



# ACCESS TO (GREEN) ENERGY IN RURAL AFRICA

*Evaluation report*

*Executive Summary*

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# IMPRINT

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# EXECUTIVE SUMMARY

## Background

**Living without access to modern energy<sup>1</sup> – in this evaluation, people from rural areas of Benin, Senegal and Uganda give striking accounts of what this means for their everyday lives:** people cook over an open fire in dark houses or gardens; the smoke from the fireplaces represents a health hazard; children do their homework in the dim light of candles or paraffin lamps; a lot of time is spent searching for firewood; neither private households nor shops tend to have refrigerators to protect perishable food; water has to be carried out to the fields for irrigation – mostly by women and girls.

**600 million or 43 percent of all Africans still have to manage without electricity in their households (IEA, 2022).** Most of these people without access to modern energy live in sub-Saharan Africa. Even where the households are connected to the electricity grid, energy access is often unreliable and many people can barely afford the connection fees. This represents a major barrier to development and severely restricts the production potential and expansion of micro, small and medium-sized enterprises (MSMEs) in rural areas; it also inhibits business start-ups. The population's education and health also suffer from the lack of basic energy access. Schools can rarely offer evening classes. In 2023, only half of the hospitals and health centres in sub-Saharan Africa had reliable access to electricity (WHO, 2023), making it impossible to use important medical equipment adequately or store medicines safely. In maternity wards, midwives often have to work by the light of mobile phones or torches.

**The lack of access to modern energy in households primarily affects women and girls since household activities are traditionally their responsibility (OECD, 2021).** In global terms, sub-Saharan Africa is the region with the lowest access rates to modern cooking energy. The spread of more efficient and less polluting cooking systems is not keeping pace with population growth, so that, in 2021, 0.9 billion people had no access to modern cooking energy. It is estimated that 1.1 billion people in sub-Saharan Africa will still have no access to modern cooking energy by 2030 (UN, 2023). Women and girls in rural sub-Saharan Africa therefore spend much of the

day collecting firewood, fetching water and preparing food over an open fire. This leaves little time for education or any economically productive activities of their own. The fact that people have to make do with firewood, charcoal and inefficient cookstoves is also one of the causes of deforestation.

**With the 2030 Agenda and its Sustainable Development Goal (SDG) 7, the United Nations – and its member Germany – have set themselves the objective of ensuring access to affordable, modern and reliable energy for all by 2030.** In order to actually achieve SDG 7 by 2030, 70 million people in rural sub-Saharan Africa would have to gain access to energy every year; another 130 million people would have to switch to modern cooking energy (IEA, 2022). However, economic recessions in the wake of the COVID-19 pandemic, rising energy prices as a result of the Russian war of aggression in Ukraine, the growing debt burden and continued population growth are leading to stagnating expansion rates and a rise in relative energy poverty (IEA, 2022; OECD, 2021).

**Development Cooperation (DC) can contribute to achieving SDG 7 (Access to energy) in developing countries.** With its "Renewable Energy and Energy Efficiency" field of action, the Federal Ministry for Economic Cooperation and Development (BMZ) aims to meet energy needs without harming the climate (BMZ, 2021). The "Green People's Energy for Africa" (GBE) initiative, which expires in September 2024, aimed to support partner countries in expanding renewable energies by involving citizens, communities, cooperatives and private investors (BMZ, 2021). Other important priorities of German DC are the involvement of women, the promotion of gender equality, inclusion and the use of energy to boost income, such as in the global "Energising Development" (EnDev) intervention (EnDev, 2021).

**In addition, DC makes further demands on the supply of and access to energy.** Greenhouse-gas emissions are to be reduced, as agreed in SDG 13 (Climate action) and the 2015 Paris Climate Agreement as part of the United Nations Framework Convention on Climate Change (UNFCCC) (Wencker et al., 2024). At the same time,

<sup>1</sup> The evaluation defines modern energy not only as electricity but also as modern cooking technologies that release fewer pollutants and are more efficient and environmentally friendly than conventional cooking with coal, wood or paraffin.

the BMZ intends to promote a transformative development policy that utilises the wealth of resources on the African continent and available technologies to achieve a just transition (BMZ, 2023a).<sup>2</sup>

**Various approaches are implemented in Technical and Financial DC to provide access to energy.** These include expanding the central power grid and implementing decentralised approaches such as mini-grids, Pico-photovoltaics (PV), solar home systems (SHS) and solar-powered appliances such as pumps or mills. Various modern cooking technologies are used in the field of cooking energy.

**In view of the great distances involved and the low levels of expected energy consumption, expanding the electricity grid in rural areas is rarely profitable, so that governments and donors would need to invest heavily in subsidizing grid expansion (Langbein and Reiners, 2019; Lee et al., 2020b); a decentralised energy supply represents an alternative.** However, a decentralised energy supply – independent of the central power grid – involves new problems such as e-waste, and can often only secure energy access for a few years (Duran and Sahinyazan, 2021; Duthie et al., 2023; Grimm and Peters, 2016; Kinally et al., 2022). One prerequisite for economic growth generated by the productive use of energy in rural companies is access to corresponding sales markets, and this is often inadequate. In addition, a decentralised energy supply often follows a market-based approach in which the end users themselves are expected to bear most of the costs of energy access and technical appliances such as solar-powered irrigation pumps or refrigerators. For energy-poor population groups, however, these costs represent an obstacle to energy access – despite falling prices for decentralised energy systems, including solar technologies.

### **Objectives, purpose and subject of the evaluation**

**The evaluation aims to assess Germany's contribution to improving energy access in rural Africa in terms of accountability and evidence-based learning for future policy design and implementing DC interventions.** The Development Assistance Committee of the Organisation for Economic Cooperation and Development (OECD DAC) evaluation

criteria of relevance, effectiveness, impact, sustainability and coherence are examined for this purpose (OECD DAC, 2019). The evaluation criterion of efficiency is not analysed in depth due to the disproportionate effort required to evaluate it in very different country contexts. Nevertheless, findings on production and allocation efficiency are compiled from the various analyses of the evaluation and from a literature review on the efficiency of different technical approaches to energy access.

**The evaluation's conclusions and recommendations aim to help improve interventions to provide access to (green) energy in Africa and in similar contexts.** Within this framework, they are to be incorporated into the reflection process on the core-area strategy entitled "Responsibility for our Planet – Climate and Energy". This complements the evaluations of the German Institute for Development Evaluation (DEval) on climate-change-adaptation interventions (Leppert et al., 2021; Noltze et al., 2023a, 2023b; Noltze and Rauschenbach, 2019), climate-change mitigation through development cooperation (Wencker et al., 2024), the synthesis study on Germany's contribution to the REDD+ forest- and climate-protection programme (Reinecke et al., 2020), and the ongoing evaluation on the circular economy. Moreover, the evaluation provides evidence on approaches to productive energy use that are being piloted by the BMZ's GBE initiative, also with a view to their use in future bilateral or multi-donor interventions. The conclusions and recommendations of this evaluation also serve to document accountability for the work of the BMZ and the implementing organisations to the German Bundestag and the German public – an especially important aspect in these times of tight federal budgets.

**The evaluation assesses German DC interventions aimed at providing initial or improved access to electricity or modern cooking energy in rural Africa.** The main focus is on rural households, MSMEs and social institutions such as schools and healthcare facilities. The evaluation defines initial energy access as the first-time provision of access to modern cooking energy or electricity, regardless of the wattage involved.

**The evaluation examines the BMZ's energy portfolio in Africa as a whole.** According to a portfolio analysis on BMZ-funded energy interventions in Africa, Germany is the most important

<sup>2</sup> Alongside social transformation, German DC will also focus increasingly on ecological economic transformation in the future, particularly following the ideas of the circular economy (BMUV, 2023; BMZ, 2023b; EU, 2020).

bilateral donor in the energy field. Furthermore, the energy sector is the third largest sector in the BMZ's portfolio in Africa. Funding for grid expansion accounts for the largest share of the financial volume involved. However, the share of off-grid, decentralised approaches has also risen in recent years. Among the interventions to provide decentralised energy access in the period under review (2000-2022), to which the BMZ devoted the largest financial volumes (evaluated according to BMZ intervention figures),<sup>3</sup> are the "FC Programme Renewable Energies and Energy Efficiency" (115.6 million euros) and the "Clean Energy and Energy Inclusion for Africa" Foundation (CEI Africa) (43.6 million euros), the global multi-donor intervention EnDev (91.6 million euros in the 2008 financial year, 45.9 million euros in the 2016 financial year) and the BMZ initiative GBE (58.6 million euros in the 2018 financial year, 41.7 million euros in the 2019 financial year).

**The evaluation takes an in-depth look at 72 energy-access interventions in rural Africa that are considered especially relevant and primarily support decentralised energy access.** Some of the interventions are implemented by KfW Development Bank (KfW), others by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Relevant intervention documents were analysed, including programme and module proposals, progress, final and evaluation reports; the focus was on their priorities, objectives and target achievement.

**In three country case studies in Benin, Uganda and Senegal, the evaluation closely examines decentralised technical approaches and the productive use of energy access, particularly by women.** Comparatively little research has been conducted into decentralised approaches and productive energy use, which are potentially especially relevant for energy access in rural areas that would be very expensive to connect to the central power grid, especially in sparsely populated countries in sub-Saharan Africa.

**As regards the suitability of decentralised energy access for economic development in rural Africa, the evaluation takes a particularly close look at stand-alone solar appliances such as solar irrigation pumps and refrigerators.** This is because in interventions that promote a decentralised energy access

and involve large volumes of funding, such as GBE and EnDev, one of the aims is to take approaches that are piloted and successful here and expand them in the rest of the portfolio. Furthermore, there are evaluation gaps on the productive use of decentralised energy access. At the same time, individual studies indicate potential for the economic use of these technologies, which are intended specifically for the commercial use of energy. One question of particular interest for the study of stand-alone solar appliances is their suitability for improving the financial situation of women. Furthermore, mini-grids are evaluated, and findings on the production and allocation efficiency of different approaches are synthesised in a literature review (Ankel-Peters et al., 2024a).

**This evaluation focuses on rural areas because these regions are particularly affected (IEA, 2022) – also because of the BMZ's goal of "reducing energy poverty in the partner countries" (BMZ, 2021).** The case studies focus on EnDev and GBE interventions which specifically promote the productive use of energy via stand-alone solar appliances such as irrigation pumps and refrigerators, or via mini-grids.

## Methodology

**Benchmarks and rating scales are created in order to operationalise each of the evaluation questions.** This reveals the conditions under which German DC interventions are deemed appropriate and successful from the perspective of the evaluation.

**The evaluation works primarily in a way that tests theories and combines case-centred and cross-case data collection and analyses with both qualitative and quantitative methods.** The theory-based approach initially required a literature- and document-based reconstruction of the theory of change by the evaluation team including comments by the reference group. The evaluation combines an analysis of the German portfolio on rural Africa with a case-based evaluation design in order to examine the interdependencies and answer the evaluation questions. The first overall step was an expert-based literature review and an analysis of the German portfolio on the expansion of energy access in rural Africa on the basis of financial data on German DC and intervention documents.

<sup>3</sup> Interventions can be made up of several BMZ identification numbers. At this point, the data are always aggregated to one BMZ number and not across several BMZ numbers. The budget year quoted is the one that is assigned to the corresponding BMZ number in the MeMFIS data. The amount is aggregated over the entire term of the intervention.



**Benin, Uganda and Senegal were selected as case-study countries for the primary data collection because of their particular relevance and suitability.** On the one hand, these countries vary greatly in terms of their electrification rates, which makes it easier to transfer the findings to diverse contexts. At the same time, they have received extensive commitments from Germany in the energy sector. Both the multi-donor intervention EnDev and the BMZ's GBE initiative have promoted productive energy use with stand-alone solar appliances in the case-study countries. The prospects of the interventions financed by German DC to improve energy access having positive effects on economic development in rural areas are comparatively good; as a result, these countries were selected as the most likely cases (Eckstein, 1975) of energy access having a positive effect on productive use.

**Primary and secondary data were collected and analysed in three case-study countries.** These include structured interviews with actors from the implementing and partner organisations, the BMZ and experts. Focus-group discussions were also held with the final beneficiaries. In addition, relevant documents on the interventions and strategy documents of the partner institutions in the case-study countries were consulted. Quasi-experimental survey designs were used in Benin and Senegal to study the effectiveness and impact of access to stand-alone systems such as solar-powered irrigation pumps and refrigerators. An additional, descriptively analysed quantitative survey in Senegal focuses on the contribution of German DC to energy access via mini-grids. Any limitations in the validity of the findings are outlined in the discussion of the methodology and analysis.

## **Findings, conclusions and recommendations**

### ***Evaluation question 1: To what extent are the interventions relevant for rural energy access?***

**Various aspects were considered to assess the relevance of the German energy and cooking-energy portfolio.** They include its orientation towards SDG 7.1 (Access to modern, reliable and affordable energy for all by 2030), especially for energy-poor population groups. Furthermore,

its relevance for the productive use of energy by women and girls and for transformative low-carbon development paths in accordance with SDG 13 (Climate action) and the Paris Climate Agreement was also analysed.

**The energy portfolio is partially relevant for energy-poor population groups, and its suitability for contributing to improving energy access for all by 2030 varies from country to country.** While grid expansion, which dominates the portfolio, is relevant in smaller countries with high electrification rates and subsidies for end consumers, off-grid approaches are relevant in territorial states with low electrification rates. Decentralised approaches with a relatively low wattage and tier level are cost-efficient from the donor's perspective and generally more affordable for energy-poor population groups than approaches with higher tier levels. However, at 10.2 percent of the BMZ's energy portfolio, decentralised approaches only account for a small proportion of the funding volume. The analysis of the 72 interventions implemented by GIZ and KfW, which implement primarily decentralised energy access, also shows that Tier 1 approaches such as PicoPV are only promoted in about a tenth of the interventions. In addition, these interventions barely reach any of the population groups who are particularly affected by energy poverty: the financial resources of end users in general, and their support needs in particular, are barely taken into consideration even at the design phase. For example, the end users' ability to pay is only analysed in isolated cases and seldom taken into account in the calculation of what contributions they can afford.<sup>4</sup>

**The main priorities of German DC are partially relevant for the productive use of energy.** Studies show that neither access to energy via the central grid nor decentralised, non-targeted energy access is alone sufficient to contribute to economic development in rural Africa (Durga et al., 2024). The promising approaches are those that aim not just to create access to energy, but also to promote the use of energy for economic activities. However, at 11.6 percent, these interventions make up only a small proportion of the decentralised energy-access portfolio.<sup>5</sup>

<sup>4</sup> The data are based on the documents from 72 individual Financial and Technical Cooperation interventions and interviews with representatives of German DC.

<sup>5</sup> The data are based on all BMZ-funded decentralised energy and cooking-energy interventions that were approved between 2000 and 2022. This statement refers to the financial volume of the interventions.

**Interventions on cooking energy are generally still relevant for women and girls due to the traditional distribution of household tasks, but they are not a priority area of German DC.** Research and portfolio analyses emphasise the importance of cooking-energy interventions for women. Even if they are often not transformative in ways that dismantle gender-specific norms, power structures and the causes of related inequalities, cooking-energy interventions do address women's gender-specific needs. Although Germany is an important donor in the field of cooking energy (BMZ, 2014), and the BMZ's financial contributions are increasing slightly despite their persistently low overall level, cooking energy's financial share is very low, only accounting for 3.7 percent of the total energy portfolio.<sup>6</sup> The fact that German DC does not prioritise cooking energy but focuses on other aspects is also shown by the low and declining number of cooking-energy interventions, which account for two percent of the BMZ energy portfolio's financial volume in Africa. The corresponding needs of women and girls are therefore not being met in the field of modern cooking energy. Furthermore, energy interventions only make up 32 percent of the portfolio with gender equality as a primary or secondary objective, and the trend is declining over time.

**The energy and cooking-energy portfolio is relevant for climate-change mitigation according to the Rio marker "Climate Change Mitigation" (KLM), even though the contribution of the rural energy supply to reducing emissions and to transformative development paths is probably small.** According to German DC's own reporting to the OECD DAC, the energy portfolio, and thus also the off-grid interventions, contribute fully to climate-change mitigation by formulating specific targets in this regard and promoting climate-change mitigation at least proportionately. This is done, for example, by promoting renewable energies or raising energy efficiency. According to the report, cooking energy, too, mostly promotes climate-change mitigation. The relevance of Germany's energy portfolio for climate-change mitigation is also reflected in the level of funding. At 87 percent, the financial commitments for climate-change mitigation in the energy sector are considerable.

The evaluation thus sees a fundamental contribution to promoting low-carbon development paths in that the portfolio completely dispenses with inefficient or fossil technologies, although the evaluation subject's contribution to reducing emissions is likely to be small. After all, sub-Saharan Africa is responsible for less than three percent of global greenhouse-gas emissions (see Climate Watch, 2022), and the contribution of rural areas to these emissions is likely to be even lower (Connolly et al., 2022). The interventions analysed – also in view of the large number of small-scale approaches – are barely relevant for transformative development paths (Noltze et al., 2023a). Furthermore, the results do not suggest any contribution to an economic transformation, not even as a result of productive energy use via solar appliances. There are no recognizable innovation spaces in which German DC identifies and develops transformative energy interventions (Noltze et al., 2023a). In such innovation spaces, for example, transformative approaches, goals and indicators can be developed and transformative interventions piloted in collaboration with the scientific community and through accompanying research.

**The analysis of the relevance of the German energy portfolio in Africa shows that the current priorities are partially geared towards transformative low-carbon development paths and partially relevant for energy-poor population groups, for women and girls, and for the productive use of energy.** This means that the focus of the energy portfolio is only suitable to a limited extent for contributing to achieving SDG 7.1 (Access to modern, reliable and affordable energy for all by 2030) and gender equality. The fact that energy-poor population groups are not being adequately reached also highlights the limits of market-based approaches. Although this requirement is generally not applied to the expansion of the central grid, the intention is for the expansion of energy access to be largely private, cost-covering and profitable. However, the findings show that these market-based approaches – under which a large proportion of the costs are borne by the final beneficiaries – are not well suited to providing initial energy access and ensuring energy access for all by 2030.

<sup>6</sup> The data are based on all energy and cooking-energy interventions that were approved with BMZ funds between 2000 and 2022.

**Recommendation 1: The BMZ should gear its energy portfolio in Africa more towards the needs and financial capacities of women and girls, as well as to energy-poor population groups, in order to expand initial energy access and to meet both its own benchmarks and those of international agreements.**

**Implementation guidelines for Recommendation 1:**

- The implementing organisations could meet the benchmarks by increasing support for productive energy use among female entrepreneurs.
- The BMZ could expand its contribution to achieving SDG 7.1 by expanding the portfolio on modern cooking energy as a cost-efficient approach for energy-poor population groups.
- The implementing organisations could do more to adopt and implement the BMZ's objectives on gender equality.
- The BMZ could expand its contribution to transformative development paths by providing innovation spaces for the identification and development of transformative energy interventions.

**Evaluation question 2: To what extent do the interventions make an effective contribution to energy access in rural areas?**

Within the German energy portfolio, relatively few interventions (39 out of 72) formulate explicit targets for expanding initial access and improving energy supplies, which limits the relevance of the German portfolio for SDG 7.1 (Access to modern, reliable and affordable energy for all by 2030). Of these 39 interventions, however, only 17 can be assessed, as no audits or final reports were available for 22 interventions from which information on target achievement could have been obtained.<sup>7</sup>

Nevertheless, the 17 assessable interventions achieve their objectives. The case studies examined in depth the promotion of productive energy use by the multi-donor intervention EnDev and the BMZ's GBE initiative. These largely achieve their objectives in terms of the number of companies and female entrepreneurs reached. The aim of promoting the productive use of energy with solar appliances such as irrigation pumps and refrigerators has also been achieved. In contrast to interventions to provide electricity for entire regions (without specifying the target group and the promotion of commercial energy use), the promotion of solar appliances achieves a high level of productive energy use.

**Evaluation question 3: To what extent do the interventions for rural energy access make an impactful contribution for the target groups?**

The use of stand-alone solar appliances helps reduce energy expenditure for companies; in Senegal it makes crop cultivation possible in the dry season.<sup>8</sup> Agricultural enterprises that in the past have practised rainfed agriculture are very likely to start growing crops in the dry season once they have acquired a solar irrigation pump. This is an important prerequisite for increasing yields and profits.

According to the quasi-experimental studies, the companies that received GIZ-supported access to stand-alone solar appliances are in a better economic position in Benin than comparable companies; the trend in Senegal is similar. Positive effects were shown in systematic analyses of MSME revenues in Benin – but no robust effects on other economic indicators. Nevertheless, the participants in the surveys and focus groups in the case-study countries reported other positive developments during the period of the interventions such as higher profits, an increase in the number of customers and greater satisfaction with working conditions.

<sup>7</sup> The lack of documents could be partly due to the fact that 26 interventions have not yet been completed.

<sup>8</sup> This aspect could not be analysed in Benin due to a lack of data.



**Similarly, although self-assessments of the development of entrepreneurs' revenues and living conditions are positive, a systematic comparison leads to more critical findings.** For example, the quasi-experimental analyses were unable to demonstrate any positive effects on the material prosperity or food security of the entrepreneurs and their families, even though the interviewees reported perceived improvements.

**For the most part, the same effects as in male-run companies are also evident under female entrepreneurs; according to the self-assessment of the beneficiaries, there are also gender-specific effects.** In some cases, the positive effects on the economic indicators of women-led companies in Senegal are even stronger than among companies run by men. In addition, the interviewees state that, as a result of the interventions, women spend less time fetching water and doing housework, and their decision-making power has been strengthened.<sup>9</sup>

**It remains to be seen to what extent the subsidised solar appliances will be used productively in the long term; moreover, the interventions in Benin are only accessible to MSMEs that show a strong economic performance.** The subsidised solar appliances are used for economic activities, and most of them are still functional after several years. The surveys both in Benin and Senegal and in the focus groups in Uganda suggest that the appliances were largely functional and in use at the time of data collection in summer and autumn 2023. The first appliances were purchased in Benin in December 2015,<sup>10</sup> in Senegal in autumn 2022<sup>11</sup> and in Uganda in summer 2021. A study of use in Benin is therefore the most informative as regards durability.

Interviewees in Benin purchased their appliances between 2015 and 2022, and 84 percent of interviewees were still using them in summer 2023. Nevertheless, there has been little research into the sustainability of stand-alone solar appliances, so particular attention should be paid to this aspect when expanding this approach in the portfolio. In Benin, it was also shown that only those companies whose economic performance was already significantly better than comparable companies in the same localities before the interventions were able to purchase the subsidised solar appliances. Companies with lower economic performance and entrepreneurs with lower household incomes had difficulties acquiring the subsidised appliances.

**The promotion of stand-alone solar appliances for productive use has been shown to have had minor unintended negative effects; however, there have been isolated effects in the case of mini-grids.** For example, isolated cases of insolvency have been reported among the operators of mini-grids. Furthermore, in Senegal damage to household appliances used via the mini-grid has led to a loss of confidence in renewable energies among end users.

**The targeted promotion of productive use via solar appliances is more effective and impactful in terms of economic development in rural areas than the electrification of rural areas without targeted promotion of productive energy use.** It contributes to SDG 8 (Decent work and economic growth). Targeted promotion is relevant for women. To date, however, approaches specifically promoting productive energy use only account for a small proportion of the portfolio.

<sup>9</sup> If women travel shorter distances to fetch water, they can use the time they save for other things; life becomes easier and they have more time for relaxation. For example, female participants in a focus-group discussion in Benin expressed their satisfaction that, since they have been using a solar irrigation pump, they no longer have to carry water to the fields to prepare food for the harvest workers. Research also reports improved safety because women may be less exposed to the risk of (sexual) assault – and enjoy better health because the physical strain of fetching water is reduced (Caruso et al., 2022). At the same time, in other contexts, fetching water together with other women can also represent a free space that women would like to preserve (Caruso et al., 2022); this is also addressed by the ongoing DEval evaluation of protected-area promotion by the BMZ.

<sup>10</sup> At the time of the survey in Benin, 84 percent of the beneficiaries stated that they were still using their appliances. The date of acquisition was between 2015 and 2022. Eight percent have never used the solar appliance they purchased; a further eight percent have used it in the past.

<sup>11</sup> At the time of the survey in Senegal in September 2023, 95 percent of the solar appliances purchased as part of EnDev and GBE were in use.

**Recommendation 2: The BMZ should expand the portfolio for the targeted promotion of productive energy use in Africa.****Implementation guidelines for Recommendation 2:**

- The BMZ could apply lessons learned from the GBE initiative and from multi-donor and global interventions and transfer the targeted productive use of energy using solar appliances to the bilateral portfolio.
- The BMZ could systematically examine the extent to which the sustainability of solar appliances for productive use is ensured.
- If solar appliances prove to be sustainable, the implementing organisations could develop and use Financial Cooperation instruments to meet the target group's demand for affordable solar appliances.
- Subject to market readiness<sup>12</sup>, Financial Cooperation could provide more funding for solar appliances and mini-grids.

In times of tight budgets, expanding the portfolio of cooking-energy interventions and approaches that are particularly relevant to energy access for all and productive energy use may necessitate cuts in other areas of the energy portfolio. The BMZ should examine this if necessary. The evaluation was unable to identify any potential for cuts in the area of rural energy supply and access.

**Evaluation question 4: To what extent are the interventions for rural energy access sustainable?**

**Institutionalised ownership on the part of actors in the partner countries is a prerequisite for the durability of outcomes and impacts, and this is largely the case with stand-alone solar appliances in the case-study countries.** The importance of institutionalised ownership was emphasised, for example, in the Paris Declaration on Aid Effectiveness in 2005 and at the subsequent High-Level Forum on Aid Effectiveness in Accra in 2008. The interventions studied for stand-alone solar appliances promote the ownership of relevant partner actors by developing sustainability plans, supporting public-private partnerships and building institutional processes. Even so, there is more potential for improving the integration of these interventions into national and local development plans.

**In addition to ownership, the interventions studied have strengthened the technical capacities of the relevant actors.** Examples include the administrative and technical capacities of the partner institutions.

**In the case of mini-grids, by contrast, the technical and financial capacities of the implementation partners are challenging.** Across all technical approaches but particularly in the case of mini-grids, the short intervention durations of German DC were perceived as an obstacle to ownership. This led to follow-up costs for which neither private nor public actors in the partner country felt sufficiently responsible. The limited financial capacities of partners like state electrification agencies in rural areas or final beneficiaries therefore pose a challenge.

**The subsidised solar appliances are used for economic activities and are mostly still functional and operational after a few years.** Nevertheless, there are difficulties with regard to the functionality, maintenance and repair of the appliances, and this can have a negative effect on the durability of outcomes and impacts. It is difficult for MSMEs to enforce claims based on manufacturer warranties for defective refrigerators or irrigation pumps. In rural areas, there is also a lack of spare parts and expertise for repairing and maintaining the subsidised appliances. This is not conducive to German DC's benchmarks for a circular economy (BMZ, 2023b) and could have a negative impact on the ecological transformation of the economy.

<sup>12</sup> Technologies that have proven their functionality under real operating conditions, meet local market and certification standards, are scalable and energy-efficient can be regarded as market-ready (see GIZ, no date; European Commission et al., 2017).

**Only a fraction of the mini-grids analysed in Senegal are still functioning six to nine years after their installation.** With 73 mini-grids defective and only nine in operation, the results suggest that the operator models have structural weaknesses. For example, when carrying out grid maintenance the operators cannot usually cover their costs. Defective transmission lines and an inadequate supply of diesel fuel have also often been reported. In addition, 13 villages are now connected to the central grid.<sup>13</sup>

**The outcomes and impacts of off-grid approaches are only partially durable.** Nevertheless, the BMZ's financial support for off-grid approaches has increased slightly since 2012 in the period under review (2000-2022), even though interventions involving large amounts of finance have expired or their expiry is under discussion. In view of the relevance of the portfolio of decentralised energy access for rural areas in Africa, the evaluation recommends increasing their sustainability.

***Recommendation 3: The BMZ and the implementing organisations should make the outcomes and impacts of decentralised approaches to energy access in rural areas in Africa more durable.***

**Implementation guidelines for Recommendation 3:**

- The BMZ could extend intervention durations, ensure that interventions interact and promote multi-donor interventions.
- The implementing organisations could pilot and expand operator models for mini-grids in which the operators generate profit from the long-term operation of the grids by integrating them into local value chains.
- The implementing organisations could examine and implement a mix of private-sector operator models in economically stronger areas and non-cost-covering models in economically weaker areas.
- The implementing organisations could help mini-grid operators to mobilise private capital, for example by enabling them to sell carbon credits on the voluntary carbon market.

***Evaluation question 5: To what extent are the energy-access interventions coherent with the partners' own efforts and those of other donors?***

The priorities of the German interventions correspond largely with the priorities of the partners who are involved and affected. The coherence of Germany's contributions with the priorities of the partner countries is a fundamental principle in planning, implementation and reporting to the BMZ. Furthermore, in some cases the interventions can even respond flexibly to the partners' evolving needs. In areas where partner strategies on fossil fuels and nuclear energy contradict German positions, they are not supported – in the interests of coherence. Partners tend to regard low-tier energy-access solutions such as PicoPV systems as interim solutions for electrification and prefer to expand central grids. In addition, however, most of the other

technical approaches are also supported by the partners and taken up by German DC, so that coherence is basically ensured.

**The German interventions are largely complementary to the efforts of other donors and based on a division of labour, although cooking energy is given little support overall.** Complementarity, harmonization and coordination with other donors (external coherence) is ensured in the majority of cases. The fundamental willingness of German DC to exchange information and cooperate is recognised. Existing round tables at embassy level are also used for the energy sector, albeit with varying intensity. In some cases, however, donor coordination is also handled on a personal level. Providing support – for example with developing national energy-information systems by providing data for decision-making,

<sup>13</sup> The observations in Senegal are consistent with structural problems in the mini-grid sector elsewhere, with economically viable operator models remaining a major challenge (see Duthie et al., 2023; Peters et al., 2019). Nevertheless, mini-grids are of key importance for Africa's rural energy supply and access (Adamopoulou et al., 2022; ESMAF, 2022; Harrison and Adams, 2024; Tenenbaum et al., 2024). German DC is aware of the challenges with regard to the durability of mini-grids and is taking these into account in their ongoing implementation in Senegal (EnDev, 2023) and in knowledge products on mini-grids in Sierra Leone, Uganda, Nigeria and Ethiopia (Holzigel, 2021; Holzigel et al., 2020; Pérez-López, 2020; Wearne and Tiwari, 2021).

or with drawing up policy papers on the development of the energy sector with strategic guidelines – is seen as a contribution to strengthening coherence with partners and donors. On the other hand, potential conflicts could arise with donors, especially if positions differ on market-based approaches or fossil fuels. A further harmonization of processes – such as via multi-donor interventions with German participation – offers potential for a further strengthening of donor coherence.

### *Synthesis of the findings on efficiency (no separate benchmark)*

**PicoPV systems and improved biomass cookstoves have the highest production efficiency, and the allocation efficiency of improved biomass cookstoves is also comparatively high.**

The acquisition costs within the scope of the above-mentioned approaches are the lowest. By contrast, the acquisition and maintenance costs for central grids, mini-grids and biogas digesters are the highest, which indicates that the production efficiency of these approaches is lower. The relationship between resource input and the impacts (allocation efficiency) is particularly favourable in the case of PicoPV systems and improved biomass cookstoves. Stand-alone solar appliances, on the other hand, are the most efficient for productive energy use. The allocation efficiency of central and mini-grids is low for all target groups examined with regard to the desired impacts.

### *Contributions to the 2030 Agenda*

**The results on relevance, effectiveness and impact indicate both synergies and potential trade-offs between the supported technical approaches with regard to different SDGs.** While the approaches to productive energy use achieve their targets when it comes to promoting economic growth (SDG 8) and contributing to gender equality (SDG 5), they are less key for reaching the aim of energy access for all by 2030 (SDG 7). This also means that they are only partially in line with the principle of the 2030 Agenda of "leaving no one behind". Similarly, their contribution to reducing greenhouse-gas emissions (SDG 13) and to a transformative development path could also be greater.