Insights for development interventions in the clean-energy sector

With a focus on sub-Saharan Africa

SEI brief
April 2025

Daniel Duma
Maximilian Bruder
Annika Hilgert

Key messages

- Access to reliable and affordable electricity is necessary, but not a guarantee, for economic development. A review of the literature on renewable-energy and clean-cooking interventions, primarily in sub-Saharan Africa, reveals seven key areas for interventions, each with distinct dynamics:
- **Electricity-generation interventions** have been effective in increasing wind and solar photovoltaic capacity.
- **Transmission** is becoming a bottleneck. However, externally financed transmission projects with independent operators offer a promising way forward for struggling utilities.
- **On-grid electricity access** is challenging due to low consumption rates, the poor state of electric utilities, and a lack of affordability.
- **Off-grid electricity access** has increased and improved through innovation. Nevertheless, many businesses offering off-grid services struggle to maintain profitability.
- **Clean-cooking interventions** have low adoption rates largely due to affordability constraints and designs that do not focus on user preferences.
- **Knowledge-sharing and capacity-building interventions** are particularly difficult to assess. Nevertheless, long-term, programmatic, co-designed approaches are promising.
- **Policy reforms** are key for ensuring that investments generate the benefits they are designed to achieve. However, reform interventions are challenging due to a focus on form over function, and a lack of both local buy-in and trust.

Introduction

Access to affordable, sustainable and reliable electricity is essential for human and economic development. Universal access to energy is considered to be an enabler for myriad global goals, including reducing poverty, expanding access to healthcare and education, increasing gender equality, boosting sustainable economic growth, and taking actions to limit and adapt to climate change (UN Department of Economic and Social Affairs [UNDESA], 2024).

Workers cleaning panels at the 20 MW Gomoa Onyaadze Solar Power Station in Ghana (Photo: Daniel Duma / SEI)

Some 685 million people lack access to electricity, and 2.1 billion people lack access to clean cooking, according to the most recent Energy Progress Report (International Energy Agency [IEA], 2024). Though most of those who lack these basic services are in sub-Saharan Africa, greater access to energy and clean cooking is needed across the entire African continent (IEA, 2024).

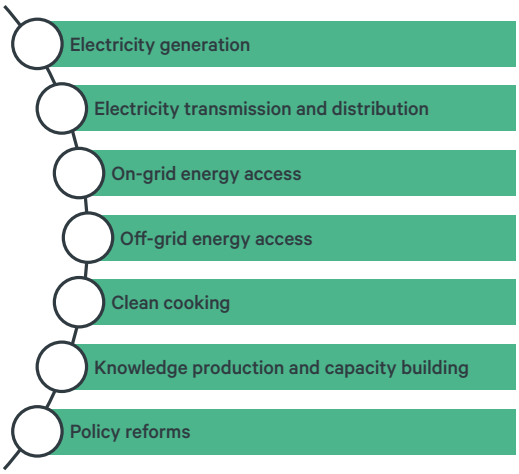
Renewable energy has an important role to play in widening access to electricity – and tapping the potential development aims it can help unlock. Though significant advancements have been made in the renewable-energy sector globally, the rate of progress to meet the growing energy needs is insufficient, particularly in sub-Saharan Africa where it is most lacking. Key challenges lie in identifying the types of interventions that make energy more widely available and create conditions for its beneficial use – and in sufficiently connecting the dots to better understand how such interventions directly lead to specific benefits, and why specific interventions did or did not lead to hoped-for improvements.

To help address these challenges, this policy brief summarizes key findings from a literature review and synthesis of the literature on renewable-energy and clean-cooking interventions – focusing on sub-Saharan Africa but examining issues that may also warrant consideration in low- and lower-middle-income countries more generally.[1] The brief highlights seven focus areas that should be considered, outlines a theory of change to inform decision-making stages from concept to impact, provides an evidence base for informing donors' choices on the composition of their energy portfolio in different stages of development, and offers recommendations for projects being proposed and implemented.

Key areas for interventions in the renewable-energy sector

We focus on seven key areas that emerged from the literature review. Figure 1 lists these areas.

Figure 1: Focus areas within the renewable-energy chain

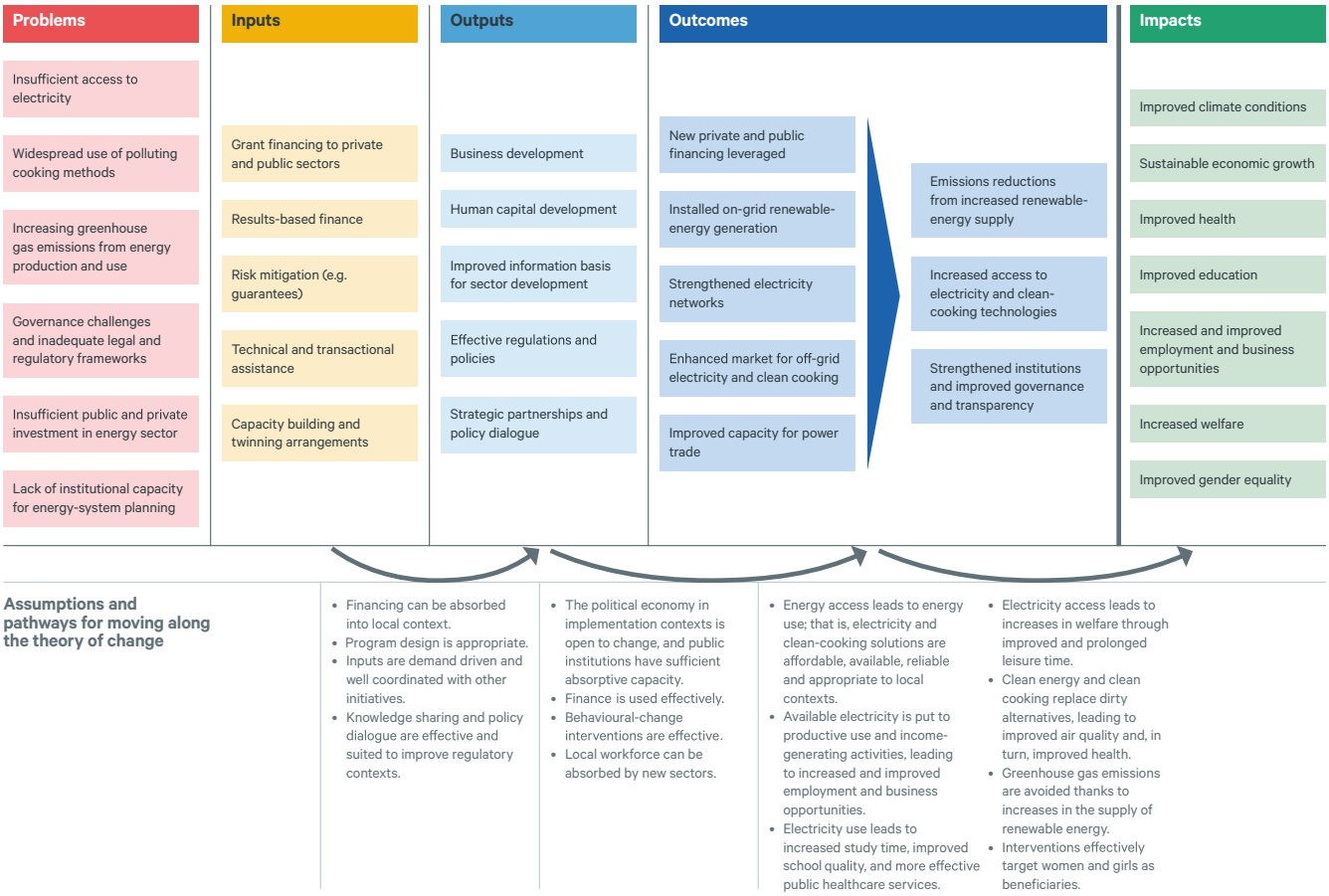


1 The literature review and synthesis were undertaken as part of ongoing work with the energy section at the Norwegian Agency for Development Cooperation (Norad).

Theory of change for interventions in the renewable-energy sector

After conducting a comprehensive review of academic and practitioner literature, we developed a theory of change (Figure 2) to illustrate how and why renewable-energy interventions can lead to the desired outcomes and impacts.

Figure 2: A theory of change for development interventions in the energy sector



Any energy-development intervention passes through different stages to reach its desired impact, and each stage depends on assumptions. First, development partners provide various inputs, such as grants, loans or technical assistance, to elicit a certain output, such as a new business or better information for decision-making. These outputs are intended to lead to outcomes, such as improved markets, increased power trade, or new installed capacity or transmission lines. Ultimately, these outcomes are meant to generate impacts that directly benefit the intended users, for example by enhancing access to and use of off-grid electricity. The final results in the chain are the intended, positive impacts: the envisioned contributions to sustainable socioeconomic development and human wellbeing.

What are the key factors of success? The picture is complicated. Successful graduation from one stage to the next occurs only when necessary conditions are in place; often, such conditions lie outside the control of development partners. Moreover, successful outputs do not automatically lead to successful outcomes or successful impacts.

Indeed, the factors that can lead to successful implementation of interventions are different at output and outcome levels and across the seven areas highlighted.

We address these issues separately. We first examine outputs and outcomes for each of the seven intervention areas: generation, transmission and distribution, on-grid energy access, off-grid energy access, clean cooking, knowledge sharing and capacity development, and policy reform. We then assess the impact-related evidence of electricity and clean cooking across all areas.

Evidence for the effects of energy interventions on outputs and outcomes

Focusing on the first part of our theory of change, we find evidence for outputs and outcomes in the seven areas are as follows:

Electricity generation – Significant progress has been made in adding utility-scale capacity to the grid (Attridge et al., 2019). For example, between 2013 and 2023, installed wind and solar photovoltaic capacity in sub-Saharan Africa increased by a factor of 16 (excluding South Africa, which is an outlier among countries in the region[2]) (IRENA, 2023). Capacity grew from close to zero in 2010, to around 200 MW in 2013, to 3504 MWs in 2023. Projects were developed, financed, built and connected to the grid in nearly all countries in the region thanks to sustained efforts by governments and partners to create regulatory environments and blended-finance instruments required for the pioneering clean-energy projects. However, significant challenges remain: the financial viability of the power system, transmission and system-integration issues, and the (financial) risk of overcapacity (Eberhard & Dyson, 2020). Tailored interventions and integrated planning are essential to ensure that additional capacity is well integrated into the market and energy systems, and to generate benefits while avoiding overburdening utility offtakers with debt.

Transmission and distribution – These interventions tend to be more challenging than generation. They represent a significant bottleneck to clean-energy expansion, to the overall viability of the energy system (due to large energy losses in networks that are not adequately maintained), and to the economy (due to reliability issues). Transmission and distribution require long-term support via grants and loans for operational improvements of the utility to effectively connect new-generation assets, enhance reliability, and improve efficiency. Innovative solutions – such as externally financed transmission projects with independent operators – may play an important role, offering a way forward for struggling utilities.

On-grid energy access – Efforts to expand access by extending grids or connecting new households to existing grids have succeeded in sharply increasing connection rates, which have reached 75% in Kenya and 85% in Ghana, for example (IEA, 2023). However, expansion efforts face hurdles: high connection costs, low consumption, and a limited willingness to pay among potential customers. Addressing these challenges requires targeted subsidies (both on the demand and supply sides) and improvements in utility performance to enhance the value proposition of connections.

2 South Africa's installed capacity in wind and solar power generation (9101 MW) is higher than all the rest of sub-Saharan Africa's capacity combined (3504 MW).

Off-grid energy access – Such solutions remain essential for remote communities, as demonstrated in some markets in East Africa (such as Kenya and Uganda). High costs and market inefficiencies pose barriers to their adoption and sustainability. Making these solutions viable and suitable for different contexts will require financial support, market reforms, and risk-reduction measures.

Clean cooking – Even though more people have gained access to clean cooking in recent decades, expansion has failed to keep pace with population growth in sub-Saharan Africa. There are many different types of stoves with unique challenges, but, at present, there remains a fundamental trade-off between the efficiency and affordability of stoves. Donors' approaches differ, with some prioritizing efficiency and others affordability. Stove designs often do not cater to users' preferences or cooking habits, hindering uptake (Karanja & Gasparatos, 2019). To improve uptake, efforts must be made to adopt user-focused designs, employ long-term education campaigns, and tap into robust supply chains that can improve affordability and accessibility. These approaches require strong national policy programs, reinforced by international financial support. Recently, clean cooking enterprises have begun to shift their approaches, moving from donation-based to market-based concepts, with business models often leveraging carbon credits. However, such approaches entail risks in terms of potential price volatility and uncertainty on carbon credit certification standards.

Knowledge sharing and capacity building – Though the evidence on such interventions is limited, measures can and should focus on policymakers and regulators as key enablers for a functioning energy sector. Such interventions aim to facilitate access to research, technology, and know-how for clean energy and energy efficiency; and on enabling scaling up, coordination and management of renewable energy and energy access. Successful interventions require long-term efforts that are adapted to local needs and situations. Achieving meaningful progress will require co-designing initiatives with local stakeholders, and allocating time and resources to systematically evaluate results over time.

Policy reform – Policy reform is a crucial enabler for other interventions. Indeed, operational improvements in the power sector are seen as the only way to ensure that investments in generation and transmission bring about the benefits they are designed to achieve and sustain improvements over the long term (Toman et al., 2018). Long-term, trust-building approaches are key to securing significant and sustainable change. Understanding the political and economic contexts behind sector weaknesses is essential for crafting effective interventions. Independent regulators can be both targets of reform interventions to develop "islands of good practice", and enablers of further reforms in the sector to improve performance.

Impacts of energy interventions

At the macroeconomic level, evidence suggests that energy contributes to economic growth and employment mainly by reducing energy costs by replacing expensive, fossil-fuel-powered back-up generation, and by minimizing outage times (Stern, Burke & Bruns, 2019). Despite the academic debate over whether electricity has a causal link for socioeconomic development, reliable energy supply is widely regarded as necessary for growth – but not sufficient in itself to achieve growth. Indeed, one cannot imagine a country in the modern world finding a way to achieve economic growth and enhance the wellbeing of its citizens in the absence of secure, affordable electricity provision.

At the microeconomic level, evidence shows that energy generally has positive yet modest effects on households in terms of economic outcomes, education, health, and gender equality (Asian Development Bank [ADB], 2019). However, significant variation exists among studies due to factors such as study design, outcome types, measurement methods, geographic location, methodology, and follow-up duration. Unexpected outcomes and negative externalities are often not clearly measured or addressed. For clean cooking, the evidence shows that inconsistent adoption and use by target populations continue to limit impact. In all, the variability of outcomes that surfaces in the literature underscores the importance of considering local contexts (Steward Redqueen, 2019).

Energy interventions in the face of uncertainties

Though the direction of causation – whether power primarily drives development, or development primarily drives power demand – may be a source of academic debate, energy is unquestionably essential to modern development. Indeed, there is no example of a modern economy that has managed to create economic prosperity and improve human wellbeing without it.

Energy is an essential enabler. It affects – and is affected by – a wide variety of forces that play out over time – including the presence or absence of other infrastructure, the reliability of services, the cost of power, and the matter of who bears these costs. Things may look different in the short term than in the long term. For these reasons, it is difficult to put an exact figure on the direct impacts of energy and energy investments (ADB, 2019).

Evaluations acknowledge the difficulty in attributing results to prove or dispel the value of specific interventions (Independent Evaluation Unit [IEU], 2024). Efforts to demonstrate measurable impacts from energy interventions are stymied by myriad factors, including selection bias, high data-collection costs, and spillover effects that obscure causality. Counterintuitive results and gaps in evidence further complicate evaluations. Though most measurement efforts look at the short term, most impacts (such as economic growth and improved wellbeing) take decades to materialize.

Beyond the difficulties of measurement are other difficulties. The designs of energy interventions (and, thus, the impact these interventions have) depend on major assumptions that may or may not hold in particular cases, regions or periods of time

(ADB, 2019). Even the assumption that access to energy will be achieved by a given intervention does not always hold. The service may be unavailable due to technical faults, or the inability to pay for things such as electrical connections, bills for electrical use, or electricity-powered appliances. And, even if power is available, the assumption that it will be used right away is also not a given. Another assumption is that creating the enabling conditions will help markets develop and cater to previously unserved populations in a sustainable way. This assumption has been challenged, with many private-sector initiatives struggling to maintain profitability as consumers at the base of the economic pyramid cannot afford to make regular payments for the service in the long run (Wörlen et al., 2023).

With energy interventions seeking to achieve more objectives that go beyond mere energy provision – such as contributing to income generation, education, health, gender equality and environmental sustainability – there are more untested assumptions about the behavioural changes induced by energy access. In light of this, the systematic collection and assessment of data about the impacts of energy interventions have become more important (see recommendation 3).

Nevertheless, one message remains clear: though energy does not guarantee beneficial socioeconomic development, such development is unlikely to occur in its absence. In this sense, energy interventions represent a fundamental development strategy.

Policy recommendations

Based on the literature review and our own work, we offer the following five recommendations:

1. **Carefully assess needs.** Develop thorough needs-assessment tools to ensure that the context is well understood. The evidence suggests that situations differ widely between and within countries and regions. Needs assessments should map energy-intervention options to find the right complementarities and synergies with other donors, and to assess the desirability and willingness to pay for energy services on a local level. Such efforts will help pinpoint the most effective interventions and help avoid duplication.

2. **Find a balance of approaches to include both large and small, and for-profit and grant-supported initiatives.** Find a balance between targeting two distinct approaches: 1) larger, potentially viable projects with instruments that facilitate private investment and 2) smaller and grant-supported long-term interventions for the base of the pyramid. Private-sector, for-profit investment will be more suitable for commercially viable projects: the segments of the population and business that are willing and able to pay a price that covers costs and generates an adequate return. Smaller-scale interventions that provide lower-tier access and clean-cooking equipment but require significant and long-term subsidies will be more suitable for serving those at the base of the economic pyramid.

3. **Learn and adapt.** Apply an adaptive approach to long-term monitoring, evaluation and learning to constantly assess interventions and adjust when necessary. Provide support to initiatives that contribute to generating sector knowledge and data (which are still lacking). A context-relevant and up-to-date evidence base is necessary for planning future interventions.

4. **Involve users from the start.** Design services starting from the users' perspective, incorporating their needs, wants and feedback explicitly. Develop tools to gauge the desirability and the willingness to pay for energy services (including clean cooking) for users at the base of the pyramid. Focus on providing support for the whole ecosystem and lifecycle of products (including usability and maintenance). Utilize evidence from the early stages of interventions for a rich understanding of drivers and exact causal chains of desired impact.

5. **Start from local conditions.** To foster trust and local authority buy-in, integrate policy-reform activities into longer-term interventions that address other issues such as electricity generation or access. When designing interventions, consider existing relationships with the targeted authority and the political-economy implications of activities, and identify "islands of capacity" that are relatively insulated from political pressure.

Published by

Stockholm Environment Institute
Linnégatan 87D, Box 24218
104 51 Stockholm, Sweden
Tel: +46 8 30 80 44

DOI:

https://doi.org/10.51414/sei2025.013

Author contact

daniel.duma@sei.org

Editor

Karen Brandon

Layout

Richard Clay

Media contact

karen.brandon@sei.org

Visit us: sei.org
Twitter: @SEIresearch
@SEIclimate

Stockholm Environment Institute is an international non-profit research institute that tackles environment and sustainable development challenges.

We empower partners to meet these challenges through cutting-edge research, knowledge, tools and capacity building. Through SEI's HQ and seven centres around the world, we engage with policy, practice and development action for a sustainable, prosperous future for all.

References:

Asian Development Bank (ADB). (2019). *Impact evaluation of energy interventions: A review of the evidence.* https://doi.org/10.22617/TCS190113-2

Attridge, S., Engen, L., te Velde, D. W., & Calow, J. (2019). *The impact of development finance institutions.* Department for International Development. https://assets.publishing.service.gov.uk/media/5d1232bee5274a066ad2cf79/DFI_Impacts_REA_Report__June_2019.pdf

Eberhard, A., & Dyson, G. (2020). *What is the impact of investing in power?* CDC Group. https://assets.bii.co.uk/wp-content/uploads/2020/01/30151049/Whats-the-impact-of-investing-in-power.pdf

International Energy Agency (IEA), International Renewable Energy Agency (IRENA), UN Statistics Division (UNSD), World Bank, & World Health Organization (WHO). (2023). *Tracking SDG7: The energy progress report.* https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2023

IEA, IRENA, UNSD, World Bank, & WHO. (2024). *Tracking SDG7: The energy progress report, 2024*. https://www.iea.org/reports/ tracking-sdg7-the-energy-progress-report-2024

Independent Evaluation Unit. (2024). *Independent evaluation of the Green Climate Fund's energy sector portfolio and approach.* Green Climate Fund. https://ieu.greenclimate.fund/evaluation/ES2023

Karanja, A., & Gasparatos, A. (2019). Adoption and impacts of clean bioenergy cookstoves in Kenya. In *Renewable and Sustainable Energy Reviews,* 102, (pp. 285–306). https://doi. org/10.1016/j.rser.2018.12.006

Stern, D. I., Burke, P. J., & Bruns, S. B. (2019). *The impact of electricity on economic development: A macroeconomic perspective.* Center for Effective Global Action, UC Berkeley. https://escholarship.org/uc/item/7jb0015q#author

Steward Redqueen (2019). *Power investments & welfare benefits: Describing pathways to impact from a literature review.* Finnfund. https://www.finnfund.fi/wp-content/uploads/2019/08/Power-and-Welfare-Literature-Review-July-2019.pdf

Toman, M., Steinbuks, J., Peters, J., Mensah, J. T., & Timilsina, G. (2018). Electricity Access and Economic Development in Africa: Options for Accelerating Progress. *International Association for Energy Economics Online Proceedings.* https://www.iaee.org/proceedings/ article/15488

UN Department of Economic and Social Affairs (UNDESA). (2024). *The sustainable development goals report 2024*. https://digitallibrary.un.org/ record/4053200

Wörlen, C., Paffenholz, J., Paredes, J. R., & Stoyanova, R. (2023). *External performance evaluation of the Power Africa Off-Grid Project (PAOP).* ICF.

SEI Stockholm Environment Institute