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Unlocking climate finance potential and policy barriers—A case of renewable energy and energy efficiency in Sub-Saharan Africa

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ABSTRACT

Sub-Saharan African is in a unique position to reap the socio-economic and environmental benefits of renewable resources, and the energy efficiency practices as the demand for energy in the continent grows. Assessment of the financing potential and the related obstacles for the financing deployment of renewable energy and energy efficiency sectors mapping will be a step forward to help in mobilizing the financial flows into sectors. With the Sub-Saharan Africa population growth, urbanization, economic growth coupled with the global commitment of Sustainable Energy for All Initiative, the need for accessible clean energy has never been more urgent. This paper aims to assess the renewable energy (RE) and energy-efficient (E.E.) investment potential as well as policy barriers in Sub-Saharan Africa (SSA). Analyzing five investment indicators, using secondary sources of information, and conducting interviews with key stakeholders. The RE and E.E. investment potential, investment gap, and policy barriers in 14 countries from West, Central, Southern, and East Africa was quantified conducted. The result of the study indicates a promising yet very susceptible future for the implementation of RE and E.E. in SSA. To enhance access to electricity, promote energy security, and propel economic growth in an environmentally friendly approach, SSA has to overcome the significant challenge of inadequate private and public funding for the energy sector. The conclusion is that there is a need to address the institutional knowledge gaps and policy gaps that will be key to helping in unlocking the financing potential of RE and E.E. in the continent of Africa.

1. Introduction

In the last two decades, Africa as a whole has posted a robust economic performance that is increasingly creating unprecedented energy demand. Ensuing efforts to power growth, create jobs, and alleviate poverty will quadruple primary energy consumption in Africa and double in Asia but grow marginally in Europe and North America by 2050 (Schiffer, 2008). Specifically, Africa's energy demand is approximated to increase by 85% between 2010 and 2040 (Pielli et al., 2016). Interestingly, scholars argue that most African countries' geographical position adds them an advantage in abundance in renewable sources of energy; solar, hydro, wind, geothermal, and biomass (Basaran et al., 2015; Hafner et al., 2018). Conclusively, renewable energy sources have a staggering role in matching the growing demand and meeting the current energy deficit through the electrification process.

According to World Bank (2019), access to energy is critically low to meet Africa's development and growth objectives. Notably, SSA has the lowest household electrification rate globally — at 43% in urban areas and lower still in rural areas, which stands at 25% (World Bank, 2019). In every ten people in Africa, only four have access to electricity, unlike the global scenario of nine (World Bank, 2018). Furthermore, SSA accounts for 57% electricity access deficit worldwide and has sixteen countries with the most significant energy deficit. World Bank (2019) observes that low electrification results in substantial constraints on economic activities, provision of public services, quality of life and impedes the adoption of new technologies in education, finance, and agriculture. Nearly 81% of the SSA population depend on traditional sources of energy such as wood and charcoal for cooking and heating that cause indoor air pollution, deforestation, and soil degradation (Chirambo, 2016). The latter is amidst the engulfing sustenance role Africa's renewable energy deposits can play in the economy and welfare of nearly 620 million people currently afflicted by energy poverty.

To bridge the energy gap and achieve a universal 100% access to electricity by 2030, Africa needs to intensify energy generation, supply, and consumption through sustainable pathways (Chirambo, 2016), a discourse blends with unexploited potential in energy efficiency and renewable energy sources. These pathways are untapped due to insufficient funding (Sweerts et al., 2019; Avila et al., 2017). Though public climate finance to developing countries is rising, it is predominantly publicly funded (OECD, 2019). There are insufficient

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finances for deploying renewable initiatives and projects (Chirambo, 2016; Fagbemi and Osinubi, 2020). This has culminated into a gapping financial deficiency that, according to ECA (2019); Chirambo (2016), can be filled by an additional investment by the private sector. Private funding into climate finance accounts for a mere 10% of the energy financing in Africa (ECA, 2019). To attract private sector interest, this study quantifies the RE and E.E. potential in SSA. In doing so, private investors will better understand emerging investment opportunities and identify the barriers that may restrict their investments. On the other hand, governments and policymakers will indicate the financing possibilities and the obstacles they will need to address to unlock and attract more financing got RE and E.E. in the continent.

In 2015, United Nations Secretary-General Ban Ki-moon launched the Sustainable Energy for All Initiative (SEforALL). A global initiative to accelerate action towards achieving Sustainable Development Goal 7, whose aim is to provide universal access to affordable and clean modern energy services by 2030 (UNEP, 2015). 'Modern' in the sense that they are clean – the least possible particulate and carbon emission – and seemingly efficient through the use of current technology. Adding the challenge of delivering development pledges to a fast-growing population, Africa will need to prioritize electricity access (Copenhagen Centre on Energy Efficiency, 2015). It may be tempted to pursue a strategy of providing energy access through the cheapest energy source available at the expense of the environment (Schwerhoff and Sy, 2017). Such an approach may disregard economic, health, and environmental disadvantages borne by the general population, as witnessed in the western world during the industrial revolution era. Solutions to circumvent the energy gap in Africa lie in two approaches; First is tapping into the potential of RE that adds energy to the national grid with the minimal amount of carbon dioxide emission and hence reducing the exposure to climate change. Secondly, it embarks on wide-scale E.E. practices that result in energy savings, cuts on energy costs, and reduces greenhouse gas emissions (GHG).

There is a need to mobilize financial resources to exploit renewable energy sources to adequate generation capacity and implement energy efficiency satisfactorily. Simultaneously, there is a need to resolve related financial and economic barriers that make the African energy sector lag behind other regions (Mukasa et al., 2015). It will be instrumental in attracting the private sector to make investments in these two sectors with a possibility for maximum return on investment and sustainable development. For instance, lack of policy reforms and poorly executed and implementation of reforms aimed at improving electrification have resulted in low traction in implementing RE and E.E. practices leading to doubts on whether the region would achieve the sustainable development goals agenda (Mohammed et al., 2013). Additionally, countries in East Africa have generally weak electricity utilities (European Investment Bank, 2018). Consequently, to promote innovative funding solutions by the private sector for the African energy landscape, this study explores the impending financial, policy, and institutional barriers.

This study's contribution to the extant literature is two-fold; Firstly, we add to the climate finance allocation literature. We take the investor's perspective by developing rough estimates, which focus on the spending side that, according to Steckel et al. (2016), has been scholarly deserted in favor of reflecting on the available options of raising additional finance existing capital flows. This is by identifying and quantifying the investment potential of both renewable energy and energy efficiency. Scholars, practitioners, and legislators alike, unanimously concede that finance is a crucial determinant in the global response to the prevailing crisis of climate change. However, the successful deployment of climate mitigation and adaptive measures is primarily pegged on the quantity and type of funding. Consequently, various organizations have made many efforts to track, monitor, and analyze different elements of climate finance. Yet, the picture of which country has the most investment potential and a specific area in SSA is mainly vague. Availing such data is fundamental in ensuring the precision of climate finance flows, its adequacy, and achieving the desired productivity.

There is barely any previous study that has attempted to quantify the E.E. and RE potential in SSA financially. Similarly, extant reports on the E.E. and RE give energy investment potential regarding electricity units in demand (IEA, 2019; UNEP, 2017). Besides, this is a response call by Lema et al. (2015), who recommended linkage information on low carbon innovation and development to stimulate interactions between components. Assumedly, the interacting elements in this study are the private investors and the green energy sector.

Secondly, the study attempts to fill in the information deficit regarding underlying obstacles to optimal exploitation of smart energy. This is by enhancing a better understanding of Africa's green energy sector regulatory context, both legal and political, and resulting economic implications. Overall, we seek to enhance the sufficiency, transparency, and productivity of climate finance by exploring the barriers that generally impede climate finance flows towards RE and E.E. The latter is aimed at informed decision-making by private investors, setting appropriate regulations and clear targets by the policymakers, and developing tailor-made financial products by the financial stakeholders to support the deployment of E.E. and RE programs.

Drawing on the study findings, among the top four countries with the highest financial investment potential for RE in USD are Ethiopia (76B), Congo (42B), Nigeria (39B), and Kenya (36B). Additionally, while Congo ranks top in E.E.'s financial investment potential at (3B), Senegal and Ghana come second with one billion. Much of the renewable energy potential was within hydroelectricity, solar, and wind sectors, while opportunities in E.E. were in residential lighting, heating, and commercial uses. RE investment potential has been derived by subtracting individual country's RE 2030 targets from NDC's from related technology costs. Similarly, E.E. investment potentials have been drawn from secondary sources, and in each approximation, the researchers sought third-party expertise. Further, the study observed barriers hindering the exploitation of RE and E.E. potential were primarily regulatory and macroeconomic risks. Sustainable energy schemes have not been adequately addressed or mitigated, resulting in costly finance, high taxation, and transaction costs. More so, subsidies for fossil fuels, monopoly structures in the energy sectors, and slow introduction of feed-in-tariffs were also major drawbacks in exploiting the green energy sector potential.

The rest of the paper is structured as follows: Section 2 presents both the theoretical and empirical review. Section 3 presents an account of the study methodology. Section 4 has been dedicated to results and discussion, while Section 5 offers the study conclusion remarks.

2. Literature review

This section is classified into two smaller sub-sections. First, the theoretical underpinnings concerning the unlocking of financial flow into RE and E.E. sectors are discussed. Second, the corresponding empirical evidence documented in the literature is summarized.

2.1. Theoretical review

In the last two decades, there has been a surge in cross-border capital flows. However, several countries are lacking adequate capital to finance domestic investment (Papaioannou, 2009). As expected, capital is not flowing to the developing countries postulated by the standard neoclassical model due to decreasing returns and frictionless markets predicting capital flowing to developing countries with higher marginal returns. Social, economic, technological, and regulatory risks impede the general flow of capital towards energy investment in Africa. Other related risks include moral hazard and lack of collateral (Gertler and Rogoff, 1990), a history of serial default (e.g., Reinhart and Rogoff, 2004), and informational frictions (e.g., Portes and Rey, 2005).

Unfortunately, the theoretical literature on climate finance has historically ignored the assessment of downstream investments in RE and E.E. rather than focusing mainly on investments in research and development (Popp et al., 2011; Sagar and van der Zwaan, 2006). The financing gap is expanding regarding downstream investment in RE and E.E., capital intensive and riskier (Zindler and Locklin, 2010; European Commission, 2013; Veugelers, 2012).

It is on this basis that this study will contribute to the knowledge on how to unlock climate financing from the private and public sectors, exclusively the RE and E.E. domains. Thus, there is a need to develop a way to identify high-return, low-risk investments. Notably, the Modern portfolio theory (MPT) – initially known as Markowitz's theory – has found wide application in investment decisions. Harry Markowitz conceptualized the idea in the influential "Portfolio Selection" paper in 1952 (Omisore, 2012). It postulates that investors are risk-averse and should therefore create an investment portfolio to maximize returns. Fundamentally, the theory urges asset diversification to minimize investment risks. As an extension, the investment attraction into RE and E.E. is contingent upon quantification – manifested in the form of financial potential and identification – of the specific portfolio areas of focus.

Unfortunately, MTP theory is mainly focused on risks and returns related to capital markets but has been extrapolated to the general financial industry. MTP theory has been criticized for adopting simple assumptions and technical challenges in optimizing the model. Nonetheless, this paper's presentation can be construed as an attempt to aggregate basic knowledge that is a prerequisite in understanding SSA renewable energy and energy efficiency finance market. It is worthwhile to note, adequate evaluation of returns and risks in the RE and E.E. sector in SSA requires in-depth mathematical modeling.

2.2. Empirical review

According to a Joint Research Center (2011) report, energy-related information in Africa is insufficient relative to the rest of the world, with particular conspicuousness of renewable energies. The underlying assumption is that presenting the geography of information – on the renewable energy and energy efficiency investment potential – will help resolve the allocation puzzle. Unrevealing the investment potential indirectly presents the energy market size that, according to Portes and Rey (2005), is among the major determinants of cross-border transactions.

The first potential is the diverse continental endowment in renewables such as hydro, solar, and wind. SSA technical solar power potential is approximated at about 10,000 GW, 350 GW for hydroelectricity, and a natural gas capacity of 400 GW, totaling approximately 11,000 GW (Avila et al., 2017). Szabó et al. (2013) contend that exploiting existing RE potential in Africa would exceed Africa's energy demands. Courting Africa's electricity gap with renewable sources will offer economic and environmental trade-offs that match SSA's co-existence of challenges and opportunities. Energy from renewable sources is potent in reducing emissions that contribute to climate change.

Nonetheless, installations for RE in Africa remain significantly low at 2% compared to the total global UNEP (2017), mainly due to inadequate public funding (Gamula et al., 2013). As a solution to enhancing RE sector development, the private sector needs a more active role, which brings additional finances that reduce the large financing gap, better management, and technical capacity. To enable adequate funding opportunities and facilitate dependable costing methods by the financial institutions that hinder private investment in the RE sector, there is a need to create awareness of the potential of renewables.

The other potential lies with closing the energy deficit is by implementing energy efficiency technologies. Although Sub-Saharan Africa has adequate renewable resources to meet future energy demands at even unprecedented demands, the current consumption patterns are highly inefficient. Energy utilization is sub-optimal even in industrial applications that are the biggest consumers. Inefficient energy use increases the cost of energy supply, that of goods and services, and has detrimental effects on the environment. Adoption of E.E. increases the energy access levels, saves on production and distribution costs and averts the need for energy importation (Baležentis et al., 2011). Likewise, the concept of decreased energy consumption as a result of E.E. leading to a decrease in the levels of GHG emission is vital in closing the energy deficit in SSA. Investments in industrial, public usage, and domestic E.E. increases energy availability and reduces the cost of energy bills resulting in economic competitiveness, energy security, and environmental sustainability. According to UNEP (2017) estimates, implementing E.E. policies would save about 16.7% (0.139 GW) on energy consumption and 16.6% (0.634 GW) of energy generated in Africa. However, as Lee (2014) noted, energy measures are not being implemented due to market, financial, institutional regulations, technical, information, and awareness factors that act as barriers, creating the efficiency debate gap. The present study quantifies the E.E. financial potential to spur investment interest to overcome the information and awareness barrier.

It is prudent to admit that renewable energy and energy efficiency alone cannot solve SSA's energy shortcomings. In addition to the economic fundamentals of the investment potential and opportunities, institutions also determine international capital flow (Alfaro et al., 2005). Institutional under-development (political risk) is a crucial explanatory factor in the lack of foreign financing in developing and underdeveloped countries. Policies – rules, laws, and the constitution – affects the structure of the economy and that of investments in three ways (i) costs and revenue allocation, (ii) risks allocation (iii) the choice of business practices and technology (Alfaro et al., 2005). Investors will generally opt for countries with effective policies that lead to productive capacities, unlike those with weak policies. Given the strong effect of institutions on productivity (Acemoglu et al. 2005, for a review), this paper's results can be viewed as revealing a specific mechanism on how property rights and contractual institutions affect economic development. It makes sense to contend that studying the policy corpus is complementary to studying the investment potential because policies reveal the nature of the market frictions encountered by the investors, mostly country-specific.

Most studies have aggregated data to examine the impact of innovation policies by the government aimed at upstream innovation on private RE and E.E. deployment (Haščič et al., 2015; Popp et al., 2011) and private downstream activities (Eyraud et al., 2013). The studies found that policies mobilize private finance (Polzin et al., 2015) with specific policies more conducive to investment in RE and E.E. than others (Veugelers, 2012). According to Alfaro et al. (2005), institutional quality — government size, political stability, and openness is among the determinants of capital flows that have shaped their disbursement in the past thirty years. Contrary to expectations, some policies in SSA countries depress the use and investment into RE and E.E., gravely affecting the investment efforts of private and foreign investors (Nygaard and Bolwig, 2018). Private sector investment in RE in the SSA Countries has been curtailed by the absence of well-defined policies on private investment coupled with delays in the authorization of private sector projects (Kariuki, 2018).

Individual countries in the SSA region have embraced sustainable energy agenda, but there are essential policy gaps across all the SSA countries which highlight opportunities for rapid progress (World Bank, 2019). Lack of regulatory framework coupled with a lack of clear policies in most countries in the SSA region impose barriers to E.E. implementation. The guidelines in place are outdated and irrelevant in the ever-changing energy environment (UNEP, 2015). Nevertheless, there are renewable energy targets that exist in 40 countries. Also, many countries in the SSA region have initiated regulatory policies which support grid-connected renewables via feed-in tariffs, auctions, net metering, and investment incentives (Qiutzow et al. 2016). Notably, a remarkable number of SSA countries have adopted policies

Fig. 1. Regions in Sub-Saharan Africa.
Source: https://unstats.un.org/unsd/methodology/m49/

for decentralized approaches to boost rural electrification based on renewable energy. They have also established regional power pools and renewable energy transmission corridors, which is a step forward for future expansion of renewable energy (Quitzow et al., 2016).

3. Methodology and data description

To build a comprehensive picture of the climate investment potential, this study used journals, review, print, and online materials that have been previously referenced in reliable journals. Further, these materials have been authoritatively reporting on the past and present trends of climate finance in Sub-Saharan countries. Careful evaluation of these sources shows rich but segmented data on renewable energy and energy efficiency investment potential in a wide range of sources. Therefore, we conducted a deep-dive review of all the available data to show this potential and further delved into related obstacles to its exploitation with full acquittance of the different types of definitions and underlying gaps in data. While this study's baseline year is 2017, there is a difference in the timeframes of the source documents.

3.1. The rationale for countries selection

With due consideration that Sub-Saharan Africa consists of four geographical regions – Western, Central/Middle, Eastern, and Southern Africa – with forty-nine countries (Fig. 1), it was inherent to narrow down to a suitable sample size. This was premised on five key indicators that are related to climate change and influence the investment potential.

The first indicator was *Foreign direct investment* (FDI), which presents an important factor in promoting recipient countries' economic development and environmental sustainability. It also constitutes a substantial proportion of climate finance through the deployment of clean technologies. Further, the study incorporated the *Global Climate Risk Index*, which indicates a country's vulnerability and exposure to extreme weather conditions, by quantifying the events (Germanwatch, 2020). The latter is in terms of fatalities and economic loss. As a consequence of growing climate risk awareness, so is the investors' capital deployment. Therefore, it is a crucial pointer in determining the association between a country's level of vulnerability and climate finance potential.

Further, the research factored in *the Climate Finance Requirement,* which are funds drawn from either the private, public or other sources to support climate change adaptation and mitigation efforts. The financing may be from the local, national, or transnational sources, whose aggregate presents the investment needed to enhance climate technologies such as renewable energy. The data on climate finance requirements were sourced by reviewing the Nationally Determined Contributions of individual country mitigation and adaptation activities. In addition, the study included the *Ease of Doing Business-* a measure of the economy's performance to regulatory practices based on the aggregate score of ten topics (World Bank, 2020). Consequently, a country with high ease of doing business has a conducive regulatory environment that determines climate investment potential. *Gross Domestic Product Growth Rate* measures how fast an economy is growing and is a determinant of investment. A country's actual GDP was used to determine its' climate investment demand.

Data on the five indicators were sourced from reliable sources, including reports by the World Bank, International Finance Corporation (IFC), NDC's, and German Watch for the Climate Risk Index Score. The study ranked all SSA countries from the highest to lowest based on their GDP, FDI, and climate finance requirement and from lowest to highest on the climate risk score and ease of doing business. Consequently, 14 countries – 30% representation – were identified for further analysis; two from Central Africa, four from East, Southern, and West Africa.

Table 1
Sample selection from the four regions in Sub-Saharan Africa.

Areas in sub-Saharan Africa	Countries as per each region	Study sample from each region
Central Africa	7	2
East Africa	13	4
South Africa	14	4
West Africa	15	4

Since these factors can significantly affect the financial estimates, their consideration demonstrates the sensitivity of the results to the general approximation of climate finance needs. Table 1 gives a tabular impression of the sample selection, while Table 2 outlines the ranking of the selected countries based on the five earmarked vital indicators.

3.2. The rationale for approximating climate investment potential

After identifying fourteen priority countries, comprehensive desk research was done on climate change scenarios, climate vulnerabilities, policies, and national priorities related to climate change with a particular focus on renewable energy and energy efficiency. The assessment of the total requirement of financing in renewable energy as well energy efficiency sectors was based on qualitative as well as the quantitative approaches arrived at through techniques such as cost-saving and payback period (Ryan et al., 2012; Jachnik et al., 2015).

To ascertain the RE investment potential, respective country 2030 RE targets were subtracted from RE technology costs. Information on the 2030 RE target was sourced from key documents which included National Climate Change Action, Action Agenda of SE4ALL, Nationally Determined Contributions, and National Renewable Energy Action Plan. Similarly, RE technology costs were sourced from documents such as Planning Prospects for Renewable Energy, Africa Power Sector, IRENA (2017, 2020), and AFDB-Roadmap to the new deal of Energy in Africa. It is also important to note that, where the RE target data was missing, it was directly uplifted from the AFDB report *"Roadmap to new deal of Energy in Africa"*. To determine the E.E. investment potential, comprehensive desktop research was conducted on the aforementioned documents. Also, third-party expertise was sought in determining the RE technology costs and corroborating the E.E. investment potential.

4. Results and discussions

Researchers agree that access to energy is linked to sustainable development, this study sought to serve as an initial estimate of climate investment potential with 2017 as a base year. While this study does not delve into complex analysis, MTP anchors its' motivation to financially quantify the investment potential and present a positively related investment portfolio. This is with a broader effort to narrow the information gap, inform policy and decisions about climate investments. Specifically, in RE and E.E. initiatives and projects. Besides, the study brings on board the various challenges/barriers to accessing climate finance in the SSA countries. Analysis of priority countries yields useful insights on areas with vast investment potential in SSA that could be exploited to bridge the energy gap, meet development energy requirements for SSA and enable the attainment of her sustainable development objectives (Chirambo, 2016; Schiffer, 2008; UNEP, 2017; Mohammed et al., 2013).

To engage investors especially from the local private sector in initiatives and projects to produce RE and enhance E.E., there is a need to first create awareness on the underlying potential in RE and E.E. in Africa. Table 1 below presents the quantified investment potential for RE and E.E. for 14 countries in SSA. Ethiopia has the greatest investment potential for RE finance at USD 76.2 billion. It is followed by Congo, Nigeria, Kenya, and South Africa at USD 42.9, 39.3, 37.0, and 20.3 billion respectively. Mozambique, Madagascar, Tanzania, and Cameroon are above USD 10 billion but below USD 20 billion in terms of their RE finance investment potential whereas Ivory Coast, Ghana, Rwanda, Senegal, and Zambia are below the USD 10 billion marks. About E.E. finance potential, Congo is the highest at USD 3.6 billion, Ghana and Zambia are above the USD 1 billion marks while the rest of the countries are below the USD 1 billion marks (see Table 3).

In terms of RE financing potential, the maximum RE investment potential is in grid-connected RE, followed by the mini-grid and off the grid. The study ranked countries according to the level of RE and E.E. investment potential. The top 3 countries having the highest investment potential in the grid-connected category are Ethiopia, the Democratic Republic of Congo, and Nigeria as shown in Table 2.

According to the annual African Investment Index evaluated by Quantum Global (2018) to rank African countries based on Economic growth, Liquidity, Business environment, Risk, Demography, and Social capital, among the countries most common in the rankings above, Kenya, South Africa, and Ethiopia appear in Top 10 rankings in African Investment Index as shown in Table 2. Hence for starters, private players could focus on Kenya, South Africa, and Ethiopia on climate-smart sectors, in this case specifically RE and E.E.

Sources of climate finance are varied and include multilateral and bilateral, public and private. Climate funds are provided by NGOs such as the Overseas Development Institute (ODI), international organizations like the Organization for Economic Cooperation and Development (OECD), and private sector sources including tech companies like Tesla, Apple, Amazon, Microsoft, as well as NGOs such as the ODI (Cho, 2016; Buchner et al., 2013). According to a report by the Climate Policy Initiative, CPI (2019) public climate finance has been rising through the years, though funds from private players have remained a larger percentage of total climate financing.

The Green Climate Fund (GCF) stood as the biggest cumulative multilateral climate fund active in SSA, trailed by the Least Developed Countries Fund (LDCF) and the World Bank administered Clean Technology Fund (CTF). In 2019, data provided by the Climate Funds Update (an independent website that tracks multilateral climate finance initiatives) reported that USD 4.5 billion had been approved for 665 projects and programs throughout SSA since 2003 (Watson and Schalatek, 2019).

Next, the study estimated the climate finance trends for investment in clean energy. The study assessed the clean energy investment scenario (last ten-year investment trends in RE) for the focus countries. The top 5 countries with the greatest clean energy-related investment value for the last 10 years are South Africa, Kenya, Ethiopia, Nigeria, and Senegal. South Africa has had the highest investments in clean energy from 2007 to 2017 to the tune of 1.5 billion USD. The difference between South Africa and Kenya is significant and so is the difference between Kenya and Ethiopia and between Ethiopia and the last two top 5 countries Nigeria and Senegal, each at about 50 million USD. To be able to arrive at the financing gap, the study used the difference between the relative climate investment required and the level of access to finance in a given country (Fankhauser et al., 2016).

The study established that there is a 91% gap in RE funding which limits the capacity of SSA Countries in realizing their huge Finance potential in RE. International experience shows that around 15%–20% of Climate finance requirements can be fulfilled by Development Banks, Bilateral and Multi-lateral funds whereas the greatest portion of investment or fund flows will be provided by local government, financial institutions, local commercial banks, and private investors (Junghans and Dorsch, 2015). This has been the trend in developing countries like China, India which are quite successful in the RE sector. Financial and policy-related barriers are the most identified barriers by stakeholders for upscaling investments in climate-smart sectors like RE and E.E. Promoting blended finance, establishing dedicated local climate funds and risk guarantee funds, fiscal incentives, developing investor-friendly policies and such initiatives could help stimulate investment flows in climate-smart sectors for cities and countries. Soon, SSA will be the

Table 2
Countries ranked as per key parameters/indicators.

Region\Parameter	GDP (in US$ Billions)	FDI inflow (in US$ Million)	Climate risk score	Climate finance requirement	Ease of doing business	GDP growth rate (%)
Central Africa	1) DR Congo 2) Cameroon 3) Gabon	1) Gabon 2) DR Congo	1) DR Congo 2) Cameroon	1) DR Congo 2) Chad	1) Gabon 2) Cameroon 3) DR Congo	1) The Central African Republic 2) DR Congo 3) Cameroon
East Africa	1) Sudan 2) Ethiopia 3) Kenya 4) Tanzania	1) Ethiopia 2) Tanzania 3) Sudan 4) Uganda	1) Somalia 2) Kenya 3) Ethiopia 4) Sudan	1) Ethiopia 2) Tanzania 3) Kenya 4) Rwanda	1) Rwanda 2) Kenya 3) Seychelles 4) Uganda	1) Ethiopia 2) Tanzania 3) Rwanda 4) Seychelles
Southern Africa	1) South Africa 2) Angola 3) Zambia 4) Zimbabwe	1) Mozambique 2) South Africa 3) Zambia 4) Namibia	1) Madagascar 2) South Africa 3) Mozambique 4) Malawi	1) South Africa 2) Zambia 3) Madagascar 4) Namibia	1) Mauritius 2) Botswana 3) South Africa 4) Zambia	1) Zimbabwe 2) Madagascar 3) Malawi 4) Sao Tome and Principe
West Africa	1) Nigeria 2) Ghana 3) Ivory coast 4) Senegal 5) Mali	1) Nigeria 2) Ghana 3) Ivory coast 4) Guinea 5) Sierra Leone	1) Sierra Leone 2) Niger 3) Nigeria 4) Ivory Coast 5) Ghana	1) Nigeria 2) Mali 3) Ghana 4) Senegal 5) Ivory coast	1) Ghana 2) Cape Verde 3) Mali 4) Ivory Coast 5) Senegal	1) Guinea 2) Ghana 3) Ivory Coast 4) Senegal 5) Burkina Faso

Table 3
RE & E.E. finance investment potential.

Country	RE finance potential (USD millions)	E.E. finance potential (USD millions)
Ethiopia	76,157	54
Congo	42,919	3,577
Nigeria	39,319	641
Kenya	36,961	165
South Africa	20,370	908
Mozambique	16,077	25
Madagascar	13,110	960
Tanzania	11,968	273
Cameroon	10,024	330
Ivory Coast	7,280	NA
Ghana	3,323	1,008
Rwanda	1,349	318
Senegal	1,314	1,031
Zambia	1,094	NA
Total	**281,265**	**9,290**

Table 4
Top five countries according to investment potential in Renewable Energy and Energy Efficiency.

Renewable energy	Energy efficiency
Ethiopia	Congo
Congo	Senegal
Nigeria	Ghana
Kenya	Madagascar
South Africa	South Africa

next destination for climate-smart sectors, an opportunity that private players can tap if proper policies and incentives are put in place.

There is immense potential for private sector investments in RE and E.E. throughout SSA as detailed in Table 4. As detailed below, SSA presents investors with numerous opportunities concerning renewables, specifically in wind, solar, hydroelectricity, and geothermal energy. At the same time, opportunities exist to enhance energy efficiency through incentives and installations in residential, commercial, and industrial premises in the region. These opportunities cannot be explored nor exploited without the cooperation and coordination of all stakeholders involved. Building bankable projects and securing financing for the benefit of the SSA population will require the transparent involvement of government, government agencies, and the private sector and the existence of appropriate policies to ensure an enabling environment. Table 4 shows the potential implementation measures in RE and E.E. that the private sector could explore for investment in the countries shortlisted for the study (see Table 5):

The study identified the barriers and challenges to investment in RE and E.E. in the SSA region. Broadly, they can be classified as financial, policy and regulatory, governance, and institutional barriers. Regarding the financial obstacles, the private sector encounters challenges to access climate finance and carry out climate-smart projects to mitigate climate change. Consequently, though SSA is home to 14% of the world's population, only 3% of global climate finance flows into the continent (AFDB, 2018).

Policies and regulatory measures on climate change are non-existent, and in cases where they exist, they are ill-executed or not implemented at all. It was also evident that governments and organizations still approach climate mitigation from a silo perspective, regarding climate change as an environmental rather than a development issue, hence failing to attract multi-functional solutions and funding. In terms of the national budgets, there is very little climate funding, if at all. However, there are subsidies for fossil fuels that make green energy uncompetitive. There were clear indications that governments and government agencies in SSA have limited capacity and often do not comply with procedures, requirements, and standards of funding sources.

Additionally, they are unable to absorb funding through bureaucratic processes or even develop 'bankable projects.' That is, they struggle to put in place mechanisms and systems to enhance their climate finance readiness. Unfortunately, there is a lack of awareness of the various sources of climate finance and limited stakeholder engagement, including the private sector. The study noted macroeconomic and regulatory risks, high taxation and transaction costs, monopoly structures in the energy sectors, and the slow introduction of feed-in-tariffs. The study findings coincide with Hafner et al. (2018) reported that SSA lags in renewable policy based on the World Bank Regulatory Indicators for Sustainable Energy (RISE) tool.

In SSA, renewables and energy efficiency opportunities are as immense as are diversified, and there is no such thing as a one-size-fits-all policy approach. In consensus is that a kind of framework is an inherent precursor for renewable and energy efficiency development. Government and institutional barriers – policies and regulations – governing electricity vary throughout SSA, determining the success or failure of RE and E.E. deployment. For some countries, production and transmission are separate, and independent power producers are allowed to conduct business, while for countries, state-owned monopolies produce, transmit and distribute electricity (Kessides, 2012). According to Kojima and Trimble (2016), the major obstacle to electricity access in SSA and Africa as a whole is the financial capability of utilities to satisfy

Table 5
Implementation areas for Renewable Energy and Energy Efficiency with the maximum potential for investment by the private sector.

Country	Renewable energy	Energy efficiency
Cameroon	NA	NA
Cote D'Ivoire (Ivory Coast)	Technology: • Hydroelectricity: 1.592 GW • Bioenergy: 0.485 GW	NA
Democratic Republic of Congo	NA	NA
Ethiopia	Technology: • Hydroelectricity 16.864 GW • Geothermal: 2.094 GW	• Moving to efficient lighting in residential, commercial, and industrial premises • Switching to efficient motors in industrial and irrigation machinery
Ghana	Technology: • Solar P.V.: 1.112 GW • Wind Energy: 0.065 GW	• Lighting • Transportation • Industrial Machinery
Kenya	Technology: • Hydroelectricity: 3. G.W. • Geothermal: 5.45 GW	• Variable Speed Drivers • Compressed air instruments
Madagascar	Renewables are expected to take up 85% share in electricity generation by 2030	Plan under development
Mozambique	Technology: • Wind: 0.15 GW • Large Hydro: 0.1 GW • Small Hydro: 0.1 GW • Solar: 0.03 GW • Biomass: 0.03 GW	• Distribution of CFLs
Rwanda	Technology: • Solar Energy: 0.337 GW	• Upgrading to efficient lighting in residential, commercial, and industrial premises
Nigeria	Technology: • Solar P.V.- 18 G.W. • Hydroelectricity- 5.9 GW	• Installation of energy-efficient lighting bulbs e.g., LED • Incentives to spread the use of improved kerosene cookers amongst households • Implementation of energy-efficient electrical appliances in the residential premises • Upgrading to efficient motors in the industry
Senegal	Technology: • Solar P.V.: 0.257 GW • Hydroelectricity: 0.225 GW	• Moving to energy-efficient lighting in residential, commercial, and industrial premises
South Africa	Technology: • Solar P.V.: 8.400 GW • Wind Power: 8.4 GW • CSP: 1 G.W.	• Residential premises • Transport Sector • Industry and Mining sectors • Commercial and Public Sectors • Agricultural Sector
Tanzania	Technology: • Hydroelectricity (2.95 GW) • Solar P.V. (0.12 GW) • Wind energy (0.1 GW)	• Refrigerator Recycling and Replacement • Residential Lighting • Energy Solutions for Commercial premises • Commercial Refrigerated Vending • Commercial Direct Load Control • Energy Solutions for Industrial
Zambia	0.2 GW increase in renewable energy capacity by 2020	• Promoting the use of LED and CFL bulbs • Adoption of more energy-efficient technologies in smelting.

supply and the capability of households to pay. Numerous reforms on policies and regulations in the electricity supply industry have been implemented especially on prices, in a bid to ensure supply and demand converge at a price that satisfies producers and consumers as in a well-functioning market. According to Moussa & Cosgrove-Davies, for starters, policies and regulations and governments and institutions need to evolve to the point where more private investment and more public–private partnerships are attracted to investments in infrastructure for E.E. and E.E. in Africa.

5. Conclusion

Drawing on MTP and against a broader background of climate finance, this paper quantified the climate investment potential in renewable energy and energy efficiency in select SSA countries. From the review, it emerges there is vast climate finance investment potential for the private sector in SSA, particularly with the deployment of RE and E.E. technologies. As such, countries need to treat climate change as a development issue that needs to be addressed systematically in their respective development strategies and policies. An approach that is envisioned to translate into low carbon development as well as promoting resource use efficiency and increase private investments.

Improved policy and regulatory environment are paramount in scaling up public funding and attracting private sector climate-resilient investments. Besides, there is a general urgency for regional, cross-border and multi-country cooperation between SSA countries on climate change-related issues in a more harmonized and integrated manner to curb policy barriers. Of essence to note is the call for the government to initiate proper mechanisms for channeling climate finance to local actors, thereby reaching a more significant population which will ensure better climate impact and poverty reduction benefits.

Given that the private sector has a primary objective of economic profitability of any investment project, the government must develop guidelines and fiscal frameworks that lead towards long-term societal benefits with monetary value. Consequently, it is significant for the government to create substantial synergies with the private sector to close the climate finance gap necessary for sustainable development (Chirambo, 2016; Duvenage et al., 2011). SSA countries could alleviate the funding gap and enhance their climate mitigation activities by collaborating with the private sector through public–private partnerships, providing affordable capital, incentives, subsidies, scaling up well-performing private sector investments, correcting market failures (for instance by delivering costly infrastructure). In doing so these countries will be creating an enabling environment for improving peoples' living standards and adapting to climate change at the same time.

This study is not without limitations that need to be acknowledged. First, this study considered five key indicators that influence climate change which enabled the individual selection of the fourteen countries. We would prod future studies to statistically examine how each of the five indicators affects the climate investment potential and the flow of climate finance. Second, the argument that facilitating private action in the deployment of RE and E.E. projects and initiatives will result in improved energy access and livelihoods may be inconclusive. The public sector is aimed at maximizing social welfare and protection of environmental impact whereas the private sector interest is financial returns. Therefore, there is a need for a study to consider the effectiveness of private sector investments in RE and E.E. and how this will lead to the social and economic transformations as well as sound protection of the environment. Lastly, there are several climate investment potential estimation methods with a variety of assumptions. As a result, these estimates are expected to change as technology costs and other influencing factors are integrated.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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