

World Energy Scenarios | 2017

The background of the lower half of the cover is a dark, abstract composition. It features numerous white musical notes of various shapes and sizes, some appearing to float or move across the frame. Interspersed with the notes are bright, glowing white lines that form a complex, swirling pattern, resembling a stylized waveform or a series of interconnected paths. The overall effect is one of dynamic energy and rhythm, set against a black backdrop.

**REGIONAL PERSPECTIVE FOR
SUB-SAHARAN AFRICA**

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PREPARING FOR 'THE GRAND TRANSITION'

The world energy system is undergoing faster and more fundamental changes and both shapes and is shaped by the significant diversity of regional energy perspectives.

Since 2010, the World Energy Council (The Council) has been developing World Energy Scenarios. Scenario planning is a useful tool when dealing with accelerating changes and complex challenges. The latest report on the World Energy Scenarios was published by the Council in 2016, in conjunction with its 23rd World Energy Congress in Istanbul. It notes that since 1970, the world has seen rapid growth in energy demand, mainly satisfied by fossil fuels. It anticipates that the future will be different and describes three different energy futures to 2060, which are called: Modern Jazz, Unfinished Symphony and Hard Rock.

Since their launch in 2016, the Council's members have been using these scenarios to explore the implications for energy business model innovation, develop regional perspectives and conduct deep dives focussed on specific geographies or resources. World energy leaders can use this set of scenarios to identify new opportunities to shape a new world energy system for the benefit of all and to support strategic decision making under deep uncertainty.

The World Energy Scenarios are not forecasts, nor do they offer a vision of a better future. They are stories that describe what might happen, rather than should or will happen. The starting point for all three scenarios is 'The Grand Transition', which is already underway. The World Energy Scenarios provide an enabling framework to guide and prepare whole societies and different organisations for the uncertain journey ahead.

Each scenario reflects the same set of predetermined factors, but places a different emphasis on how critical uncertainties about the development of the world energy system might play out. Predetermined factors include: a slowly growing global population; the shift in economic power from West to Asia; an accelerating pace and more disruptive pattern of new technology developments; and the growing risk of planetary overshoot and irreversible climate change. Critical uncertainties reflect the pace of innovation and productivity; the development of international governance; the priorities given to equality and sustainability; and the selection of tools for action – the balance between the use of markets and state-directed policy.

Modern Jazz foresees the accelerated growth of a new digitally disrupted and innovative, market-driven world energy ecosystem. **Unfinished Symphony** describes a future in which more 'intelligent' and sustainable energy systems are enabled by internationally coordinated policies on climate change and regional integration opportunities. **Hard Rock** suggests that a combination of sluggish global growth and rising inequality might trigger inward-looking, nationalistic security policies, and, as a result, regional and national energy systems develop along different pathways.

REFOCUSING THE SCENARIOS ON THE REGIONAL ENERGY OUTLOOK

The Sub-Saharan African region is both a shaper and taker of new global trends and disruptive developments. It is important to look beyond the global outlook and engage with regionally specific situations and developments. How will society's shifting needs drive the development of renewables and decentralised energy technologies within the region?

This report presents a preliminary set of implications for the Sub-Saharan African region according to each of the World Energy Scenarios. These provide a starting point for a deeper dialogue about the evolution of the Sub-Saharan African regional energy that engages the perspectives of regional energy leaders and wider stakeholders.

By using these regional impressions of different world energy futures – and associated illustrative projections – regional energy leaders can identify emerging issues and prepare new and better solutions for navigating the Grand Transition.

Key Messages

- 1** Whilst global energy demand peaks in coal and oil are anticipated in the World Energy Scenarios, in the Sub-Saharan African region demand for oil increases to 2060 in all scenarios and demand for coal also increases in all but one scenario (Unfinished Symphony) due to strong, internationally coordinated climate change policy.
- 2** Total final energy consumption in Sub-Saharan Africa is expected to triple by 2060 due to a growing population, economic development and increasing accessibility to energy. However, full energy access by 2060 is only to be reached in the Modern Jazz.
- 3** Electricity generation in Sub-Saharan Africa will increase six-fold by 2060. There will be a significant shift toward renewables in the electricity generation fuel mix, mainly as a result of a strong push to develop wind, solar photovoltaics and hydro. The Unfinished Symphony indicates that renewables will increase from 26% of the mix in 2014 to 81% in 2060.
- 4** Wind and solar energy supplies are key areas for investment and increase rapidly in all three scenarios. Hydro power has enormous potential, but development of that potential depends on trust among regional partners. The estimates out to 2060 for the required investment in power generation vary from US\$ 2.2 trillion in the Hard Rock to US\$ 2.9 trillion in the Modern Jazz.
- 5** Recently discovered hydrocarbons will help transform the region between 2040 and 2050 from an energy importer to an energy exporter. The development of downstream activities and refinery capacities will help build economic strength.
- 6** While the importance of economic growth and access to affordable modern energy cannot be underestimated, there is also a need to address carbon emissions in the region. Without sufficient external funding to support adaptation and mitigation measures, Sub-Saharan Africa will quadruple its carbon emissions by 2060 (to 1.9-2.6 Gt CO₂) according to Modern Jazz and Hard Rock Scenarios.
- 7** In the Hard Rock, the lack of political stability and an unreliable business environment significantly reduce the foreign direct investment and external technology transfer upon which the region depends, resulting in the lowest economic growth, lowest energy efficiency rates and highest carbon emissions of all three scenarios.

GENERAL DESCRIPTION

The Council includes 46 countries in its definition of Sub-Saharan Africa. Most of these countries gained independence between 1960 and 1980, but since then, the region has faced multiple internal wars, resulting in political and economic frailty for many countries. According to the World Bank definition, the region includes 27 of 31 low income countries¹.

FIGURE 1: SUB-SAHARAN AFRICA GENERAL INFORMATION (2014)



GDP: US\$ 1.4 trillion

Population: 937 million

Primary Energy: 25 EJ (606 MTOE)

Share of Biomass in Energy: 60%

Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

However, the potential for growth is substantial. The region is rich in natural resources and has strong traditions in agriculture. The economy has been growing steadily at an average rate of 4.8% a year over the last decade, according to World Bank figures².

The energy sector remains underdeveloped, resulting in issues of energy inaccessibility and inequity for much of the population. Sub-Saharan Africa accounts for 13% of the global population, but only 4% of global energy demand due to lack of supply. The electricity access rate has improved from 23% in 2000 to 32% in 2012 but needs to grow even more if access is to be available for all inhabitants by 2060. The biggest challenge is to find adequate funding for the infrastructure build-out to rural areas, where small-scale projects are of little interest for development banks. There is an urban and rural imbalance: 80% of those without reliable access to electricity live in rural areas³.

In the absence of modern forms of energy, roughly 750 million people in the region rely on the traditional use of solid biomass⁴. This is the major cause of domestic air pollution and is a serious public health issue.

Climate change poses a huge threat to Sub-Saharan Africa, although the region contributes only 4% of the global greenhouse gas emissions. Several areas – especially the deserts and the arid subtropical regions

¹ The World Bank, 2016: World Bank Country and Lending Groups

² The World Bank, 2016: Sub-Saharan Africa GDP growth rate

³ International Energy Agency (IEA), 2014: African Energy Outlook

⁴ The World Bank, 2015: Global Tracking Framework 2015 – Summary report

both north and south of the equator – are highly susceptible to climate change, which threatens food production, prices and food security. External financing is critical for the deployment of modern, sustainable energy solutions and the development of adaptation and mitigation mechanisms. International bodies like the World Bank are directing funds to the region, but current financing levels must be increased considerably if they are to have a material impact.

PATHWAYS TO 2060: CRITICAL UNCERTAINTIES

Sub-Saharan Africa faces significant challenges between now and 2060 if it is to be able to increase productivity, encourage informed policy action and take steps to manage climate change. The following section explores the pathways for the region as it develops over the next 45 years.

Productivity and Economic Growth

The region's economy has been strongly dependent on exports of unprocessed or semi-processed commodities like solid minerals, oil and gas. However, poor infrastructure and inadequate skills have constrained resource development for these exports. While agriculture has been a major driver of economic growth, contributing 20% of regional GDP and 65% of the employment⁵, there is substantial scope for improving productivity in this sector.

Infrastructure upgrades across sectors and the use of technology to improve agricultural yields should bring great benefits. Increasing foreign direct investment (FDI) in the region could facilitate this. The decrease of FDI by 17.5% in 2015 to US\$ 43.2 billion was mainly due to low commodity prices, unstable local currencies and delays in major projects. The United Kingdom, the United States and France remain the largest investors in the continent⁶, but China and India are playing an increasing role in bringing in foreign direct investment. Regional integration could lower the cost of infrastructure development by up to 30%, giving countries access to more efficient technologies and a larger scale of production. Regional integration is also a critical enabler for large-scale projects such as hydro.

However, growth driven by commodity exports, urban bias and social inequity has the potential to widen social and economic inequality. These key challenges must be addressed in order to create stability and reduce the drag on economic growth.

Regional Governance

Sub-Saharan Africa's role and influence in international alliances and trade blocs, despite some country memberships in the G20 (South Africa) and OPEC (Angola, Gabon and Nigeria)⁷, remains relatively low.

Almost 30% of global oil and gas discoveries made over the last five years have been in Sub-Saharan Africa⁸, reflecting growing potential for the development of the region's economies. India and China could

⁵ International Energy Agency (IEA), 2014: African Energy Outlook

⁶ United Nations Conference on Trade and Development (UNCTAD), 2016: World Investment Report 2016

⁷ Organization of the Petroleum Exporting Countries (OPEC), 2017

⁸ International Energy Agency (IEA), 2014: African Energy Outlook

emerge as new export destinations along with the EU. Additionally, the region has the potential to overcome food scarcity through advanced and sustainable farming techniques and could become a significant supplier to the global food market. However, dependence on external funding, combined with volatile commodity prices, creates vulnerabilities for the region, which needs to focus on achieving balance by developing strong domestic economies and improving socio-political institutions.

Climate Challenge

Sub-Saharan Africa could benefit from the knowledge gained through the developed world's experience; this knowledge could enable the region to leapfrog the pollution intensive stages of manufacturing industry development. The region can also leverage economic opportunities in the development of renewable sources that will encourage clean power. However, the social and economic challenges which the region faces will make it difficult to focus on low carbon development. In addition, the low level of external funding to help the region address climate change challenges can be a strong headwind against the need for climate change adaptation and/or mitigation.

The region continues to be vulnerable to extreme weather events, such as droughts, hurricanes, tropical cyclones and convective storms, which have multiple, significant impacts. These climate-related events affect electricity generation and grid facilities; therefore, one of the most important issues to be addressed is the need to make energy systems resilient. Regional integration can support these activities⁹.

The energy-water-food nexus plays a significant role in the region. Water is a critical resource for food and energy production, impacting the stability of energy supply and demand for years to come. This brings with it the prospect of greater competition between different uses and individual users of water.

SUB-SAHARAN AFRICA SCENARIOS

The three scenarios of Modern Jazz, Unfinished Symphony and Hard Rock describe the development of a possible future world energy system. Below is a further exploration of the three scenarios with the overlay of the Sub-Saharan African region.

Modern Jazz

Modern Jazz describes a competitive market landscape which drives higher efficiency, innovation, open access to information and deployment of new technologies. This builds confidence for larger-scale projects and investments. Additionally, regional financing bodies work with the public sector to develop smaller-scale projects.

Governments open up the manufacturing sector for private sector companies. Investments flow into the agricultural sector, driving up productivity through technologically advanced farming techniques. These developments diversify sources of income and generate employment, improve the standard of living and increase literacy rates. The economy grows at a rate of 7.4% a year between 2014 and 2060.

⁹ World Energy Council, 2015: The road to resilience - managing and financing extreme weather risk

Demand for energy grows, and the supply infrastructure is enhanced with state-of-the-art technologies. Dependence on traditional biomass decreases; oil and gas become the dominant fuels in transport and power respectively.

In the electricity sector, tariff reforms and subsidy rationalisation brings in private producers. Renewable energy develops, leveraging economic opportunities to participate in regional and inter-regional markets. Energy access in rural regions is provided largely through distributed energy systems. New business models specifically designed for the rural energy sector enable energy access and are supported and enabled by light regulation. By 2060, all Sub-Saharan Africans have access to electricity.

Unfinished Symphony

The Unfinished Symphony Scenario is marked by strong political systems and regional integration. Regulatory frameworks are established to address issues of corruption and accountability. Monetary and fiscal policies are used to mitigate vulnerability to commodity price fluctuations in export markets. There is increased global collaboration, both with developed regions and with emerging countries like China and India. Long-term contracts with these partners de-risk the region from volatile commodity prices. Regional integration creates efficiencies and supports the growth in the least developed countries. The economy grows at 6.6% a year in the period from 2014 to 2060.

The energy sector also sees substantial policy reforms which enable the public sector to access financing that facilitates the modernisation of the supply infrastructure. As modern electricity infrastructure is built, reliance on traditional biomass is reduced. Non-fossil-fuel-based energy sources dominate the primary energy supply.

In the electricity sector, external financing from private and institutional organisations supports gas and renewable energy developments. The government continues to control tariffs, but there are reforms in the structure which make the industry viable, thus ensuring affordability, providing increased access and improving the overall quality of life. Strong international partnerships and global-level agreements attract funds for climate change mitigation and adaptation.

Hard Rock

The Hard Rock Scenario is marked by a greater focus on resource development for domestic consumption. As export-oriented growth opportunities decline, there is a focus on building up local industries and developing the agricultural sector, with emphasis on more efficient and more resilient harvests. This diversifies and expands domestic sources of national income. The transition is facilitated by programmes of local content development which include basic education and on-the-job-training. Additionally, the national governments focus on services-orientated growth, especially in the energy and telecommunications sectors. Economic growth, however, is dampened by lower technology transfer and decreased international trade. Thus, economic growth averages 4.8% a year to 2060. Inequitable resource allocation persists. Governments must address major development hindrances, such as food shortages and a low level of energy access, especially in rural areas. The region is exposed to the challenges of the energy-water-food-nexus and needs to develop the immense potential of hydropower which exists in many countries in the region.

Energy demand grows as economies develop, but the energy intensity of GDP declines slowly in the absence of significant technology transfer. In the electricity sector, tariff controls and subsidies are put in place to enhance affordability, but in some cases, prices do not reflect the cost-to-serve. Utilities cannot

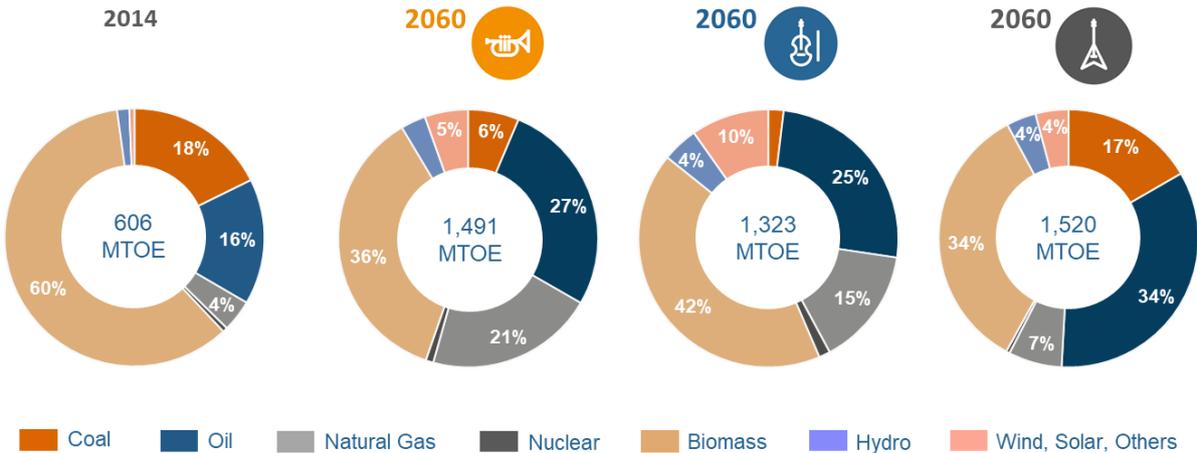
recover the cost of production and have difficulties upscaling business models with either on-grid or off-grid solutions. As a result, private players do not make investments, and the industry remains underfunded, resulting in many rural areas lacking reliable electricity access. Energy security is the focus of government policies, and thus funding for climate adaptation and mitigation becomes challenging in the absence of international cooperation and financing.

IMPLICATIONS FOR ENERGY

Primary Energy

Total primary energy demand increases 2.2-2.5 times in each scenario, growing at the rate of 1.7-2% a year until 2060 as the region develops. In all three scenarios, recently discovered resources of oil and gas will be exploited and will reduce energy imports significantly. Oil demand goes up 4-5 times due to growth in transport fuel consumption and gas demand increases by 3-6% a year due to an uptake in power generation. Biomass continues to be the dominant fuel, with supply doubling to meet energy needs like cooking, especially in the rural and some peri-urban areas.

FIGURE 1: SUB-SAHARAN AFRICA PRIMARY ENERGY BY FUEL SOURCE

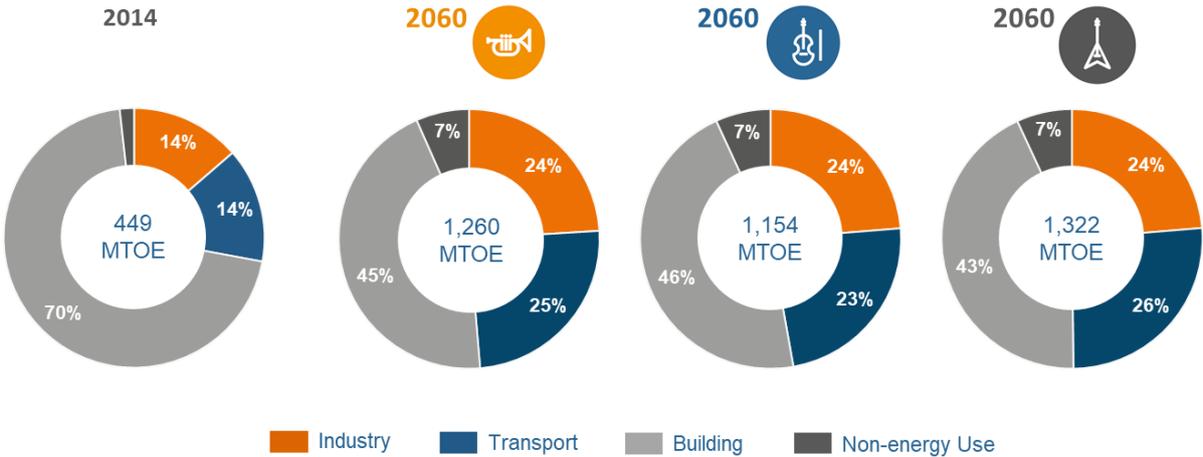


Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

Final Energy Consumption by Sector

Total final energy consumption increases 2.5-3 times between 2014 and 2060 and grows consistently in all three scenarios at around 2% a year as the region develops. With population growth and improving electricity access, the residential/commercial sector (building) accounts for the majority share in final energy consumption. Transport surpasses industry demand in final energy consumption after 2020 as infrastructure improves and car ownership increases by roughly 3.5% a year.

FIGURE 3: SUB-SAHARAN AFRICA FINAL ENERGY CONSUMPTION BY SECTOR

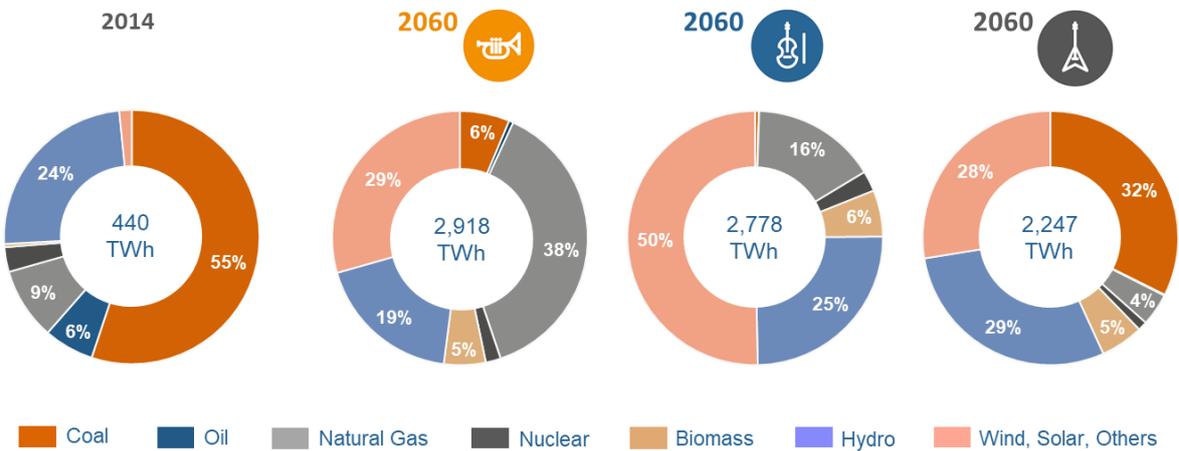


Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

Electricity Generation by Fuel Source

Electricity generation increases six-fold as decentralised power generation applies and energy supply infrastructure improves. In all three scenarios, wind grows at a rate of 11.8%-12.7% a year, while solar grows by 12-15% a year up to 2060. In Unfinished Symphony, gas starts developing with CCS after 2030 at 2% a year. Hard Rock sees the domination of gas and some presence of coal to ensure security.

FIGURE 4: SUB-SAHARAN AFRICA ELECTRICITY GENERATION BY FUEL SOURCE

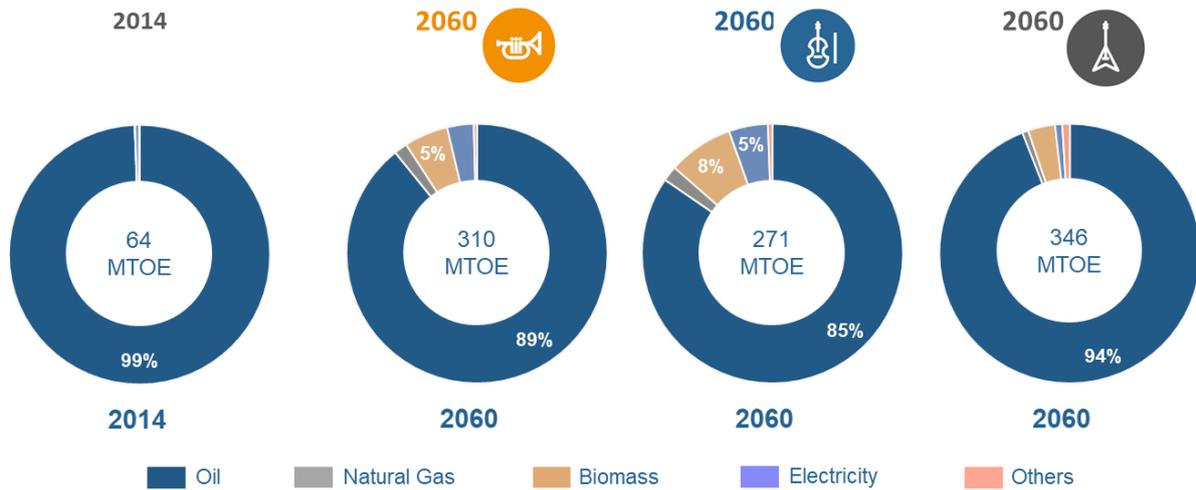


Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

Transport Energy by Fuel Source

Consumption of transport fuel increases by 4-5 times, depending on the scenario, while oil continues to dominate the transport fuel mix in all three scenarios. Electricity and biofuels begin to penetrate the mix in Modern Jazz and Unfinished Symphony.

FIGURE 5: SUB-SAHARAN AFRICA TRANSPORT BY FUEL COURSE (MTOE)

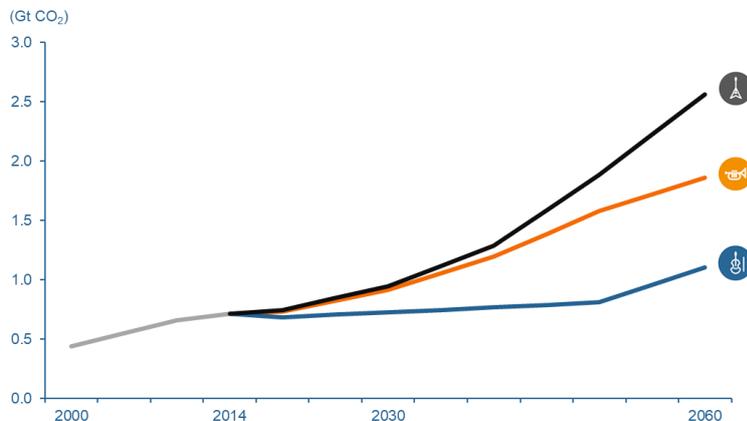


Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

Carbon Emissions from Fuel Combustion

Carbon emissions from fuel combustion grow by over 2% a year in Modern Jazz, driven by population and GDP growth and by a carbon intensive energy mix. However, the carbon intensity of GDP falls by 5% a year because of learnings from the developed world which facilitate efficient consumption. About 14% is covered by CCS in 2060.

FIGURE 6: SUB-SAHARAN AFRICA CARBON EMISSIONS FROM FUEL COMBUSTION



Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

In Unfinished Symphony, external financing helps develop mitigation mechanisms in the form of low carbon energy sources and energy efficient technologies. As a result, emissions grow at only 1% a year, with about 17% covered by CCS.

Hard Rock sees the highest growth in emissions at 2.8% a year due to the high energy intensity of GDP. This scenario also sees a rise in the carbon intensity of the energy mix. The carbon intensity of GDP falls at only 1.9% a year.

The following table illustrates the Kaya identity for Sub-Saharan Africa. The Kaya identity is an equation relating factors that determine the level of human impact on climate, in the form of emissions of the greenhouse gas carbon dioxide. It states that total emission level can be expressed as the product of four inputs: population, GDP per capita, energy use per unit of GDP, carbon emissions per unit of energy consumed. With the Kaya identity, it is possible to deconstruct the factors that influence the GHG emissions outcomes in each of the three scenarios. This is of interest for the region because it illustrates the interlinkages between economics, the political situation, the energy sector, development, security and other factors which play a role in the future outlook for Sub-Saharan Africa.

TABLE 1: KAYA IDENTITY FOR SUB-SAHARAN AFRICA (% Δ in variables from 2014 to 2060)

	Kaya Variable	Modern Jazz	Unfinished Symphony	Hard Rock
1.	Carbon Intensity of Energy Mix	0.1%	-0.8%	0.8%
2.	Energy Intensity of GDP	-5.1%	-4.6%	-2.7%
3.	GDP per Capita	5.2%	4.3%	2.6%
4.	Population	2.2%	2.2%	2.2%

Source: World Energy Council, Paul Scherrer Institute, Accenture Strategy Analysis

SUGGESTIONS TO HELP RESOLVE CRITICAL UNCERTAINTIES

Establishment of reliable political systems and political and market reforms. Most Sub-Saharan African countries introduced multi-party political systems in the 1990s, but many of them continue to face challenges of single party domination, weak institutions, lack of accountability and corruption. Numerous armed conflicts and the risk of cross-border contamination mean that there are prohibitive risk premiums on external investment. Lack of financing is a major bottleneck to development. Therefore, governments need to establish reliable political systems which can protect local and foreign investments. Political and market reforms are needed to reassure investors and serve as a strong incentive for development.

Deepening the involvement of local and regional banks and the public sector and encouraging transparency. Financing institutions and the public sector can lead by example and invest in small projects to unlock investments for large-scale projects. For example, Zambia has partially privatised its energy sector by providing licenses to Independent Power Producers (IPP), which has proven successful by increasing the sectors' generation capacity. But the current fiscal regimes create challenges for investors who want to see a move to cost-recoverable tariffs and a more transparent system.

ABOUT THE WORLD ENERGY COUNCIL

The World Energy Council is the principal impartial network of energy leaders and practitioners promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all.

Formed in 1923, the Council is the UN-accredited global energy body, representing the entire energy spectrum, with over 3,000 member organisations in over 90 countries, drawn from governments, private and state corporations, academia, NGOs and energy stakeholders. We inform global, regional and national energy strategies by hosting high-level events including the World Energy Congress and publishing authoritative studies, and work through our extensive member network to facilitate the world's energy policy dialogue.

Further details at www.worldenergy.org and [@WECouncil](https://twitter.com/WECouncil)

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