Harnessing Renewables in Sub-Saharan Africa: Barriers, Reforms, and Economic Prospects[1,2]

Abstract

To achieve universal electricity access and rapid economic development, sub-Saharan Africa must significantly accelerate its electricity generation. Despite rising real per capita incomes over the past two decades, electricity production per capita has declined. Hydropower is prominent in some countries, but solar and wind power generation lags behind other regions, despite sub-Saharan Africa's favorable conditions, particularly for solar energy. Increasing reliance on solar and wind energy would be economically beneficial due to the reduced costs of renewables and the region's geography, irrespective of climate ambitions. However, a faster transition is necessary to meet climate policy objectives. Low-carbon energy sources have low operating expenses but require high initial capital investments. The main challenge for sub-Saharan Africa is securing financing for renewable energy investments. A combination of domestic and external financing can boost renewable electricity generation and GDP. Sole reliance on domestic financing would increase power generation but reduce overall economic benefits due to the crowding-out effect on other sectors. Domestic revenue sources for green energy investments vary by country and include carbon taxes, repurposing fossil fuel subsidies, and revenues from mining critical minerals. Advanced economies have pledged $100 billion annually to climate finance for emerging markets and developing economies, with a new collective quantified goal expected at COP29 in November 2024. In one scenario, sub-Saharan Africa could receive about half of this finance, allocated to climate mitigation and adaptation. If half of the climate finance received is dedicated to renewable energy, renewable electricity production could be up to 24% higher than the baseline scenario, boosting annual GDP growth by 0.8 percentage points on average over the next decade and increasing labor demand in the electricity sector.

1. Introduction

To achieve universal electricity access and rapid economic development, sub-Saharan Africa needs to significantly accelerate its electricity generation. Despite rising real per capita incomes over the past two decades, electricity production per capita has been declining. In addition, while hydropower is prominent in some countries, solar and wind power generation has lagged other world regions, even though sub-Saharan Africa has some of the most favorable conditions, particularly in terms of solar potential. Relying more on solar- and wind-based energy would be economically advantageous for sub-Saharan Africa because of the reduced cost of renewables and the region’s geography, regardless of climate ambitions. However, a swifter shift would be needed to meet climate policy objectives. Increased power generation holds the potential to benefit sub-Saharan African economies, but effects will differ significantly depending on the design and execution of relevant policies. While low-carbon energy sources have relatively low operating expenses, they require high initial capital investments. Thus, the primary challenge across sub-Saharan Africa is securing the necessary financing for renewables investment.

Solar and wind energy are the only low-carbon energy sources that can be scaled sufficiently to power Africa’s expected development. Until the mid-2010s, scenarios for the future electricity mix in sub-Saharan Africa strongly relied on carbon capture and storage, as well as biofuels. During the 2010s, two major developments changed scenario results. First, the cost for solar energy declined by 89 percent between 2010 and 2022 and the cost of onshore wind energy declined by 69 percent in the same period

[1] All authors work at the IMF. The views expressed here belong solely to the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management

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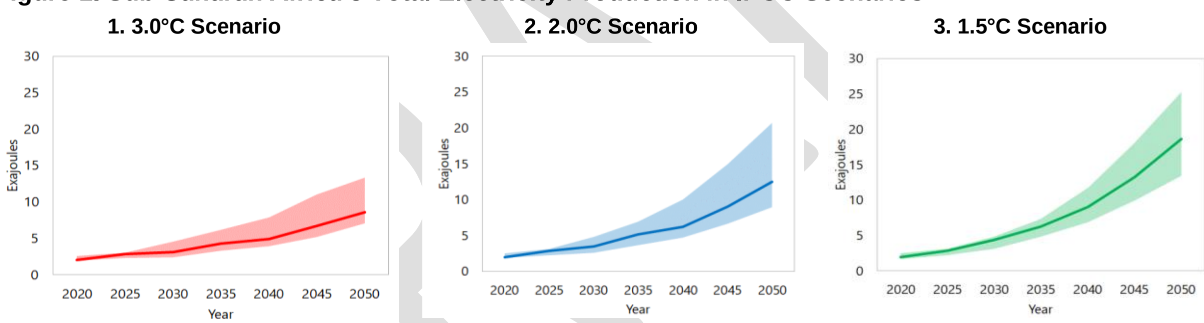
(IRENA 2023). Second, the technology for balancing the intermittency of these two sources matured (see Pietzcker and others 2017, among others). As a result, projections of the future electricity mix now rely very strongly on solar and wind power. Given excellent natural conditions, solar energy is expected to dominate electricity generation across the sub-Saharan African region (Bogdanov and others 2019). Studies now argue that the entire African electricity system can be based on renewable energy (Barasa and others 2018; Sterl and others 2021; Bamisile and others 2023).[11]

The future pathway of electricity systems in sub-Saharan Africa can be explored with the IPCC scenarios generated with high-quality models. Scenarios of global climate mitigation that would keep the average temperature increase below 1.5°C and 2°C are compared with a 3°C case. While the first two cases represent very and moderately ambitious climate policies, respectively, the last case broadly represents warming that is likely to be reached with unchanged climate policies.[12] The IPCC is deliberately inclusive in its coverage of models. Scenario results from many models are included in the database.[13] The temperature targets refer to the global temperature increase. Models generally let advanced economies decarbonize first, but reaching net zero emissions globally requires all regions, including sub-Saharan Africa, to decarbonize.

Figure 1. Sub-Saharan Africa's Total Electricity Production in IPCC Scenarios



Sources: Byers and others (2022); and authors.
Note: The bold line shows the median scenario. The shaded area shows the range between the 25th and 75th percentile. Total electricity production refers to secondary energy produced from all primary energy sources. IPCC = Intergovernmental Panel on Climate Change.

Stronger climate ambition would require accelerated electrification in sub-Saharan Africa, so that electricity production is expected to increase to a larger extent under tighter temperature goals. Electrification allows phasing out the direct use of fossil fuels, for example, in transportation (Luderer and others 2022) and cooking.[14] As a result, the amount of electricity production would have to increase to a larger extent under more ambitious climate policy. Figure 1 shows the total electricity production for the three global mitigation goals. For each of them, the bold line indicates the value in the median scenario for each year. The shaded area shows the range of results between the 25th and 75th percentile of the

[11] Nuclear fusion (Nicholas and others 2021) and nuclear energy (Laureto and Pearce 2016; Muellner and others 2021) suffer from high costs and technical challenges. Carbon capture and storage (Fuss and others 2018), biofuels (Jha and Schmidt 2021), and hydropower (Xu and others 2023) can play a role but cannot be scaled up to satisfy the total electricity demand because of limited capacity.

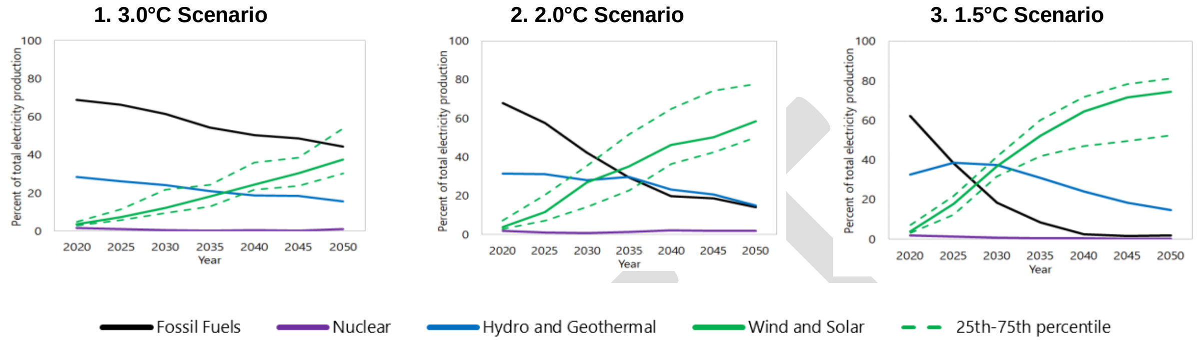
[12] In December 2023, it was estimated that the implemented policies would lead to warming between 2.2°C and 3.4°C with a median estimate of 2.7°C (CAT 2023). The 3°C scenario thus represents a no-policy scenario, where countries do not take action beyond what they already did.

[13] Not all models submit scenario results for each temperature category. There are 97 scenarios in the 1.5°C category, 310 scenarios for 2°C, and 96 scenarios for 3°C.

[14] Note that the United Nations Environment Programme is already implementing programs on electric mobility in Africa (UNEP 2022).

whole distribution of results. In all cases, scenarios project a rapid growth in electricity production.[15] While electricity production in 2020 was at about 2 exajoule (EJ), scenarios predict it to have median values of 8.5 EJ for an average temperature increase of 3°C, 12.5 EJ for 2.5°C, and 18.6 EJ for 1.5°C by 2050.

Figure 2. Sub-Saharan Africa's Electricity Production in IPCC Scenarios



Sources: Byers and others (2022); and authors.
Note: The bold line shows the median scenario. The dashed green lines show the 25th percentile and 75th percentile for solar and wind energy. IPCC = Intergovernmental Panel on Climate Change.

Even under less ambitious climate goals, IPCC scenarios project a transition from fossil fuels to solar and wind energy. Figure 2 shows median values of electricity generation from four groups of energy sources: (1) nuclear energy, (2) fossil fuels, (3) hydropower and geothermal energy, and (4) solar and wind energy. The scenarios under the 3°C category show that nuclear energy is not expected to play a material role. The role of fossil fuels (which risk becoming stranded assets, as shown in Gardes-Landolfini and others 2023), as well as of hydropower and geothermal energy, is expected to decrease gradually. The decline in the weight of these last two sources is due to the limited technical potential (Elbarbary and others 2022; Xu and others 2023). The fact that, even in the 3°C category, solar and wind are expected to gain market share steadily until 2050 in sub-Saharan Africa demonstrates the technical and economic potential of these energy sources for the continent.

Greater climate ambition at the global level would require an acceleration of the transition from fossil fuels to solar and wind energy also in sub-Saharan Africa. In the 2°C category, the pace of the decline in the share of fossil fuels is expected to be significantly more pronounced than in the 3°C category and the fossil fuel share would decrease below the share of hydropower and geothermal energy already in 2035. Nuclear energy remains insignificant across all scenarios and categories, because of high cost (Lovering, Yip, and Nordhaus 2016; Wealer and others 2021). Hydropower and geothermal energy are expected to double or triple total production, but given the much stronger total electricity growth, their share in total production is expected to decline. This amount of growth in hydropower use is possible in a sustainable and cost-effective manner (Xu and others 2023), despite the effect of climate change on water availability (Cáceres and others 2022). The share of solar and wind is expected to increase at a much faster pace

[15] GDP and population pathways follow the assumptions of the SSPs, as defined in section 2.1 of Riahi and others (2017). GDP growth in low-income countries in the SSP2 scenario, for example, is assumed to be 3.7 percent between 2010 and 2040 and 3.3 percent between 2040 and 2100 (Leimbach and others 2017). In SSP2, the population in Africa would grow from 1 billion in 2010, to 2 billion in 2050, and to 2.6 billion in 2100 (KC and Lutz 2017).

than in the 3°C category, primarily because neither source has a limited technical potential, their prices are expected to fall, and the technology for handling intermittency is expected to improve.[16]

The overarching objective of this paper is the analysis of the important role of renewables in increasing the availability of electricity and boosting inclusive growth in sub-Saharan Africa. The specific questions are as follows:

1. What will the sub-Saharan African energy mix look like under alternative degrees of climate ambition?
2. What economic, employment, and energy impacts can sub-Saharan Africa anticipate from improving the existing power capacity and increasingly shifting toward renewable energy for future energy needs?
3. How do these effects vary with financing options, differentiating between external finance and domestic financing, toward sustaining the capital costs for setting up new renewable capacity?

2. Model setup and baseline

The IMF-ENV model is a recursive-dynamic neoclassical, global, general equilibrium model, calibrated primarily with a database of national economies and a set of bilateral trade flows (Chateau and others forthcoming). The model describes how economic activities and agents are interlinked across several economic sectors, as well as countries and world regions. The central input of the model is version 11 of the Global Trade Analysis Project (GTAP) database (Aguiar and others 2023). The database includes country-specific input-output tables for 160 countries and 65 commodities, as well as real macroeconomic flows. It also captures world trade flows comprehensively for a given starting year. The currently used version 11 is based on data from 2017.

The model captures the activities of key economic actors: representative firms by sector of activities, a regional representative household, governments, and markets. Firms purchase inputs and primary factors to produce goods and services, optimizing their profits. Households receive factor incomes and, in turn, buy the goods and services produced by firms; households' demands result from standard welfare optimization under budget constraints. Markets determine equilibrium prices for factors, goods, and services. Frictions on factor or product markets are limited, except for some features described in the following. The model is recursive-dynamic; that is, it is solved as a sequence of comparative static equilibria. The fixed factors of production are exogenous for each time step and linked between time periods with accumulation expressions, similar to the dynamics of a Solow growth model.

Output production is implemented as a series of nested constant-elasticity-of-substitution functions to capture the different substitutability across all inputs. International trade is modeled using the so-called Armington specification, which posits that demands for goods are differentiated by region of origin. This specification uses a full set of bilateral flows and prices by traded commodity. In contrast to intermediate inputs, primary factors for production are not mobile across countries. Model closures assume real government expenditure and current account to be constant to baseline values. While the capital market is characterized by real rigidities, the labor market is not.

One major characteristic of the model is that it features vintage capital stocks in such a way that the representative firm's production structure and behavior are different in the short and long term. In each year, new investment is flexible and can be allocated across activities until the return to the "new" capital

[16] In the 1.5°C category, these developments are expedited even further. The median share of solar and wind energy would increase to almost 75 percent of the electricity mix by 2050. The share of fossil fuels would fall even more rapidly reaching nearly zero by 2040. Hydropower and geothermal energy would increase further in absolute terms than in the other temperature categories. However, given the higher total electricity production, their share is similar across temperature categories, especially toward the end of the simulation horizon.

is equalized across sectors; the “old” (existing) capital stock, on the contrary, is mostly fixed and cannot be reallocated across sectors without costs. Therefore, short-term elasticities of substitution across inputs in production processes (or substitution possibilities) are much lower than in the long term and make adjustments of capital more realistic. In contrast, labor (and land) market frictions are limited: in each year, labor (land) can shift across sectors with no adjustment cost until wages (land prices) equalize, and the labor (land) supply responds with some elasticity to changes in the net-of-taxes wage rate (land price).

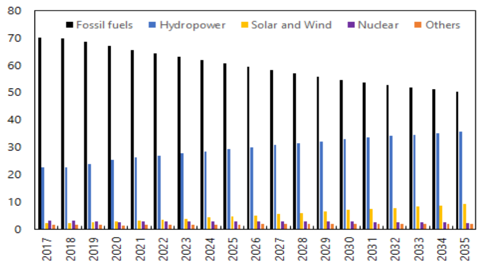
The model also links economic activity to environmental outcomes. Emissions of GHGs and other air pollutants are linked to economic activities either with fixed coefficients, such as those for emissions from fuel combustion, or with emission intensities that decrease (nonlinearly) with carbon prices—marginal abatement cost curves. This latter case applies to emissions associated with non-energy-input uses (for example, nitrous oxide emissions resulting from fertilizer uses) or with output processes (like methane emissions from waste management or carbon dioxide emissions from cement manufacturing). In the very long term, the model may overestimate the cost of decarbonization, since it does not consider radical technology innovations that could materialize at this longer horizon (for example, hydrogen, second generation of nuclear, biofuel, and carbon capture and storage technologies). While some of these new technologies are at an experimental stage, it is difficult to include them in the model at the moment because of a lack of information about their future costs if they were deployed at industrial scale. The full description of the model is available in Chateau et al. (2025).

Baseline dynamics

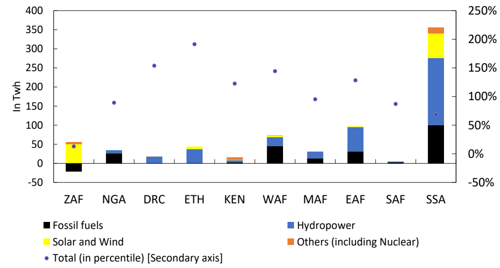
We calibrate the global dynamic general equilibrium model IMF-ENV to sub-Saharan Africa and explore a variety of scenarios pertaining to the expansion of power generation and its associated macroeconomic effects. For this paper, the model has been calibrated to reflect sub-Saharan African subregions in line with the UN classification, in addition to specific countries selected for focused analysis. Carbon prices are included in the baseline based on the effective carbon rates database of the Organization for Economic Co-operation and Development for Kenya and the South African government’s carbon tax proposal. For other sub-Saharan African countries and regions, emissions follow projections from the Climate Policy Assessment Tool (CPAT) until 2030 and are then driven by model dynamics until 2035. Macroeconomic trends between 2024 and 2029 are based on the IMF’s World Economic Outlook 2024 database. The post-2029 GDP growth projections are based on shared socioeconomic pathways (SSP) database, which provides narrative pathways for future population and GDP. We use the SSP2 scenario, which is characterized as a scenario with intermediate challenges. Population growth is also taken from the SSP2. Electricity mix between 2017 and 2021 is calibrated using data from the IRENA, while GHG emissions are calibrated using data from the United Nation Framework Convention on Climate Change (UNFCCC).

Figure 3: Baseline composition of electricity in SSA

A. Sub-Saharan Africa: Power Generation Shares (Percent)



B. Sub-Saharan Africa: Change in Composition of Electricity Generation from 2021 to 2035



Sources: International Renewable Energy Agency; and Authors calculations using IMF-ENV model.
Note: Data from the IRENA is used to calibrate IMF-ENV model between 2017 and 2021. The left axis displays changes in production (measured in TWh) across various power generation technologies, whereas the right axis shows the overall change in total electricity generation (measured in percentage). Refer to Annex Table 1.2. for the regional abbreviations. Data labels in the figure use International Organization for Standardization (ISO) country codes. pct = percent; TWh= terawatt-hour.

Under baseline assumptions, electricity production would increase, characterized by an expanding contribution of solar and wind energy within the generation mix (Figure 3, Panel A). The baseline scenario is shaped by long-term GDP growth rates, demographic trends, energy efficiency gains, and key energy and climate policies in large economies. Compared to the year 2021, total power generation in sub-Saharan Africa would increase by a factor of 1.7 by 2035, aligning with the range of the 3°C IPCC scenarios presented in the previous section. Compared to 2021, solar and wind generation would increase the largest, by a factor of 5.6, followed by a 2.2-times increase in other non-fossil fuel–based technologies, and lastly fossil fuel–based technologies would grow by a factor of 1.3. The increase in the share of solar and wind energy generation is supported by the implementation of all policies governments have already announced, alongside a continued global reduction in the costs of solar and wind energy technologies. This shift would result in the share of all renewable energy sources climbing from 31 percent in 2021 (as reported by IRENA) to 47 percent by the year 2035. In absolute terms, total electricity generation would increase from 520 TWh to approximately 880 TWh within the same timeframe, with hydropower playing the most significant role (300 TWh in 2035).

Under the baseline scenario, substantial heterogeneity is expected to persist in the composition of power generation technologies across sub-Saharan African economies through 2035 (Figure 3, Panel 2). Throughout the period from 2021 to 2035, total electricity generation would increase across all sub-Saharan African regions, with this growth being accompanied by a change in the composition of generation technologies. In South Africa, a reduction in coal generation is expected, underpinned by the effective enforcement of carbon pricing and Eskom’s decommissioning plans for coal plants. This move toward less carbon-intensive sources is primarily driven by an increase in the generation from solar and wind technologies. In Nigeria, and across three aggregate sub-Saharan African subregions—Eastern Africa, Western Africa, and Middle Africa—natural gas is the main driver of the increase in fossil fuel–based electricity generation and is followed by generation from oil (diesel) sources in the latter three regions. Moreover, hydropower generation would expand in Eastern Africa, Western Africa, Middle Africa, as well as Ethiopia and the Democratic Republic of Congo.

3. Scenarios

We explore the macroeconomic costs involved in three strategies for funding the growth of renewable energy. As an illustration, the three scenarios—domestic, mix, and international—are designed such that total annual new investments in solar and wind sectors are 0.5 percent of baseline GDP higher annually until 2030.

- *Domestic*: In this scenario, the investment shock is realized by redirecting additional domestic investments only to the renewable sectors.
- *International*: The investment shock is achieved by using international transfers only
- *Mix*: an equal mix of these two strategies

As an illustration, the three scenarios—domestic, mix, and international—are designed such that total annual new investments in solar and wind sectors are 0.5 percent of baseline GDP higher annually until 2030 (in addition to the accumulated capital stock amounting to 0.5 percent of sub-Saharan Africa's GDP in renewable electricity sectors under the baseline). If both solar and wind sectors are present in a country, then the investment is equally shared between the two sectors. If only one of these two-generation sectors is present, then the full investment is channeled into it. This keeps the aggregate shock comparable across sub-Saharan African economies. In the domestic scenario, the new investments are entirely funded by reallocating domestic resources that would otherwise be allocated to other sectors. Differently, in the international scenario, new investments are covered by financing coming from abroad. In the illustrative mix scenario, 50 percent of investments are assumed to be funded through domestic sources and the rest through international funds. Importantly, increased electrification and improved reliance of electricity can unlock productivity gains in sub-Saharan Africa (Alam et al. 2018; Rojas-Romagosa et al. 2024). Estimates of long-term labor productivity improvements from eliminating power outages by (Fried and Lagakos 2023) average 15 percent across four significant economies in sub-Saharan Africa. Here, simulations conservatively assume that investments sufficient to modernize the electricity sector (estimated at $25 billion per year by IEA 2022) would lead to a 5 percent improvement in productivity by 2035. In each scenario, productivity shocks are rescaled proportionally to the increase in renewable investment.

The paper also presents a second set of scenarios that model international climate finance flows. Advanced economies have committed $100 billion per year to climate finance for emerging market and developing economies and a new collective quantified goal (NCQG) is expected to be set during COP29 in November 2024. We develop an illustrative scenario where this finance is allocated based on the relative difference between national and global per capita emissions, sub-Saharan Africa would receive about half, which in turn would have to be allocated to climate mitigation and adaptation. Further, we assume that half of the climate finance flows received by sub-Saharan Africa are assigned to renewable energy sector in three ways-

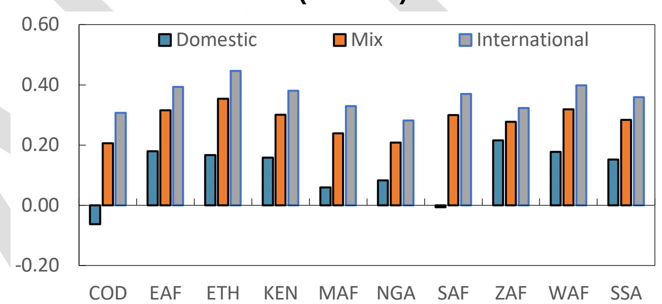
- *Solar+wind*: Investments in solar and wind power generation,
- *T&D*: Investments in transmission and distribution in addition to solar and wind power generation
- *Energy efficiency*: Investments in energy efficiency measures in addition to those in T&D, solar and wind power sectors.

Under these three investment options, renewable electricity production could be up to 24 percent higher than in the baseline scenario excluding this financing. Annual GDP growth in this illustrative scenario would be boosted by 0.8 percentage point on average over the next decade, accompanied by stronger labor demand in the electricity sector.

4. Results

Macroeconomic benefits would be greater the higher the share of external resources used to finance investment (Figure 4). As a result of the diversion of resources from other sectors, if investment policies were pursued exclusively using *domestic* financing, most sub-Saharan African regions would experience lower GDP gains compared to the mix and international scenarios, while some would face small GDP loses relative to the baseline.[17] In the *domestic* scenario, between 2025 and 2030, annual GDP growth in sub-Saharan Africa would increase by 0.15 percentage point relative to the baseline, with some regions facing relatively more pronounced gains, like an increase of 0.2 percentage point in South Africa and Eastern Africa while DR Congo and Western Africa would face small GDP losses. In the *international* scenario, all sub-Saharan African economies would realize gains in annual GDP growth (relative to the baseline) ranging from about 0.3 to 0.45 percentage point with overall GDP growth in sub-Saharan Africa rising by 0.4 percentage point. Under the *mix* scenario, sub-Saharan Africa's GDP would increase by approximately 0.3 percentage point. Therefore, the *mix* scenario illustrates that a financing strategy where both external and domestic sources cover a fraction of the investment needs can yield higher GDP levels than those achievable with the *domestic* scenario. This is because the economic benefits of increased power generation are accompanied by a smaller crowding-out of investments in other sectors.[18]

Figure 4. Average Annual GDP Growth Impacts between 2025 and 2030 (Percent)



Source: Authors based on IMF-ENV model.
Note: Refer to Annex Table 1.2. for the regional abbreviations .Data labels in the figure use International Organization for Standardization (ISO) country codes.

In the *mix* scenario, the increase in GDP is driven by higher investment and private consumption, while net exports decline relative to the baseline scenario. As shown by the decomposition of the change in GDP for the *mix* and *domestic* scenarios, external financing allows for higher overall investment levels across sub-Saharan African economies, contributing more prominently to the increase in GDP (Figure 5, panel 1). Wages also increase to a larger extent under the mix scenario, and higher incomes allow for higher private consumption. In the *domestic* scenario, as a result of the crowding-out of other sectors, the aggregate change in investment is more limited.[19] Real net exports contribute negatively to GDP in both scenarios, owing to a larger increase in import volumes relative to the increase in exports.[20]

[17] In practice, domestic financing may encounter two additional constraints: (1) it can be more costly, potentially affecting debt sustainability; (2) due to the capital- and import-intensive nature of renewable energy investments, it may exert more pressure on reserves or the exchange rate compared to external financing.

[18] Reliable access to electricity is a big concern in sub-Saharan African economies and productivity gains above and beyond the labor productivity gains included in the simulations could be unlocked with increased access and strengthened reliability of the electricity sector (Alam et al. 2018; Rojas-Romagosa et al. 2024) . Absent granular estimates about these additional productivity gains, the simulations are intentionally conservative.

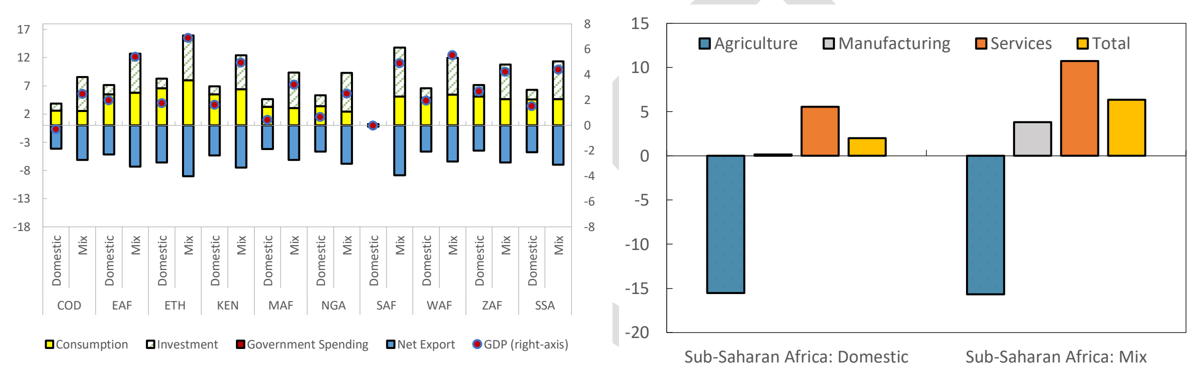
[19] IMF-ENV has a savings-driven investment closure, a standard closure rule in the computable general equilibrium models. Regional savings rate (as a share of GDP) is exogenously defined, and this determines total investments in the subsequent period. Therefore, absent additional savings, total domestic investments are affected in a limited manner because of changes in GDP under the *domestic* scenario in Figure 5.

[20] In IMF-ENV, the external closure fixes the current account as a share of GDP to the baseline values in the policy simulations. Under the mix and international scenarios, foreign savings of each sub-Saharan African country/subregion increase by the amount of the transfers received.

Especially if supported by external financing, higher electricity supply would contribute to boosting output in manufacturing and services. Under the *mix* scenario, higher electricity supply would bolster production in the energy-intensive manufacturing and services sectors, with an overall domestic production increase of approximately 6 percent in sub-Saharan Africa by 2030. Specifically, output in manufacturing would increase by 4 percent, while services (including electricity) would increase by 11 percent. This shift would be accompanied by a decline in the agriculture sector by about 15 percent. Although magnitudes vary, this pattern of structural change is consistent across all sub-Saharan African economies. With only *domestic* financing, the overall domestic production would increase by only 2 percent, and there would be only a marginal increase of 0.2 percent in manufacturing and a modest increase of 6 percent in the services sector. The decline in the agricultural sector is very similar across the two scenarios.

Figure 5. Decomposition of GDP Impacts under the *Domestic* and *Mix* Scenarios (Percent)

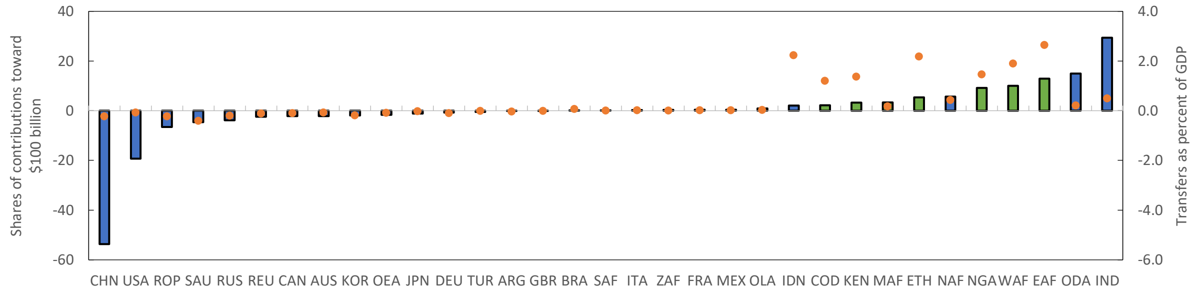
1. Demand Side (2030) **2. Supply Side (2030)**



Source: Authors using IMF-ENV model.
Note: Results are calculated as percentage change relative to the baseline. In panel 1, the change in government consumption (*G*) is fixed to baseline levels in IMF-ENV (closure rule); therefore, the change in *G* relative to baseline is zero. The secondary axis shows the changes in GDP levels relative to baseline in 2030. In panel 2, services include the electricity sector. Output of the services sector, excluding electricity sector, increases by 2 percent and 5 percent, respectively, under the *domestic* and *mix* scenarios. Data labels in the figure use International Organization for Standardization (ISO) country codes. Refer to Annex Table 1.2. for the regional abbreviations.

Climate finance will be pivotal in promoting green investments, particularly in economies constrained by limited fiscal space. The concerted efforts to mobilize both official and private climate finance are crucial for accelerating green investment initiatives in emerging market and developing economies (Black and others 2022). As part of the Copenhagen Accord in 2009, high-income countries pledged to mobilize at least $100 billion per year in climate finance from 2020 onward. The pledge, however, did not clarify the exact modalities (Weikmans and Roberts 2019). In 2015, it was decided as part of the Paris Agreement to extend this commitment to 2025 and to set a new collective quantified goal (NCQG) before 2025. Advanced economies exceeded the $100 billion annual goal for the first time in 2022, mobilizing $103.6–$115.9 billion, depending on available estimates (OECD 2024; Mitchell and Wickstead 2024). However, sub-Saharan Africa typically receives a relatively small share. Of the climate finance flows disbursed by advanced economies during 2016–20, only a quarter went to Africa, including North Africa (OECD 2022). The definition of the NCQG is planned for COP29, which will be held in November 2024.

Figure 6. Illustrative Climate Finance Contributions: $100 Billion (2035)



Source: Authors using IMF-ENV model.
Note: This is an illustrative scenario and not a policy recommendation. All sub-Saharan African countries/subregions are marked in green bars. The bars (left axis) represent the share of transfers in billions of $, whereas the dots (right axis) display these shares as a percentage of GDP in 2035. The allocation rule underlying these calculations is based on the proposal by Raghuram Rajan, which states that countries either contribute to or receive funds in proportion to the difference between their per capita emissions and the global average. This is further adjusted by an emissions price and the size of the regional population. Data labels in the figure use International Organization for Standardization (ISO) country codes.

Annual flows of $100 billion starting in 2025 are assumed, with the allocation being determined according to the difference between national and global per capita emissions. Given that the NCQG is still to be decided, the assumed flows are kept at the level of the Copenhagen Accord. A previous IMF work has discussed different rules that could be used to allocate climate finance from advanced economies to emerging market and developing economies, while maintaining global equity in mitigation efforts (see Black and others 2022). This note borrows one illustrative scenario from Black and others (2022), namely the framework proposed by Raghuram Rajan[21] to design the distribution of the climate finance flows, because it incentivizes all countries to decarbonize. This allocation rule envisions that countries either contribute to or receive funds to an extent proportional to the difference between their per capita emissions and the global average, adjusted by an emissions price and the regional population size. Based on this proposal, at the aggregate level, sub-Saharan Africa would receive about half of the total funding flows by 2035 (Figure 6).[22] Except for South Africa, all other sub-Saharan African regions would remain beneficiaries, given their relatively low per capita emissions compared to the global average.[23] Recognizing that a significant part of these financial flows should be allocated to climate adaptation, the following illustrative simulations assume that $25 billion per year (half of the about $50 billion flowing to sub-Saharan Africa) will be assigned to the renewable energy sector. Clearly, countries may have different preferences regarding the funds' allocation. For simplicity, these simulations also assume that these flows are in the form of transfers. In practice, they will be a combination of debt instruments (which

[21] See https://www.project-syndicate.org/commentary/global-carbon-incentive-for-reducing-emissions-by-raghuram-rajan-2021-05.
[22] In terms of economic size, contributions from advanced economies toward the $100 billion goal would represent about 0.1 percent of their GDP, while sub-Saharan Africa would collectively receive funds equivalent to 1.6 percent of its GDP in 2035. The analysis of Black and others (2022) is conducted until 2030 and models alternate allocation options in which the sub-Saharan Africa share would vary from 17 to 30 percent, with the highest share being realized under the Rajan proposal. To compare, the 2030 allocation share toward sub-Saharan Africa in this note is 38 percent, with updates in baseline emission projections being the primary drivers of the increased share of financing allocated to sub-Saharan Africa under the Rajan proposal.
[23] In the illustrative scenario, a country's role as a donor or recipient in climate finance is influenced by its decarbonization pace relative to the global average. South Africa, heavily reliant on coal, emits more per capita than the global average until 2032, making it a donor until it becomes a recipient post-2033. This shift could occur sooner if South Africa accelerates its decarbonization or if global efforts slow. Additionally, initiatives like the Just Energy Transition Partnership, established during COP26, where wealthy nations pledged $8.5 billion to aid South Africa's coal transition, highlight how climate finance can address specific national challenges and encourage decarbonization at different levels.

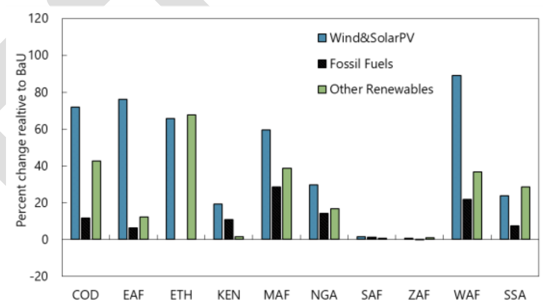
may have a grant component), grants, and equity. The transfer-based nature of these flows likely leads to an overestimation of the GDP impact. This will be more muted the smaller the grant component in overall financing.[24]

The allocation of climate finance within the power generation sector is envisaged to follow three alternative investment strategies:

1. *Solar & Wind*: In this scenario, the funds are exclusively allocated toward investments in the solar photovoltaic (PV) and wind generation sectors.
2. *Transmission and distribution (T&D)*: Beyond the investments in solar PV and wind generation, this scenario extends the use of funds to investments in the T&D sector, which is a critical input for scaling up power generation capacity across any technology.
3. *Energy Efficiency*: This scenario envisages that new investments will not only bolster the solar PV, wind, and T&D sector but will also contribute to improvements in energy efficiency.

Figure 7. Change in Total Electricity Supply in Sub-Saharan African Regions (Percent Change Relative to baseline)

Solar and Wind: Electricity Supply (2035)



Source: Authors using IMF-ENV model.
Note: The results for scenario *T&D* and *Energy Efficiency* are like that for scenario *Solar and Wind*. Annex Figure 1.5 shows the complete results for all three scenarios. Refer to Annex Table 1.2. for the regional abbreviations. Data labels in the figure use International Organization for Standardization (ISO) country codes. T&D = transmission and distribution.

In the *Solar & Wind* scenario, funds finance the new capital invested in these two sectors and the distribution of funds is proportional to the share of investments these two sectors receive under the baseline scenario. In the *T&D* scenario, the allocation of investments across the three sectors—solar, wind, and T&D—is determined based on their respective shares of investments in the baseline scenario. The share of investments going jointly to the wind and solar sectors is reduced substantially under this allocation because of the large share of existing capital stock in the T&D sector.[25] Moreover, investments in the T&D sector are technology-neutral within the model, given that an efficient T&D infrastructure is essential for the deployment of all power generation technologies. Finally, in the *Energy Efficiency* scenario, the same level of output can be produced with less energy inputs relative to the baseline scenario. The energy efficiency improvements are designed to be unbiased toward any specific power generation technologies, thus benefiting both fossil fuel–based and renewable energy sectors.

The allocation of climate finance toward solar and wind sectors, along with the expansion of transmission and distribution networks, would substantially boost electricity supply (Figure 7). Total electricity generation in sub-Saharan Africa would increase by about 17 percent to 18 percent across scenarios relative to the baseline scenario, with solar and wind generation increasing by 24 percent. The generation from solar PV and wind sources would see a boost in all sub-Saharan African countries. However, the

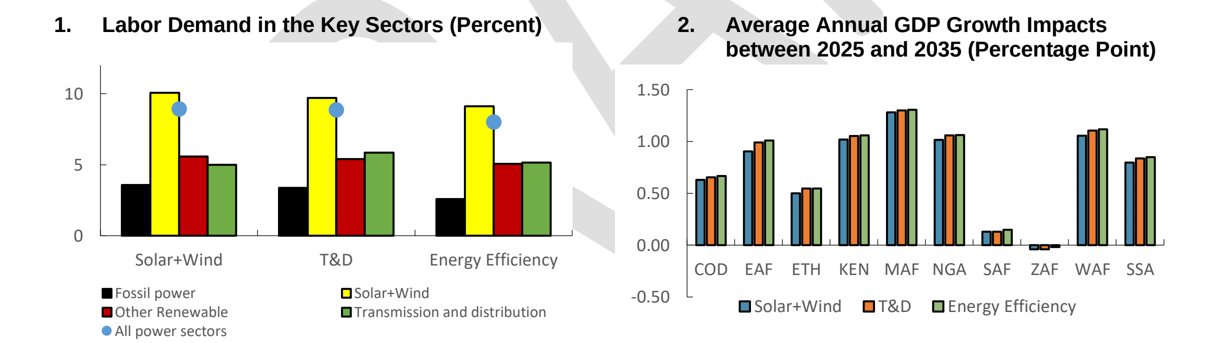
[24] Although the effect on electricity generation and energy sector employment remains constant across financing scenarios, given equal investment levels, the broader macroeconomic outcomes will vary by financing mix. Allocating half of climate funds to mitigation in sub-Saharan Africa equates to an annual $25 billion investment or about 1% of the region's GDP by 2035, doubling the investment rate to 0.5% of GDP annually by 2030 as seen in previous simulations. The increased investment and extended analysis to 2035 mark the primary distinctions between these scenarios, influencing the magnitude of projected outcomes.

[25] Based on the GTAP data, apart from South Africa and Kenya, in the rest of the sub-Saharan African economies, over half of the capital stock within the electricity sector (all power technologies including T&D) exists in the hydropower sector. In South Africa and Kenya, most of the capital stock is in coal generation (74 percent) and geothermal generation (48 percent), respectively. On average, a quarter of the investments in electricity sector go to the T&D sector in sub-Saharan African countries.

composition of electricity generation varies based on which electricity sector is targeted for investments. Among the three policy scenarios, the *Solar & Wind* scenario, which channels the most substantial investments into solar and wind energy generation, showcases the largest increase in electricity generation relative to the baseline. The increase in wind and solar PV is as high as 76 percent to 90 percent in the Eastern and Western African regions. In the electricity sector, within the IMF-ENV model, T&D sector is recognized as an essential input for power generation. Therefore, even when funds are exclusively allocated to renewable power generation sectors, additional investments in the T&D sector take place. This explains the increase in fossil fuel and other renewables-based generation under both the *Solar & Wind* and *T&D* scenarios even though these sectors are not directly targeted by investments.[26] As a result of this mechanism, the expansion of the T&D sector benefits all power generation technologies by enhancing the overall efficiency and reach of the energy grid. The expansion of the grid is likely to expand access.[27] In the *Energy Efficiency* scenario, the growth in power generation sectors is marginally lower as a result of the reduced energy requirements for generating output given higher efficiency of energy inputs (see Annex Figure 1.5).

The *Solar & Wind* scenario amplifies employment within the renewable energy sector the most (Figure 8, Panel 1). All three investment strategies would contribute to an overall increase in labor demand within

Figure 8. Impact on labor demand and GDP growth in Sub-Saharan Africa



Source: Authors using IMF-ENV model.

Note: Both charts show percentage changes relative to the baseline. Regional abbreviations as in Annex Table 1.2. Refer to Annex Table 1.2. for the regional abbreviations. Data labels in the figure use International Organization for Standardization (ISO) country codes. T&D = transmission and distribution.

the electricity sector, which would increase by about 8 percent to 9 percent by 2035 under each of the three investment options, with the *Solar & Wind* scenario registering the most pronounced overall growth. Labor demand in renewable generation rises by 15 percent to 17 percent, and a smaller increase of 3 percent to 4 percent is also seen in the fossil generation sectors as these sectors also gain from improved grid structures, through expansion of the T&D sector, regardless of the investment focus.[28] To ensure that

[26] Higher generation from other renewables does not necessarily reflect expansion of capacity but could also result from higher utilization rates because of improved grid infrastructure.

[27] The link between higher electricity generation (with scaling up of the T&D sector) and electricity access is not directly modeled in IMF-ENV. The literature shows that the electricity demand of newly connected households will be low at the beginning and therefore, the impact of new connections on overall demand will remain small in the early years (Valickova and Elms 2021). Therefore, rather than increase in demand for electricity, we can use the expansion in the T&D sectors as a proxy for improvement in access. Population density and local grid characteristics play a key role in determining the cost-effectiveness of standalone and mini-grid solutions. Existing studies for Nigeria and Ethiopia show that scaling-up of grid-based solutions would be the least costly option for improving access for most households (see Nerini and others 2016), especially given the high population density in urban areas.

[28] On average, in sub-Saharan Africa (excluding South Africa), almost half of the labor in the electricity sector is employed in T&D sector (based on the GTAP data for the year 2017).

the domestic labor pool can meet the increased demand for specialized skills in the renewables sector, policy support for workforce development, including training and education programs, would be essential (Alexander and others forthcoming). Increased electricity supply supports the expansion of the manufacturing sector, which increases its labor demand by about 9.5 percent relative to the baseline. Employment falls by 18 percent in the fossil mining sector (with a small increase in other mining activities) and 4 percent in all services sectors (excluding the electricity sector). However, given the low labor intensity of the mining sector, the reduction in labor demand in the services sector remains the substantial source of new labor in the manufacturing sectors.[29]

These climate finance flows would result in higher GDP growth across most sub-Saharan African economies (Figure 8, Panel 2). Collectively, sub-Saharan Africa would benefit from a GDP boost of about 9 percent by 2035, compared to the baseline scenario, across all three scenarios. In other words, 0.8 percentage point would be added every year to GDP growth on average. The most significant gains would be observed in the Eastern, Middle, and Western African regions, which would receive a substantial portion of the $100 billion flow according to Rajan's rule. As South Africa would transition from a contributor to a recipient only between 2032 and 2035, the country would see a slight decrease in the GDP level.

5. Conclusions and discussion

Renewables have an important role to play in sub-Saharan Africa's electricity supply. Several sub-Saharan African countries already have low-carbon electricity mixes, mainly based on hydropower and, to a lesser extent, on geothermal energy. For both these countries and for those that are currently relying on fossil fuels, renewables can play an important role in their future energy and green growth strategies. As evident in the results of the IPCC scenarios, energy-economy models identify solar and wind as important drivers of electricity generation in the region, given its geographical advantage. Hydropower can play a crucial supporting role. By sending the right signals and creating economic incentives, climate policies may help accelerate the green electrification process.

Boosting electricity generation through renewable energy sources will significantly affect growth, but sub-Saharan African countries cannot achieve this relying solely on domestic resources. Scaling up renewable energy generation requires significant investments because of its capital-intensive nature. Thus, securing sufficient financing and implementing complementary reforms is crucial. A mix of domestic and external financing can lead to sizable increases in both renewable electricity generation and GDP. Conversely, relying solely on domestic financing would still boost power generation but would dampen overall economic benefits because of the crowding-out effect on other sectors of the economy. Sources of domestic revenues for financing green energy investments are country-specific and diverse. These sources can include, but are not limited to, carbon taxes, the repurposing of fossil fuel subsidies, and the mining of minerals critical for the energy transition.

Climate finance is crucial for supporting green investments, especially in economies with limited fiscal space. The commitment under the Copenhagen Accord by advanced economies to mobilize at least $100 billion annually in climate finance for emerging market and developing economies is expected to be revisited during COP29 in November 2024. The objective is setting an NCQG. Absent information on the new goal, this note explores scenarios with an annual target of $100 billion starting in 2025, based on an allocation rule where countries either contribute or receive funds proportional to relative per capita

[29] The labor supply elasticity in sub-Saharan Africa is set to 0.1. With an increase in wages, labor supply increases by an average of 2.5 percent in sub-Saharan Africa. This increase in overall labor, along with reallocation from other sectors (mostly fossil mining), drives the increase in employment in the electricity generation sector.

emissions. Under these conditions, sub-Saharan Africa would receive approximately half of the total funding flows. Contributions from advanced economies would amount to about 0.1 percent of their GDP, while sub-Saharan Africa would collectively receive funds equivalent to about 1.6 percent of its GDP, which could be used for climate adaptation and mitigation. As an illustration, if half of the funds received by sub-Saharan Africa were primarily directed to green power generation, renewable electricity production would increase by up to 24 percent relative to a scenario excluding these financing flows, boosting annual GDP growth by an additional 0.8 percentage point, and contributing to an overall rise in labor demand within the electricity sector over the next decade.

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Annex 1. Further Results and Details of the Stylized Facts and Model Analysis

Annex Table 1.1. Key Model Parameters Calibration

Parameter	**Values**
Substitution between process emissions bundle and net-of-emissions output	Specific values per gas and sector; positive values for GHG emissions; zero for air pollutants
Substitution between intermediate demand and value-added bundles	• 0.2 for agricultural sectors • [0.4; 1.0] for manufacturing and services sectors • [0.1; 0.81] for energy sectors • Always 0 for old vintage technologies
Substitution between intermediate goods and services	• 0 for agricultural sectors • [0.1; 0.4] for manufacturing and services sectors • 0.2 for energy sectors
Substitution between capital and specific factor	• 0.2 for new and 0 for old vintage technologies
Elasticity between electricity and non-electricity energy bundle	• 0.125 for old vintages, 1 for new vintages in all nonenergy sectors • 0.025 for old vintages, 0.22 for new vintages in non-electric energy • 0.05 for all vintages in electricity
Elasticity between coal and non-coal bundle	• 0.0625 for old vintages • 0.55 for new vintages
Elasticity between energy inputs in liquids bundle	• 0.125 for old vintages • 1.1 for new vintages
Armington trade elasticity, domestic versus imports	Varies from 0.9 to 5 depending on the sector, identical across regions. GTAP data are used
Armington trade elasticity, import origins	Value equals from 0.9 to 10, generally twice higher than Armington trade elasticity for domestic versus imports

Source: IMF-ENV model.

Note: The elasticities are based on the assumptions in the IMF-ENV model. GHG = greenhouse gas; GTAP = Global Trade Analysis Project.

The model can be used for scenario analysis and quantitative policy assessments. For scenario analysis, the model projects an internally consistent set of trends for all economic, sectoral, trade-related, and environmental variables up to the year 2050. In this context, the model can be used to analyze the economic impacts of various drivers of structural changes like technological progress, increases in living standards, and changes in preferences and in production modes. A second use for the model is quantitative economic and environmental policy assessment for the coming decades, including scenarios of a transition to a low-carbon economy. In this case, the model assesses the costs and benefits of different sets of policy instruments for reaching given targets like GHG emission reductions. Annex Table 1.1 reports key parameters for the calibration.

Model Regions

There are two major approaches for dividing Africa into regions: one from the African Union[30] and the other from the United Nations.[31] While both approaches share the region names (Northern, Western, Central, Eastern, and Southern) and there is considerable overlap, there are a few differences. Angola, Burundi, Mauritania, Mozambique, Sudan, Zambia, and Zimbabwe are in different regions. In this note, we follow the UN geoscheme for Africa, because it is also used by GTAP, which is the main data source for country data in the IMF-ENV model. Annex Table 1.2 shows which model region and UN geoscheme region each country belongs to. For consistency, these country groupings are used also in other sections of the note.

Annex Table 1.2. Definition of Model Regions in Sub-Saharan Africa

Country	UN Geoscheme Region	Model Region
Nigeria	Western Africa	NGA
Benin	Western Africa	WAF
Burkina Faso	Western Africa	WAF
Côte d'Ivoire	Western Africa	WAF
Ghana	Western Africa	WAF
Guinea	Western Africa	WAF
Mali	Western Africa	WAF
Niger	Western Africa	WAF
Senegal	Western Africa	WAF
Togo	Western Africa	WAF
Cabo Verde	Western Africa	WAF
Gambia	Western Africa	WAF
Guinea-Bissau	Western Africa	WAF
Liberia	Western Africa	WAF
Mauritania	Western Africa	WAF
Sierra Leone	Western Africa	WAF
Democratic Republic of the Congo	Middle Africa	DRC
Angola	Middle Africa	MAF
Cameroon	Middle Africa	MAF
Central African Republic	Middle Africa	MAF
Chad	Middle Africa	MAF
Congo	Middle Africa	MAF
Equatorial Guinea	Middle Africa	MAF
Gabon	Middle Africa	MAF
Sao Tome and Principe	Middle Africa	MAF
Ethiopia	Eastern Africa	ETH
Kenya	Eastern Africa	KEN
Madagascar	Eastern Africa	EAF
Rwanda	Eastern Africa	EAF
Tanzania, United Republic of	Eastern Africa	EAF
Uganda	Eastern Africa	EAF
Burundi	Eastern Africa	EAF

[30] See https://au.int/en/member_states/countryprofiles2.
[31] See https://unstats.un.org/unsd/methodology/m49/.

Djibouti	Eastern Africa	EAF
Eritrea	Eastern Africa	EAF
Seychelles	Eastern Africa	EAF
Somalia	Eastern Africa	EAF
South Sudan	Eastern Africa	EAF
Comoros	Eastern Africa	EAF
Malawi	Eastern Africa	EAF
Mauritius	Eastern Africa	EAF
Mozambique	Eastern Africa	EAF
Zambia	Eastern Africa	EAF
Zimbabwe	Eastern Africa	EAF
South Africa	Southern Africa	ZAF
Botswana	Southern Africa	SAF
Eswatini	Southern Africa	SAF
Namibia	Southern Africa	SAF
Lesotho	Southern Africa	SAF

Source: IMF staff.

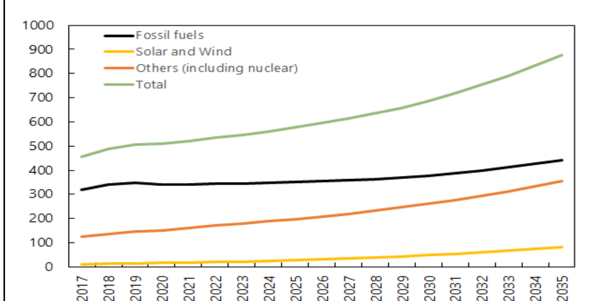
Note: Beyond sub-Saharan Africa, the G20 economies are represented individually while the rest of the world is aggregated into four model regions (Other Eurasia, Other Latin America, Other East Asia and New Zealand, Other Organization of the Petroleum Exporting Countries and Middle Eastern and North African countries).

Scenario Assumptions

Baseline: Carbon prices included in the baseline (based on the effective carbon rates database of the Organisation for Economic Co-operation and Development and the South African government's tax proposal) are:

- Kenya: Fuel excise taxes resulted in an effective carbon price of \$18.72/tCO2e in 2021 and this rate is held constant in the baseline.[32]
- South Africa: Carbon price starts in 2021 and is set to increase to \$30/tCO2 by 2030 (Qu et al. 2023).[33]

Annex Figure 1.3: Power generation for SSA in the IMF-ENV baseline scenario (in TWh)



For other sub-Saharan African countries and regions, emissions follow projections from the Climate Policy Assessment Tool CPAT until 2030 and are then driven by model dynamics until 2035. Macroeconomic trends between 2024 and 2029 are based on the IMF's World Economic Outlook 2024 database. The post-2029 GDP growth projections are based on shared socioeconomic pathways (SSP) database, which provides narrative pathways for future population and GDP. We use the SSP2 scenario, which is characterized as a scenario with intermediate challenges. Population growth is also taken from

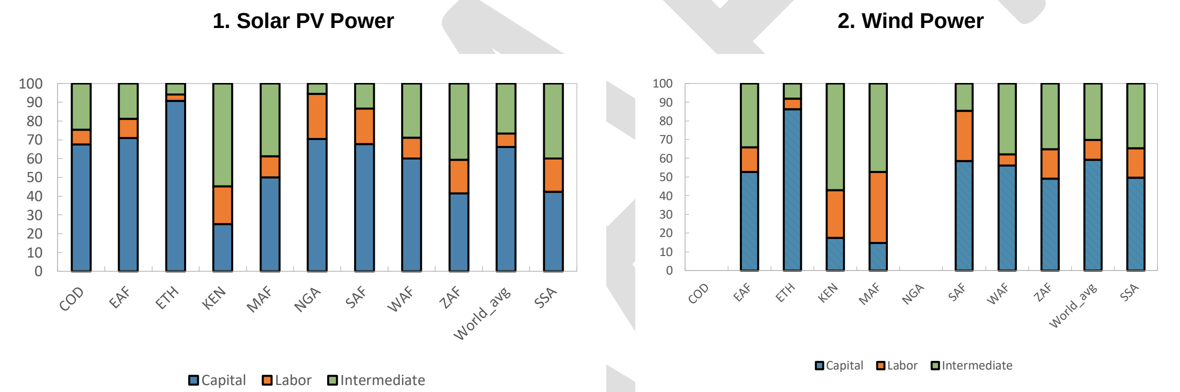
[32] Excise tax rates for specific commodities including energy commodities were introduced in Kenya through the Excise Duty Act of 2015 and are periodically revised. This effective tax rate assumption is based on the OECD effective carbon rates database for the year 2021 and is one element of the baseline scenario but should not be interpreted as a policy recommendation.

[33] Revenues collected in FY2021/22 showed that policy enforcement was low because of tax-free allowances and exemptions (see Qu 2023). The baseline assumes that, by 2030, policy enforcement would be improved; therefore, the effective tax rate would be the same as the official tax rate.

the SSP2. Electricity mix between 2017 and 2021 is calibrated using data from the IRENA (see Annex Figure 1.3), while GHG emissions are calibrated using data from the United Nation Framework Convention on Climate Change.

Scaling up renewable energy capacity requires significant investments because of its capital-intensive nature (Annex Figure 1.4). On a global scale, in 2017, capital expenses accounted for an average of 60 percent to 65 percent of the overall input costs for solar PV and wind technologies (from Global Trade Analysis Project (GTAP) Power V11 database, see Aguiar and others (2023)). The composition of intermediate costs largely includes electricity, services, and metal and mineral inputs, leading to regional variations in their cost share, influenced by the availability and pricing of each of these inputs. In many sub-Saharan African countries and regions, capital inputs represent over half of the total input costs for both solar PV and wind technologies, with some variability in cost structures. For instance, in Ethiopia's solar PV sector, capital costs are the predominant expense, whereas in Kenya intermediate inputs, primarily business services, and manufacturing make up more than half of the total costs. In South Africa, the costs of capital and intermediate inputs (mostly services) each contribute around 40 percent to the total. In the wind sector, intermediate costs are especially significant in Kenya and the Middle Africa region, with the largest cost share attributed to the business services sector.

Annex Figure 1.4. Cost Shares for Generation of Solar PV and Wind Sector (Percent)



Sources: IMF staff calculations using IMF-ENV and GTAP Power data V11.
Note: Intermediates include inputs like machinery and equipment, services, metals, electricity, and fossil fuels (for fossil power technologies). See Chepeliev (2023) for details on the cost share estimation techniques used in the GTAP Power database. Refer to Annex Table 1.2. for the regional abbreviations. Data labels in the figure use International Organization for Standardization (ISO) country codes. GTAP = Global Trade Analysis Project; PV = photovoltaic.

Green Investments: New sectoral investments in solar and wind sectors are targeted and annually increase by a total of half percent (denoted by μ) of the region's GDP, in addition to the baseline investments in the sector. If a region has only one of the two sectors, then the entire half percent of GDP investment is allocated to the sector, otherwise it is split equally between the two sectors. Thus, the shock in investments across sub-Saharan African economies is comparable.

$$kv_{\text{policy}}^{\text{new}}(r,a,t) = kv_{\text{Bau}}^{\text{new}}(r,a,t) + \mu * gdp(r,t)$$

All investments are assumed to be publicly financed (*rsg*). The key difference between the three simulations lies in the shares of domestic financing (rsg_{Bau}) and external financing (ext_inv) that is used to reach the targeted increase in investments, captured by parameter θ. External financing represents any type of investment flow that do not draw down from the domestic investment pool. The value of θ is set to 0 in *domestic* policy, 0.5 in *mix* policy, and 1 in *external* policy simulations, respectively.

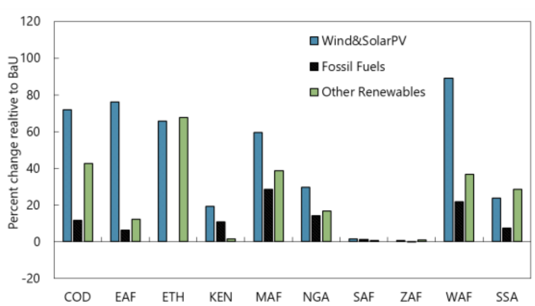
$$rsg_{\text{policy}}(r,t) = rsg_{\text{Bau}}(r,t) + \theta * \text{ext\_inv}(r,t)$$

Climate Finance: The Rajan rule is implemented as described in the proposal where transfer denotes the amount of contributions provided (negative value of transfers) or collected (positive value of transfers) by country r, GCI denotes the global carbon incentive, population is denoted by pop, and per capita emissions by emi_pc. GCI is calculated by dividing the targeted global climate finance goal, in this case 100 billion, by the transfers that would be realized in the reference scenario.

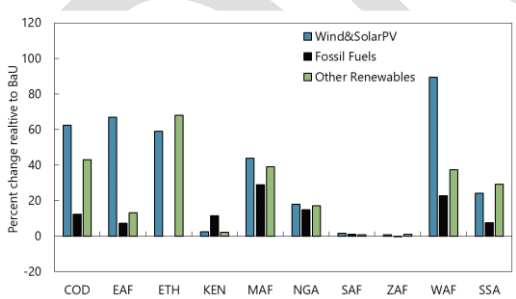
$$\text{Transfer}(r) = GCI * pop_{\text{domestic}}(r) * \left[emi_{pc(r)\text{baseline}}^{\text{global}} - emi_{pc(r)\text{baseline}}^{\text{domestic}} \right]$$

Additional results from IMF-ENV

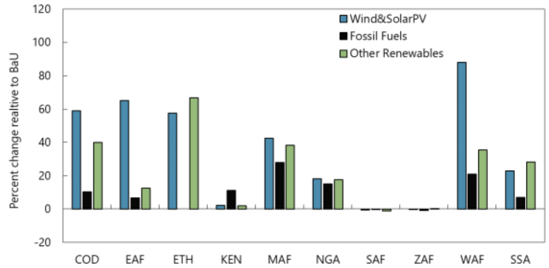
Annex Figure 1.5. Change in Total Electricity Supply in Sub-Saharan African Regions with Policies (Percent Change Relative to baseline)



2. T&D: Electricity Supply (2035)



3. Energy Efficiency: Electricity Supply (2035)



Source: IMF staff calculations using IMF-ENV model

Note: Refer to Annex Table 1.2. for the regional abbreviations. Data labels in the figure use International Organization for Standardization (ISO) country codes. T&D = transmission and distribution.

This sub-section presents the impact on electricity supply for all three investment scenarios using climate finance – *Solar and Wind, T&D* and *Energy Efficiency* (Annex Figure 1.5).

Scaling up renewables could lower electricity prices in many sub-Saharan African economies. Renewable generation is a capital-intensive activity in most sub-Saharan African economies (Annex Figure 1.4). Climate finance helps channel capital in the sector, which reduces its cost, but the scaling-up of production also causes an increase in the demand for labor and intermediate inputs, affecting their prices. Higher labor demand in the recipient countries increases wages. In addition, there is a mixed impact on prices of intermediate inputs, with prices in construction and services rising but those of energy-intensive inputs falling. The combination of these price movements ultimately determines the net effect on the change in electricity prices. Altogether, these would decline in DR Congo (13 percent), Ethiopia (20 percent), South Africa (4 percent), Western Africa (1 percent), Middle Africa (7 percent), and Southern Africa (5 percent),[34] while they would increase in other regions (with a range between 5 and 10 percent).

[34] Price declines may not occur in countries where electricity prices are artificially kept below production prices.