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Risk Mitigation Strategies in Financing Renewable Energy Projects in Sub-Saharan Africa

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Abstract

There is an acute electricity shortage in Sub-Saharan Africa (SSA), and electricity blackouts are common. 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. However, there is currently a knowledge gap on how renewable energy projects can be derisked to increase the flow of international private capital into them. Based on a literature review, this study aims to identify the risk 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. Efficient risk mitigation strategies are proposed. The study also finds that the global utility-scale levelized costs of electricity from renewable energy resources compare favourably with those 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. SSA faces a large infrastructure financing gap. Closing this financing gap requires building efficient local capital markets to mobilise domestic savings, reduce the costs of capital for renewable energy projects, and reduce reliance on foreign debt. An important consequence of this work is that it is possible to accelerate the development of innovative financing solutions to ramp up investment and deliver clean energy for all.

Keywords: Finance, Renewable Energy Projects, 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 enable nations to reduce global warming. Africa's per capita greenhouse gas emissions are much lower than those of developed countries. However, African countries are more likely to be disproportionately affected by 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

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to create a prosperous Africa with renewable energy development as one of the priority areas (African Union, 2015). At present, 789 million people worldwide lack access to electricity. Of these 648 million (or 69%) live in Sub-Saharan Africa. Over 900 million people in Sub-Saharan Africa lack access to clean cooking (Ireri and Shirley, 2021). Most families rely on 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, Africa's energy consumption per capita 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 an annual capital investment of USD 100 billion in the energy sector until 2040 (KfW Development Bank, 2020). Africa has seen lower investment in the energy sector than other parts of the world due to higher perceived risks for 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.

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 economic climate to attract investment into renewable energy projects. Eight research questions guide the study, namely:

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. To what extent can financial derivatives be used to mitigate risks faced by investors?
6. What lessons can we draw from countries that have successfully upscaled investment in renewable energy?
7. What package of policies and incentives could make a significant impact and breakthrough to stimulate widespread adoption and investment in renewable energy in SSA?
8. How can the infrastructure financing gap in SSA be closed?

This paper reports preliminary findings from the literature. A structured and focused narrative review was undertaken, starting with the identification of peer-reviewed journals, conference papers, books, theses, dissertations, and academic reports. The literature was identified through electronic databases, including Google Scholar, Scopus, ScienceDirect, 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 also excluded.

3. Renewable Energy Resources in Africa

Africa has vast untapped renewable energy resources. 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. Fossil fuels account for 71% of Africa's power supply (International Renewable Energy Agency and African Development Bank, 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/m^2. 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 mainly in desert areas, as dry air is required (Komendantova et al., 2012).

If African countries could develop the right policies, the learning curve and associated cost reductions could make solar energy a pivotal part of their energy supply. The only challenge solar PV energy supply faces, particularly in off-grid solutions, is the high cost of batteries. 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 significant positive impact across all dimensions of sustainability, including social, economic, technical, and environmental (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 mainly found in coastal areas of Northern, Eastern, and Southern Africa. In these areas, wind is the cheapest form of energy when hydropower is unavailable. One of the most significant challenges in developing wind power in Africa is the operation 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 maintenance than other forms of renewable energy generation.

The countries with the greatest potential for wind power generation in Africa 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. Africa's geothermal resources are most significant 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., 2020). 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, all located in East Africa (International Renewable Energy Agency, 2020). The development of geothermal energy in Africa will depend not only on sufficient heat resources but also on adequate financing (Moore et al., 2025).

3.4. Biomass

Biomass is an important source of energy in Africa. Charcoal, a biofuel, 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. Charcoal production is a significant source of employment, but it can destroy trees and forests unless fast-growing varieties are used. Bioenergy is also an important renewable energy source, derived from 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 sufficient feedstock 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 (International Renewable Energy Agency, 2021). Hydropower is a clean and renewable, emissions-free electricity-generating technology. However, hydropower plants are capital-intensive. The silting of dams over time and during droughts can reduce available head and power generation.

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 (Climate Analytics, 2022).

Hydropower will be an essential contributor to Africa's future energy mix. 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 level of risk for international investors has also driven low investment levels. The other reason is that tariffs in many countries are political decisions and do not reflect the market costs of generating, transmitting, and distributing electricity. There is an urgent need in many countries to develop transparent, fair regulations and a policy framework. An energy pricing system that reflects electricity production costs is necessary to attract private-sector investment. As the technology for 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 over recent years offer an 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 the 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) (International Renewable Energy Agency, 2021).

This data indicates that the financial and economic viability of renewable energy generation is now well established and competitive 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. The quality and availability of energy resources, project details, and the specific site also influence power generation costs. 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, a brief review of infrastructure financing in developed and developing countries is provided, along with the economic rationale.

6. Review of Project Finance for Infrastructure

The early 1980s saw the revival of using project finance to fund infrastructure investments in telecommunications and power generation in developing countries. Brealey et al. (1996) argue that equity investment by shareholders in such projects, together with high leverage and the complex web of contractual arrangements, reduces agency problems in the design, construction, operation, and maintenance of large infrastructure projects. Additionally, Kensinger and Martin (1988) note that project finance, which is centuries older than shares or bonds, gained widespread use in the 1980s for financing the construction of industrial developments, factories, oil and gas exploration projects, power generation, and research and development, and highlighted its potential to catalyse change in the governance of business activities.

Esty (2003) provides detailed case histories on the structuring, valuation, risk management, and project financing of a wide range of infrastructure investments in developed and developing countries, including Islamic finance. Meanwhile, Shah and Thakor (1987) provide the economic rationale for project finance. In their theoretical analysis of the capital structure, they show that riskier firms acquire more debt, pay higher interest rates, but have higher equilibrium values. They argue that project finance is optimal when there is asymmetric information between insiders within the firm and external market participants. In other words, the market value of the riskiest projects is maximised with project financing.

The United Kingdom government launched the Private Finance Initiative (PFI) in 1992 to use private-sector funding to design, build, operate, and manage essential public infrastructure projects such as schools, roads, hospitals, and prisons. The rationale for this policy was to introduce market discipline in the development and provision of infrastructure services and to transfer risk to the private sector. The policy, however, faced criticism due to the complexity of the procurement processes, procedures, and costs.

The PFI was rebranded as the Public-Private Partnership (PPP) programme by the Labour government in 1997, which expanded the programme's scope and the number and value of projects commissioned under it. The refurbishment and modernisation of the London Underground was one of the projects procured under the PPP program. This was one of the most high-profile projects in Britain at the time, and the significant challenges it faced, leading to a buyout by the central government, highlighted that

PPPs are not a panacea for infrastructure financing challenges (Glaister, 2025).

Grout (1997) provides an analysis of the economics of the PFI programme, concluding that although this approach incentivises construction contractors to limit time and cost overruns, it does not limit the public sector borrowing requirement in the long run.

In their analysis of the strategic factors driving innovation in infrastructure finance, Badu et al. (2013) note that the infrastructure deficit in developing countries is inextricably linked to a lack of funding. Additionally, Estache (2010) shows that the private sector has limits as a source of financing for infrastructure projects in the third world. Therefore, public sector support is needed if infrastructure services are to be offered at affordable, commensurate prices with consumers' ability to pay in developing countries.

A brief review of the barriers to renewable energy development in SSA and potential solutions is discussed next.

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

7.1. Structure of Electricity Markets in Sub-Saharan Africa

The economic case for developing and expanding 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 is encouraged. However, electricity markets in many African countries are still relatively small, 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 many developing-country governments in Africa have favoured rural electrification strategies over renewable energy development. 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 African countries experience electricity blackouts due to load shedding, particularly during peak demand periods. Generating electricity from petrol- or diesel-fired plants is expensive but is 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 higher 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. The removal of electricity subsidies can help the broader economy achieve 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. The development of broad energy strategies, coupled with ease of access to the electricity transmission grid and competition in electricity generation and distribution, can encourage Independent Power Producers (IPPs) 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, driven by 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 have historically outperformed renewable energy projects based solely on their financial profiles. 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, modular manner, particularly in rural areas, and should also prove attractive for improving energy access for the rural poor.

Finally, developing countries should implement electricity market reforms and establish a practical regulatory framework to encourage private-sector IPPs 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 assurances of an adequate legal and regulatory framework, coupled with sound, consistent policies, this will attract private-sector funding to enable the scale-up of investment in renewable energy projects.

7.2. Policy Reforms Required in Developing Countries

Renewable energy projects generally have high capital costs but lower operating costs than 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. Perceptions of high risk in Africa increase the cost of capital for 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 and solar insolation means feasibility studies take much longer to complete. 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, and fuel price guarantees. This puts renewable energy project financing 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 to the total energy mix, where this has not yet been done. Setting out clear, 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 should be implemented in a way 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 communication, and civic engagement to ensure they are gradual, socially and economically fair, and generally acceptable to the public.

Alongside renewable energy targets, governments should also set 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 project's profitability and increase returns on investment. The introduction of feed-in tariffs reduces the uncertainty around energy prices and revenues, thereby improving project bankability. Although over 30 countries had feed-in tariffs in 2010, only four were in sub-Saharan Africa: Uganda, Kenya, Tanzania, and Mauritius. By 2021, only 14 African countries had feed-in tariffs. Even then, these had not been successful in increasing investment in renewable energy projects due to a weak regulatory framework.

Many electricity utility companies in developing countries are publicly owned. Governments should set clear, 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 essential prerequisites for attracting private-sector capital into renewable energy generation.

7.3. Financial Risks and Effective Mitigation Strategies

Investors in renewable energy projects in SSA face several risks, including political, currency, and commercial risks. Commercial risks arise because state-owned utilities often have weak 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 from prices that do not reflect the market production costs of energy.

Country and political risks include 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 underdeveloped in SSA, suggesting that hedging instruments denominated in 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 investments from losses arising from war, terrorism, and civil disturbances. 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.

8. Project-Related Risks in Renewable Energy Projects

8.1. Project Completion Risks

Renewable energy projects are capital-intensive, with time and cost overruns being recurrent concerns for investors and sponsors. Such overruns delay the capital recovery period and result in additional interest payments. They also affect the project's profitability. Extensions of time to the construction contractor may be justified due to unforeseen ground conditions. To mitigate these risks, date-specific and lump-sum contracts may be used, with the risk transferred to construction contractors. Construction contractors may also be required to provide performance guarantees. In any case, these risks are also insured.

8.2. Political Risks

Political risks arise from the project's exposure to changes in the political climate. A sitting government or a change in government may lead to the imposition of new taxes or excessive bureaucratic controls on the repatriation of profits, changes in laws that are discriminatory to the project, or, in the extreme, its expropriation. As already noted, such risks are insurable through multilateral agencies that can act as guarantors against unfavourable events.

8.3. Environmental Risks

Environmental campaigner actions and protestors can disrupt renewable energy projects during implementation. There are also concerns that wind projects can be risky because they affect land use and wildlife, including birds. Hydropower projects can affect river flow characteristics, including silt loading. Lenders in recent years have become increasingly concerned about environmental risks. Project sponsors must undertake environmental impact assessments and demonstrate full compliance with national legislation and international best-practice guidelines on environmental matters.

8.4. Market Risks

Market risks faced by investors in renewable energy projects take three forms. The first is that markets may be insufficient for the power generated. The second is that competition may arise from new power-generating companies entering the market. The third is that the tariffs set may be at levels that are not commensurate with electricity market production costs. These risks are generally addressed through an availability or capacity charge in the Power Purchase Agreements (PPAs). Offtake contracts usually include take-or-pay clauses. In other words, since electricity cannot be stored once generated, power distribution companies are required to pay for the power irrespective of whether they take it or not.

8.5. Financial Risks

The profitability of a renewable energy project may be affected by changes in interest rates, currency exchange rates or commodity prices of inputs. Currency exchange rate risks are usually allocated to the power purchasing entity. Financial derivative tools may be used to hedge against risks arising from changes in interest and currency exchange rates. The use of financial derivatives for risk hedging in renewable energy projects is addressed in the next section.

9. Using Derivatives in Financing Renewable Energy Projects in SSA

Techniques for hedging risks in renewable energy projects to protect lenders include insurance contracts, government guarantees, policy incentives such as feed-in tariffs, multilateral agency guarantees, and financial derivatives. A financial derivative instrument is an agreement between two parties to mitigate risks arising from, for example, changes in interest rates, exchange rates, project revenues, credit risks and production quantities such as hourly energy outputs.

In developing countries such as South Africa, India, or Thailand, with well-developed financial systems and capital markets, funding for domestic infrastructure projects in local currency can be raised through local and international banks and bond issues. However, most countries in SSA have undeveloped financial systems. Their capital markets are illiquid and cannot provide long-term financing in local currency for major projects. Instead, utility-scale renewable energy projects rely on external funding denominated in hard currency from multilateral development agencies, international banks and export credit agencies. Such loans also attract hard currency variable interest rates. Thus, when user fees for the electricity generated are designated in local currency, such investments are subject to risks arising from interest rate and currency exchange rate fluctuations.

If a renewable energy project finance loan is designated in local currency at a fixed interest rate, there is no interest rate or currency risk. Where the infrastructure finance loan is denominated in local currency but offered at a variable interest rate, such a project is not exposed to foreign exchange risk. However, the risk of interest rate changes can be hedged through a local-currency interest rate swap.

If the project loan is denominated in a foreign currency at a fixed interest rate, there is no interest rate risk. However, the project faces currency exchange rate risk, which can be managed through offtake contracts or foreign currency swaps. Finally, when the project loan is denominated in a foreign currency and at a variable interest rate, the project faces both interest rate risk and currency exchange rate fluctuations. Interest rate risks in this case can be managed through hard-currency interest rate swaps. Furthermore, foreign exchange risks can be allocated through off-take contracts or hedged through cross-currency swaps.

Currency depreciation, which can lead to volatility in exchange rates, can materially impact a project's profitability and investment performance. This can also affect its ability to meet interest rate payment obligations and the ability to repay the loan.

Cross-currency derivative products are generally traded over the counter and are available only from large international banks. Cross-currency derivative products with maturities commensurate with long-term financing for renewable energy projects are generally unavailable in SSA financial markets. Most hedging for cross-currency risks is available for the short- to medium-term, particularly during the construction period.

Local market characteristics and the extent of capital market development influence the availability of over-the-counter (OTC) derivatives in financing packages for large renewable energy projects. Most developing countries in SSA have weak capital markets with poor liquidity. In such markets, there is a significant gap between the financing of renewable energy projects and the availability of hedging solutions to manage currency risks. Over-the-counter currency swaps and interest rate swaps, when available, are costly, which adds considerably to the required rates of return on capital to invest in such projects.

10. Strategies to Address the Renewable Energy Financing Gap

There is currently a massive infrastructure financing gap, particularly for renewable energy projects in developing countries, estimated at USD 1.5 trillion per annum (World Bank, 2024). Closing this gap requires a multi-pronged approach. Investors perceive infrastructure projects in developing countries, including renewable energy projects, as very risky. This deters private-sector participation and limits capital inflows into such projects. Borrowing in hard currencies also exposes developing countries to fluctuations in interest rates and exchange rates. However, hard-currency-denominated debt remains a significant burden and concern for many developing countries.

The financing gap could be narrowed by pursuing four strategies, namely:

- Improving project preparation and feasibility studies;
- Developing a stable macroeconomic framework, good governance and strengthening local capital markets;
- Leveraging the capacity of multilateral agencies to enhance global guarantees to de-risk renewable energy projects;
- Enhancing private sector participation in the development of energy projects.

Developing country governments in SSA should first and foremost focus on building local capacity among qualified, experienced infrastructure professionals to manage project execution and delivery processes, starting with feasibility studies. Well-prepared feasibility study reports and proposals during the initiation period are likely to improve project bankability. Developing a pipeline of bankable projects can enhance governments' credibility and attract private sector investment.

Collaboration with multilateral agencies will also assist developing countries with technical assistance, the development and enhancement of risk mitigation products, and the de-risking of projects, thereby making them more attractive to the private sector. It is estimated that enhanced de-risking of renewable energy projects by multilateral agencies, in collaboration with governments, can reduce the Levelised Cost of Electricity (LCOE) from renewable sources by USD 0.031 per kWh (Deloitte, 2023). Multilateral agencies can also assist developing countries by providing political risk cover, guarantees and insurance to reduce risks to the private sector. In addition, they can assist governments in developing policies that are favourable to attracting institutional investors, such as pension funds, insurance companies, and sovereign wealth funds.

Finally, closing the infrastructure financing gap will require developing countries to pursue sound macroeconomic policies, economic stability, low inflation and development of efficient and liquid local capital markets. Such markets will enable the mobilisation of domestic savings to provide long-term financing for clean energy development.

11. 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 lack access to electricity, and over 900 million lack access to clean cooking. Universal access to electricity in SSA is possible with an enabling policy framework and increased investment in innovative financing.

The work reported in this paper synthesises the barriers to financing renewable energy (RE) in Sub-Saharan Africa (SSA). It links them to a set of risk mitigation strategies, including market and regulatory reforms, project-related risk management, and the use of financial derivatives and multilateral guarantees. The originality of this work lies in bringing together the energy sector, project risk and financing, and perspectives on the use of financial derivatives into a single, SSA-focused framework. This work also frames the infrastructure financing gap explicitly in terms of local capital market development and de-risking strategies.

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, legally binding renewable energy targets to signal a clear commitment and build market confidence. They also need to develop technical capacity to identify suitable projects and undertake comprehensive feasibility studies to demonstrate bankability.

Providing targeted grants may also be necessary, including the implementation of feed-in tariffs and competitive auctions. Removal of subsidies from conventional energy generation, bringing bankable projects to market, and working with multilateral agencies to de-risk them will reduce required capital rates of return and attract international financial investment. The author acknowledges the limitations of a literature-only analysis and the need to validate these recommendations empirically.

Renewable energy expansion in SSA will, in the short to medium term, require substantial financial resources from a range of sources, including public and private sources, grants and bilateral aid, and multilateral agency loans. In the long term, the huge financing gap can only be bridged by the development of efficient and liquid domestic capital markets to mobilise local savings. Additionally, it will be necessary to attract local institutional investors, such as pension funds and insurance companies, to support long-term financing for renewable energy development.

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 the attitudes of international investors, energy companies, and developers regarding the changes needed to make the renewable energy sector in SSA more attractive to investment. Research on financing innovations to reduce the cost of capital required to accelerate investment in renewable energy in SSA is urgently needed.

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