauritania, etc.) like yesterday (in Nigeria, Angola, Congo-Brazzaville, etc.), many think that oil and gas will provide a revenue stream that will break the cycle of poverty that plagues their countries. They believe that oil and gas will bring jobs, food, schools, healthcare, agricultural support and housing.

Unfortunately, the lived experience of Sub-Saharan African oil-producing countries over the past several decades tells a story which differs radically from the promise of petroleum. The dramatic development failures that have characterised most oil-producing countries in the region warn that petrodollars have not helped developing countries to bring economic growth and reduce poverty. In many cases they have actually exacerbated it and more generally have had a very negative impact on the local economies (Ross 2013). Like many oil exporters in other developing regions (with the notable exception of Arab Monarchies), 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. With the emergence of the oil sector in the 1970s, the so-called Dutch Disease set in. Initially, oil development seems to work—at least for some time. Especially at the beginning, oil exploitation provides positive outcomes as per capita income may rapidly increase: Gabon and Equatorial Guinea, two oil-producers with a tiny population, do have amongst the highest GDP per capita of the continent (as well as very high inequalities in the distribution of these revenues). But these positive outcomes are undermined by greater and greater rent-seeking.

Because profit margins are so huge, the rents generated by oil generally overwhelm all other revenue sources. Even healthy pre-existing economic activities can be quickly disrupted and replaced by the growing reliance on petrodollars. It is easier to import food or consumer goods than to produce it if a government has the cash, and it is far simpler to buy technological know-how than develop it. Thus, the fiscal advantage of petroleum can actually serve as a handicap, hindering the development of other productive activities. When oil windfalls push up the real exchange rate of a country's currency, it tends to render most other exports non-competitive. The decline of the agriculture and manufacturing sectors of oil countries not only makes them more dependent on oil, thereby exacerbating other problems of dependency, but it can also lead to a permanent loss of competitiveness. Meanwhile, the oil sector cannot make up for the shortfall: because oil is an economic enclave and a highly capital-intensive activity, it provides little employment and relatively few linkages with the rest of the economy.

As oil becomes the dominant economic activity of a country and the leading export activity, governments become dependent on oil money. For those governments, oil is the main source of revenue and foreign exchange and, as a consequence, the economic basis of their power. Oil-led development has a strong tendency to concentrate on both production and revenue patterns, and this occurs in countries where economic and political power is often already very concentrated. Only those who control political power can grant the opportunity to make money from oil, and only those who receive this opportunity can provide the revenues to keep regimes in power. This does not occur to the same extent in more diffuse wealth-generating activities based on, say, fertile soil or fisheries, where the barriers to entry are far lower, the actors more numerous and the benefits more dispersed.

This dependence on oil 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: in Nigeria (about 200 million inhabitants), petrodollars account for more than 50% of federal government revenue and more than 80% of export earnings, although it only accounts for 10% of GDP (World Bank 2020b). Like Nigeria, Angola's oil dependence is legendary: oil and gas account for about two-third of Angola's government revenue, more than 90% of its export earnings and approximately 30% of its GDP (International Monetary Fund 2019). 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 Africa where State institutions are usually 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 problem is that high vulnerability to oil revenues makes it difficult to plan or project government spending levels. In almost every African oil-producing country various development schemes over the past decades have been launched and then abandoned because of declines in oil revenues due to

a sudden drop in the oil price, like in early 2020. The volatility of oil prices—the rapid fluctuation from \$20 to \$100 per barrel and back—makes planning extremely difficult and undercuts efforts to turn oil wealth into other more permanent forms of sustainable development. Furthermore, volatility has been shown by scholars to be bad for investment, income distribution, educational attainment and poverty alleviation (Humphreys et al. 2007). Everywhere, the result has been painful.

2.1 *The Paradigmatic (and Dramatic) Case of Nigeria*

Nigeria, Sub-Saharan Africa's largest oil and gas producer, is a classic illustration of the oil dependency in Sub-Saharan Africa's oil-producing countries. The country abounds in proven reserves (approximately 37 billion barrels of oil and 5675 bcm of natural gas) and is currently the OPEC's sixth producer (Enerdata 2020). For the last 50 years, Nigeria has earned several dozen billion dollars annually from the oil and gas industry. The earnings depend on the production level and the price of oil: while it was only 20 billion dollars in 2018, it reached nearly 70 billion dollars in 2008 and 2011 when the oil price was at its highest (NEITI 2019). But these oil riches have done little to change the situation of the poor. Nigeria ranks 152nd out of 157 countries in the World Bank's Human Capital Index despite being a lower-middle-income country, reflecting the country's prolonged underinvestment in health, education and nutrition of its citizens. Health outcomes in the country are among the poorest in the world, and there are large regional and socioeconomic inequalities. Life expectancy (53 years in 2016) is particularly low while maternal mortality (576 per 100,000 live births in 2013) and infant mortality (65 per 1000 live births in 2017) are particularly high for a lower-middle-income country. In 2019, 40% of the population lived below the national poverty line (against 28% in 1980), and that rate will most probably increase because of the economic consequences of the COVID-19 pandemic (World Bank 2020b). Nigeria is not an isolated case as Angola, the second largest oil producer in the region, exhibits more or less the same patterns: despite the country's impressive expansion of the economy and the exceptional revenues generated by the oil industry over the last 20 years, the proportion of people living below the US\$ 1.90 poverty line showed only a small decline, from about 33% in 2000 to 28% today. Only two-thirds of the Angolan urban population and less than a quarter of the rural population have access to clean drinking water and to basic sanitation, and life expectancy is only just above 60 years. Worldwide, Angola ranks among the last in terms of human resources in the health sector, with only one physician and 23 healthcare workers per 100,000 people; maternal and child mortality rates are about double the average in lower-middle-income countries (World Bank 2020a).

Over the years, the deterioration of the socioeconomic situation in Nigeria has been accompanied by political decay, a rise in oil-related human rights violations and violence, most notably in the Niger Delta where most oil is

produced, causing huge environmental degradation resulting in the loss of livelihoods for many residents. For more than 25 years, there has been a cycle of activism, militancy and repression linked to oil (Ariweriokuma 2009). Given the neglect by the local authorities, which are generally highly corrupted,¹ the local population tends to turn straight to the oil companies to obtain the fruits of what they consider to be “their” oil. Since government institutions are practically non-existent on the ground (or at least invisible), the companies are the sole representatives of public authorities that are accessible to the local populations. Although companies pay considerable sums to the federal State in the form of royalties and income taxes, most of the population of the Niger Delta feels completely excluded from the benefits of oil activities and complain about serious environmental damage and human rights violations and hold multinational oil companies responsible. Regularly and in a more and more violent way, young members of these forgotten people demonstrate their hostility to the oil companies and claim better access to positions of power and, more specifically, a redefining of the distribution of oil rent in their favour. Pressure is applied in various ways, ranging from sabotage of pipelines, kidnapping of employees and occupation of installations, including offshore platforms.

The oil companies find themselves caught in a vicious circle, where their activities and the revenues they generate distort political life, increase the tendencies towards the formation of the rent economy and the collapse of political institutions, and create the frustrations of which they are the first victims, while being considered guilty by public opinion in the West. Confronted with this double threat (local instability and accusation at an international level that could impact their reputation), companies are adopting strategies to change this image through programmes which are intended to enable the local populations to benefit directly from the presence and activity of the oil companies. These efforts, not surprisingly, are well publicised by the oil companies. They insist that their investments are not just for extracting oil resources and generating revenues for the governments, but are also used to pay for scholarships, build roads, schools, clinics and housing, to provide job training, to fund small businesses, or even to support the fight against AIDS. Every year companies spend over 100 million dollars on community development projects in the Niger Delta, in an attempt to restore their legitimacy in the eyes of the local population and international observers.

Sometimes oil-company-funded social development projects are well designed, useful, they address an expressed need of the community and really help the local economy. Other times oil company projects can amount to no more than a cash payout to a local leader in order to quell agitated youth activists. But in the long run these actions can actually exacerbate community tensions or other cleavages, without contributing to any sustainable

¹Nigeria ranks 146 out of 180 in the 2019 Transparency International’s Corruption Perceptions Index.

development of the economy (Chukwana 2015). In the Niger Delta region, much of the infrastructure built by the oil companies is usually not operational since there are no public funds to cover the running costs (teacher's salaries, health equipment, maintenance of roads, etc.). Without any lasting impact on local development, due to the lack of partnership with the public authorities (often non-existent), these programmes seem essentially to be a mere response to the critics and to pressure from the local populations and international NGOs.

Companies are not well suited to be development agencies. They are private oil companies: their aim is to do business, not development. While some of the companies' efforts may produce laudable outcomes, corporate philanthropy can not be an answer to the failure of the local and national governments to respond to the needs of their people. In fact, companies find themselves obliged to take the place of the State in order to assure a minimum of public services. Thus they are locked in a vicious circle where, by taking on the role of the State in order to buy short-term social peace, they perpetuate a situation (the weakening of the State and the tendency to rent-seeking) which is the very source of the problems they face.

Africa's trade relationship with the rest of the world is dominated by extractive industries, especially oil, gas and mining. For most African oil-producing countries, notably Nigeria, the failure to develop has been catastrophic. The gap between the promise of petroleum and the perversity of its economic performance in recent times is enormous. Study after study demonstrates that, as a group, countries dependent on oil as their leading export have performed worse than other developing countries on a variety of economic indicators.

But while the record of oil and gas exporters in Sub-Saharan Africa shows that oil-dependence is most often a perilous development path, negative outcomes from oil booms are not inevitable. This has been illustrated by the case of Norway that managed to use the benefits from North Sea petroleum to earn the highest place on the United Nations Development Program's list of best development performers. This means that the underlying development problems around oil and gas are not inherent in the resource itself. Whether countries succeed in turning oil and gas revenues into long-term economic benefits for their people, ultimately depends on the quality of public policies, especially those dedicated to fuel poverty reduction, including access to energy.

3 THE LACK OF ACCESS TO ENERGY

Long neglected, the issue of access to energy for the population has recently become a priority for the international community as well as for most of African governments. While none of the eight UN Millennium Development Goals (MDGs) in 2000 covered the issue of energy, the UN has since identified access to sustainable energy as a prerequisite for poverty eradication. The UN has made it a specific topic in the 2015 Sustainable Development Goals (SDG) through the SDG 7 which aims, amongst other things, at ensuring universal

access to affordable, reliable and modern energy services by 2030, and at substantially increasing the share of renewable energy in the global energy mix.

Energy supports the provision of basic needs (cooking, heating, lighting, access to clean water, transport, social services, etc.), creates productive activities (manufacturing, industry, commerce, agriculture, etc.) and stimulates employment creation. Conversely, the lack of access to reliable, affordable and modern energy services severely impedes social and economic development, especially as the poorest segments of the population often pay the highest price (in money, time and health) for the worst-quality energy services. The lack of access to modern energy also hampers enterprise development, and undermines competitiveness and thus access to regional and global markets for producers. Promoting access to electricity and clean cooking energy is now acknowledged as a key driver for economic development and essential to fostering inclusive growth in view of lifting people out of poverty.

3.1 The Lowest Electrification Rate in the World

As for many of the SDG, Sub-Saharan African countries are particularly concerned by the SDG 7. With the exception of South Africa,² Sub-Saharan Africa is by far the region on the globe with the lowest electrification rate and where progress towards achieving SDG 7 is the slowest. While the population without access to electricity dropped worldwide from 1.2 billion in 2010 to about 840 million in 2017, the decrease is much slower in Sub-Saharan Africa. In 2017 about 55% of the Sub-Saharan African population (some 573 million people, that is, two-thirds of the world population without electricity) still lacked access to electricity, and that number will probably be about the same in 2030 (whereas everywhere else in the world it will further decrease) (IEA et al. 2019). Based on the relationship between electricity access on one hand and GDP per capita, population growth (given that most Sub-Saharan African countries haven't achieved their demographic transition yet), and urbanisation rate on the other, model projections show that about 515 million people will still lack access to electricity in 2030 (IEA 2019). At the moment Sub-Saharan Africa is clearly not on track to achieve the seventh SDG.

²South Africa is an exception in the energy landscape of Sub-Saharan Africa. The country has a long history of industrialisation and inherited an extensive, large capacity centralised system from the apartheid era in 1994. Having been diplomatically and economically isolated for decades because of the apartheid regime, the country was forced to set up its own pathway to ensure the energy supply of its economy: historically, the country relies mostly on its own coal resources, which still provide 90% of its electricity production, as well as on nuclear energy (5% of the electricity generation), of which it is the only producer on the continent (data from Enerdata). However, despite having the largest energy system in Africa, the country is nowadays grappling to ensure an adequate energy supply, especially electricity. The latter along with severe limitations in generation capacity and frequent load shedding have hobbled economic growth for the last two decades, thus bringing South Africa closer, in that aspect, to the rest of the continent.

The average electricity consumption per capita in Sub-Saharan Africa (excluding South Africa) is 175 kilowatt hours (kWh), compared to 2100 kWh in emerging Asian economies, 2855 kWh on average globally, 5100 kWh in Europe, and more than 10,000 kWh in the United States (Pistelli 2018). The energy challenges facing households vary, however, significantly between urban and rural areas. In urban areas, on average, almost three-quarters of the Sub-Saharan African households have access to electricity, whereas in rural areas, where populations are spread over large distances and are usually not connected to a grid, this figure falls to one-quarter. It is expected that in 2030 about 85% of the population without access to electricity will be located in rural areas (Dagnachew et al. 2018).

At about 120,000 MW, the installed power generation capacity in Sub-Saharan Africa is even below that of France, with a population 16 times bigger. Moreover, two-thirds of the Sub-Saharan African countries experience recurrent outages and load shedding, forcing businesses as well as households to rely on back-up generators running on diesel or gasoline at costs that are four times the price of grid power. In other words, not only Sub-Saharan Africa isn't producing enough electricity, but the production costs are generally much higher than in other developing regions. The small scale of most national power systems and the reliance on expensive, oil-based generation make the cost of electricity generation in Africa two to three times higher than the global average (AfDB 2016). Hence modern energy services are not affordable for the poor segments of the Sub-Saharan population as the costs of energy services are generally higher than anywhere else and the up-front costs of connection very high.

Investments in energy generation and transmission are generally inadequate, and regional cooperation to boost energy supply is moving slowly. Indeed, most investment in power generation in Sub-Saharan Africa is geared not towards the basic energy needs of the poor, but towards industrialisation and the rising demands of existing consumers. Approximately half of current electricity consumption in Sub-Saharan Africa is used for industrial activities, mostly mining and refining.

3.2 Limited Access to Clean Cooking Energy and Heavy Reliance on Biomass

Access to clean, non-polluting cooking and heating facilities is even more restricted. Mostly used for cooking, traditional biomass is by far the most widely used energy source across Sub-Saharan Africa, with the exception of South Africa, where the energy mix is coal-heavy. Despite the fact that burning biomass causes serious health hazards that have a major impact, particularly on women and children, biomass' share in the overall Sub-Saharan African energy mix has barely changed over the last 25 years. Biomass continues to dominate the primary energy mix, accounting for 65% of total energy use in the region (if South Africa is excluded, this share increases to almost three-quarters).

According to the IEA nearly four in five people of the population in Sub-Saharan Africa use biomass energy (often used in inefficient and unhealthy forms), compared with 52% in the developing world as a whole (IEA 2019). As a consequence, some 600,000 Africans die each year from the effects of household air pollution. There is no other region in the world that relies so heavily on bioenergy. The high levels of poverty partly explain the heavy reliance on traditional biofuels as an energy source for cooking.

Reliance on traditional biomass (especially charcoal) also encourages deforestation and land degradation. In many areas around major cities, charcoal demand contributes to the degradation of the surrounding woodlands and forests. In addition, foraging for fuel takes time, especially for women and children, who may therefore miss out on opportunities to undertake more productive activities, such as schooling and livelihood activities. In some places climate change and deforestation are compounding the problem of finding suitable biomass for fuel.

Over the last decade, although Africa's global primary energy supply has grown by more than 3% each year, the energy mix has remained substantially unchanged. In 2018, biomass still represented two-thirds of the final energy consumption in Sub-Saharan Africa (and even three-quarters without considering South Africa) while oil accounted for about 20%, as it was ten years ago. As far as power generation is concerned, fossil fuel dominates, accounting for 70% (50% for coal, 12% for natural gas and 7% for oil), and hydroelectricity for 25%. However, as South Africa, which relies mostly on coal (90% of its electricity production), accounts for about half of the whole Sub-Saharan African electricity production, the figures for the region excluding South Africa are slightly different, with hydroelectricity representing half of the electricity generation, natural gas 25% and oil 15%. In any case modern renewable energies (wind, solar, geothermal, etc.), although growing fast, only account for less than 5% of the electricity generation (coming from less than 1% in 2010) (Enerdata 2020).

Despite 15 years of economic growth, Africa's energy systems are still grossly inadequate. Restricted access to electricity, power shortages and dependence on biomass for fuel are undermining efforts to reduce poverty. At the same time energy demand is climbing as cities, populations and economies grow. The lack of access to modern energy is clearly a major factor in the high level of poverty in Sub-Saharan Africa and its slow progress towards the achievement of the SDGs. The energy-sector bottlenecks and power shortages that affect most of the Sub-Saharan countries have a deep economic impact. In practice the lack of reliable and affordable power is one of the biggest constraints when investing on the continent undermining job creation and social development. As African businesses have to wait an average of 130 days to receive an electricity connection, it is estimated that the difficulty to access energy costs between 2 and 4% of GDP annually (AfDB 2019). In rural Africa agricultural production and productivity are constrained by limited access to modern energy services to power water for irrigation, agriculture mechanisation and post-harvest storage

and processing. This in turn depresses crop yields, added value and farmers' incomes, thus aggravating food-security problems. Low incomes from agriculture in turn make it difficult for farmers to afford cleaner, modern energy services, thus perpetuating the poverty trap.

4 THE CHALLENGES AHEAD

4.1 *Harnessing the Resources*

There are enormous power deficits across Africa. The situation seems paradoxical as the continent has huge renewable energy potential as well as abundant natural gas—the cleanest hydrocarbon—which could be combined to deliver stable and relatively environmentally sustainable electricity generation (Hafner et al. 2019).

The continent is indeed reported to have more than half of the world's renewable energy potential. In particular, Africa has the richest solar resources on the planet, although only 5 gigawatts of solar photovoltaics (PV) are installed, accounting for less than 1% of global capacity. If properly harnessed solar could certainly become one of the continent's top energy sources and help meet a significant proportion of energy demand, especially in rural areas (Hafner et al. 2018b). Due to a high irradiation potential (many African countries have daily solar radiation ranging between 5 and 6 kWh/m²), the falling cost of solar photovoltaic and the limited capital investment required (compared to grid connections), solar home systems could be an attractive solution for the population currently deprived of access to electricity. Even low levels of electrification, especially solar lamps, can bring substantial economic and non-economic benefits (Aevarsdottir et al. 2018).

The second important potential source of renewable energy is hydropower. Although it already accounts for half of the electricity generation in Sub-Saharan Africa, it is estimated that the potential remains substantial as only 7% of it has been harnessed. Similarly, the technical potential of wind and geothermal energy is significant. Using the prevailing technology, the region of the Great Rift Valley has the potential to generate 20,000 MW of electricity from geothermal sources. To date, the exploitation of the resource remains limited to only 150 MW in Kenya and 7.3 MW in Ethiopia, partially because of the significant up-front cost and the specialised expertise required.

With sizeable reserves in much of the region, natural gas, meanwhile, could certainly play a key role in meeting Africa's industrial growing need for reliable electricity supply. Today, however, the share of gas in Sub-Saharan Africa's energy mix is among the lowest in the world. Natural gas accounts for just 12% of Sub-Saharan Africa's on-grid power generation capacity (most of that in Nigeria), against 23% globally.

Although natural gas has a large potential, reserves are often only developed when the production can be exported by LNG. International companies usually don't consider the domestic markets because prices are usually subsidised and

thus provide inadequate return on investments, or the off-takers have creditworthiness issues. Even when gas is associated with oil production, flaring is still very common.

The experience in Ghana, the only country in Sub-Saharan Africa in which non-associated gas has been developed in deep water and is entirely dedicated to the domestic market, is a good example of a model that could be more frequently applied. The development of the gas resources was made possible by the negotiation of an innovative payment security structure involving World Bank guarantees amounting to \$700 million to secure payments by the state-owned Ghana National Petroleum Corporation for the purchase of gas (Pistelli 2018). As a result, Ghana is today one of the most advanced countries in the region in terms of access to energy, with the electrification rate above 80% (against 44% in 2000), thanks to its natural gas and hydropower resources that account respectively for 52% and 37% of the power generation (Enerdata 2020).

4.2 *Improving the Governance to Attract Investments*

The production and distribution system of electricity in Sub-Saharan Africa is globally a failure: not only the current power systems are inadequate for present day demand for reliable power, but given the projected growth of population, the future expanding demand will result in worsening shortfalls unless radical strategies of expansion and change are implemented.

Sub-Saharan Africa is endowed with important energy resources, including both fossil fuels and renewable sources, that could easily meet the continent's energy demand. However, the lack of access to energy doesn't seem to be related to the availability of energy resource per se but rather to the way these resources are harnessed. The main issue is not the resource endowment, but the difficulty to mobilise or attract investment needed to valorise them, which, ultimately, pertains to the level of governance and the quality of the institutions.

There are three priority tasks for electrifying Sub-Saharan Africa, each of them involving a significant improvement of the governance of the energy sector (Harris 2018). The first one is to expand the output and reliability of existing centralised systems for power generation, transmission and distribution that supply connected consumers through centralised grids. The second one is to connect the unconnected population (mainly rural) with the development of decentralised small systems in which distributed local generation is linked to mini-grids. The third task is to decarbonise the energy mix by substituting coal, biomass and diesel with renewable sources.

Governance of power utilities is indeed one of the key components of Africa's energy crisis. Effective governance and regulatory frameworks in the energy sector are crucial for promoting sound management practices and attracting private investments. By setting up the rules in the sector, regulation increases comfort for the private sector to invest and imposes on utilities cost discipline and quality standards for enhanced efficiency. Regulation also helps

maintain a balance between the interests of service providers and the needs of consumers in terms of quality of service, profits and reasonable tariffs.

For a long time, the energy sector in Africa (especially the power sub-sector) was under state ownership and poorly managed because of political interference requiring that utilities play a difficult dual role as commercial entities and implementers of governments' social objectives. The consequences have been inadequate maintenance, poor performance of utilities and low-quality service. In response to these inefficiencies and under the pressure of international donors, many Sub-Saharan African countries initiated a liberalisation process in order to boost performance and energy supply. In practice, African governments spend around \$20 billion annually bailing out loss-making utilities and providing subsidies for oil-based products, while these funds could be spent on more productive energy investments, including setting up targeted subsidies for the poorest households within a full cost recovery system.

Establishing robust legal and regulatory frameworks at national and regional levels is critical in order to attract international private investors and improve operating efficiency (Hafner et al. 2018b). However, most African households, especially in rural areas, live on very modest budgets, which constitute a barrier for access to modern energy services in a liberalised market where energy providers rely solely on revenues from sales. In other words, it is very unlikely that the market alone would succeed in achieving universal access to energy in Sub-Saharan Africa. Meeting the energy needs of low-income communities implies finding a balance between the traditional supply-oriented approach and a demand-driven one, which means paying greater attention to the needs of the end-users and their capacity to afford services. This can be done through innovative pricing mechanisms and flexible payment schemes, including targeted subsidies, to reduce the financial burden for consumers, facilitate access and share potential financial risks with investors, all of which, once again, depends on the quality of the governance.

Despite its high level of corruption and ethnic competition and violence, Kenya offers a good example of what can be achieved. Thanks to a well-developed regulatory framework and innovative off-grid solutions (especially in geothermal and micro-hydropower), Kenya has been able to attract domestic and foreign private investments in renewable energy which resulted in an impressive expansion of access to electricity (Gordon 2018). With an electrification rate above 75% (against less than 20% in 2000) both from grid and off-grid solutions, the country now has the highest electricity access rate in East Africa and is projected to achieve universal access before 2030 (IEA et al. 2019).

4.3 *Fostering Regional and International Cooperation*

The African Development Bank (AfDB) estimates the total investment requirement, in order to reach universal access to reliable and clean electric power in all the countries of the continent by 2030, at an average annual investment of

between US\$27 billion (assuming a global climate policy) and US\$33 billion (assuming no global climate policy) (AfDB 2019). For now these amounts seem totally out of reach and the chances of meeting the SDG7 in Sub-Saharan Africa seem minimal. However, change seems to be happening, as efforts to promote energy access are clearly gaining momentum. For the first time in 2017 the increase in the rate of access to energy in Sub-Saharan Africa out-paced population growth.

Africa's strong economic growth since 2000 has resulted in an increase in demand for energy from the private sector, prompting major investments in power generation and transmission. A considerable push towards cleaner, lower-carbon energy is promoting investment in the Sub-Saharan African energy sectors, strongly supported by international development agencies. Indeed, for the last decade or so, numerous international organisations such as the World Bank Group, the African Development Bank (AfDB, through its New Deal on Energy for Africa), European governments and institutions (Africa-European Union Energy Partnership, AEEP) and the United States government (USAID's Power Africa programme) have launched several ambitious initiatives. These initiatives aim to promote investment in the energy production and distribution infrastructure and establish effective governance systems needed to reach a sustainable and cleaner energy sector that ensures universal access to modern, affordable and reliable energy services for all Africans. Some private initiatives also exist, including the Sustainable Energy for All (SEforAll) initially launched by former UN Secretary-General Ban Ki-moon in 2011, and the Clean Cooking Alliance established in 2010.

All these initiatives from international public donors are important not only for the funds they provide, but also because they help to catalyse private funds. In many cases, the presence of development institutions, providing financing and risk mitigation measures, has been critical to obtain funding (Tagliapietra 2018). In particular, the action of some donors such as the AfDB is also crucial in helping to plan and implement regional cooperation in the energy sector in view of developing infrastructure, especially for electricity generation and distribution, and promoting regional electricity markets. This is illustrated by the establishment of several sub-regional power pools, namely the South African Power Pool (SAPP), West African Power Pool (WAPP), Central African Power Pool (CAPP) and East African Power Pool (EAPP). Although most of them are still fairly embryonic and face challenges such as a lack of funding, political instability and weak cross-border regulations, they could enable countries to develop their energy systems more collaboratively and stimulate cross-border trade of energy resources and services, avoiding the inefficiencies of small national markets and therefore enhancing the security of electricity supply on the continent (Hafner et al. 2018a).

In recent years a high proportion of the foreign investments being made in Sub-Saharan Africa's centralised electricity systems originates from China. Although precise data about China's financial involvement on the continent are lacking, it is estimated that Chinese companies (which are mostly

state-owned) are responsible for about a third of new power capacity in Sub-Saharan Africa since 2010. Over the last decade China has completed about 150 projects for new capacity in generation, transmission and distribution all over the continent (Harris 2018). Focusing mostly on large hydropower projects, China has become the largest national source of investment in the electricity sector's expansion and upgrading in Sub-Saharan Africa.

Praised by most African governments, eager to benefit from Chinese funds as they are deemed to be unconditional (in terms of governance)—contrary to those from Western donors—these loans, however, raise questions about their sustainability as well as their political cost. Indeed, by contracting a loan from the Chinese government in order to finance infrastructures, African governments not only are obliged to call in Chinese companies to design and carry out the projects, but also might end up finding themselves caught in a debt trap (Copinschi et al. 2019). Unable to reimburse the loans, African governments could eventually have to give away the property of the infrastructures to Chinese companies, giving them control on key strategic energy assets.

Times are changing in Sub-Saharan Africa. As Africa's population continues to grow at a rapid rate and the continent could number up to four billion people by the end of the century, working for development is more than ever a political and moral imperative. While access to energy is now well identified as a necessary condition for development, it seems less and less acceptable to continue to consider Africa only as a reservoir of energy resources available for supplying the rest of the world. The economic, social and political consequences have become too great, as illustrated by the evolution of Nigeria, a demographic giant and a major oil and gas country, where the mismanagement of oil revenues and the carelessness of the local political class have plunged the country in a spiral of violence that threatens to spill over into its neighbours.

Africa's energy potential is enormous. However, turning this potential into economic growth and development requires more than political will; it is important to put in place the conditions for attracting the investments that are essential to develop these resources for the benefit of the emerging middle classes but also the poor. The experiences of several countries, such as Kenya and Ghana, show that very different strategic choices can lead to positive results. However, there is still a long way to go before these good practices can apply across the continent.

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