EIB-GDN WORKING PAPER

POTENTIAL IMPACT OF THE AFRICA ENERGY GUARANTEE FACILITY (AEGF)

GDN Global Development Network

European Investment Bank The EU bank

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Potential impact of the Africa Energy Guarantee Facility (AEGF)

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Content

Summary

Sub-Saharan Africa is the most underpowered region in the world and has the largest number of people without access to electricity. According to the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA) (2017), only 43% of the region's population had access to electricity as of 2016, which means that 588 million people were without access. The lack of regular and reliable access to electricity is partly responsible for the economic and development challenges facing the region, and attainment of the Sustainable Development Goals (SDGs) depends on achieving significant improvements in electricity generation and supply.

However, substantially improving electricity supply and access is challenging because investment in energy infrastructure is inadequate. The financing requirements for energy infrastructure are enormous and beyond the funding capacity of governments in the region, hence the need for private sector participation and investment. However, private sector investment in the energy sector has not been forthcoming, despite the potential of electricity markets in the region.

The high-risk profile of energy investments seems to deter private investors and financial institutions. The risks include political and policy risks, currency risks, sub-sovereign risks and breaches of contract — all threatening the viability of investments. So mitigating the risks associated with energy investments, especially non-commercial risks, is critical for attracting investment to the region. This is the challenge the Africa Energy Guarantee Facility (AEGF) aims to address.

The AEGF is the product of a collaboration between the European Investment Bank, Munich Re and the African Trade Insurance Agency. It is a dedicated risk-sharing facility for supporting the development of sustainable energy infrastructure in Africa. The facility aims to enhance access to finance for energy projects in Africa by eliminating potential political and sub-sovereign risks faced by investors. It is expected to facilitate around $1.4 billion of private investment in sustainable energy projects. The facility supports energy projects that meet the criteria for the European Union and the United Nations Sustainable Energy for All (SEforAll)'s projects. Thus, the energy projects induced by the AEGF will contribute to and support attainment of the SDGs and the Paris Climate Agreement goals in sub-Saharan Africa.

This report examines the potential macroeconomic and welfare impact of the AEGF. Specifically, it describes the transmission mechanism of the AEGF's impact, namely lower investment risk, better financing terms, improved viability of energy projects, enhanced electricity access, and higher macroeconomic and welfare outcomes. The report also reviews three case studies of guarantee use for energy projects in the region, and outlines several major reasons why investors are less likely to adopt investment insurance as a financing instrument. In addition, the study reviews empirical literature on the impact of risk mitigation instruments on access to finance, aiming to determine how the AEGF will likely influence access to finance for energy investors in the region. The study subsequently applies a cost-benefit analysis on an African solar power project to demonstrate the potential impact of the AEGF on project viability. Finally, assuming that the AEGF will facilitate investment in the energy sector and thus enhance electricity access, the study provides insights into the ultimate impact of the guarantee facility, based on the energy development literature.

The study's key findings are:

- **Risk mitigation instruments have been used to mitigate energy investment risks and encourage private financing on affordable terms for energy project investments in Africa**. The World Bank Group, other development finance institutions, and commercial lenders and investors have worked together to support major energy infrastructure projects in Africa, including the Azura-Edo greenfield power project in Nigeria, the Azito power plant expansion project in Côte d'Ivoire and a group of electricity projects in Kenya. The instruments used in these projects helped to mitigate the inherent risks and facilitated private financing for their implementation. One key lesson from the experiences of these projects is that risk mitigation instruments alone cannot ensure the success of energy projects: it is also necessary to provide other forms of support, such as technical assistance for energy sector reforms and for energy project planning and appraisal.

- **Available risk mitigation instruments may not necessarily be adopted by investors as financing tools because of major demand-side factors**. These factors include the high cost/fee of the instrument, which tends to offset the financing advantage; the partial risk coverage of investment insurance, which makes it difficult to evaluate uncovered risks; the complexity of insurance products; the lengthy process of negotiation and approvals, which investors deem too time-consuming; the low certainty and slow speed of claim payment (in some cases); investors' lack of awareness of the products; and investors' inadequate financial or administrative capacity to manage the application process.

- **There is limited empirical evidence on the impact of risk mitigation instruments on financing for infrastructure and energy projects**. However, available evidence on similar instruments for small and medium-sized enterprises (SMEs) points to significant positive effects such as lower interest rates and longer loan tenors. Despite the differences in these types of risk mitigation instruments, the beneficial impact on SME financing is indicative that financing for infrastructure and energy projects can be similarly enhanced. The study's literature review reveals that risk mitigation instruments improve access to financing for investors/SMEs as insured firms are able to raise external loans, which they would not have been able to access in a normal credit market (without the instruments). It also finds that the availability of risk mitigation instruments could embolden investors to take on higher-risk projects.

- **The availability of risk mitigation instruments like the AEGF can potentially reduce the real financing costs of energy projects while also enhancing their viability**. It is expected that a non-insured project could only access financing at the market rate and under unfavourable terms — high interest rate, short tenor, and high collateral requirement. Consequently, most projects may not be able to access private financing. Given the high cost of financing and the short repayment period, projects that do obtain finance are unlikely to generate enough financial revenue to meet annual loan repayments in their early years. Thus, investors will have to use equity or take out another loan to continue funding a project. By contrast, for a project insured by a risk mitigation instrument, the lower interest rate and longer tenor reduce the annual repayment amount so that revenue in the initial years of the project is enough to cover the annual loan repayments, thereby enhancing project liquidity. An insured project also has a lower real financing cost than a non-insured project. Overall then, a risk mitigation instrument can improve the viability and reduce the total cost of an insured project.

- **By improving the viability of energy projects and engendering a significant increase in electricity generation and supply, the AEGF should lead to significant macroeconomic improvements and promote human development and welfare**. Based on the electricity access development literature, the potential macroeconomic and welfare effects should include economic growth, higher investment and employment, increased household incomes, empowerment of women, greater SME development, improved health and educational outcomes, enhanced quality of life, and other social and environmental benefits. However, mere improvement in electricity supply may not achieve development outcomes: people need to be connected to a power supply and know how to use electricity for productive and economic purposes. Moreover, electricity access alone may not be enough to promote economic growth and welfare improvements: other complementary infrastructure and policy interventions, such as skills development, may also be essential. These considerations imply that while the AEGF may enhance electricity access in the region, its ultimate impact on other socioeconomic and development outcomes is uncertain.
- **The AEGF addresses some of the major limitations of investment insurance by providing supply-driven investment insurance for sustainable energy projects in Africa**. It also leverages the capacity and geographical coverage of local financial institutions, especially the African Trade Insurance Agency, by designing investment insurance policy products for potential investors in the region. This is expected to simplify the negotiation process and reduce the time required for projects to reach financial disclosure, while also enhancing projects' commercial viability.

List of acronyms

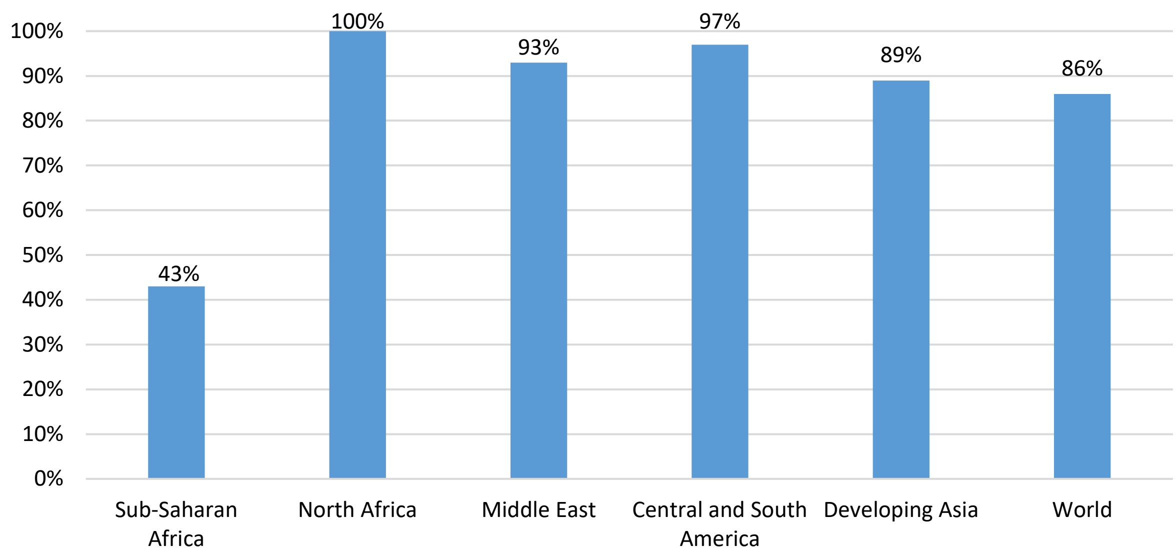
ADB	Asian Development Bank
AEGF	Africa Energy Guarantee Facility
ATI	African Trade Insurance Agency
DiD	Difference-in-difference
EIA	Energy Information Administration
EIB	European Investment Bank
EU	European Union
IDA	International Development Association
IEA	International Energy Agency
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
LCOE	Levelised cost of energy
MDB	Multilateral development bank
MIGA	Multilateral Investment Guarantee Agency
OECD	Organisation for Economic Co-operation and Development
OPIC	Overseas Private Investment Corporation
PPA	Power purchase agreement
PSM	Propensity score matching
PV	Photovoltaic
SDGs	Sustainable Development Goals
SEforAll	Sustainable Energy for All
SME	Small and medium-sized enterprise

1. Background to the study

This report examines the potential impact of the Africa Energy Guarantee Fund (AEGF), a guarantee instrument that supports investment insurance aimed at mitigating the risks associated with sustainable energy investments and facilitating financing for energy projects in Africa.

Sub-Saharan Africa has the lowest levels of electricity access in the world. According to the OECD and International Energy Agency (IEA) (2017), the region's average electrification rate in 2016 stood at 43%, which means that 588 million people had no access to electricity (Figure 1). This rate is much lower than the global average of 86%. Such limited access to electricity partly explains the poor economic performance, abysmal human development record and high poverty incidence in sub-Saharan Africa (Esfahani and Ramirez, 2003; Lejarraga, 2009). Major contributors to the region's low electrification rates include inadequate investment and financing, inappropriate energy policy, poor tariff systems, lack of appropriate regulatory frameworks and lack of competition in the electricity sector. Limited financing is particularly pronounced in the energy sector because of the high investment outlay needed for energy infrastructure (Eberhard et al., 2016).

Figure 1: Electrification rates in developing regions of the world



Source: OECD and IEA (2017).

Analysis by the IEA suggests that $586 billion would be needed for investment in new power infrastructure in sub-Saharan Africa from 2015 to 2030 (Hogarth, 2017). This equates to an annual investment of $39 billion, significantly higher than the current level of investment in energy projects in the region. Furthermore, public sector funding of renewable energy — accounting for about 15% of total investment in the sector — is unlikely to increase (International Renewable Energy Agency, 2015), implying that private sector investment is crucial for improving access to sustainable energy supply. However, the limited capacity of the domestic financial system in developing countries presents a major obstacle to private investment in sustainable energy. This is reflected in the high costs, variable rates and short tenors of debt financing. For example, Nelson and Shrimali (2014) note that the cost of financing renewable energy projects in India is 24–32% higher than in the United States, and that this gap is partly explained by India's less developed financial system.

Private investors face difficulties accessing credit from financial institutions because of high investment risks, including political and sovereign risks. This, in turn, hinders investment in energy infrastructure in sub-Saharan Africa. In collaboration with Munich Re and the ATI, the EIB urged the AEGF to mitigate these risks and facilitate private investment in the energy sector in Africa.

This report assumes that the impact of the AEGF will take time to materialise. Thus, the primary objectives are to:

(i) Review case studies of the use of risk mitigation instruments for energy projects in Africa.
(ii) Examine some of the reasons why existing risk mitigation instruments are rarely adopted by private investors.;
(iii) Systematically review the impact of risk mitigation instruments on access to financing.
(iv) Demonstrate how such instruments improve the viability of energy projects by reducing financing costs. and
(v) Highlight some potential macroeconomic and welfare effects of improved energy access that will be induced by the AEGF.

The report is divided into eight sections. This section provides the background to the study. Section 2 overviews the AEGF and the intervention logic of the facility. Section 3 then presents case studies of some energy projects in sub-Saharan Africa that have benefited from risk mitigation instruments, while the factors explaining the low adoption of such instruments by private investors are detailed in Section 4. Empirical evidence on the impact of risk mitigation instruments in facilitating financing is examined in Section 5. In particular, it reviews and summarises the findings of empirical studies on how investment insurance affects access to funds, default rates and other performance indicators. Section 6 demonstrates the importance of risk mitigation instruments for a typical energy project in sub-Saharan Africa through a cost-benefit analysis of an African solar energy project. The analysis compares the simulated costs of a project with and without AEGF support to examine how the AEGF affects the financial viability of energy projects in the region. Section 7 draws on the energy development literature to briefly overview the potential macroeconomic and welfare impact of the AEGF, assuming that it successfully facilitates investment in the energy sector. Finally, Section 8 concludes the study. Overall, the AEGF is expected to enhance the viability of energy projects by reducing the real financing costs. Should the AEGF successfully facilitate private financing for energy projects in Africa, then improved availability of and access to energy will enhance socioeconomic and human development in the region.

2. Overview of the Africa Energy Guarantee Facility

The Africa Energy Guarantee Facility (AEGF) is a dedicated risk-sharing facility for supporting the SEforAll initiative in Africa. The facility was initiated through a collaboration between the EIB and Munich Re. As the EU bank, the EIB is mandated to represent the interests of its shareholders — the EU Member States — by providing finance for sustainable investment projects that contribute to EU policy objectives. Munich Re is a private reinsurance company based in Germany. The African Trade Insurance Agency (ATI), an Africa-based and -focused institution, was established to facilitate foreign direct investment in the region by providing political and commercial risk insurance. The facility aims to enhance access to finance for energy projects by eliminating the potential political and sub-sovereign risks faced by energy sector investors in the region. It is expected to facilitate around $1.4 billion of private investment for energy projects in Africa. Under the terms of the facility, the EIB will issue guarantees to Munich Re, which will, in turn, reinsure some of the ATI's SEforAll-eligible projects.

The constraints on private investment in Africa's energy sector include unpredictable regulatory regimes, weak off-takers, unfavourable business and economic environments, and political instability. These challenges make investors cautious and dissuade them from investing in sustainable energy projects because their investments are not adequately protected against certain non-commercial risks. In addition, financial institutions in the region are not inclined to finance these projects because of the inherent risks involved. To overcome these impediments, the AEGF provides long-term investment insurance against specified risks that are deemed to constrain investment in sustainable energy projects.

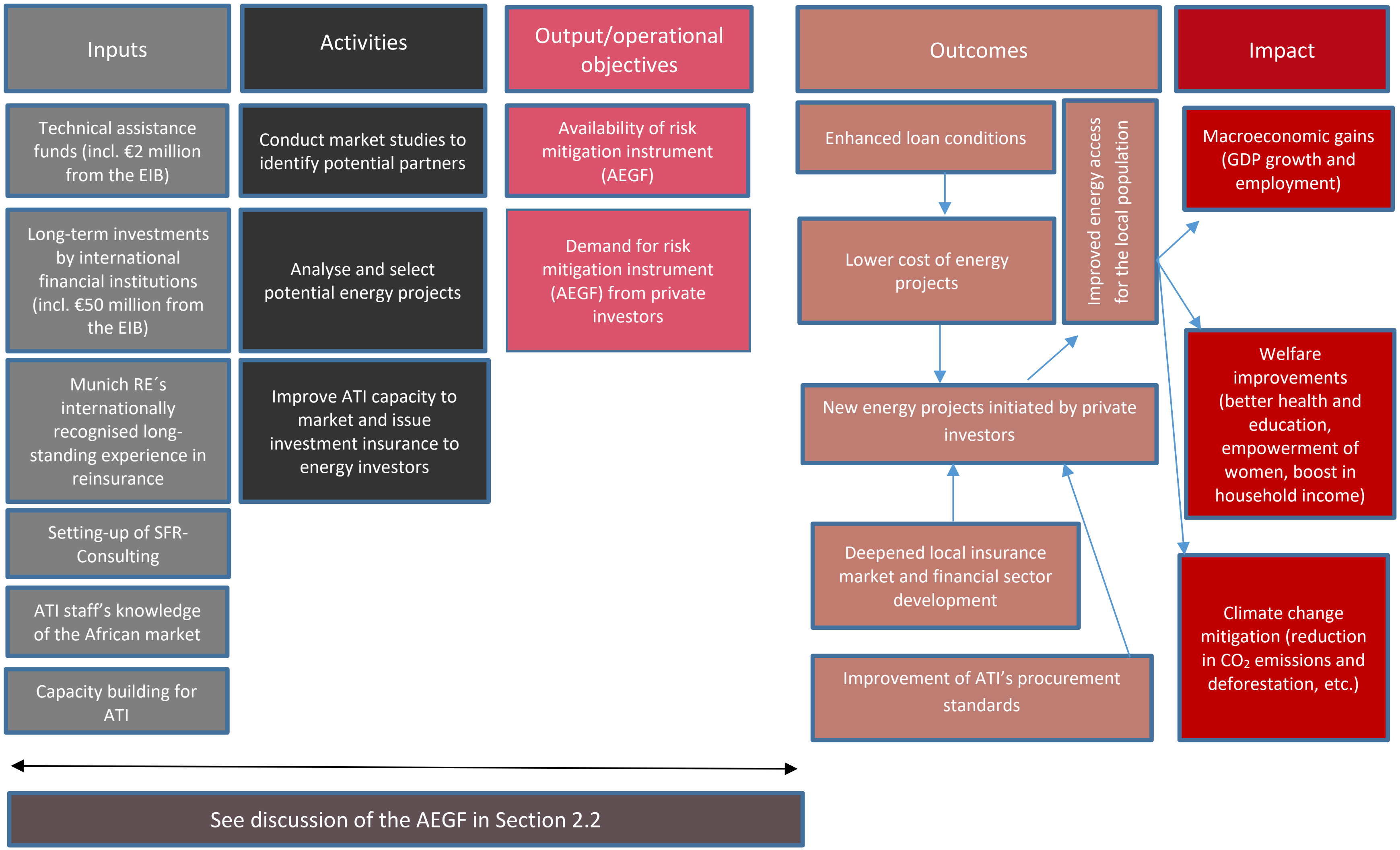
The facility is dedicated to mitigating political, sovereign and sub-sovereign non-payment risks for energy projects in sub-Saharan Africa. Munich Re will create a portfolio of political and (sub-)sovereign non-payment risk reinsurance for energy projects insured by the ATI, totalling up to $1 billion in reinsurance exposure. Munich Re will cover the first-loss exposure of the reinsurance portfolio up to the lesser of 12% and $120–150 million. The EIB will, equally, guarantee the second loss under the reinsurance portfolio up to the lesser of 10% and $100 million. Losses above the maximum amount of the second loss will be covered by Munich Re. SFR-Consulting, a fully-owned subsidiary of Munich Re, will manage the facility. It will be responsible for vetting insurance policies for inclusion in the facility to ensure consistent underwriting quality and compliance with EIB standards (for instance on environmental and social matters). One distinct feature of the AEGF is that it leverages the expertise and coverage of existing local insurance capacities in Africa while also seeking to address the ATI's capacity gaps by establishing a dedicated reinsurance capacity through Munich Re, whose exposure is further mitigated by the EIB. The ATI is the primary insurer responsible for marketing and business development, as well as performing the initial underwriting due diligence on individual policies. In addition to its financing, the EIB will provide a €2 million technical assistance programme under the AEGF, thus enhancing the ATI's capacity to offer investment insurance for energy projects in the region.

To be eligible for AEGF support, a project must meet the criteria for EU SEforAll funding. According to the implementation guidelines for EU SEforAll funding[1], specific projects that fall under the EU SEforAll include projects related to energy and electricity access, rural, peri-urban and urban electrification, sustainable cooking, energy efficiency and renewable energy. Furthermore, potential projects need to be financially viable and sustainable, and demonstrate strong developmental impact in terms of poverty reduction, socioeconomic development, and equal access and opportunities for all, while minimising environmental impact. Renewable energy and solutions for mitigating climate change are also favoured, except where use of fossil fuels is essential to increasing access. Thus, the energy projects that will be induced by the AEGF will contribute to and support attainment of the SDGs and the Paris Climate Agreement goals in sub-Saharan Africa.

The potential transmission channels of the AEGF's socioeconomic impact are illustrated in Figure 2.

[1] https://www.ati-aca.org/wp-content/uploads/2017/09/SE4All-EU-Guidelines.pdf

Figure 2: Intervention logic for the economic impact of the AEGF



According to West and Tarazona (1998), the ultimate impact of investment insurance and guarantees is the anticipated development benefits yielded by infrastructure projects it financed. This section describes the inputs into and activities that characterised the initiation and launch of the AEGF. The next step is for potential project promoters to subscribe to the facility. An underlying assumption is that project promoters will use the AEGF if the lower borrowing cost it ensures is not offset by transaction costs and fees. Other factors that will determine demand for the AEGF are awareness of the facility among project promoters, their financial and administrative capacity to manage the application process, and their perception of the partial risk coverage. These factors and how they influence the use of risk mitigation instruments are further discussed in Section 3.

Subscription to the AEGF by project promoters aims to enhance their access to financing for energy projects. By mitigating against certain non-commercial risks, the AEGF reduces the riskiness of energy investment. The partial risk cover provided by the facility will encourage commercial lenders to provide funding for the projects on favourable terms, enabling project promoters to enjoy lower interest rates and longer tenors than would have been available without investment insurance (see Section 5). However, access to funds will also depend on project viability, the promoter's credit record, and other financial and technical considerations for the lender. Obtaining funds on favourable terms will eventually reduce the cost of financing and boost the viability of energy projects (see Section 6). The viability of the project would also depend on the economic and social benefits of the project, as well as other non-financing costs. Through a combination of favourable loan terms (resulting in lower financing costs for energy projects), developed insurance and financial sectors, and enhanced procurement standards of the ATI, private investors are likely to initiate new sustainable energy projects. A basic assumption underlying this link is that other important factors, such as government policies and regulatory frameworks, are favourable to the new projects.

New energy projects, whether focused on generation, transmission or distribution, will improve electricity supply and enhance access by the local population. However, it is important to note that new electricity projects do not automatically guarantee improved electricity supply or access. Households need to be connected to the new power sources, and regular, reliable supply must be assured. Reliable and regular access to electricity will bring macroeconomic benefits such as gross domestic product (GDP) growth, rising employment, productivity growth and increased economic competitiveness (see Section 7.1). It will also ensure welfare benefits for the local population, such as increased household income, improved education and health outcomes, empowerment of women, and boosted enterprise development and employment (see Section 7.2). Furthermore, improved access to electricity from mostly sustainable (rather than conventional) sources will support climate change mitigation.

3. Reasons for the limited adoption of existing risk mitigation instruments

The extent to which risk mitigation instruments, including the AEGF, stimulate private investments largely depends on project promoters' use of the instruments. This section examines the various reasons why existing instruments are rarely used by private investors: they currently represent a small share of development finance portfolios (Lee, 2017) and multilateral development bank (MDB) operations (Table 1). A recent review of blended finance deals by Convergence and the Business & Sustainable Development Commission (2017) shows that only 12% of blended finance deals involve a guarantee or insurance instrument. Humphrey and Prizzon (2014) also note that only 4.2% of the approved $706 billion in development lending (between 2004 and 2013) by six international and regional MDBs they reviewed was in the form of project guarantees.

Table 1: Outstanding guarantees of selected MDBs, 2016 (MDB global portfolio)

	Multilateral Investment Guarantee Agency	International Bank for Reconstruction and Development	International Development Association	International Finance Corporation	Inter-American Development Bank Group	Asian Development Bank	African Development Bank	European Bank for Reconstruction and Development	European Investment Bank
Guarantees ($ billion)	14.2	1.5	1.1	3.5	0.2	2.1	0.5	0.6	7.5
% of loans	N/A	0.9%	0.8%	15.9%	0.3%	3.1%	2.5%	2.4%	1.6%

Source: Pereira dos Santos and Kearney (2018).

The use of risk mitigation instruments to finance infrastructure is even more limited, as most of the outstanding guarantees in Table 1 are directed towards trade finance, SMEs and other programmes. According to Pereira dos Santos and Kearney (2018), MIGA accounts for about 50% of all existing outstanding guarantees, and has half of its outstanding guarantees portfolio in infrastructure projects. The use of risk mitigation instruments for renewable energy projects is also very limited. Only about 4% of the total infrastructure risk mitigation issuance by international financial institutions is allocated to renewable energy projects (IRENA, 2016).

The following demand-side factors may explain the limited use of these instruments for infrastructure projects, including energy projects, in developing countries. The first is the high cost of risk mitigation instruments. Humphrey and Prizzon (2014) argue that guarantees are less prevalent than other financing structures because their lower borrowing costs are offset by higher transaction costs and fees, and are deemed expensive by investors and sovereign borrowers. For these instruments to be attractive, the reduction in interest rates and other beneficial financing terms need to offset the fees.

A second factor limiting the use of risk mitigation instruments for infrastructure projects in developing countries is the partial risk coverage. Generally, investment insurance only partially covers political risks or credit risks to prevent moral hazard among project promoters. However, many financial institutions are still concerned about the risks not covered by the insurance, as well as the difficulties of evaluating uncovered risks and the pricing of partial coverage. These issues are corroborated by Gordon's (2008) study, which notes that political risks are not generally conceived as insurable because the probability and severity of losses are not easily quantifiable and it is difficult to predict when they might occur.

The complexity of investment insurance products and the lengthy processes of negotiation and approval are further important factors hindering these instruments' adoption. The complicated nature of investment insurance, in which only some risks are covered, makes the negotiation process laborious and time-consuming as all parties work to understand the exact scope of the cover. Similarly, the low certainty and slow speed of claim payment are also undermining factors. Due diligence is a lengthy process, and this can have an effect on access to liquidity. The AEGF addresses this particular challenge by engaging with Munich Re and the ATI.

The demand for risk mitigation instruments in developing countries is also undermined by lack of awareness of the products (IRENA, 2016). This issue is compounded by potential investors' limited financial or administrative capacity to manage the application process. Some investors and project promoters in developing countries may not have the required expertise and technical capacity to manage the application process, which discourages them from using the instruments.

In effect, despite the potential of risk mitigation instruments, private investors are often discouraged from using them by high costs, product complexity, partial risk coverage, long periods of negotiation and preparation, lack of awareness of the products, and difficulties in processing claims. A survey of infrastructure investors, project developers, insurance and reinsurance companies, professional service firms, banking institutions, construction companies, and MDBs by the World Economic Forum (2016) shows that only a very limited proportion of the respondents perceive these instruments as effective tools for infrastructure project financing.

4. Case studies of risk mitigation instruments for energy projects in sub-Saharan Africa

Even though available risk mitigation instruments have not been widely used by investors (Section 3), a few energy projects in sub-Saharan Africa have successfully leveraged these instruments to facilitate private financing. This section reviews case studies of some risk mitigation instruments, particularly guarantees, for energy projects in Africa and examines how they have been structured to ensure successful projects in the region.

4.1. Kenya electricity projects (World Bank, 2017)

This review of a group of electricity projects in Kenya draws extensively from the World Bank (2017) Implementation Completion and Results report on a series of International Development Association (IDA) partial risk guarantees in Kenya.

The guaranteed project was relatively complex because it included the preparation of four different subprojects (Thika power plant, Triumph power plant, Gulf power plant and Olkaria III geothermal plant 2 expansion), with different sponsors, financiers, and engineering, procurement and construction contractors. The World Bank identified seven risks: political, governance, technical, timely financial closure, regulatory, sustainability and supply–demand balance. In reality, three of these risks — timely financial disclosure, regulatory and supply–demand balance risks — have partially occurred.

The World Bank supported the Kenyan government through risk mitigation packages including IDA partial risk guarantees to backstop Kenya Power and Lighting Corporation's payment security obligations under power purchase agreements (PPAs); MIGA provision of termination coverage for commercial debt and equity cover for transfer restriction, expropriation, and war and civil disturbance (Table 2); and IFC loans to Thika Power and Gulf Power.

Table 2: Kenya electricity projects: impact and risk mitigants

Impact	• Using $135 million of IDA resources to mobilise $623 million of additional financing • 250 MW capacity of conventional generation constructed under the project and 85% annual average plant availability for each plant constructed under the project
Market/off-taker risk mitigants	• IDA partial risk guarantees to backstop Kenya Power and Lighting Corporation's payment security obligations under the PPAs • MIGA support in the form of termination coverage for commercial debt and equity cover for transfer restriction, expropriation, and war and civil disturbance • Detailed sectoral due diligence and constant monitoring of Kenya Power and Lighting Corporation finances by the World Bank team to provide strong risk mitigation for any defaults on payments that may affect the project
Construction/operational risk mitigants	• Active monitoring of project implementation by the World Bank task team • Proposed review of tax laws for the energy sector to mitigate their impact on the financial integrity of independent power projects • Experienced international contractors to handle construction

Source: World Bank (2017).

The project leveraged $135 million of IDA resources to mobilise $623 million of additional financing, including $357 million in private investment and commercial lending, contributing significantly to the project's financial viability and successful implementation. The equity contribution of $149 million was funded by project sponsors, while the debt financing of $474 million was obtained through IFC loans, commercial lenders (Amalgamated Banks of South Africa and Standard Bank) and development finance institutions (Overseas Private Investment Corporation and African Development Bank).

4.2. Azura-Edo power project in Edo State, Nigeria (Audu et al., 2016)

The Azura-Edo power project is the first project-financed independent power plant in Nigeria and seeks to provide electricity to about 14 million people. Several financial institutions, including commercial banks and development finance institutions, worked with the World Bank Group to support this large project. The World Bank Group underpinned accompanying power sector reforms by developing the Nigeria Energy Business Plan, which leveraged the resources and capacity of the IFC, World Bank and MIGA to attract private investment to the sector.

A financing package of around $876 million was approved by the financing partners, including the World Bank Group, Overseas Private Investment Corporation, Siemens Bank, Standard Chartered Bank, and others. Financing was structured using partial risk guarantees from the World Bank and political risk insurance cover for equity, swaps and commercial debt from MIGA (Table 3). The IFC provided $50 million in senior and $30 million in subordinated debt and mobilised $267.5 million of senior debt alongside the Netherlands Development Finance Company, and an additional $35 million of subordinated debt.

A put-call option agreement between the project promoter and the off-taker serves as the project's market/off-taker risk mitigant. Other market risk mitigants for project investment include credit enhancements through World Bank partial risk guarantees and MIGA political risk insurance. In addition to the standard project financing structure, construction and operational risks were mitigated by working with Nigerian and international companies with good track records. Gas supply for the project was also ensured through a contractual arrangement with a credible gas supplier (Seplat).

Table 3: Azura-Edo project: impact and risk mitigants

Impact	• Increasing power supply by 459 MW by 2018, a rise of 10% over currently available national generation capacity • Providing electricity to an estimated additional 14 million residents • Creating new project document templates for privately-financed power projects
Market/off-taker risk mitigants	• A put-call option agreement between the project promoter and the off-taker backstopping off-taker payments • Credit enhancements through a World Bank partial risk guarantee and MIGA political risk insurance • World Bank Group participation through multiple instruments providing comfort to other investors
Construction/operational risk mitigants	• Standard project finance structure • Fixed-price turnkey contract with Nigerian and international entities with strong operational track records
Gas supply risk mitigants	• Strong contractual arrangements with gas supplier with strong operational track record (Seplat) and with the off-taker under the PPA

Source: Audu et al. (2016).

The project became operational in December 2017, ahead of schedule. Without its innovative combination of private financing and risk mitigation instruments, the project would not have been possible, as no private investor and lender would commit to it. Moreover, the project's financing structure involved almost 20 investors with no previous experience in Nigeria. As such, this project facilitated new investment and players in the Nigerian power sector, with significant potential for future investments. The project employed 1 000 people during the construction stage and is expected to induce further job creation by improving electricity supply to local businesses.

4.3. Azito power plant expansion project in Côte d'Ivoire (Audu et al., 2016)

Private sector interest in financing power and infrastructure projects in Côte d'Ivoire is undermined by political instability and regulatory, currency and other technical risks. However, nine development finance institutions were able to combine resources and expertise to support regulatory reforms and provide long-term finance for a 139 MW power plant expansion in the country. The Azito power plant was initially built in 1998 with the IDA providing about $30 million support in partial risk guarantees.

The expansion project was complex and had an estimated cost of $430 million. Given its scale and complexity, the project required financing and technical expertise as well as risk mitigation instruments (Table 4) to address issues including currency hedges, interest rate swaps, political risk insurance, reliable natural gas fuel supply, and end-user purchase agreements. Working with eight other development finance institutions, the IFC raised $345 million, comprising a $125 million anchor investment from the IFC and $220 million in long-term loans from the other partners. The MIGA guarantee protects the project against concession contract, political and transfer risks. In addition, the World Bank supported the Côte d'Ivoire government in energy sector reform and financial management to boost technical expertise and efficiency in the sector. The project was handled by international contractors experienced in the power sector, thus mitigating the construction and operational risks.

Table 4: Azito expansion project: impact and risk mitigants

Impact	• Creating power generation capacity for 2.3 million additional customers with no incremental fuel consumption
Market/off-taker risk mitigants	• MIGA equity guarantee against concession contract, political and transfer risks • World Bank engagement in sectoral structural reforms and financial management
Construction/operational risk mitigants	• Project sponsors very experienced in power sector • Experienced international contractors
Financing risk mitigants	• IFC long-term finance, providing comfort to other investors • Strong financial standing of project sponsors • IFC swap, fixing interest rate on the debt for 15 years

Source: Audu et al. (2016).

Key points from the review of case projects:

- **The reviewed projects mostly involve a series of financing partners**, including multilateral development financial institutions and commercial lenders.
- **The risk mitigation instruments adopted under these projects cover several types of risks depending on the specific project**. A well-structured package of these instruments is used in combination with other World Bank Group instruments to mitigate the identified risks. No single instrument could address all the risks associated with the projects.
- **The most common instruments are** IDA partial risk guarantees to backstop payment security obligations under PPAs, and MIGA political risk insurance to cover termination, transfer restriction, expropriation, war and civil disturbance.
- **The reviewed projects were able to successfully mobilise private financing**, which would not have been possible without the instruments.
- **In addition to the risk mitigation instruments**, some cases involved technical and regulatory support for sectoral reforms.
- **The risk mitigation and guarantee instruments were designed not to replace traditional PPA arrangements but rather to provide complementary means of mitigating investment risks**.
- **Other risks that could not be mitigated through financial instruments, such as construction and operational risks, were addressed in different ways**, such as involving credible local and international companies with good track records to handle the projects.

5. Evaluating the effectiveness and impact of risk mitigation instruments

Mitigating the risks associated with infrastructure investments, risk mitigation instruments can facilitate access to finance for private investors. This section tests this assumption by reviewing empirical evidence on the impact of risk mitigation instruments on access to finance. However, very few empirical studies have examined these instruments' effect on access to finance for infrastructure projects. Accordingly, this review considers available evidence on how they affect SMEs' access to finance. While there are considerable differences between risk mitigation instruments for SMEs and infrastructure projects, this review provides indicative insights on how such instruments can enhance access to finance for investors generally.

The issue of additionality is central to evaluating the impact and effectiveness of risk mitigation instruments (Ramlogan and Rigby, 2012). The literature offers various interpretations of additionality, including longer loan tenor, financing of previously excluded projects, and other long-term development effects, such as on borrowers' financial viability, investment, employment, and economic growth (Meyer and Nagarajan, 1996; Saadani et al., 2010; Ramlogan and Rigby, 2012).

Evaluations of the impact of risk mitigation instruments face two main challenges (Vogel and Adams, 1997, cited in Ramlogan and Rigby, 2012). The first is determining an appropriate counterfactual — namely, what the financial institutions would have done were the instruments not available. The second is a measurement challenge emanating from intra-portfolio substitution, whereby financial institutions provide multiple loans to investors. This affects the accuracy of additionality measurement.

The World Bank (2016) reported that guarantees lead to lower aggregate interest rates. This is corroborated by Pereira dos Santos and Kearney (2018), whose findings are depicted in Figures 3 and 4. The provision of a guarantee instrument affects interest rates and, to a greater degree, loan tenor. However, Pereira dos Santos and Kearney's (2018) analysis does not consider the cost of the guarantee instrument (fees), so it is unclear whether the benefits are offset by the costs. They also do not control for observed and unobserved differences between guaranteed and non-guaranteed loans.

Figure 3: Loan tenor (years)

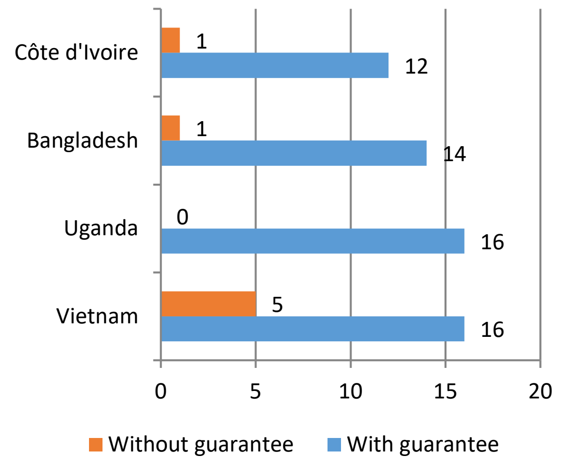
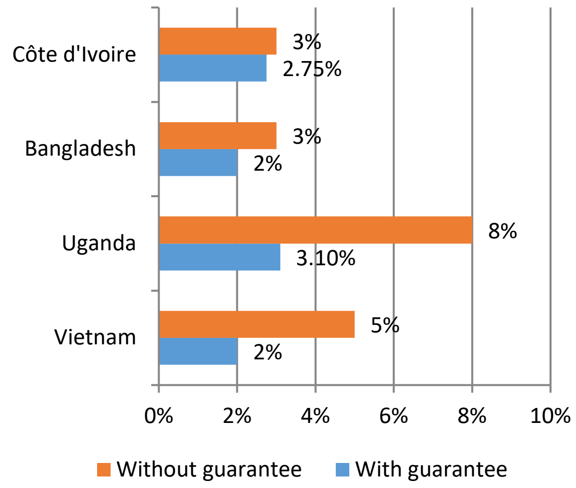


Figure 4: Interest rate spread



Source: Pereira dos Santos and Kearney (2018).
Note: Uganda's repayment period without a guarantee is several months.

A rigorous evaluation of the impact of risk mitigation instruments needs to control for the effects of other factors. Earlier research used qualitative assessments to determine whether bankers and beneficiaries saw any improvements in the availability and terms of credit as a result of the instruments. For instance, KPMG Management Consulting (1999) evaluated the impact of the UK Small Business Loan Guarantee Scheme by interviewing borrowers, loan account managers and beneficiaries of loan guarantees. The study found that about 60% of total loan value or 70% of the number of recipient firms are additional as a result of the guarantee scheme. A similar method was adopted by Boocock and Shariff (2005) to evaluate the impact of Malaysia's guarantee scheme. Their evaluation used postal questionnaires and detailed case studies of beneficiaries, and found that an extra 37% of funding was induced by the scheme.

Other studies have used quantitative evaluation methods to assess the effectiveness of risk mitigation instruments by comparing the performance of beneficiaries with that of non-beneficiaries. To avoid the problem of selection bias and ensure similarity between beneficiaries and non-beneficiaries, these studies primarily combine the analytical methods of difference-in-difference (DiD) and propensity score matching (PSM). As summarised in Table 5, these studies evaluate how different kinds of risk mitigation instruments affect access to funds, loan default rates and firm performance.

Table 5: Impact of loan guarantee schemes

Overview of the evaluation				Impact		
Study	Country	Year/period	Method of evaluation	Access to funds	Firm performance	Loan default rates
Riding et al. (2007)	Canada	2000	PSM	Yes[2]	n.c.	n.c.
Cowan et al. (2008)	Chile	2003-2006	PSM & DiD	Yes	n.c.	Yes
Arráiz et al. (2011)	Colombia	2002-2007	PSM & DiD	n.c.	Output (+)[3] Employment (-) Investment (n.e.) Productivity (n.e.)	n.c.
Lelarge et al. (2008)	France	1995-2000	Quasi-natural experiment	Yes[4]	Capital growth (+) Employment (+)	Yes[5]
Zecchini and Ventura (2009)	Italy	2000-2004	PSM & DiD	Yes[6]	Output (+) Employment (+)	n.c.
Uesugi et al. (2010)	Japan	2001-2005	PSM & DiD	Yes[7]	Profit (-)	Yes[8]
Oh et al. (2009)	Korea	2000-2003	PSM & DiD	n.c.	Output (+) Employment (-) Productivity (n.e.) Investment (n.e.)	Yes
Cowling (2010)	United Kingdom	2006-2008	PSM	Yes	Output (+) Employment (+) Productivity (+)	Yes

Source: Ramlogan and Rigby (2012).

Notes: The column "access to funds" indicates whether the guarantees improved access to funds for the beneficiary firms; the column "firm performance" indicates whether the guarantees improved the beneficiary firm's performance based on the performance indicator used in the study; the column "loan default rates" indicates whether beneficiary firms default on their loan obligation; n.c. = not considered in the study; performance variable + or - = significant positive or negative impact; performance variable n.e. = no effect.

[2] Of the firms that accessed credit under the guarantee programme, 75% would not have qualified for loans in the normal credit market (without the guarantee).

[3] Based on a comparison of these outcome indicators between a group of firms that benefited from guarantees and firms that did not, guaranteed firms generated 4.6% more employment and grew by 5.8% more in terms of revenues.

[4] Guaranteed firms are able to raise more external loans. The bank debt of guaranteed firms grew by 6.9% more than that of non-guaranteed firms, and guaranteed firms have a lower debt burden because of lower short-run interest rates.

[5] There is a significant increase in the probability of default, which rises from 6% in the initial two years to 29% in the long term.

[6] The median value of bank debt is 12.4% higher for guaranteed firms compared to non-guaranteed firms.

[7] Compared to non-guaranteed firms, guaranteed firms have a 2-3% increase in the availability of bank loans.

[8] The number of guaranteed firms with a higher probability of financial problems (profit-interest ratio less than 1) is 3-7% higher than non-guaranteed firms.

Key findings from the evidence on how risk mitigation instruments affect access to finance:

- **The availability of these instruments improves access to funds for investors and SMEs** as guaranteed firms are able to raise external loans, which would not have been accessible in a normal credit market (without guarantees).
- **Evidence suggests that the availability of these instruments increases the probability of loan default**, probably by incentivising risky behaviours by both investors and the financial institutions providing funds. This supports the moral hazard hypothesis.
- **The instruments' secondary impact varies according to the specific measure of firm performance**. Generally, they improve firm output but have mixed effects on employment, productivity and investment.
- **While risk mitigation instruments on access to funds for SMEs and infrastructure investors are different**, the above evidence from SME financing tends to suggest that such instruments generally enhance access to funds.
- **Overall, the summary implies that an investment insurance facility like the AEGF can potentially facilitate access to funding for infrastructure investors in Africa**. It is also likely to have secondary effects on the performance of supported projects and investors. However, the initiative may also embolden investors to take on higher-risk projects.

6. Analysing the potential impact of the AEGF on the viability of energy projects: case study of a hypothetical solar power project in Africa

This section examines whether investment insurance enhances the viability of energy projects by reducing the real financing costs. The literature review in Section 5 shows that the primary effects of risk mitigation instruments are a reduction in interest rates and an increase in loan tenor, although these effects vary across countries. This section conducts a cost-benefit analysis using a hypothetical example designed to be reflective of the kind of project that could be supported under the AEGF. This is used to demonstrate how the AEGF could improve the viability of sustainable energy projects by reducing financing costs.

We use approximate parameters estimated to be plausible for an African solar power project which could be considered for inclusion in the AEGF. Table 6 lists a set of project parameters based on information provided by project partners. These parameters may differ from the final project parameters of projects supported under the facility. Nonetheless, this provides a useful case study to examine the facility's potential benefits.

The analysis here will be largely focused on how the AEGF reduces the financial costs of energy projects. Project construction is forecast to take two years, and the plant is expected to start producing electricity from the third year. Given the parameters in Table 6 and based on the evaluation of energy production of solar PV by Jamil et al. (2017), the potential annual electricity output of the power plant would be 77 088 000 kWh[9]. Based on a review of solar degradation rates over the past 40 years, Jordan and Kurtz (2012) find that solar panel output falls by a median rate of 0.5% annually. This depreciation rate is used to work out the plant's electricity output from the second year onward.

[9] This is obtained by converting 40 MW capacity to kWh to reflect annual electricity output. The formula is 40*0.22*24*365*1000.

Table 6: Parameters of a hypothetical African solar power plant

Characteristics	Values
Project costs	$92 million[10] (25% equity; 75% debt)
Proposed plant installed capacity	40 megawatts
Fuel consumption cost	Nil
Operating and maintenance costs	$14 430/megawatt/year
Engineering, procurement and construction cost	$0.955/watt
Capacity factor	22% (Xoubi, 2015)
Lifetime of the plant	20 years
Construction period	2 years
PPA tariff	$0.12/kWh

Source: Author's compilation.

Of the $92 million projected project costs, 25% is assumed to be provided in the form of equity. To amortise the loan, an interest rate of 7% is used[11]. Based on the available literature on loan tenor for sustainable energy projects (IRENA, 2016), an 8-year loan tenor is assumed for this scenario. These values serve as the assumed financing terms without AEGF support. However, the actual interest rate and tenor for the project may vary from the assumed values because of risk premiums, bank margins and other considerations for the lender. A discount rate of 8% is used to evaluate the project's social value and to discount the project's costs and benefits over its lifetime, based on studies of the levelised cost of energy (LCOE) in the project country. The reimbursement amortisation for the loan is worked out using the formula: $A = P\frac{r(1+r)^n}{(1+r)^n+1}$. The project's financial benefit is obtained by multiplying the plant's electricity output by the PPA tariff of $0.12/kWh.

To determine the viability of the solar power project, the project's LCOE is estimated and compared with the LCOE of the marginal alternative power plant. The project's costs and benefits are presented in Table 7. Its LCOE is estimated at $0.060/kWh, which means that the solar power plant will produce electricity over its lifetime at an average unit cost of $0.060/kWh. This is within the range estimated for solar photovoltaic (PV) by the US Department of Energy's Energy Information Administration ($0.058–0.143/kWh; see Table 8). It is also in line with IRENA (2020) estimates for the weighted average global LCOE of solar PV in 2019 ($0.068/kWh), 2020 ($0.045/kWh) and 2021 ($0.039/kWh), as presented in Table 8.

The project's viability is determined by comparing the LCOE of the solar plant with the LCOE of the alternative (marginal) power plant (in this case, natural gas). If the solar plant's LCOE is lower than the LCOE of this marginal alternative plant, then the project is viable; otherwise, it is not viable. Analysis reveals that the solar plant's LCOE ($0.060/kWh) is within the range of the LCOE of natural gas technology estimated by the Environmental Investigation Agency (EIA) ($0.052–0.148/kWh; see Table 8). This means that, in some cases, solar power plants without financial/policy support may be less competitive than a typical combined-cycle natural gas plant (without considering the environmental costs). We take the LCOE of natural gas plants in Kenya as a comparison, as this is a

[10] The project costs include the engineering, procurement and construction cost, and operating and maintenance costs.
[11] This is based on the existing literature and interviews with key informants in the country of operation.

probable market for AEGF support (Table 8). In this market at least, the LCOE of the solar power project is lower. Hence, this project is viable.

To work out the project's environmental benefits, it is assumed that, were the solar power project not implemented, a marginal power plant (combined-cycle natural gas) would be constructed instead. So the environmental cost of the natural gas plant — producing the same amount of electricity as the solar power project — is used to estimate the environmental benefits of the solar power project. The solar power plant will produce 1 470 677 459 kWh of electricity over its 20-year lifetime. A natural gas power plant producing the same amount of electricity would emit 808 872 603 $kgCO_2e$ (or 808 872.6 tonnes of CO_2e)[12].

The Environmental Defense Fund estimates the current social cost of carbon at $40/tonne[13]. Using this value, the environmental cost of a natural gas power plant producing 1 470 677 459 kWh of electricity is estimated to be $32 354 904. This constitutes the environmental cost avoided by building the solar power plant. Thus, $0.022/kWh is the environmental cost of the natural gas plant or the environmental benefit of the solar PV plant. Accounting for this environmental cost/benefit would enhance the viability of the solar PV project by reducing its LCOE from $0.060/kWh to $0.038/kWh. This makes the project more competitive against the natural gas alternative.

To determine how the AEGF would improve the solar plant's viability through the financing cost, the study introduces a second scenario where the project is financed with AEGF support, and then compares the financing cost with that of the first scenario. Based on the intervention logic in Section 2 and evidence on the impact of risk mitigation instruments in Section 5, we infer that the AEGF would influence project cost viability by reducing the interest rate and extending the tenor. Hence, referring to the spread of interest rates and repayment periods in Figures 3 and 4, a lower interest rate and longer repayment period are expected with AEGF support.

Figures 3 and 4 show that the differences in interest rates and loan tenors with and without investment insurance vary between countries. For example, the respective gaps in interest rates and loan tenors are approximately 5% and 16 years in Uganda, compared to 0.25% and 11 years in Côte d'Ivoire. The study draws from available information in the project brochure and discussions with those knowledgeable about the project financing to infer the potential interest rate and loan tenor given AEGF support. A 5% interest rate and a 15-year tenor are assumed. The project financing costs and viability are compared for the initial scenario of no investment insurance (7% interest rate, 8-year tenor) and the scenario with AEGF support (5% interest rate, 15-year tenor). The AEGF fee or insurance costs are added to the margin charged by lenders.

The total repayment amount (principal and interest) is higher for the AEGF-supported loan than for a loan without AEGF support. However, the discounted financing cost of the AEGF-supported loan (Table 7, column d) is lower than that of the loan without AEGF support (Table 7, column c) because the AEGF loan is discounted over a longer period. This is a major advantage of the AEGF: the longer tenor allows the investor to pay lower annual financing costs. As financial revenue from the project can cover these costs, the project's liquidity is ensured.

[12] According to Heinrich Böll Stiftung Nigeria and the Nigerian Economic Summit Group (2017), the emission profile of a natural gas power plant is 0.55 kgCO2e/kWh.
[13] https://www.edf.org/true-cost-carbon-pollution.

The projects financed with and without AEGF support experience an equivalent loss in their first two years as the financial benefit is zero[14]. The first-year loss is covered by the equity worth \$23 million/(1+*R*) in Year 0, where *R* is the investor's return in the financial sector (the main reference here being the 8% discount rate). In the second year too there is no electricity production whose revenue can cover the loan repayment costs.

The AEGF-financed project becomes profitable from the third year, whereas the financial benefits from the project without AEGF support only cover annual costs from the eighth year of production (tenth year of the project). The AEGF-supported project becomes profitable more quickly because the real financing cost is lower, and so can be more easily covered by the annual financial revenue. By contrast, the project without AEGF support does not generate enough financial revenue in the first seven years of production to cover the large annual loan repayment amount over the shorter time period. Therefore, to support the project's continuation, the investor may have to provide additional equity or take out another loan. In reality, this scenario would typically be provided for within the project's financial model.

If another loan is needed to cover the shortfall in the project's financial revenue, this will add to the financing costs over the years and ultimately raise the total costs. For example, to finance the shortfall in financial revenue, the investor in the project without AEGF support would need to borrow \$1.7 million at the market rate in year 3, then \$1.6 million in year 4. This will cover the financial losses in each year but incur additional interest charges in subsequent years. Under this scenario, the investor is unlikely to be able to access a new loan to finance the shortfall.

It may be feasible for the government to help the investor cover the loss by issuing more debt, incurring the opportunity cost of the interest rate on the debt. However, this is unlikely given limited public finances in the project country. If no government support is available and the investor lacks access to another loan, then the project is not feasible without AEGF support. In fact, the investor would likely be unable to secure funding for the project without AEGF support or a government guarantee, such that the project would not have been undertaken in the first place. This highlights the major advantage of the AEGF: enabling projects to access private financing. This comparison demonstrates that an investment insurance facility like the AEGF can significantly improve the viability of sustainable energy projects by reducing real financing costs. Thus, the availability of such investment insurance can be the deciding factor in whether investors proceed with a major sustainable energy project.

Finally, LCOE is worked out and compared for the projects with and without AEGF support. The calculations reveal that the LCOE of the project with AEGF support (\$0.054/kWh) is lower than the LCOE of the project without AEGF support (\$0.060/kWh). This indicates that AEGF support enhances cost viability and competitiveness. These results are in line with the United States Agency for International Development (USAID)'s (2018) conclusion that a high interest rate and/or short-term loans lead to higher LCOE.

This analysis assumes that construction of the power plant will take two years. However, construction delays are quite common in large infrastructure projects. A delay in the plant's construction would affect the cost-benefit analysis as the investor could start paying back the loan

[14] Project construction takes two years, so there is no electricity production in Years 1 and 2. Electricity production begins in Year 3.

before production begins and revenue is generated. Another consideration is that the estimated LCOE of the natural gas plant (obtained from other studies) may differ by country, considering that the LCOE is highly sensitive to location and country-specific parameters and factors. Besides, the analysis may be sensitive to changes in the operating and maintenance costs, depreciation rates and taxation.

The financing terms and discount rate used in the analysis were based on preliminary information for an African solar power project. A sensitivity analysis is conducted to examine how sensitive the project's viability is to variations in interest rate and loan tenor. For this purpose, a new scenario is created in which the changes in interest rate and tenor occasioned by AEGF support are lower than initially assumed. Specifically, the new scenario assumes a 6% interest rate and 12-year tenor, representing the averages of the loan terms in the first and second scenarios. Hence, the sensitivity scenario assumes that the AEGF reduces the interest rate from the market rate of 7% to 6% (not 5%) while increasing the tenor from the standard period of 8 years to 12 years (not 15 years).

The results of the sensitivity analysis are shown in column g of Table 7. The LCOE under this scenario ($0.057/kWh) is still lower than in the scenario without AEGF support ($0.060/kWh). This implies that provided the AEGF offers better loan terms than those available in the market, AEGF support would reduce the unit cost of energy. In terms of the viability of the solar power project relative to the alternative (natural gas), the LCOE in the sensitivity scenario ($0.057/kWh) is within the EIA-estimated range of the LCOE of natural gas technology and lower than the LCOE of natural gas plants in the project country. This implies that the viability and net benefit of the project are sensitive to the interest rate and loan tenor used in the analysis. Overall, energy projects supported by the AEGF would be more viable than those without AEGF backing. Without an available investment insurance policy such as the AEGF, investors may not have access to financing in the first place.

In summary, the AEGF's aim of mitigating the risks inherent in sustainable energy projects can potentially reduce the financing costs and improve the viability of such projects. This will ultimately enhance attainment of the socioeconomic development objectives associated with implementing key sustainable energy projects. These objectives are further discussed in the next section.

Table 7: Social cost-benefit analysis for a 40 megawatt solar power project ($1 000)

Year	tricity output (kWh	Total benefit[16]	ing cost (no AEGF supp	ng cost (with AEGF sup	benefit (no AEG	t benefit (AEGF	ncing cost (sensiti analysis)[21]	benefit (sensitiv analysis)[2
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
	-	-	23 000	23 000	-23 000	- 23 000	23 000	-23 000
	-	-	10 453	6 063	-10 453	-6 063	7 482	-7 482
	77 088	7 931	9 678	5 614	-1 747	2 317	6 927	1 004
	76 703	7 307	8 961	5 198	-1 655	2 109	6 414	892
	76 319	6 732	8 298	4 813	-1 566	1 919	5 939	793
	75 937	6 202	7 683	4 456	-1 481	1 746	5 499	703
	75 558	5 714	7 114	4 126	-1 400	1 587	5 092	622
	75 180	5 264	6 587	3 821	-1 323	1 443	4 715	549
	74 804	4 850	6 099	3 538	-1 249	1 312	4 365	484
	74 430	4 468		3 276	4 468	1 193	4 042	426
	74 058	4 116		3 033	4 116	1 083	3 743	374
	73 688	3 792		2 808	3 792	984	3 465	327
	73 319	3 494		2 600	3 494	894	3 209	285
	72 953	3 219		2 408	3 219	811		3 219
	72 588	2 966		2 229	2 966	736		2 966
	72 225	2 732		2 064	2 732	668		2 732
	71 864	2 517			2 517	2 517		2 517

[15] See Table 6.

[16] Electricity output multiplied by electricity tariff.

[17] Financing cost is worked out with the formula: $A = P\frac{r(1+r)^n}{(1+r)^n+1}$, where *r* = 7% and *n* = 8 years for a loan without AEGF support. The annual payment is then discounted over the term of the project.

[18] *r* = 5% and *n* = 15 years for a loan with AEGF support.

[19] Net benefit without AEGF = Total benefit – total financing cost without AEGF.

[20] Net benefit with AEGF = Total benefit – total financing cost with AEGF.

[21] *r* = 6% and *n* = 12 years for sensitivity analysis.

[22] Net benefit (sensitivity analysis) = Total benefit – total financing cost (sensitivity analysis).

Table 7: Social cost-benefit analysis for a 40 megawatt solar power project ($1 000) (continued)

Year	Electricity output (kWh)	Total benefit	Financing cost (no AEGF support)	Financing cost (with AEGF support)	Net benefit (no AEGF)	Net benefit (AEGF)	Financing cost (sensitivity analysis)	Net benefit (sensitivity analysis)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
18	71 504	2 319			2 319	2 319		2 319
19	71 147	2 137			2 137	2 137		2 137
20	70 791	1 958			1 968	1 968		1 968
21	70 437	1 813			1 813	1 813		1 813
22	70 085	1 671			1 671	1 671		1 671
Total	**1 470 677**	**81 211**	**86 540**	**79 046**	**-6 661**	**2 166**	**82 194**	**-2 681**
LCOE/kWh			**0.060**	**0.054**			**0.057**	
LCOE-B/kWh			**0.038**	**0.032**			**0.035**	

Source: Author's computation.

Note: LCOE-B denotes the levelised cost of energy including environmental cost/benefit.

Table 8: Range of the relative cost of energy across mini-grid technologies

Energy technology options	LCOE ($/kWh)	Source
Utility-scale solar PV (general)	0.058-0.143	EIA (2017) cited in USAID (2018)
Natural gas (general)	0.052-0.148	EIA (2017) cited in USAID (2018)
Solar PV (globally weighted)	0.068 (2019), 0.045 (2020), 0.039 (2022)	IRENA (2020)
Natural gas	0.113	Republic of Kenya (2011)
Natural gas	0.110	Henbest et al. (2015)

7. Potential socioeconomic impact of the AEGF in Africa: insights from the energy access economic development literature

Figure 2 shows that the AEGF's ultimate impact objective is to enhance the macroeconomic performance of African countries and improve their social and human development conditions. It is assumed that if the AEGF can successfully facilitate access to funding for energy investors in Africa, this will enable new electricity projects that will improve the current level of electricity supply and access, resulting in important socioeconomic and human welfare effects for the populations of beneficiary countries. Thus, this section explores the potential macroeconomic and welfare impact of the AEGF in Africa, drawing on empirical literature on the macroeconomic and development effects of electricity access. Prior findings on how improving electricity access affects the economy and local population should be indicative of the AEGF's potential outcomes in beneficiary countries.

7.1. Macroeconomic impact

Improving electricity access has considerable macroeconomic effects, some of which are summarised in Table 9. Although the effects of electricity interventions on GDP and employment vary according to the nature and size of the project, there is overwhelming evidence that electricity projects, and the consequent improvement in electricity supply, boost the economy and generate employment. This implies that if the AEGF successfully improves electricity supply in the beneficiary countries, it will also boost GDP and employment.

7.2. Welfare impact

In addition to boosting the macroeconomic performance of sub-Saharan African countries, the AEGF will also lead to improvements in the welfare and wellbeing of local populations. These potential welfare effects are elaborated in Figures 5 and 6, which summarise prior empirical findings on the direct, indirect and household-level effects of electricity access. The reviewed empirical evidence points towards significant potential welfare effects of the AEGF. If the initiative meets expectations by facilitating private investment in the energy sector and improving electricity access, this will positively affect the livelihoods and wellbeing of the local population, with benefits in terms of health and education outcomes, empowerment of women, household productivity and income, and overall quality of life.

Further details of the magnitude of the effects of electricity access on core socioeconomic and welfare indicators are provided in Table 10.

Table 9: Evidence of the macroeconomic effects of electricity interventions

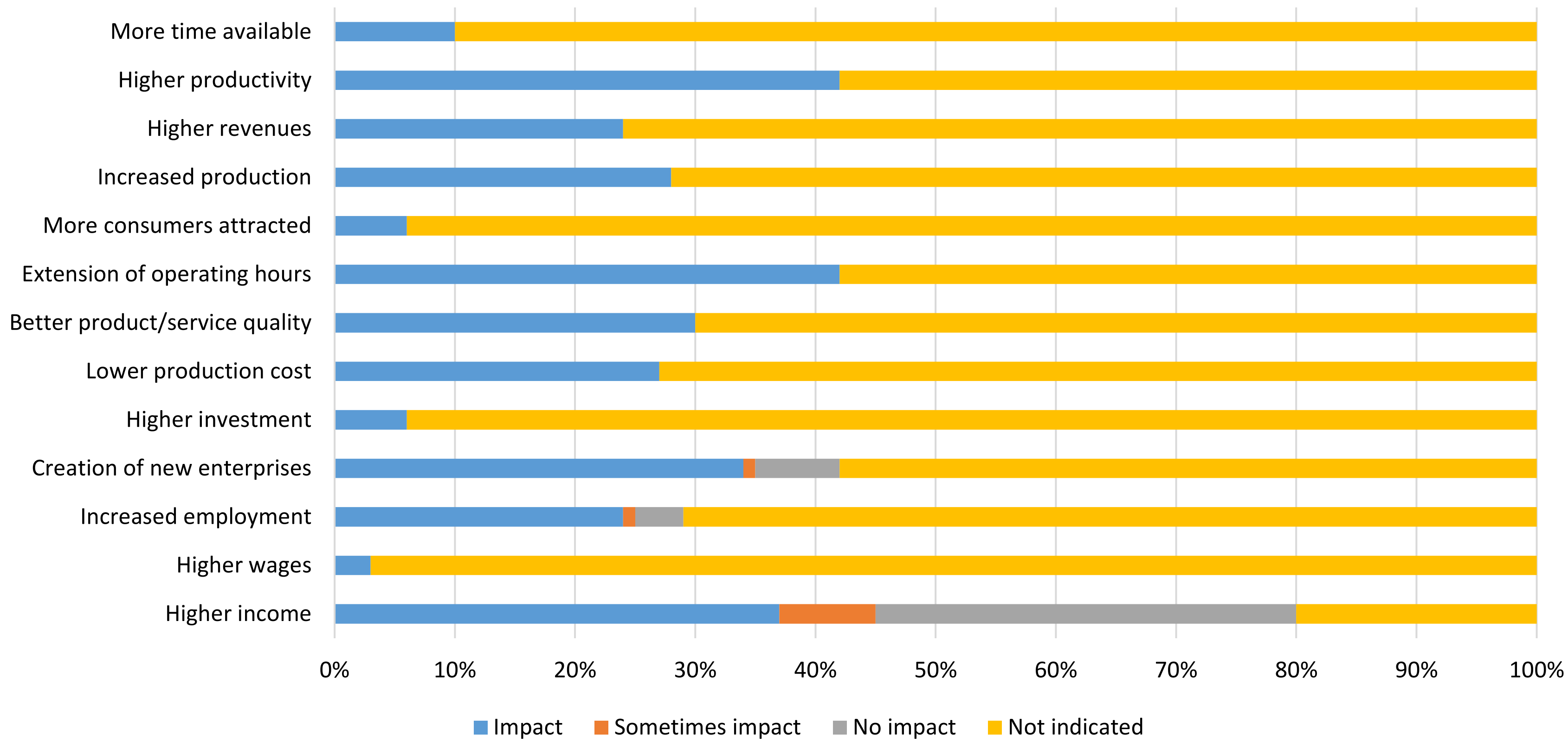
Study	Country	Project/intervention	Methodology	Impact
London Economics (2012)	New York (United States)	333-mile underwater and underground high-voltage direct current transmission links	Regional economic model Inc. PI+ model incorporating input-output model, computable general equilibrium model, econometrics and new economic geography theory	Construction stage 300-600 direct jobs 1 200 indirect and induced jobs New York GDP rose by $150 million per year Operational stage 2 400 indirect and induced jobs in the first ten years GDP rose by annual average of $600 million from 2017 to 2026 $650 million savings in electricity costs
Pollin et al. (2009)	United States	Clean energy investment legislation	Input-output model	$150 billion in investment Net increase of 1.7 million jobs
Hodges and Rahmani (2007)	Southeastern United States	20 MW and 40 MW biomass electricity project	Macro model, including input-output model	20 MW plant Increased output/GDP by $2.8-45.3 million 27-379 jobs Value added impact of $1.7-25.9 million 40 MW plant Increased output/GDP by $3.8-$78.7 million 39-653 jobs Value added impact of $6.3-44.9 million
Goldman Sachs (2016)	29 countries	Clean energy investment		129 000 jobs; $34 billion revenue Avoided 74 million metric tonnes of greenhouse gases
Chen et al. (2017)	Small Island States	1% increase in renewables	Structural equation model	0.025% or $18 million increase in GDP
IFC (2012)	Bhutan and India	Power transmission project	Input-output model, vector error correction model, step-by-step estimation method	9 700 jobs; 1 760 direct, 2 200 indirect, 5 700 induced

Table 9: Evidence of the macroeconomic effects of electricity interventions (continued)

Study	Country	Project/intervention	Methodology	Impact
Scott et al. (2013)	Uganda	Bugoye (small) hydropower project	Input-output model, time series analysis, step-by-step estimation method	1 270-1 278 jobs during construction and operation stages 8 434-10 256 indirect/induced jobs
Private Infrastructure Development Group (2017)	Senegal	Tobene 70 MW power plant and Senergy solar power project	Step-by-step estimation, input-output model	Economic output growth of $434.5 million 68 500 jobs
Beguy et al. (2015)	Niger	Hydro dam project	Macro model	Increased GDP by 0.25% Increased government revenue by 0.45 percentage points of GDP
Major and Drucker (2015)	Hungary	Electricity outages	Computable general equilibrium model	A 2.08% decline in electricity supply (increase in electricity outages) led to a 0.53% reduction in GDP and a 0.84% decrease in employment

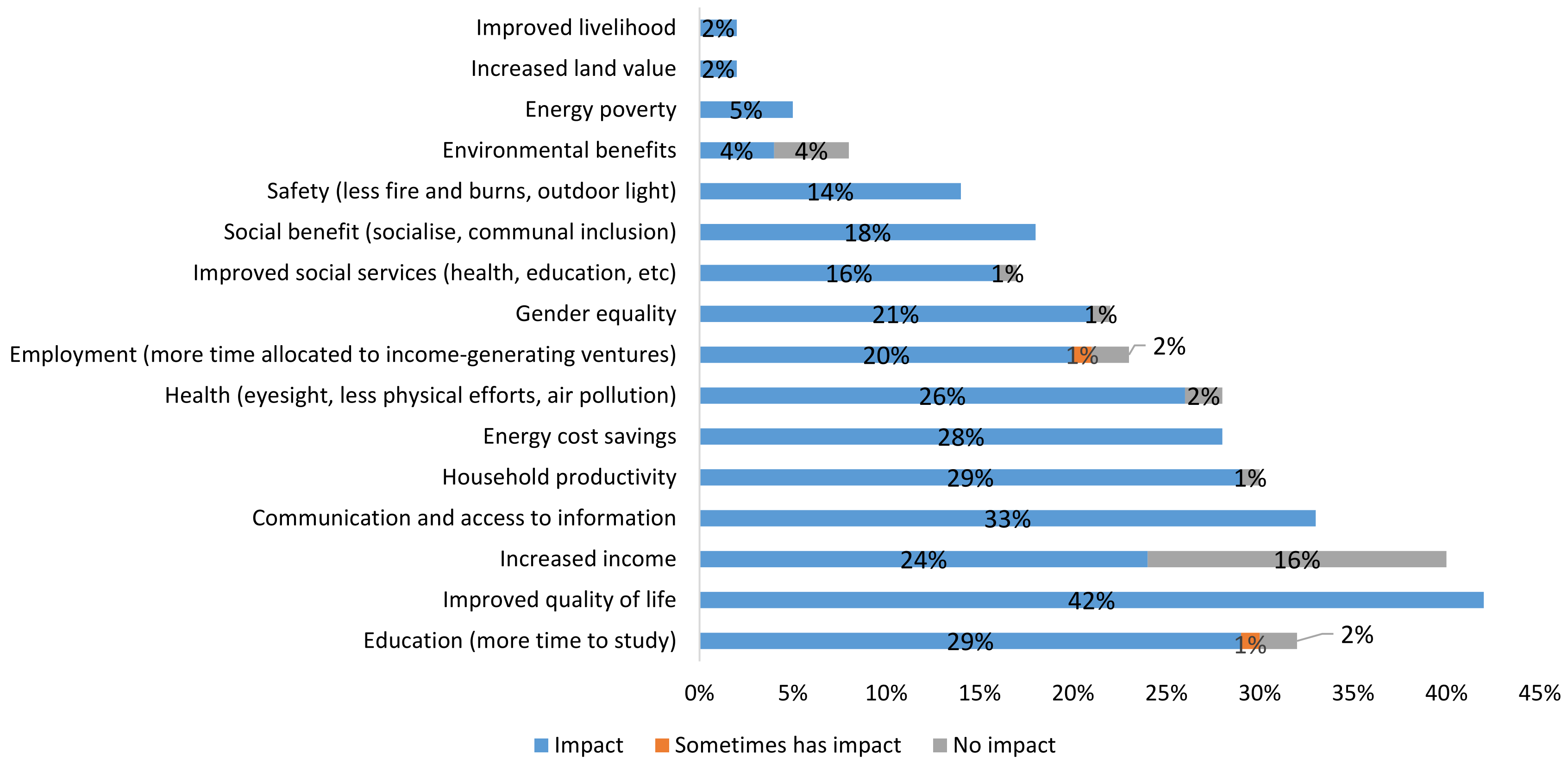
Source: Author's compilation.

Figure 5: Summary of the literature on the direct and indirect effects of electricity access



Source: Pueyo and Hanna (2015).
Note: Impact means there is an impact in all cases; sometimes impact means there is impact in some cases and no impact in some cases.

Figure 6: Summary of the literature on the household-level effects of electricity access



Source: Pueyo and Hanna (2013).

Note: Impact means there is an impact in all cases; sometimes impact means there is impact in some cases and no impact in some cases. The items in brackets () are the indicators for measuring the outcomes described in the figure. For example, education is indicated by the extra time/hours students have to study as a result of access to electricity; health is indicated by the improvement in health associated with less use of physical efforts in performing some tasks as a result of electricity access, improved eyesight and reduced air pollution as a result of using modern energy instead of traditional fuel for cooking.

Table 10: Overview of the estimated impact of electricity access on social welfare

Impact	Author	Country	Electricity intervention	Methodology	Outcome indicator	Impact
Education	Gustavsson (2007)	Zambia	Solar electric services	Pre-and post-survey	Improvement in children's school performance (school marks)	↔
					Possibility to receive formal education in rural areas	↑
	Kanagawa and Nakata (2008)	India	Rural electrification	Regression analysis	Literacy rate	↑ from 63.3% to 74.4%
	Asian Development Bank (ADB) (2010)	Bhutan	Household connection	Propensity score matching (PSM)	Years of schooling completed	↑ 0.64 years (girls), 0.41 years (boys) and 0.52 years (both)
	Banerjee et al. (2011)	Nepal	Household connection	PSM	Study time (min/day)	↑ 12 minutes per day (girls) and 7.7 minutes per day (boys)
					School years completed	↑ 0.24 years (girls) and ↔ (boys)
	Bensch et al. (2011)	Rwanda	Community electrification	PSM	Children study time (hours/day)	↑ 0.23 hours per day
	Karumba and Muchapondwa (2017)	Kenya	Micro hydroelectricity schemes	PSM	School children study time	↓ 43 minutes
	Khandker et al. (2014)	India	Household connection	Instrumental variable	School enrolment	↑ 6% (boys) and 7.4% (girls)
					Study time (hours/week)	↑ 1 hour per week
					Completed schooling years	↑ 0.3 years (boys) and 0.5 years (girls)

Table 10: Overview of the estimated impact of electricity access on social welfare (continued)

Impact	Author	Country	Electricity intervention	Methodology	Outcome indicator	Impact
	Khandker et al. (2012)	Bangladesh	Household connection	Cross-sectional survey and instrumental variable	Schooling years	↑ 0.092 years (boys) and 0.133 years (girls)
					Study time (min/day)	↑ 6.0 minutes per day (boys) and 8.9 minutes per day (girls)
Health	ADB (2010)	Bhutan	Household connection	PSM	Cough incidence	↓ 2.8%
					Respiratory ailments	↓ 5.6%
					Eye irritation	↓ 13.5%
					Headache	↓ 4.2%
	Banerjee et al. (2011)	Nepal	Household connection	PSM	Respiratory problems	↓ 3.4% (women), 1.6% (girls) and 6.1% (boys)
	Shonchoy (2016)	Bangladesh	Rural electrification projects	Instrumental variable	Reported proportion of children with stunted growth	↓ 9 percentage points between 2000 and 2014
					Nutritional status of children under five years old as measured by height-for-age Z-score	↑ over 0.15 points
Enterprise development	Kumar and Rauniyar (2011)	Bhutan	Household connection	PSM	Number of enterprises	↔
	ADB (2010)	Bhutan	Household connection	PSM	Number of enterprises	↔

Table 10: Overview of the estimated impact of electricity access on social welfare (continued)

Impact	Author	Country	Electricity intervention	Methodology	Outcome indicator	Impact
Fertility	Shonchoy (2016)	Bangladesh	Rural electrification projects	PSM	Fertility	↓ at least one child
	Banerjee et al. (2011)	Nepal	Household connection	PSM	Contraceptive prevalence rate	↑ 0.038%
	ADB (2010)	Bhutan	Household connection	PSM	Number of children born in the last five years	↓ 0.05
Women empowerment	ADB (2010)	Bhutan	Household connection	PSM	Participation in decisions on education and health index	↑ 0.049
	Banerjee et al. (2011)	Nepal	Household connection	PSM	Women's time in income generation	↑ 0.19 hours per day
					Women's time studying	↑ 0.20 hours per day
					Women's leisure time	↑ 0.21 hours per day
	Khandker et al. (2014)	India	Household connection	Instrumental variable	Fuel collection time	↓ 3.3 (hours/month)
	Grogan and Sadanand (2011)	Nicaragua	Rural electrification	Instrumental variable	Probability of women's employment outside household	↑ 23%

Table 10: Overview of the estimated impact of electricity access on social welfare (continued)

Impact	Author	Country	Electricity intervention	Methodology	Outcome indicator	Impact
Employment	Dinkelman (2011)	South Africa	Mass roll-out of electricity to rural households	Instrumental variable and fixed effect	Female employment	↑ 9-9.5%
					Working hours for men and women	↑ 8.9 hours per week (women) ↑ 13 hours per week (men)
					Wages for men and women	↓ 20% (women), ↑ 16% (men)
	Chowdhury (2010)	Bangladesh	Community electrification	Ordinary least square method and probit model technique	Probability of participation in non-farm work	↑ 0.1 (women) ↑ 0.649 (women – joint treatment of electrification and road access)
	Costa et al. (2009)	Ghana	Rural electrification	Ordinary least square method and instrumental variable	Total hours worked	↑ 0.21 hours (men) ↔ (women)
	Khandker et al. (2014)	India	Household connection	Instrumental variable	Total hours worked growth (%)	↑ 17% (women) and 1.5% (men)
	Mapako and Prasad (2008)	Zimbabwe	Grid electricity	Survey of end-user perspectives	Job creation	↑ 270% increase in employment (of which 41% women)

Table 10: Overview of the estimated impact of electricity access on social welfare (continued)

Impact	Author	Country	Electricity intervention	Methodology	Outcome indicator	Impact
Income	Rao et al. (2016)	India and Nepal	Small-scale electricity system	PSM	Income	↔
	Gibson and Olivia (2010)	Indonesia	Access to reliable electricity	Tobit and probit regression techniques	Share of rural income from non-farm enterprises	↑ 27%
	Banerjee et al. (2011)	Nepal	Household connection	PSM	Non-farm income (Rupees/capita/month)	↑ 0.112 Rupees/capita/month
					Expenditure (Rupees/capita/month)	↑ 0.09 Rupees/capita/month
	Khandker et al. (2012)	Bangladesh	Household connection	Cross-sectional survey and instrumental variable	Farm income growth (%)	↑ 24.1-52%
					Non-farm income growth (%)	↑ 23-73.7%
					Total income growth (%)	↑ 12-16.7%
					Expenditure per capita growth (%)	↑ 8.2-9.2%
	Khandker et al. (2014)	India	Household connection	Instrumental variable	Income per capita growth (%)	↑ 38.6%
					Food spending growth (%)	↑ 14%
					Non-food expenditure growth (%)	↑ 30%
					Poverty rate growth (%)	↑ 13.3%

Barron and Torero (2014)	El Salvador	Grid connection	Instrumental variable	Participation in income-generating activities among adult women	↑ 46 percentage points (non-farm employment) and 25% (probability of operating a home business)
Khandker et al. (2009)	Vietnam	Household connection	Difference-in-difference, fixed effect, PSM	Farm income growth (%)	↑ 30%
				Non-farm income growth (%)	↔
				Total income growth (%)	↑ 25%

Source: Pueyo et al. (2013), with adjustments and additions by the author.

Note: ↑, ↓ and ↔ respectively indicate that the electricity intervention has a positive, negative or no impact on the corresponding welfare outcome indicator.

The impact of electricity access depends on the nature of the electricity intervention, availability of complementary infrastructure, and the existing socioeconomic context. Evidence shows that standalone off-grid connections may not be enough to promote the transformation required for economic development and poverty reduction on a large scale. Grimm et al. (2016) show that while small-scale off-grid connections like solar lamps help households reduce kerosene use, enable children to study at night, and improve health conditions associated with harmful smoke emissions, the ultimate poverty reduction effects are small compared to those of larger infrastructure. Furthermore, as Chowdhury (2010) shows, electricity access alone may not be enough to rapidly improve economic welfare in developing countries. Instead, electricity interventions likely need to be combined with other complementary infrastructure interventions. Some studies also show that the availability of electricity is not always the issue; rather, the reliability of supply and households' ability to afford electricity may be problematic (Chakravorty et al., 2014; Grimm et al., 2016). Furthermore, the impact of electricity access may take time to manifest. Several important questions require further research: What kind of electricity access interventions/projects bring the most benefits? How can consumers be encouraged to use electricity more productively? How long does it take for the impact of electricity access to take effect? What complementary policies would enhance the impact of electricity access?

The summary of the review of the macroeconomic and welfare effects of electricity access in this section suggests that the AEGF has the potential to enhance the economic development of sub-Saharan Africa and improve livelihoods by alleviating energy poverty. By promoting improvement in electricity access in the region, the AEGF will enhance macroeconomic development through rising GDP and employment. Improvements in other macroeconomic indicators, such as foreign direct investment, economic productivity and enhanced competitiveness, are also expected. In addition to boosting macroeconomic development, the AEGF will also promote social and welfare development among beneficiaries of energy projects. Expected welfare effects of the AEGF include increased household income, better education and health outcomes, empowerment of women, enterprise development and increased employment opportunities, among other benefits.

The extent of these outcomes may depend on the nature of the energy project, availability of other complementary infrastructure, and the specific context of the country or location where the project is implemented. This means that in deciding which electricity projects to support through the AEGF, the local context should be considered so as to maximise impact. To achieve desired development outcomes, it may also be necessary for other development interventions to complement AEGF-supported energy projects. Finally, as the AEGF largely focuses on enhancing electricity supply, measures to ensure the population in project locations can afford electricity, connect to the power supply and make productive use of it are equally important.

8. Conclusion

This study examines the potential macroeconomic and welfare impact of the AEGF, a financial instrument geared towards mitigating energy investment risks in Africa. Emanating from a collaboration between the EIB, Munich Re and the ATI, the AEGF seeks to mitigate the risks that undermine private investment in and financing of sustainable energy projects in Africa.

Though not the first risk mitigation instrument for infrastructure projects in Africa, the AEGF is the first dedicated investment insurance facility for sustainable energy projects in the continent. Energy projects in the region, such as the Azura power plant in Nigeria, the Azito plant in Côte d'Ivoire, and various power plants in Kenya, have benefited from existing risk mitigation instruments offered by MIGA, other World Bank Group institutions, and multilateral and private financial institutions. These facilities have successfully helped to mitigate the risks inherent in these projects and facilitated private financing for their implementation. One key lesson from the experiences of these case projects is that the instruments alone are not enough to ensure the success of energy projects; they need to be provided alongside other forms of support, such as technical assistance for energy sector reforms and for energy project planning and appraisal.

However, there are still several demand-side factors limiting the adoption of risk mitigation instruments in the region. The primary factors include the high cost of the instruments, which tends to offset their financing advantage; the partial risk coverage of the instruments, which makes it difficult to evaluate uncovered risks; the complexity of the products and the lengthy process of negotiation and approvals, which many investors deem too time-consuming; the low certainty and slow speed of claim payment; lack of awareness of the products among investors; and investors' inadequate financial or administrative capacity to manage the application process. The AEGF seeks to address the issues of cost and delays in claim payments by engaging with the ATI, which already has experience of conducting business with investors in Africa.

While there is limited empirical evidence on the impact of risk mitigation instruments on access to finance for infrastructure and energy projects, available evidence from equivalent instruments for SMEs points to a significant positive effect, reflected in lower interest rates and longer loan tenors. Despite differences between the risk mitigation instruments for infrastructure projects and SMEs, the findings that confirmed SMEs can more easily access finance indicate that financing for infrastructure projects could be similarly enhanced. The study's literature review reveals that risk mitigation instruments improve access to financing for investors and SMEs as beneficiary firms are able to raise external loans, which they would not have been able to access in a normal credit market (without investment insurance). The secondary outcomes of the instruments vary depending on what is measured. Generally, risk mitigation instruments improve firm output but have mixed effects on employment, productivity and investment. This implies that the AEGF may help investors access financing for their projects, but with mixed ultimate effects on project performance and the economy. In addition, there is evidence to suggest that the availability of risk mitigation instruments emboldens investors to take on higher-risk projects.

The study further demonstrates the AEGF's potential impact on the viability of energy projects with a cost-benefit analysis of a hypothetical African solar power project. The hypothetical example was designed to be reflective of the kind of project that might be supported under the AEGF, drawing on information from project partners, data from the literature and insights from expert interviews. The AEGF's impact on project viability was estimated by calculating and comparing the cost of the project with and without AEGF support. The analysis shows that the longer tenor and lower interest rate induced by the AEGF produce a lower real financing cost, relative to the project without AEGF support. This translates to a lower total cost and improved viability, whereas the project would not have been viable without AEGF support. The viability of the AEGF-supported project is further enhanced once the environmental benefits are considered.

By improving the viability of energy projects, the AEGF will engender a significant increase in electricity generation and supply, which should then lead to significant macroeconomic improvements and promote human development and welfare. Based on the electricity access development literature, the potential macroeconomic and welfare effects could include economic growth, employment, increased household incomes, empowerment of women, development of SMEs, improved health and educational outcomes, enhanced quality of life, and other social and environmental benefits. However, mere improvement in electricity supply may not achieve targeted development outcomes. People need to be connected to the power supply and know how to use electricity for productive and economic purposes. Moreover, electricity access alone may not be enough to promote economic growth and welfare improvements; other complementary infrastructure and policy interventions, such as skills development, may also be essential. This implies that while the AEGF may enhance electricity access in the region, its impact on other socioeconomic and development outcomes is uncertain.

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EIB-GDN WORKING PAPER

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