

Critical Review of the Challenges of Financing Renewable Energy Development in Sub-Saharan Africa

Sam Wamuziri

College of Engineering, University of Buraimi

Abstract

There is an acute shortage of electricity supply in Sub-Saharan Africa (SSA), and electricity blackouts are a common occurrence. Climate change and carbon dioxide gas emissions from conventional power-generating systems are also of great concern. Africa has vast renewable energy resources, including hydropower, solar, wind, biomass and geothermal, which are relatively unexploited. Based on a literature review, this study aims to identify the factors that hinder investment in renewable energy development in SSA. The review finds that barriers to renewable energy development include fragmented electricity markets, utilities with poor balance sheets and low credit ratings, high energy transmission losses, political risks, high initial capital costs, poorly directed subsidies, insufficiently developed money markets, and a poor regulatory framework. The study also finds that the global utility-scale levelized costs of electricity from renewable energy resources compare favourably with that of conventional sources. Countries in SSA need to draw up a clear policy framework with legally binding targets for the contribution of renewable energy to the energy supply portfolio. In addition, subsidies currently enjoyed by conventional energy generators need to be restructured to target low-income groups. SSA countries should identify pipelines of suitable renewable energy projects, complete feasibility studies and invite potential developers. Risks faced by international investors in renewable energy projects, including political, commercial and financial risks, are insurable. An important consequence of this work is that it is possible to accelerate innovative financing solutions to ramp up investment to deliver energy for all.

Keywords: Finance, Renewable Energy Development, Risk Management

1. Introduction

The United Nations Paris Agreement seeks to limit global warming to well below 2 degrees Celsius compared to pre-industrial levels. Achieving this goal requires all countries to take action to reduce greenhouse gas emissions (GHG). In Sub-Saharan Africa (SSA), there is also emphasis on climate-related capacity building to enable these countries to address these challenges. Since the Paris Agreement came into force, there is now a whole range of low-carbon technology solutions and new markets, particularly in the energy and transportation sectors. Zero-carbon solutions are now competitive with traditional technologies in many sectors. Renewable energy technologies have reached sufficient maturity and constitute sound investment opportunities that provide nations with the opportunity to reduce global warming. Africa's contribution to greenhouse gases on a per capita basis is much smaller than that of developed countries. However, African countries are more likely to be disproportionately affected by the impacts of climate change (Agyekum et al., 2021). The United Nations Sustainable Development Goal 7 calls for universal access to modern energy services for all by 2030.

Furthermore, Agenda 2063 of the African Union seeks to create a prosperous Africa with renewable energy development as one of the priority areas (African

Union, 2015). At present, 789 million people in the world do not have access to electricity. Of these 648 million (or 69%) live in Sub-Saharan Africa. Over 900 million people in Sub-Saharan Africa do not have access to clean cooking (Irerri and Shirley, 2021). Most families rely on biomass in the form of charcoal for cooking. This leads to land degradation, indoor pollution and respiratory diseases. Forty per cent of the population in Sub-Saharan Africa lives on less than USD 1.90 per day, which approximates to 433 million people. Excluding South Africa, the energy consumption per capita in Africa is 180 kWh annually compared to 6,500 kWh in the EU and 11,500 kWh in the USA. It is estimated that Africa needs a capital investment of USD 100 billion annually until 2040 (KfW Development Bank, 2020) in the energy sector. Africa has seen low levels of investment in the energy sector compared to other parts of the world because of the higher levels of risks perceived by international investors (Bashir et al, 2024). Meeting this financing challenge requires contributions from all possible sources. This paper provides an overview of the renewable energy resources in Sub-Saharan Africa. It outlines the barriers and challenges of financing renewable energy expansion in Sub-Saharan Africa, followed by a policy framework that can help to de-risk renewable energy projects and scale up investment.

¹ Corresponding Author

Email address: sam@uob.edu.om

2. Research Method

The overall aim of the study is to identify the factors that hinder public and private sector investment in renewable energy development in SSA. Furthermore, the study aims to develop effective intervention strategies to improve energy access. The study seeks to highlight the options available for countries in SSA to improve the investment climate to attract investment into renewable energy projects. Six research questions, namely, guide the study:

1. What is the overall economic case for renewable energy in the context of SSA?
2. What are the current attitudes of the multitude of actors in SSA, including policy makers, homeowners, industry, market operators and investors, towards renewable energy development?
3. What are the biggest challenges to scaling up renewable energy investment in SSA?
4. What are the most challenging risks and uncertainties faced by investors and developers for renewable energy investments?
5. What lessons can we draw from countries that have successfully upscaled investment in solar energy?
6. What package of policies and incentives could make a significant impact and breakthrough to stimulate widespread adoption and investment in renewable energy in SSA?

This paper reports preliminary findings from the literature. A systematic review was undertaken starting with the identification of peer-reviewed journals and conference papers, books, theses, dissertations and academic reports. The literature was identified through electronic search engines, including Google Scholar, Scopus, Science Direct, and ProQuest. The search terms used were finance, Sub-Saharan Africa, and renewable energy. The search terms were combined with the terms challenges, barriers, and potential solutions to narrow down and identify relevant academic literature. Non-academic literature, such as social media reports, newspaper articles, and unpublished reports, was excluded from the study. Other non-scholarly literature, such as blogs, wikis, tweets or other social media content, was excluded.

3. Renewable Energy Resources in Africa

Africa has vast renewable energy resources that remain untapped. This includes solar, geothermal, hydropower, biomass, and wind. The share of renewable energy in power generation in Sub-Saharan Africa was 29% in 2019. This is comprised of 24% hydropower and 5% other renewable energy sources (IRENA and AfDB, 2022). Therefore, the role played by non-hydro renewable energy resources in electricity supply in Africa has been at best marginal.

3.1. Solar Energy

Africa, as a region, has excellent solar energy potential. It is estimated that many parts of Africa receive a daily solar radiation of 4-6 kWh/m². Solar power can also be deployed in a decentralised manner, even in rural and remote areas of Africa. The two technologies currently employed for solar energy are solar PV and concentrated solar power (CSP). Over 95% of solar energy that is currently generated utilises solar PV technology. Only 5% of the power is based on CSP. The potential for solar PV technology is widely distributed across Africa. The potential for CSP is found mainly in the desert areas as dry air is required (Komendantova et al, 2012). If African countries could develop the right policies, the learning curve and the associated reductions in cost could see solar energy play a pivotal role in their energy supply. The only challenge that solar PV energy supply faces, particularly in off-grid solutions, is the cost of batteries, which remains high. In desert areas of North Africa, solar PV and CSP systems could play a bigger role in water desalination because the intermittency of energy supply is not an issue. Solar energy in Africa has great potential and a vast positive impact on all elements of sustainability, including social, economic, technical and environmental dimensions (Maqbool and Akubo, 2022).

3.2. Wind Energy

The potential for wind energy in Africa is enormous. In terms of distribution, wind energy resources are found mainly in the coastal areas of Northern, Eastern and Southern Africa. In these areas, wind is the cheapest form of energy in the absence of hydropower. One of the most significant challenges facing the development of wind power in Africa is the operations and maintenance of wind turbines. There is a lack of technical expertise and sufficient financial resources to ensure regular maintenance. By their nature, wind turbines require higher levels of maintenance compared to other forms of renewable energy generation. The countries with the most significant potential for wind power generation include Chad, Cape Verde, Sudan, Kenya, Madagascar and Mauritania. Countries with the most considerable installed wind power at present include Egypt, Morocco, Tunisia and South Africa. Wind energy development in Africa faces technical, economic, competition, and policy challenges. Provided suitable policies are developed, wind power in Africa can transition from a small-scale industry to large-scale commercial developments (Boadu and Otoo, 2024).

3.3. Geothermal Energy

Geothermal energy originates from the Earth's volcanic activity. Underground temperatures generally increase with increasing depth at a rate of 30 degrees centigrade per kilometre. The advantages of geothermal energy are that electricity production is continuous and can therefore serve as a baseload technology. It is reliable,

cost-effective and renewable. The most significant potential of Africa's geothermal resources is mainly found in the East African rift valley. The Western Rift Valley extends from Uganda to Mozambique, and the Eastern Rift Valley, where volcanic activity is most intense, extends from Ethiopia to Kenya, where fluid temperatures above 200 degrees centigrade can be found. In this region, the direct use of steam to produce electricity is possible. Only Kenya and Ethiopia have made some efforts to exploit geothermal energy. In Kenya, one IPP has been constructed with a capacity of 250 MW (Oluoch et al., 2024). More geothermal plants are planned, and by 2050, Kenya expects to generate 5,000 MW of electricity from geothermal energy (Olando et al, 2024). The total technical potential of geothermal energy in Africa is 105 TWh/year, and it is all located in East Africa (IRENA, 2020). Development of geothermal energy in Africa will depend not only on adequate heat resources but also on adequate finances (Moore et al., 2025).

3.4. Biomass

Biomass is an important source of energy in Africa. Biofuel in the form of charcoal is widely used for cooking and heating in many parts of Africa. It is easier to store; it has a high energy content and low levels of smoke emissions. It is the primary source of fuel for the urban and rural poor. Production of charcoal is a significant source of employment, but it is responsible for the destruction of trees and forests, unless fast-growing varieties of trees are used. Bioenergy is also an important source of renewable energy in the form of wood pulp residues and sugar cane bagasse. Bagasse accounts for the bulk of bioenergy installed capacity in Africa. The technical potential of bioenergy in Africa is currently estimated at 2,374 TWh/year, although the current electricity generation of biomass power projects in Africa is negligible (Namaswa et al, 2022). This potential is substantial, particularly in Central Africa, and represents the opportunity to provide a renewable electricity supply. The principal attractions are the low bioenergy feedstock costs compared to other parts of the world. However, the availability of feedstock in sufficient quantities to make electricity production attractive is a challenge, given that large-scale farming in Africa is rare.

4. Hydropower Potential in Sub-Saharan Africa

Africa has a huge hydropower potential, and estimates suggest that only 10% to 20% of it has been developed. Most countries in Eastern and Southern Africa depend heavily on hydropower. For example, the share of hydropower is Ethiopia (90%), the Democratic Republic of Congo (95%), Zambia (85%) and Uganda (83%). It is small in other countries such as South Africa, Zimbabwe and Mauritius, where electric power is generated mainly from thermal energy, including coal (IRENA, 2022). Hydropower is a clean and

renewable, emissions-free electricity-generating technology. However, hydropower plants are capital-intensive. The silting of dams over time and periods of drought can reduce the available head and the amount of power generated.

Hydropower projects are divided into two categories, namely: large hydro (greater than 10 MW) and small hydro (Less than 10 MW). The typical cost structure of developing a hydro power plant includes hydro-technical construction (60%), turbines (25%), electrical equipment (10%), buildings (5%), and exploration and other costs (0.5%). Africa has the potential to generate 350,000 MW of electricity from hydropower alone. Hydropower will be an essential contributor to the future energy mix in Africa. It can be used to provide a base load and to smooth out the intermittency of other renewable energy sources. The main reason for the current low level of hydropower development is access to finance. The perceived levels of high risk by international investors have also driven low levels of investment. The other reason is that tariffs in many countries are political decisions and do not reflect the market costs of generation, transmission and distribution of electricity. There is an urgent need in many countries to develop regulations and a policy framework that is transparent and fair. An energy pricing system where charges reflect the production costs of electricity is necessary to attract private sector investment. As the technology of hydropower production is proven, raising private sector investment in hydropower should be straightforward, provided appropriate risk mitigation strategies are implemented.

5. Unit Costs of Renewable Energy Generation

The falling costs of renewable energy generation recorded in recent years present the opportunity to unlock this potential. Compared to other power generation sources such as nuclear or fossil fuels, the construction of solar and wind power generation has short construction lead times, and so implementing these technologies could fast-track access to an electricity supply. The estimated global levelized cost in USD/ KWh of utility-scale electricity power generation from various renewable energy sources is as follows: Bioenergy (0.067), Geothermal (0.068), Hydropower (0.048), Solar PV (0.048), Concentrating Solar Power (0.114), Onshore Wind (0.033), Offshore Wind (0.075) (IRENA, 2022).

This data indicates that the financial and economic viability of renewable energy generation is now well-established and competes with conventional technologies. Given the low costs of hydropower, solar PV and onshore wind technologies, African governments must focus on removing institutional barriers and developing a pipeline of renewable energy projects to make progress. The costs of renewable

energy generation depend on the technology employed. Power generation costs are also influenced by the quality and availability of the energy resources, the project details and the specific site. The costs of project implementation in Africa are also higher than in other countries because of additional transportation costs and import duties. Economies of scale are important in power projects. Large projects are generally cheaper per kWh. There are also skills gaps for operations and maintenance. In the next section, the barriers to renewable energy development in SSA and potential solutions are discussed.

6. Barriers to Renewable Energy Development in Africa and Potential Solutions

6.1. Structure of Electricity Markets in Sub-Saharan Africa

The economic case for the development and expansion of renewable energy in Africa is strong. Feasibility studies need to be conducted for specific locations, projects and technologies. For rural populations in Africa without access to electricity, grid extension to rural areas is encouraged. However, electricity markets in many countries in Africa are still relatively small, and so utility companies do not benefit from economies of scale. A significant proportion of people, particularly in rural areas in Africa, also live subsistence livelihoods. Thus, extending electricity to rural areas requires governments to address affordability concerns. This is part of the reason why many developing country governments in Africa have favoured rural electrification strategies rather than the development of renewable energy. Thus, providing access to electricity must be addressed in tandem with poverty eradication and other programs that seek to raise household incomes in rural areas (Sachs, 2015).

The other challenge in electricity supply, particularly in SSA, is the large gap between electricity demand and the available generating capacity. The overall state of the generation, transmission and distribution infrastructure is old and therefore requires investment and modernisation to improve efficiency and reduce power losses. Many countries in Africa suffer from electricity blackouts due to load shedding, particularly during peak demand periods. Generation of electricity from petrol or diesel generating plants is expensive but commonly employed to meet this shortfall. Electricity tariffs in many African countries do not reflect the market costs of production. Electricity markets have had to be liberalised in many countries in order to attract private investment. Market liberalisation has therefore necessitated an increase in prices to reflect market production costs. Unbundling of generation, transmission and distribution also means that terms of access to the transmission grid can be developed and provided to private Independent Power Producers (IPP) without conflicts of interest. Reforms of the energy

market, including privatisation, can also be implemented to improve efficiency and competition in power generation. Removal of electricity subsidies can assist the general economy in delivering sound public finances.

Setting up an independent electricity regulatory agency is also an important step in the liberalisation of the electricity market. This means that regulatory policies can be developed, applied and enforced transparently, leaving the role of government to be policy development and execution. Development of broad energy strategies coupled with ease of access to the electricity transmission grid, competition in the generation and distribution of electricity can encourage Independent Power Production (IPP) companies to participate in renewable energy generation. Unfortunately, earlier reforms in the electricity market in SSA led to increased use of fossil-based generation rather than renewable energy generation because of the cost advantages of conventional energy. This needs to be addressed in energy reforms to encourage the uptake of renewable energy.

In summary, conventional energy-generating projects in the past have scored better than renewable energy projects based purely on the financial profile of such projects. This is no longer the case. Renewable energy projects are competitive in their own right. Their competitiveness improves further when their environmental and social benefits are factored in. Renewable energy projects can be developed in an off-grid and modular manner, particularly in rural areas, which should also prove attractive for improving energy access for the rural poor.

Finally, developing countries should develop the electricity market reforms and include a practical regulatory framework to encourage private sector IPP companies to invest in renewable energy. The market for the electricity generated can be guaranteed through feed-in tariffs, tax incentives, and subsidies. Provided that the private sector has guarantees of an adequate legal and regulatory framework coupled with sound, consistent policies, this will attract private sector funding to enable scale-up of investment into renewable energy projects.

6.2. Policy Reforms Required in Developing Countries

Renewable energy projects generally have high capital costs but low operating costs compared to conventional energy projects. Investing in Africa also attracts considerable country, regulatory, commercial and market risks. Capital markets in Africa are underdeveloped, and bond markets are illiquid. The perception of high risks in Africa increases the cost of capital required by investors in renewable energy projects. Renewable energy projects also tend to be smaller. Thus, transaction costs per kWh are much

higher than for conventional projects. The lack of data on wind speeds or solar insolation means that it takes much longer to complete feasibility studies. The lack of relevant data to inform economic feasibility, decision-making, siting, planning and financing decisions increases the risk and uncertainty faced by potential investors.

Fossil fuels attract considerable subsidies in developing countries, including tax breaks, research and development grants, fuel price guarantees, etc. This puts financing of renewable energy projects at a competitive disadvantage compared to conventional energy projects. Subsidies lower the costs of power generation from conventional means. Developing country governments in SSA should, as a matter of urgency, set out a clear vision for the contribution of renewable energy in the total energy mix, where this has not been done. Setting out clear and legally binding national targets demonstrates commitment, political will and determination. This assures private sector investors that the national authorities have a clear trajectory towards green electricity.

Developing country governments should also gradually phase out subsidies that are enjoyed by electric power-generating companies using fossil fuels. Switching fossil fuel subsidies to renewables is justifiable as renewable energy projects bring social and environmental benefits. Removal of subsidies needs to be implemented in a manner that does not disadvantage poor members of society (Menyeh et al., 2021). Removal of subsidies will also encourage energy efficiency in use and conservation. Removal of fossil-fuel subsidies can be controversial and poses a political challenge for most governments in SSA, as many stakeholders, including high-income groups, benefit from subsidised energy costs. Therefore, any reforms need effective planning, strong communications and civic engagement to ensure that they are gradual, socially and economically fair and are generally acceptable to the public.

Alongside renewable energy targets, governments should also set out clear feed-in-tariffs for renewable energy producers. Offering a guaranteed fixed price with a premium above the market production costs provides an output-based incentive for large-scale Independent Power Producers (IPPs). This can enhance the profitability of the project and increase returns on investment. The setting of feed-in-tariffs reduces the uncertainty associated with energy prices and revenues and improves project bankability. Although over 30 countries had feed-in-tariffs in 2010, only four of them were in sub-Saharan Africa and included Uganda, Kenya, Tanzania and Mauritius. By 2021, only fourteen countries in Africa had feed-in-tariffs. Even then, these had not been successful in delivering increased investment into renewable energy projects because of a weak regulatory framework.

Many electricity utility companies in developing countries are publicly owned. Governments should set out clear and mandatory targets for utility companies to supply a given proportion of their electricity from renewable sources as a regulatory requirement. Provided that there is transparency and competition in the awarding of contracts for renewable energy projects, auctions and feed-in-tariffs, together with efficient procurement systems, are an essential prerequisite for attracting private sector capital into renewable energy generation.

6.3. Financial Risks and Effective Mitigation Strategies

Investors in renewable energy projects in SSA face several risks, including political risks, currency risks, and commercial risks. Commercial risks arise from the fact that state-owned utilities often have poor balance sheets and credit ratings. Their credit payment obligations under power purchase agreements cannot be guaranteed. Poor balance sheets and credit ratings result from poor billing and payment collection systems, and prices that do not reflect the market production costs of energy. Country and political risks include the risks of government expropriation, war and civil disorder, and breach of contract. These risks feature highly when international investors are making location decisions for foreign investments. International investors also rank prevailing legal systems and independence of the judiciary highly, as they need confidence that commercial contracts will be enforceable in the event of default. Foreign investors in renewable energy projects also face currency risks, including fluctuations in interest rates and foreign exchange risks. If development capital is borrowed from international money markets and designated in hard currency, investors face risks if revenues are designated in local currency. Money markets are not well developed in SSA, implying that hedging instruments involving local currencies may not be readily available.

Other risks include expropriation of funds or nationalisation of assets by developing country governments. Governments may also fail to honour their contractual obligations. Clauses seeking dispute resolution through international arbitration tribunals should be incorporated in any contracts. Investors also need to protect their investment from losses arising from war, terrorism and civil disturbance. They also need guarantees against currency transfer restrictions and currency inconvertibility. Finally, governments may fail to honour their financial obligations or default on honouring guarantees provided to investors. Fortunately, all these risks are insurable through the Multilateral Insurance Guarantee Agency (MIGA) of the World Bank Group. The World Bank has operations in many developing countries, and it is therefore well diversified to mitigate the impacts of such risks.

7. Conclusion and Further Research

Africa has vast renewable energy resources. It has enough renewable energy resources to meet its demand and also be a net exporter. However, renewable energy at present contributes very little to the electricity consumed in Africa. In any case, most of the renewable energy at present is hydropower. Because of population growth and expansion of electricity connectivity, electricity demand is expected to grow by up to 10% per annum between now and 2030. Six hundred forty-eight million SSAs do not have access to electricity, and over 900 million do not have access to clean cooking. Universal access to electricity in SSA is possible with an enabling policy framework and increased investment in innovative financing.

International investors in renewable energy projects in sub-Saharan Africa face several risks, including country, political, currency and commercial risks. These risks are insurable. The cost of utility-scale power generation from renewable energy sources has declined substantially over the last few years. However, developing country governments need to implement policy reforms, including setting clear renewable

energy targets, developing technical capacity, providing grants, implementing feed-in-tariffs, holding competitive auctions, removing subsidies from conventional energy generation, and identifying bankable projects and de-risking them to attract renewable energy investments.

Renewable energy expansion in SSA will require substantial financial resources from a range of sources, including public and private sources, grants and bilateral aid, and multilateral agency loans. To unlock these investments, further research is required at the country level to collate stakeholder views on the required government policy changes, public perceptions and acceptance of various renewable energy technologies, and public willingness to pay for these investments. Further research should also survey attitudes of international investors, energy companies and developers about the changes needed to make the renewable energy sector in SSA attractive for investment. Research on innovations in financing required to accelerate investment in renewable energy in SAA is urgently required.

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