ACCESS TO (GREEN) ENERGY IN RURAL AFRICA

Evaluation report

2024

DEval
GERMAN INSTITUTE FOR DEVELOPMENT EVALUATION

This evaluation analyses the contribution of German development cooperation to energy access in rural Africa. The aim of the report is to assess the relevance of the BMZ's energy portfolio in Africa; it also examines the effectiveness, impact, sustainability and coherence of interventions for rural energy access via off-grid approaches. A portfolio analysis and content analysis of intervention documents were carried out and literature reviews were prepared. Case studies in Benin, Senegal and Uganda – with quasi-experimental surveys, focus-group discussions and interviews – complete the methodological design.

The evaluation shows that the BMZ's energy portfolio in Africa is not sufficiently geared to the needs and financial capacities of energy-poor population groups and women and girls, as the approaches to energy access it promotes are barely affordable, and there is too little focus on cooking energy. At the same time, the promotion of the income-generating use of renewable energy from solar devices by small businesses is proving effective. Challenges exist with regard to the sustainability of decentralised approaches – particularly in the case of mini-grids. German development cooperation is largely coherent with the efforts of its partners and other donors.

DEval recommends gearing energy interventions more closely to the needs and financial capacities of women and girls, as well as energy-poor population groups, and expanding the portfolio for the targeted promotion of productive energy use in Africa. Furthermore, the outcomes and impacts of decentralised approaches to energy access in rural areas in Africa should be made more durable.

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IMPRINT

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Bibliographical reference
Rauschenbach, M., A. Köngeter, K. Moull and A. Warnholz (2024), *Access to (Green) Energy in Rural Africa*, German Institute for Development Evaluation (DEval), Bonn.

Print
Bonifatius, Paderborn

ISBN 978-3-96126-210-6 (printed edition)
ISBN 978-3-96126-211-3 (PDF)

Published by
German Institute for
Development Evaluation (DEval)
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A BMZ response to this evaluation is available at:
https://www.bmz.de/de/ministerium/evaluierung/bmz-responses-19422

ACKNOWLEDGEMENTS

The evaluation team received support from numerous people in its work. We would like to express our sincere thanks to all those involved.

First and foremost, we would like to thank all the interviewees and participants in the focus-group discussions in the case-study countries who supported us by giving their valuable time and providing information.

We would also like to thank the reference group for their trustful and open cooperation, as well as their professional and organisational support. The constructive exchanges with the German Federal Ministry for Economic Cooperation and Development (BMZ) and the participating implementing organisations of the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and KfW Development Bank (KfW) were of great value for the evaluation.

We would also like to thank the experts in the case-study countries, the African School of Economics in Benin, the Consulting and Training Group and Cabinet, Données, Décisions et Impact in Senegal, and Hatchile Consult in Uganda for collecting and, in some cases, analysing data and information. Special thanks are due to Dr Gerald Leppert for his support both in the portfolio analysis and in the design and analysis of the surveys.

We would also like to thank the external peer reviewer of the evaluation, Joseph Mouanda, and our internal peer reviewer, Dr Denise Hörner, both of whose comments and remarks provided valuable input for the evaluation. The evaluation also benefited in particular from the professional exchange with, and expert opinions of, Prof Dr Jörg Ankel-Peters, Dr Gunther Bensch and Dr Maximiliane Sievert. We would also like to thank Julian Rose for sharing his questionnaires with us – and Whitney Edwards, Yannick Gunia, Arber Jasiqi, Marie Podien and Simon Schütz for their valuable support.

Finally, we would like to thank Dr Martin Noltze and Dr Thomas Wencker for their suggestions and proposed solutions.

EXECUTIVE SUMMARY

Background

Living without access to modern energy[1] – 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,

[1] 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).[2]

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

[2] 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),[3] 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.

3 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.[4]

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.[5]

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

5 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.[6] 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.

6 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.[7]

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.[8] 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.

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

8 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.[9]

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,[10] in Senegal in autumn 2022[11] 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.

9 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.

10 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.

11 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[12], 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.

[12] 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.[13]

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,

13 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; ESMAP, 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.

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ABBREVIATIONS AND ACRONYMS

BMZ
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)

CPR
Country portfolio review

CRS
Creditor Reporting System

DAC
Development Assistance Committee

DEval
Deutsches Evaluierungsinstitut der Entwicklungszusammenarbeit (German Institute for Development Evaluation)

DOK
Project document

EnDev
Energising Development

ESMAP
Energy Sector Management Assistance Program

DC
Development Cooperation

FOKG
Focus-group discussion

FC
Financial Cooperation

GBE
Grüne Bürgerenergie für Afrika (Green People's Energy for Africa)

GIZ
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH

IEA
International Energy Agency

IPCC
Intergovernmental Panel on Climate Change

IRENA
International Renewable Energy Agency

JETPs
Just Energy Transition Partnerships

KfW
Kreditanstalt für Wiederaufbau (KfW Development Bank)

KZE
Katholische Zentralstelle für Globale Entwicklung (Catholic Central Agency for Development Aid)

MSMEs
Micro, small and medium-sized enterprises

KLA
Rio marker for "Adaptation to climate change"

KLM
Rio marker for "Reduction of greenhouse-gas emissions"

LMIC
Low- and middle-income countries

MeMFIS
Management, finance and information system of the BMZ

MTF
Multi-Tier Framework of the World Bank

ODA
Official Development Assistance

OECD
Organisation for Economic Co-operation and Development

PUE
Productive use of energy

PV
Photovoltaics

QUAL
Interview

RBF
Results-based financing

SDGs
Sustainable Development Goals

TC
Technical Cooperation

UNFCCC
United Nations Framework Convention on Climate Change

USD
US dollar

WHO
World Health Organisation

GLOSSARY

Stand-alone systems:
Systems in which electricity is produced and consumed without a connection to the central electricity grid in order to meet both non-productive and productive energy requirements. These systems include stand-alone solar home systems (SHS), solar residential systems and solar appliances such as solar-powered irrigation pumps, refrigerators and mills.

Decentralised, off-grid:
Without connection to the central power grid.

Initial access:
Providing first-time access to modern cooking energy or electricity, regardless of the wattage generated according to the World Bank's Multi-Tier Framework (MTF) (Bhatia and Angelou, 2015).

Energy access:
Initial or improved access to modern cooking energy or electricity; appropriate energy access for micro, small and medium-sized enterprises (as well as social institutions such as schools and health centres).

Rural:
Areas with a population density of fewer than 300 inhabitants per square kilometre (World Bank, 2020).

Interventions for rural energy access:
Development-cooperation interventions that enable the implementation of technical approaches for initial access to modern energy, or that improve existing access in terms of affordability, reliability, security or climate-change mitigation.

Modern energy:
Electricity and modern cooking technologies that release fewer harmful pollutants and are more efficient and environmentally friendly than conventional cooking with coal or paraffin. They include improved and clean biomass cookstoves, biogas cookstoves/ biogas digesters, electric cookstoves, liquid-gas, natural-gas and ethanol stoves (adapted from IEA, 2020).

Productive energy use:
Use of energy for economic activity.

1.

INTRODUCTION

Access to modern, climate-friendly energy for all and using this energy access to promote economic development: how can this be achieved in rural Africa? This evaluation of German development cooperation (DC) to expand access to (green) energy in rural Africa contributes to finding an answer to this and related questions. In doing so, it promotes evidence-based learning, accountability and more effective policymaking and implementation in the future. Chapter 1 provides an overview of the development-policy background to the issue of energy access in rural Africa (see Chapter 1.1). Subsequently, key findings from scientific research and corresponding evaluations are outlined (see Chapter 1.2) and, finally, the motivation and contribution of this evaluation are explained (see Chapter 1.3). Chapter 1.4 sets out the evaluation questions and the assessment dimensions applied.

1.1 Development-policy background

With Sustainable Development Goal (SDG) 7, the United Nations (and the Federal Republic of Germany as one of its members) have set themselves the ambitious target of creating universal access to affordable, reliable and modern energy services by 2030 (UN, 2015). This goal looks especially ambitious in sub-Saharan Africa, particularly in rural areas, which are particularly hard hit by energy poverty: over 80 percent of the population has no access to electricity (IEA, 2022). In rural areas, most of the cooking is done over an open fire. Not only households but also micro, small and medium-sized enterprises (MSMEs) and social institutions such as schools and hospitals are affected by energy poverty. Only half of the hospitals and health centres in sub-Saharan Africa have reliable access to electricity; the percentage is even lower in rural areas (WHO, 2023).

SDG 7 on access to energy is closely linked to the goal on climate-change mitigation (SDG 13); it aims to contribute to a diversified energy mix and thus also to enhancing climate-change mitigation. SDG 7 also aims to significantly increase renewable energy's share of the global energy mix in order to contribute to transformative, low-carbon development in line with the Paris Climate Agreement. As a low-emission and comparatively climate-adapted energy source, renewable energy is of key importance for development policy. Mitigating climate risks and supporting partner countries in dealing with the consequences of climate change are also increasingly becoming priorities and cross-cutting tasks for German DC (BMZ, 2018; Noltze and Rauschenbach, 2019). The trade-off between climate-change mitigation and access to energy is reflected in the "Just Transition Framework", which identifies principles, practices and processes which, among other things, are intended to ensure fair energy access on the road to a low-carbon economy (IPCC, 2022). These principles, practices and processes were included in the final declaration at the UN Climate Change Conference in Sharm El-Sheikh 2022 (COP 27). Recent energy partnerships, such as the "Just Energy Transition Partnerships" (JETPs) with Indonesia and South Africa, for example, represent global structural policy approaches for implementing socially equitable climate-change-mitigation policies in the energy sector. The term *just transition* is also finding its way into German DC and is likely to increasingly characterise further implementation.

Energy poverty particularly affects rural areas of sub-Saharan Africa, especially the women and girls who live there. If universal energy access is to be achieved by 2030, as from 2020 approximately 90 million people per year – 70 million of whom live in rural sub-Saharan Africa – would have to gain initial access to electricity (IEA, 2022). For SDG 7 to be successful, access rates would therefore have to be increased threefold compared to the expansion achieved before the global COVID-19 pandemic. Women, who are the main users and producers of energy in the household, are at a particular disadvantage in terms of their opportunities for education and economic development due to their time- and labour-intensive household activities (such as cooking, collecting firewood, market gardening). They are also exposed to higher health risks, for example when preparing food over an open fire (OECD, 2021). In addition to access to electricity, 130 million people a year in Africa would have to switch to modern cooking technologies in order to achieve the aim of universal access to modern cooking fuels and technologies by 2030 (IEA, 2022). However, the absolute expansion of energy access in rural Africa is stagnating against the backdrop of the economic recession in sub-Saharan Africa in the wake of the COVID-19 pandemic, rising energy prices as a result of the Russian war of aggression on Ukraine, a growing debt burden and ongoing population growth (IEA, 2022; OECD, 2021).

Grid expansion to promote initial access varies greatly between countries and depends on a variety of factors, particularly investment attractiveness. Other important factors include public budgets from tax revenues and donor grants, distance from the existing central grid, expected consumption, village size and the reliability, resilience and quality of the access. At the same time, investments in the local infrastructure are also used as a political instrument to promote voter favour, although empirically, energy access does not necessarily go hand in hand with political participation (Brass et al., 2021). Expanding the electricity grid is rarely profitable in rural areas where distances are great and expected levels of energy consumption are low. Private energy suppliers have little incentive to expand central grids, mini-grids (local systems for the generation and distribution of electricity, see Table 1) and services to rural areas (Toman and Peters, 2017). State energy suppliers also face this challenge when expanding the grid (Langbein and Reiners, 2019; Lee et al., 2020b). A lot of grid expansion is subsidised worldwide, with end users contributing to the costs by paying fees. However, the low purchasing power of the rural population combined with their low electricity consumption means that there is a considerable gap between the (subsidised) costs per connection and revenues due to the low level of consumption. Renewable energy sources have the potential to provide access to modern energy in rural Africa in line with SDG 7 (Access to energy) and the Paris Climate Agreement. On the supply side, there is particular potential for strengthening technical capacity, among other things in the involvement of women both as the main consumers in the household and for training as skilled workers (OECD, 2021). At the same time, in political forums African countries have recently reaffirmed their desire to use fossil fuels to accelerate the expansion of energy access and to utilise local resources (African Union Executive Council, 2022). However, promoting fossil fuels is not conducive to the BMZ's strategic guidelines (BMZ, 2021).

Because of recently falling prices for decentralised energy sources, there is considerable potential for increasing energy access in sub-Saharan Africa (ESMAP, 2022; Practical Action, 2019). This could be realised, for example, by implementing Pico-photovoltaic (PV) systems, solar home systems or mini-grids (ESMAP, 2022; Practical Action, 2019). According to forecasts by the International Energy Agency, 18 percent of all projects to provide initial access between 2022 and 2030 in sub-Saharan Africa could be realised via solar home systems (IEA, 2022). Other off-grid approaches include diesel generators, modern cooking systems and mini-grids (see Table 1). In rural areas, access to cooking energy is primarily made possible by improved biomass cookstoves, which are expected to account for 60 percent of initial access to cooking energy in sub-Saharan Africa by 2030 (IEA, 2022).

Off-grid approaches can partially cover the energy demand for consumptive energy use and drive the expansion of energy access in rural Africa. Compared to Latin America and Asia, many households in Africa use appliances that can be battery-operated or, because of their low consumption, do not need an expansion of the central grid or access to electricity grids. However, low-cost solar home systems, which are spreading remarkably quickly via informal markets even in remote areas, bring with them the challenges of e-waste (Grimm and Peters, 2016).

Since low household incomes are empirically linked with a low rate of access to modern energy, the productive use of energy is increasingly coming into focus (Brew-Hammond, 2010). Examples of income-generating applications include solar-powered refrigerators for grocery shops, solar-powered pumps or even small solar systems that can be used to dry fruit, vegetables, meat or fish. By generating income with this type of "productive" energy use, the target group can refinance connection costs. Despite positive developments as regards the affordability and potential economic effects of off-grid technologies for rural Africa, partner governments of German DC emphasise the need to expand the central power grid rather than implement small-scale, low-power solutions (Toman and Peters, 2017).

The strategic objective of German DC is to "reduce energy poverty in partner countries and supply private households, social institutions and companies, among others, with affordable, reliable and sustainable energy" (BMZ 2021: 23). At the level of German DC, according to the "BMZ 2030" reform process the "Renewable Energy and Energy Efficiency" area of intervention aims to meet the rapidly increasing demand for energy in a climate-neutral way while completely decarbonizing the energy sector (BMZ, 2021). German DC thus recognises the

need for transformative, sustainable DC in the fields of climate and energy policy (BMZ, 2021). German DC sees potential for the countries of the African continent to achieve a just transition thanks to their wealth of resources and the availability of appropriate technologies, among other things (BMZ, 2023a). Alongside the social transformation, the BMZ will in future also increasingly focus on ecological economic transformation, including the circular economy (BMZ, 2023b), which is being analysed in an ongoing evaluation on the subject by the German Institute for Development Evaluation (DEval). In order to achieve rapid results in the above-mentioned area of intervention, the BMZ is focusing on the "Green People's Energy for Africa" (GBE) initiative, which expires in 2024, together with the "Green Hydrogen and Power-to-X Products" initiative. Here, partner countries are to be supported "with the active involvement of citizens, municipalities, cooperatives and private-sector investors in the development and expansion of renewable energy and its productive [...] use" (BMZ, 2021). Other important priorities of DC are the involvement of women, gender equality, inclusion and the use of energy to raise income, including in the "Energising Development" (EnDev) global intervention (EnDev, 2021).

German DC implements various technical approaches to energy access (see Chapter 2). With regard to electrical energy, German and international DC have in the past tended to promote grid expansion (Toman and Peters, 2017), as described in Chapter 5.[14] In view of the low electricity consumption and lack of purchasing power in rural areas, the focus now seems to be shifting towards off-grid approaches to reach the marginalised rural population. This applies not only to private households but also to companies and social institutions. Up to now, German DC has viewed decentralised power supply from renewable energy sources as a supplement to grid expansion in rural areas (BMZ, 2008; BMZ, 2021). Decentralised approaches are also promoted in combination with local operator models (including cooperatives) and innovative funding instruments such as results-based financing (BMZ, 2021). German DC interventions on cooking energy include the implementation of improved biomass cookstoves, which are intended to reduce the health impact of smoke and soot, save wood resources and reduce emissions (GIZ, 2021a). A key challenge in reaching the energy-poor population groups lies in economic viability and limits of the market-based approach. Affordability is a prerequisite for the implementation of technical approaches. Despite falling prices for decentralised approaches, the acquisition costs are often still too high, especially for the energy-poor population groups.

1.2 State of evidence in science and evaluation

The following section outlines the scientific discussion on energy access in rural Africa and the evaluation gap addressed by this evaluation. A systematic analysis and more detailed presentation of the evidence was compiled in the course of the evaluation in three literature reviews. These are incorporated into the theory and contextualization of the empirical findings.[15]

The scientific consensus is that energy access improves the target group's satisfaction, but economic effects often fall short of expectations (Bensch et al., 2013; Bonan et al., 2017; Bos et al., 2018; GIZ, 2013; Lee et al., 2020a). This is partly because electricity consumption is low and few powerful appliances are used (Adamopoulou et al., 2022; Chaplin et al., 2017; Lenz et al., 2017; Schmidt and Moradi, 2023; Taneja, 2018). Most studies analyse energy access for households and companies, while approaches to income-generating energy use are less well researched. As a result, productive energy access using stand-alone solar appliances such as refrigerators and irrigation pumps is also insufficiently researched; the existing literature is largely limited to small pilot projects (Burney et al., 2010; Durga et al., 2024).

Since German DC promotes productive energy use – such as within the scope of the multi-donor EnDev intervention and the BMZ's GBE initiative – the evaluation addresses this research gap and examines the effects of access to stand-alone solar appliances with regard to their income-generating effects, as well as other approaches to off-grid energy access. In addition to studying the economic use of decentralised energy, the evaluation focuses on the relevance of these technical approaches for expanding energy access in rural areas in general (see Barry and Creti, 2020; Bensch et al., 2018; Mukoro et al., 2022) and their impact on the living conditions

14 One exception is EnDev, which has been promoting both grid expansion and decentralised energy access for about two decades.

15 The literature reviews are printed in full in the online appendix.

and societal role of women and girls in particular.[16] In addition to the focus on approaches for productive energy use via stand-alone solar appliances, the evaluation also examines other off-grid approaches that are particularly relevant for rural areas, and compares the results with findings on energy access via the central grid, which is much better researched.

A more detailed summary of current studies – itemised according to technical approaches and target groups, particularly women, girls and especially the poor – is provided in the literature reviews in the online appendix to this evaluation. The affordability of the technical appliances is one of the biggest challenges involved in creating initial access, boosting economic development and reducing poverty for energy-poor population groups, with subsidised, improved biomass cookstoves showing great potential for reaching these population groups (Ankel-Peters et al., 2024b). Rural energy access can significantly improve the living conditions of women and girls, especially through better cooking technologies such as improved biomass cookstoves (Ankel-Peters et al., 2024a). In terms of the efficiency of different technical approaches, PicoPV systems and improved biomass cookstoves show the highest production and allocation efficiency (Ankel-Peters et al., 2024a).

1.3 Objective and contribution of the evaluation

The evaluation aims to assess Germany's contribution to improving energy access in rural Africa from the perspective of accountability and evidence-based learning for future policy design and implementation. The OECD DAC evaluation criteria of relevance, effectiveness, impact, sustainability and coherence are examined for this purpose (OECD DAC, 2019).

The evaluation's conclusions and recommendations aim to help improve interventions that provide access to (green) energy in Africa and in similar contexts. Within this scope, they are to be incorporated into the reflection process on the core-area strategy entitled "Responsibility for our Planet – Climate and Energy". This complements DEval's evaluations 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 focuses on off-grid approaches such as PicoPV systems, solar home systems, stand-alone solar water pumps, refrigerators, mills and mini-grids. One aim is to determine to what extent these technical approaches meet the needs and financial capacities (relevance) of the target groups – including, considered separately, the target group of women – and are suitable for expanding access to modern energy for all – specifically where this access is most needed and most effective. Other evaluation questions include the extent to which off-grid approaches facilitate the productive, income-generating, use of energy and can improve the living conditions of women and girls in rural areas (effectiveness and development-policy impact).

Furthermore, the question of the durability of the outcomes and impacts (sustainability) and the coherence of the German contribution – on the one hand with the partners' priorities (external coherence) and on the other with the various German interventions in the portfolio (internal coherence) – is analysed. The sixth OECD DAC evaluation criterion, efficiency, is analysed in less detail due to the diversity of implementation contexts. No benchmarks on efficiency are formulated, although findings on the overall topic of efficiency can be derived from the literature review and the analysis of the data collected. Both the relationship between the resources used (inputs) and the outputs achieved (production efficiency) and the relationship between the resources used and the outcomes and impacts achieved (allocation efficiency) are analysed. In the course of its assessments and derivations of conclusions, recommendations and implementation guidance, the evaluation contributes to learning for future programming and accountability.

16 On the women-specific effects of access to the central electricity grid, see Jensen and Oster (2009) or Peters et al. (2014).

1.4 Evaluation questions

The overarching question is:

How and to what extent does German DC contribute to access to (green) energy in rural Africa?

This question is divided into five evaluation questions. They are operationalised on the basis of evaluation dimensions that correspond to the BMZ's guidelines (2020) for dealing with the international evaluation criteria of the OECD DAC (OECD DAC, 2019), whereby individual evaluation dimensions are sometimes examined on the basis of several sub-questions. On the basis of the findings, this report assesses the relevance, effectiveness, impact, sustainability and coherence of interventions for rural energy access in Africa. The rating scale (see Table 7) and the detailed benchmarks are shown in the annex (see Table 8).

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

Evaluation dimensions related to the evaluation criterion of relevance:

1) alignment towards the BMZ's international and German policies and strategic priorities;
2) alignment towards the development needs of groups affected by energy poverty in rural areas.[17]

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

Evaluation dimensions related to the evaluation criterion of effectiveness:

1) achievement of the intended objectives;
2) contributions to achieving the objectives defined for the respective target group.

Evaluation question 3: To what extent do the interventions for rural energy access make a developmentally effective contribution for the target groups?

Evaluation dimensions related to the evaluation criterion of impact:

1) detectability and likelihood of (intended) developmental changes at target-group level;
2) avoidance of negative, unintended impacts.

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

Evaluation dimensions related to the evaluation criterion of sustainability:

1) capacities of those involved and affected to preserve positive outcomes and impacts over time;
2) contribution to supporting sustainable capacities;
3) foreseeable durability of outcomes and impacts over time.

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

Evaluation dimensions related to the evaluation criterion of coherence:

1) complementing and supporting the efforts of the (development) partners involved and affected;
2) complementarity and division of labour between German interventions and those of other donors.

17 Alignment with the policies and priorities of the partner countries is examined under the evaluation question EQ5 (coherence).

2.

EVALUATION SUBJECT AND CONCEPTUAL FRAMEWORK

The evaluation focuses on German DC interventions to expand access to (green) energy in rural Africa. Energy access is defined as initial or improved access to modern cooking energy or electricity and as appropriate energy access for MSMEs and social institutions (schools, health centres). This evaluation defines as "rural" areas with a population density of less than 300 inhabitants per square kilometre (World Bank, 2020). Due to the positive effects on living conditions, the evaluation also regards initial access to small photovoltaic systems, so-called PicoPV systems, as part of the evaluation subject (Grimm et al., 2016; Lenz et al., 2017). This is because, from a possible minimum use of four hours per day, these systems are already classified as Tier 1 energy access according to the World Bank's Multi-Tier Framework (MTF), which is decisive for DC (Bhatia and Angelou, 2015). This definition thus deviates from that of the International Energy Agency (IEA), which defines modern energy access as an average annual minimum demand by rural households equivalent to 250 kilowatt hours (IEA, 2022). The evaluation also takes energy access via generators into account. This is because generators are widespread in rural Benin, for example. It is important for the study on solar appliances to distinguish between the interventions reaching people who have not previously used modern energy and those who have at least had so-called bridging options (according to the definition of SDG 7.1, UNSTATS, 2024) such as diesel-powered generators. Like the MTF, the evaluation defines energy access as the ability of end users to actually use the energy supply for the desired energy service (Bhatia and Angelou, 2015). In addition to the availability of electricity or energy sources for cooking energy, this perspective also requires the availability of end appliances in order to consider energy access as given. The fact that the focus of this evaluation is on rural areas stems from the BMZ's aim of "reducing energy poverty in partner countries" (BMZ, 2021). By international comparison, sub-Saharan Africa and specifically its rural areas are particularly affected by energy poverty. In rural Africa, over 80 percent of the population have no access to electricity (IEA, 2022).

The evaluation defines rural energy-access interventions as those that either enable the implementation of technical approaches providing initial access to modern energy, or improve existing access in terms of affordability, reliability, security or climate-change mitigation. In addition to the actual implementation of a technical approach, interventions include accompanying activities such as strengthening capacities through training, or improving the political and regulatory framework conditions in the energy sector. Table 1 shows how the evaluation groups the electrical-energy and cooking-energy approaches implemented by interventions.

Table 1 Grouping of technical approaches to supplying rural areas with electrical energy and cooking energy

Technical approach	Tier level	Power (in watts, W)	Daily capacity (in watt hours or kilowatt hours, Wh or kWh)	Availability per day (in hours, h)	Possible applications
PicoPV systems	1	≥ 3 W	≥ 12 Wh	HH: ≥ 4 h MSME, SI: ≥ 2 h	Function-related lighting, mobile-phone charging, radio
Stand-alone systems	2	≥ 50 W	≥ 200 Wh	HH: ≥ 4 h MSME, SI: ≥ 4 h	General lighting, mobile-phone charging, radio, TV, fan, solar home systems (SHS), and solar-powered irrigation pumps, refrigerators and mills
Mini-grids	3	≥ 200 W	≥ 1.0 kWh	HH: ≥ 8 h MSME, SI: ≥ 50 percent of the company's working hours	Appliances with medium and higher wattage, including small fridge-freezer, small-scale irrigation
Limited and complete grid expansion	4–5	≥ 800 W	≥ 3.4 kWh	HH: ≥ 16 h MSME, SI: ≥ 75 percent of the company's working hours	Appliances with very high wattage, including air conditioning, large fridge-freezers, large-scale irrigation
Cooking energy and improved cookstoves					

Quelle: DEval, own visualisation based on data from Bhatia and Angelou (2015) and GIZ (2020)
Note: HH: households; MSMEs: micro, small and medium-sized enterprises; SI: social institutions

With regard to electrical energy, access is defined by several attributes. These are capacity, affordability, availability, reliability, quality, health, safety, legality and ease of use (Bhatia and Angelou, 2015). In the case of cooking energy, the relevant attributes are indoor air quality, cooker-combustion efficiency, ease of use, safety, affordability, and the quality and availability of the primary fuel (Bhatia and Angelou, 2015). The evaluation defines initial access as first-time access both to electrical energy, regardless of the Tier level reached, and to improved cooking energy in the sense of the attributes mentioned above.

The grouping of approaches is based on the Multi-Tier Framework (MTF) of the World Bank (Bhatia and Angelou, 2015), to which international and German DC refers (GIZ, 2020) It measures energy access in terms of electrical and cooking energy using a multi-level scale ranging from Tier 0 (no access) to Tier 5 (highest level of access). This grouping has been tailored to the approaches implemented in the interventions analysed (see Table 1 and Table 3).

In the case of electrical energy, PicoPV systems are assigned to the lowest access level (Tier 1) and central grids to the highest access level (Tier 5). PicoPV systems cover small, non-productive energy requirements. These include function-related lighting, charging mobile phones and operating radios. Stand-alone systems, including solar home systems (SHS), supply enough energy to operate appliances with higher productive and non-productive energy requirements, including television, refrigeration, milling and irrigation. Mini-grids (see Table 1) can cover even higher productive and non-productive energy requirements. The electricity from the central grid can be used to operate both productive and non-productive appliances with a high wattage such as air-conditioning systems, large fridge-freezers, and large-scale irrigation systems.

Similarly, different access levels are defined for cooking energy. Where possible, the evaluation differentiates results according to the various cooking technologies used. In some cases, specific results can be derived from the scientific literature. However, the specification of the implemented cooking technologies in the documentation of German DC interventions is often not sufficient to derive concrete results according to the various cooking technologies.

The evaluation examines the energy portfolio in Africa across the board in a document analysis and in the three country-case studies – with an in-depth look at decentralised energy access. As described in more detail in Chapters 4.2.2 and 5, the evaluation comprehensively analyses the energy portfolio in Africa of German DC in the years 2000 to 2022. Due to its special relevance for energy access in rural Africa, the evaluation looks in greater depth at decentralised energy-access approaches. It does this in a content-analysed document analysis of 72 GIZ and KfW interventions that are regarded as especially relevant (see Chapter 4.2.2) and in the three country-case studies.

BMZ's GBE and the multi-donor EnDev are prominent energy interventions that are analysed in greater depth in the case-study countries. GBE and EnDev are the interventions with the most funding in the BMZ portfolio promoting decentralised energy access (see Chapter 5). GBE's national activities have been implemented since 2018 by GIZ and KfW in Benin, Côte d'Ivoire, Ethiopia, Ghana, Mozambique, Namibia, Senegal, Uganda and Zambia. GBE's aim is to expand modern and renewable energy in rural Africa and to promote local value creation through productive use. EnDev is a multi-donor partnership that has been implemented since 2008 to provide energy access to poor people, small and medium-sized enterprises and social institutions in a fluctuating number of countries in Africa, Latin America and Asia, and is in line with the goals of the 2030 Agenda and the Paris Climate Agreement. In addition to Germany, EnDev is currently supported by Australia, the European Union, Iceland, Ireland, the Netherlands, Norway, South Korea, Sweden, Switzerland, the United Kingdom, the USA and a number of non-state actors. Implementation is the responsibility of GIZ and other organisations (BMZ, 2017). Among other things, EnDev and GBE use results-based financing (RBF) to promote income-generating and/or productive uses of energy (PUE), for example by using appliances such as solar water pumps, mills or dryers (Grüne Bürgerenergie, no date; Schröder and Gaul, 2021). RBF's aim is to create incentive mechanisms for companies to open up or develop markets that initially appear unattractive or risky due to low purchasing power. In the GBE and EnDev components investigated in the case-study countries, distributors sell solar appliances to end users at the market price and receive 40 percent of the original sales price from the interventions if they can provide proof of sale and successful installation. The components for productive uses of energy also include a gender component. Both projects aim to reach women-led companies.

3.

THEORY OF CHANGE

A theory-based approach was chosen (Patton, 2008; Stern et al., 2012; White, 2009). The evaluation reconstructed the theory of change on the basis of strategies and intervention documents, scientific and evaluative literature, and the reference-group comments. As a result, the main causal assumptions relating to German DC interventions on energy access in rural Africa provide a transparent basis for the evaluation. The overarching target formulations in publicly available German DC documents relating to energy access in Africa rarely distinguish between rural and urban areas, but they do recognise the relevance of rural energy access. The present evaluation derives from this the expectation that the objectives, which are formulated without reference to a geographical area, are transferable to rural areas – also because of the energy poverty that is prevalent there.

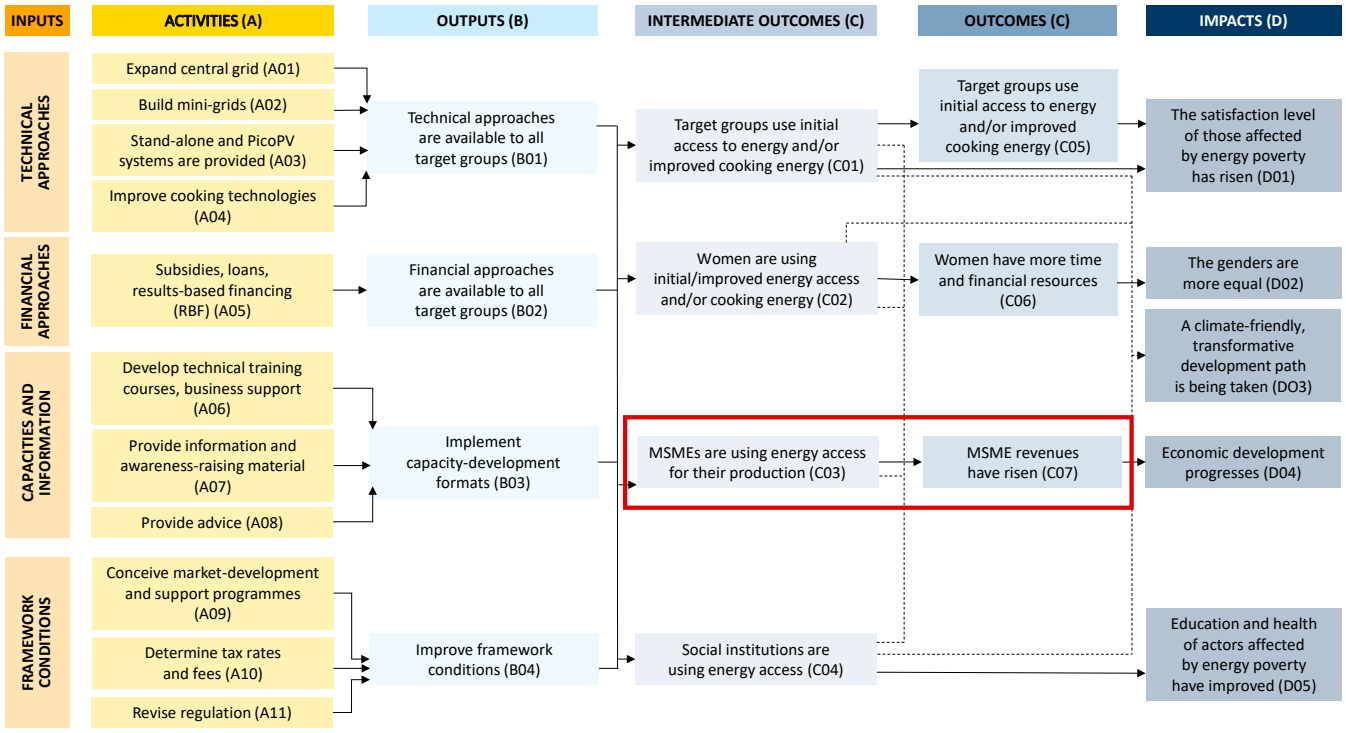
German DC promotes a range of different inputs, activities and outputs for energy access (see Figure 1) The technical approaches used include the expansion of central grids (A01) and mini-grids (A02), the dissemination of stand-alone systems (such as solar-powered irrigation pumps), PicoPV systems (A03) and the improvement of cooking technologies (A04), so that these are available to all target groups (B01). The target groups include households affected by energy poverty, women, MSMEs and social institutions. It is assumed that the inputs of German DC are in line with the needs and financial capacities of the target groups. Financial approaches are also located at the input level; they include subsidies, loans and increasingly results-based financing (A05), which are available to all target groups (B02). The other inputs at the level of capacities and information include the development of training courses for technicians on the maintenance and servicing of technical approaches, as well as business support (A06) and offering targeted information and awareness-raising material for the target groups on the productive use of energy; these include studies, communication material or data (A07) and advice (A08) aiming to strengthen the capacities of companies and partner institutions as well as the target groups (B03). In order to improve framework conditions (B04), market-development and support programmes are designed (A09), appropriate tax rates and fees determined (A10) and regulations revised (A11). Framework conditions can also be improved by giving operators access to voluntary carbon markets under Article 6 of the Paris Agreement to generate additional revenue sources. Support with verification mechanisms to prove the additionality of greenhouse-gas-equivalent emission savings is also relevant here. For example, GBE supports vocational training institutes and universities in offering new and improved practical training modules for technicians. On the level of framework conditions, GBE also supports the creation of the legal and political prerequisites for improving energy access, and advises political actors such as local regulatory authorities on, among other things, municipal citizen-participation models, including energy cooperatives. Here, GBE builds on the GET. transform component of the Global Energy Transformation Programme (GET.pro), which includes activities to improve energy planning, regulation and market development as well as the grid integration of variable renewable energies.

The effects vary according to target groups. The aim is for target groups in general (C01) – and women (C02), MSMEs (C03) and social institutions (C04) in particular – to make use of energy access and thus gain access to affordable, reliable and modern energy (C05), which can increase satisfaction (D01). At the outcome level, the use of energy access by women (C02) should result in time savings and an increase in financial resources (C06), thereby contributing to gender equality (D02). The productive use of energy by MSMEs (C03) targets an increase in revenue (C07) and thus a contribution to economic development (D04). Improved energy access based on climate-friendly technologies promotes a climate-friendly, transformative development path (D03). The use of energy access by schools and healthcare facilities (C04) strengthens education and health (D05).

The impact paths are based on various assumptions. A key assumption is that the target groups have a preference for modern energy access. One limitation of this assumption could be, for example, that the flavour of certain dishes is only generated by cooking with wood or biomass, so that modern cooking technologies are not accepted in some cases (Yonemitsu et al., 2014). It is also assumed that the use of new technologies for cooking and access to electricity in rural areas is culturally and socially accepted and that the range of services offered can adapt to changing values and needs. Failure to comply with social practices and their development

would be a risk for the underlying action mechanism. It is also assumed that there is clear, institutionalised ownership and appropriate capacities to ensure the durability of outcomes and impacts. For example, GBE aims to improve decentralised, citizen-oriented energy access in selected countries in sub-Saharan Africa; EnDev is geared towards providing needs-based, climate-friendly energy access to a greater number of poorer households, social institutions and MSMEs in selected countries. A key assumption here, too, is that the rural areas receiving support have sufficient market access to generate a demand for productive inputs, so that newly manufactured products can also be sold. The impact path from productive energy use (C03) to increased income (C07) is further specified in this chapter and empirically analysed in Chapters 6.2 and 6.3.

Figure 1 Reconstructed theory of change of German DC on energy access in (rural) Africa

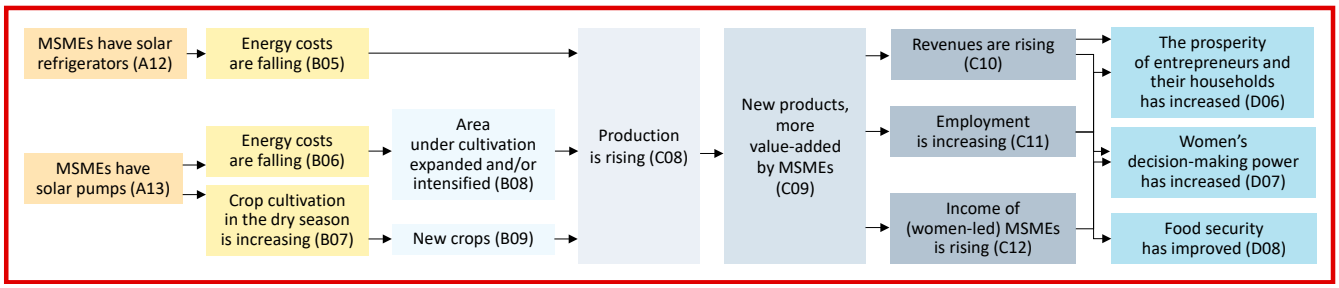


Source: DEval, own visualisation based on the theories of change of analysed interventions and existing research on the topic

Within the impact model shown in Figure 2 the path from productive energy use (C03) to higher revenues for MSMEs (C07) is shown in greater detail. These MSMEs are primarily small rural businesses in agriculture, livestock farming and the processing of agricultural products, but also operators of restaurants and small shops catering for everyday needs. Where the theories of change of the interventions were not detailed enough, scientific literature was consulted in order to formulate plausible causal assumptions and testable expectations. The starting point for the presentation is the assumption that the stand-alone systems – such as solar refrigeration (A12) and solar irrigation pumps for farms (A13) – are provided by German DC (input level), leading to a reduction in the companies' energy costs (B05, B06) (output level).[18]

18 For the GBE interventions, the theory of change focuses on output 3 and the module-objective indicators 2. The impact path shown for solar refrigeration is similar for other selectively subsidised appliances in the case-study countries, such as solar mills, sewing machines or drying appliances.

Figure 2 Causal chain for productive energy use and higher revenues for MSMEs



Source: DEval, own visualisation based on the theories of change of analysed projects and existing research on the topic

The use of solar appliances can lead to increases in production (C08) and turnover (C10). By using a solar irrigation pump (A13), MSMEs can introduce artificial irrigation systems if they have previously only practised rainfed agriculture. Alternatively, they can irrigate more intensively than with fuel-powered pumps (Burney et al., 2010), partly because of the lower operating costs of solar irrigation pumps (Closas and Rap, 2017; Kumar et al., 2020). As a result, farmers are switching to higher yielding crops (B09), which require more water, or intensifying cultivation on the same area. However, production increases can also be achieved by expanding the area under cultivation (B08) (Kumar et al., 2020). By using solar-powered refrigerators for the first time, shops can offer products such as chilled drinks or ice cubes as a short-term option for refrigeration in non-electrified households. If they were to switch from a fuel-powered refrigerator to one with an integrated solar panel, operating costs could be saved and the savings could be reinvested (analogous to B08, expansion of the cultivation area). This is based on the assumption that the costs of purchasing and maintaining solar energy are lower than the cost of fuel for conventional appliances. Similar impact paths are possible for the use of solar-powered sewing machines or mills. One obstacle to realizing the outlined effects of reducing operating costs is the cost of acquiring and maintaining the solar appliances; another aspect is the lack of spare parts and expertise for repairs. Only if the financial burden – including for loan repayment or instalment payments – does not exceed the savings in operating costs are the outlined effects on the impact path of reduced energy expenditure plausible.

The value added as an intermediate outcome (C09) is higher when solar irrigation pumps are used to grow high-value crops requiring artificial irrigation (Alaofè et al., 2016). In Benin, Uganda and Senegal, for example, this would be the case if they switched from millet to vegetables such as onions or tomatoes, or to bananas. In addition to the increase in production or higher turnover for traders, local processing into higher-value products can also be observed as an effect, such as processing maize into maize flour or milk into dairy products. Similarly, village shops can invest in new products such as ginger or baobab juice thanks to increased production and turnover or lower operating costs. Higher production or added value can lead to more sales (C10). The prerequisite for this is access to corresponding sales markets (Ankel-Peters et al., 2024a)

If the interventions lead to higher yields and/or sales, this can have a positive impact on the food security (D08) of rural households and their prosperity (D06). This causal relationship is based on the assumption that profits are generated despite the operating costs. Whether this is the case will be influenced by the company's energy costs, which in turn depend on whether it uses other non-renewable energy sources in addition to solar energy, as well as on the financing mechanism of the solar appliance and the cost of maintaining and servicing the appliances, for example pumps (Kumar et al., 2019, 2020; Louafi and Khaldi, 2017). The amount of cost savings is also determined by the level of the acquisition costs and the interest rate if the appliance is financed via a loan or in instalments (see Kumar et al., 2019).

Of course, it is also conceivable that profits generated are exclusively reinvested into the company. However, the components of EnDev's and GBE's promotion of productive energy use also aim to achieve the above-mentioned higher-value impacts that go beyond the economic situation of the individual MSMEs. GBE and EnDev aim to improve rural living conditions for the target group – in the case of EnDev, for example, by creating small businesses and service companies that help to increase income and improve the target group's economic situation. Expectations regarding the effects of access to solar-powered productive appliances are supported by selective research findings on the impacts of introducing artificial irrigation systems. For example, the provision of (diesel-powered) irrigation pumps by GIZ and KfW in Mali (and their technical support) has led to a switch from rainfed agriculture to artificial irrigation and, in addition to increasing yields, has contributed to food security and child health (BenYishay et al., 2024). The introduction of solar-powered irrigation systems also helped increase incomes in northern Benin (Burney et al., 2010). Against this background, impacts that go beyond the profitability of the companies themselves are also analysed.

The productive use of energy can increase the prosperity of female entrepreneurs and their households (D06) and strengthen the decision-making power of women (D07). Technical-cooperation interventions such as capacity development for women entrepreneurs can have an impact on their economic activities. According to traditional role perceptions, women are primarily responsible for housework. (Improved) access to energy, especially cooking energy, can have a positive impact on the quality of life for women and girls. This is expressed in time savings, less strenuous activities or an increase in perceived safety and satisfaction, for example through electric lighting. If women are gainfully employed and generate income, this can strengthen their decision-making power (D07) and support gender equality (D02).

4.

METHODOLOGY

The evaluation tests theories and is summative; it integrates qualitative, quantitative, case-centred and cross-case evidence (mixed-methods and multi-methods approaches). As part of a theory-based approach (Astbury and Leeuw, 2010; Chen, 2015), selected strands of the theory of change on energy access in rural Africa were verified (Pawson and Tilley, 1997). The methodological basis of the approach thus corresponds to the theory of change described in Chapter 3.

The evaluation combines an overarching portfolio analysis with three in-depth case studies. A quantitative portfolio analysis identifies focal points and trends in the energy portfolio. The relevant categorization was based on literature reviews. In addition, interventions in the portfolio on off-grid interventions were analysed in depth in qualitative content analyses of German DC strategy and project documents. Furthermore, both overarching and case-specific interviews were conducted with German DC actors, representatives of other donors and partners, as well as with experts. The methodology used to collect and analyse the data is described below.

4.1 Case studies and case selection

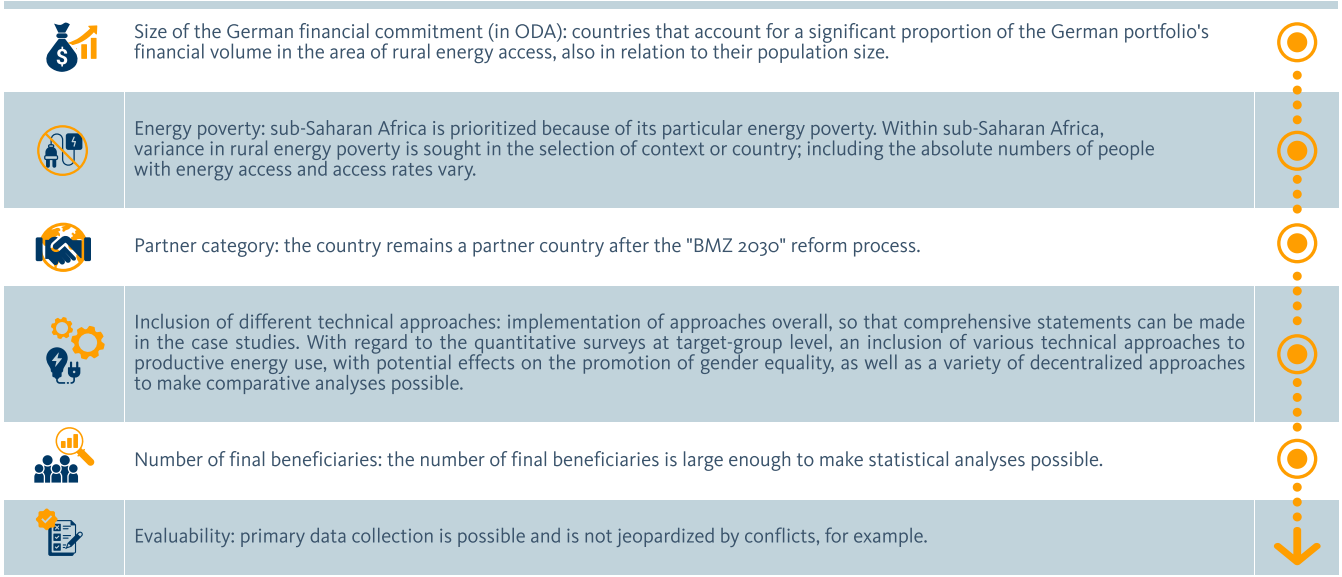
The evaluation uses a case-based evaluation design (Stern et al., 2012). The cases in the evaluation are not individual countries but implementations of German DC for rural energy access in defined geographical and temporal contexts – in this case in Benin, Senegal and Uganda. Accordingly, case studies are not individual programmes or projects but the respective comprehensive interventions of German DC to implement technical approaches. Case-based evaluation designs can generate robust findings from a defined context on the implementation, outcomes and impact of interventions at the country and target-group level. In addition, the relevance and coherence of the interventions (such as decentralised energy access for productive use) can be analysed in conjunction with other DC interventions and in the context of national policies and conditions. In order to be able to draw conclusions on causal relationships beyond the case in question (Byrne, 2009; George and Bennett, 2005) and make useful recommendations for other cases (external validity), the evaluation systematically selected the cases examined and embedded the case studies in cross-case analyses.

The systematic selection of cases with the highest possible probability of positive findings (most likely cases) was carried out both at the level of the technical approaches analysed and at the level of the case-study countries. One question in the evaluation is the extent to which energy access in rural Africa – provided it is used productively – can actually improve the economic situation of the rural population. In the survey among the target group, the evaluation focused on analysing technical approaches that are specifically intended by German DC for productive energy use, such as the solar irrigation pumps, refrigeration technologies and similar appliances promoted as part of GBE and EnDev. The evaluation thus selected most likely cases (Eckstein, 1975) as critical cases (Siewert and Wagemann, 2020). Forms of energy access with the highest ex-ante expectation that they will lead to productive use were selected as the most likely cases. It can therefore be expected that energy access will have a positive impact on the individual economic situation of the target group and/or that it will make a significant contribution to improving the situation (alongside other influencing factors such as access to markets, transport and price developments). Or, vice versa, if these technical approaches do not contribute to any discernible positive economic effects, then this finding is also very likely to apply to the rest of the portfolio (Beach and Pedersen, 2018; George and Bennett, 2005). At the country level, contexts were also selected in which it is likely ex-ante that the interventions to promote access to solar appliances will have a positive economic impact. Only the five countries in which both GBE and EnDev were implemented were considered, specifically where the effects of the interventions should be ascertainable due to the implementation period and volume: Ethiopia, Benin, Mozambique, Uganda and Senegal.[19] In these countries, it can be expected that the success of promoting productive energy use within the framework of GBE is even more likely than in countries where GBE has not been able to build on structures that have already been established in this field in the course of EnDev. Three countries with different levels of rural energy poverty were selected to generate results on the analysed interventions in different contexts. Ethiopia was excluded due to the ongoing conflict and thus limited evaluability. Benin was selected as the country with the lowest electrification rate, Senegal with the highest and Uganda with a moderate access rate. Uganda was chosen over Mozambique, which has comparatively moderate energy poverty in rural areas (IEA, 2017), because the German DC energy portfolio is larger there.

19 GBE country programmes were carried out in nine countries. EnDev has implemented interventions in 13 countries in sub-Saharan Africa (as of 2022).

See Figure 3 on the other criteria that were used downstream for case selection.

Figure 3 Criteria for case selection



Source: DEval, own visualisation

Based on the criteria shown in Figure 3, Benin, Senegal and Uganda were identified as cases and prioritised for primary data collection. The focus of the evaluation lies on small businesses in agriculture, animal husbandry and the processing of agricultural products, but also on owners of restaurants and small shops catering for everyday needs. Focus-group discussions were held with entrepreneurs in all three countries. In Benin and Senegal, these were supplemented by quantitative surveys on the (productive) use, outcomes and impact of stand-alone solar appliances. In addition to the final beneficiaries of German DC, a control group that did not benefit from the analysed interventions was also interviewed. In Senegal, a survey was also conducted among village leaders and operators of mini-grids at village level.

4.2 Methods of data collection and analysis

This section describes the procedures for collecting and analysing data. Arranged according to the evaluation questions in the evaluation matrix, further details are summarised in Table 8 (see appendix). Further information on the individual surveying and analysis methods and additional results can be found in the online appendix.

4.2.1 Literature reviews

Three literature reviews compile the scientific evidence on the relevance, effectiveness and impact of different technical approaches to energy access in rural Africa. The authors analysed the existing literature based on their many years of experience in research and evaluation in the field, with a particular focus on the following objectives: creating initial access, economic development and poverty reduction (Ankel-Peters et al., 2024b), improving the living conditions of women and girls (Ankel-Peters et al., 2023), and the efficiency of various technical approaches (Ankel-Peters, et al., 2024a). Although the assessment of the evaluation criterion of efficiency is not the subject of the evaluation,

useful findings were nevertheless generated (see also Chapter A in the online appendix).

4.2.2 Portfolio and document analysis

The portfolio analysis 1) provides an overview of the German energy portfolio and its development over time, and 2) serves as a descriptive analysis of the relevance of the focal points in the energy portfolio. The portfolio analysis represents a quantitative analysis of project databases in this context and is analysed with regard to several questions in combination with qualitative data and data from literature reviews. As regards the relevance of the focal points, the evaluation identifies the technical approaches that are of particular importance for certain objectives on the basis of the literature reviews. The portfolio analysis shows how large the portfolio is which plausibly makes a relevant contribution to target achievement based on the technical approaches implemented. The portfolio analysis covers all German DC interventions (ODA – Official Development Assistance) in the period from 2000 to 2022 in the energy sector (sector code 230) and in the funding area of cooking energy (purpose code 32174) in Africa and interventions relevant to Africa, in which off-grid technologies are (also) implemented and which are financed from BMZ funds. The primary data source is the BMZ's MeMFIS reporting system, where the evaluation identifies 443 projects (co-)financed by BMZ in the field of energy and cooking energy, corresponding to 5.4 billion euros in ODA over the period under review from 2000 to 2022 (amount in constant euros, base year 2015). Of these, 45 are off-grid interventions (763.1 million euros) and 25 cooking-energy projects (199.4 million euros) (eight projects were counted twice as they include both cooking-energy and off-grid components). Of the 443 projects in the energy and cooking-energy sector, KfW implemented 238, seventeen of which were in the off-grid sector and one on cooking energy. GIZ implemented 113 projects, 26 of them in the off-grid sector and eleven on cooking energy. Among the projects that promote off-grid approaches, two were implemented by other organisations. To identify cooking-energy projects, all interventions with the funding area code 32174 (production, market development and distribution of clean cookstoves) were considered (regardless of whether this was the first funding area code assigned or a different one). However, as this funding area code was only rarely assigned, the whole BMZ DC portfolio was also examined using relevant keywords during the period under review.[20]

The funding area codes and other meta-information in the MeMFIS data are not detailed enough to identify different technical approaches such as solar home systems or PicoPV systems. Individual analyses of the portfolio analysis are therefore based on a reduced sample of 72 projects that were commissioned by the BMZ between 2013 and 2023 and implemented by GIZ or KfW. For the evaluation of these projects, the technical approaches and further information on the projects were coded for the portfolio analysis. The projects were selected as follows: based on the MeMFIS data, the evaluation compiled a list of 112 projects in which off-grid approaches were (also) implemented in Africa during the period under review. These were validated and, in some cases, supplemented by the implementing organisations. KfW and GIZ then submitted project documents for 72 individual Financial and Technical Cooperation projects[21] whose relevance to the subject of the evaluation, particularly for off-grid interventions, was subsequently confirmed. This corresponds to 68 BMZ numbers. However, the content analysis also examined the country interventions and programmes with no BMZ numbers. These interventions cover almost the entire portfolio of off-grid approaches in Africa during the period under review. However, there are also 51 projects that (also or exclusively) promote access via the central grid. In addition to the portfolio analysis, a qualitative content analysis (DOKA) was also carried out on the basis of the project documents (DOK) for these 72 individual interventions to assess relevance, effectiveness, impact and coherence. The respective benchmark was derived from internal or external demands on German DC, which are formulated, for example, in strategies or the literature. The benchmark reveals the point from which the evaluation considers the intervention to be successful or the benchmark to be met. When assessing the benchmark, the lack of final or

20 Among the 29 keywords used to identify cooking-energy interventions were terms such as "cook", "stove", "energy-efficient" and "EEBC". In addition, all projects included in MeMFIS were counted as "cooking energy" if they were identified as relevant to the subject according to the project documents of the 72 interventions analysed in more depth.

21 The 72 analysis units comprise 68 projects, each of which can be assigned a BMZ number, as well as six programmes or modules.

progress reports[22] must be taken into account. Overall, of the 72 individual interventions, detailed information on 68 cases was included in the portfolio analysis, of which 40 interventions also implemented off-grid approaches.

4.2.3 Semi-structured interviews

In the course of the evaluation, semi-structured interviews (QUAL) were conducted on the effectiveness, impact, relevance, sustainability and coherence of rural energy-access interventions at the headquarters level of BMZ, GIZ and KfW Development Bank of German DC, as well as at country level in the three case-study countries Benin, Senegal and Uganda (37 in total). For Senegal, the evaluation also used the Country Portfolio Review (CPR) drawn up by DEval in 2022, which is unpublished for reasons of confidentiality, and 14 interview transcripts conducted as part of the CPR with representatives of the actors and partners relevant to the evaluation. The interview transcripts and the CPR-related documents and strategies were coded and qualitatively analysed using deductive categories derived from the theory of change and/or the evaluation questions (Mayring, 2012).

4.2.4 Surveys on stand-alone solar appliances for productive use

Surveys were conducted among rural entrepreneurs in Benin and Senegal between June and September 2023 (517 respondents in Benin, 569 respondents in Senegal). Both surveys aimed at making a full census of the final beneficiaries of solar appliances for productive use who purchased these appliances via RBF mechanisms under EnDev and GBE. In Benin, 116 (out of 206) of these final beneficiaries were interviewed, in Senegal 168 (out of 206).[23] In addition, a control group of entrepreneurs and farmers was surveyed who were active in the same localities and in the same value chains and ran companies of a similar size in terms of turnover, reach, number of employees (401 people respectively in Benin and Senegal) – and/or cultivated similarly large areas of land. The control group differed from the intervention group (the final beneficiaries) in that the respondents use conventional rather than solar appliances for the same economic activity.[24]

The surveys were analysed descriptively and causally.[25] The causal analyses are based on a cross-sectional comparison between the final beneficiaries and the control group at a point in time in 2023 when the intervention could plausibly have had an effect. In a quasi-experimental design, matching procedures (propensity score matching, PSM)[26] were used to achieve comparability between the intervention and control groups. For example, entrepreneurs who were similar in terms of age, education, economic prosperity and other characteristics (before the intervention) were compared with each other.[27, 28] The cross-sectional comparison is based on the assumption that differences between the groups can be attributed to the intervention after they have been made comparable with regard to observable factors that could lead to a distorted assessment of the effect of the intervention

22 Overall, the implementing organisations submitted a progress report for 68.1 percent of the analysis units and a final report for 40.3 percent of the projects. The lack of documents could be partly due to the fact that 26 projects have not yet been completed.

23 Almost all the final beneficiaries contacted were willing to take part in the survey. However, the evaluation was only able to contact or "identify" slightly more than half of the of the final beneficiaries in Benin in the field and interview 116 of them due to outdated contact details. In addition, documents in Benin contained duplications with regard to the number of final beneficiaries.

24 This group is used as the main control group in the impact analyses. However, the evaluation also interviewed entrepreneurs from the same sectors who do not use modern energy for their activities or use solar appliances that they did not acquire as part of EnDev and GBE. Where appropriate, comparisons are also made with these companies.

25 The questionnaires in this evaluation were developed on the basis of the evaluation questions and various questionnaires from previous impact analyses on rural energy supply and access (see Bensch et al., 2019).

26 According to Rosenbaum and Rubin (1983), the propensity score is defined as the conditional probability with which respondents received the treatment, based on a vector of participant characteristics. In the matching procedure, respondents with similar propensity scores from the intervention and control groups are assigned to each other in pairs; this has been shown to reduce possible distortions due to selection bias (Rosenbaum and Rubin, 1983).

27 A complete list of the variables that were "matched" and details of the procedure can be found in the online appendix.

28 The control group was recruited as follows: the beneficiaries named a number of other business owners in the same trade in the same locality, specified by the evaluators, who were similar to them in the reference year before the start of the intervention. The similarity related to the activity carried out and the size of the company. A further requirement was that these business owners and their companies had no access to an appliance provided by the beneficiaries. The survey of this control group then revealed whether the interviewees belonged to the control group that does not use modern energy or fossil fuels for its activities or to the one that has solar equipment at its disposal that it had acquired other than through the GIZ projects. Accordingly, the respondents were assigned to different groups for the statistical analyses.

(so-called statistical confounders). In order to check the robustness of the results, the difference-in-differences approach was also selected. The effect of the intervention was determined using two combined differences: the difference between the values of the indicators before and after the intervention (in Benin: 2023 versus 2015; in Senegal 2023 versus 2019) and between the final beneficiaries and the control group. In Benin (2015[29] to 2022), the period in which final beneficiaries purchased solar appliances via the RBF mechanism as part of EnDev and GBE is significantly longer than in Senegal (between 2021 and 2022).[30] A before-and-after comparison was also carried out among the final beneficiaries of GIZ between one year after and one year before the individual installation date.

4.2.5 Survey on mini-grids in Senegal

In Senegal, a representative survey was conducted in villages where mini-grids were installed between 2016 and 2021 as part of EnDev and its ERSEN 1 and ERSEN 2 country interventions. Telephone interviews were conducted in September and October 2023 with village heads and local managers of mini-grids in 82 of 90 villages. The survey was evaluated descriptively. It analysed how effectively and sustainably mini-grids function after a few years and to what extent their energy is used for economic activities. In some of these villages, MSMEs were also given access to appliances for productive use by GIZ in order to promote energy from the mini-grids for income generation. These were mainly refrigerators, sewing machines and mills. Small boutiques were also set up to make it easier to pay the usage fee for electricity from the mini-grids.

The survey on mini-grids was used to categorise the results from the impact analyses on stand-alone solar appliances. This is because mini-grids can be seen as an alternative off-grid approach to energy access (see also Chapter 2), which can also make it possible for energy to be used for productive activities, depending on its wattage. Just like stand-alone approaches, mini-grids are also suitable for regions that are so remote that electrification via the central grid would not be efficient.[31]

4.2.6 Focus-group discussions

In addition, focus-group discussions (FOKG) were held with the same target group. The 40 focus groups were made up of selected rural entrepreneurs from the localities in which the quantitative surveys on stand-alone solar appliances and mini-grids were conducted. The participants included both those entrepreneurs who had received solar appliances via GBE and EnDev and those who were not involved in these interventions. In Senegal, ten of these discussions took place with focus groups in villages where mini-grids had been installed as part of Technical Cooperation. Half of the focus-group discussions took place with female entrepreneurs, the other half with mixed groups. The aim of these discussions was to understand the energy needs of local entrepreneurs and the population, especially women and girls, and the relevance of the technical approaches implemented by GIZ with regard to these needs. The evidence from the focus groups was also used to interpret the results of the quantitative survey.

4.3 Method integration

The integration of methods in the evaluation makes use of the strengths of individual approaches and compensates for their weaknesses. The quantitative descriptive portfolio analysis, the quantitative surveys among MSMEs on stand-alone solar appliances, and the survey on mini-grids are suitable for documenting heterogeneity and variance over a large number of observations, thus providing generalizable results (Hammersley, 1989). Qualitative methods were used not only in the qualitative content analysis of German DC documents and strategies, the focus-group discussions and the literature reviews, but also in the semi-structured interviews

29 As only few final beneficiaries in Benin already purchased appliances in 2015 and this not until December, 2015 is nevertheless used as the reference year before the intervention (and not 2014).

30 Due to the COVID-19 pandemic, 2020 is not a suitable year for comparison; 2019 was used as the reference year.

31 Due to the portfolio coverage and the similarity of the approaches, mini-grids were also analysed. According to the "Progress Report" 2021 (GIZ, 2021a) and monitoring data, EnDev provided more people with access to energy via mini-grids than via stand-alone solar appliances. The evaluation gap in the productive effects of using stand-alone appliances is larger than that in mini-grids (see Chapter 1.2). The findings from past impact analyses reduce expectations regarding economic development due to electricity access via stand-alone grids. However, by equipping some of the villages or their MSMEs with appliances for productive use, the potential for productive use could have been strengthened, so that an investigation was also appropriate for this reason.

with German DC stakeholders at headquarters level, with experts at the case-study level and with representatives of the development partners in the countries. They served to better categorise the results from the portfolio analysis and the quantitative surveys among the target group, and to draw the right conclusions from them. The qualitative interviews with the target group also fulfilled the function of adapting the quantitative survey instruments to the local context and identifying possible causal mechanisms.

Quantitative methods can enrich qualitative surveys by identifying interesting cases that should be analysed in greater detail in interviews. Furthermore, statements from qualitative interviews can be verified using quantitative methods (Kelle, 2006). The case-centred analyses, which in turn triangulate different data sources and data-collection methods, contribute to the internal validity of causal conclusions. Following a multi-method research approach (Goertz, 2017), combining the case studies with cross-case evidence contributes to external validity in order to generate useful recommendations for the portfolio of energy interventions in rural Africa (see Table 2).

Table 2 Examples of the integration of cross-case and case-centred evidence from quantitative and qualitative analyses

	Quantitative	Qualitative
Cross-case	Portfolio analysis	IInterviews with stakeholders at headquarters level, content analysis of project documents
Case-centred *(within-case)*	Quantitative survey among MSMEs, with village leaders and managers of mini-grids	Interviews with stakeholders and partners at country level and focus-group discussions with MSMEs

Source: DEval, own table

To assess the effects of solar appliances, quasi-experimental results, the self-assessments from survey data and the assessments of the focus-group participants are triangulated with each other. Where the various data sources differed in some of their results, the quasi-experimental findings were weighted more heavily, as they represent the most rigorous method for measuring the effectiveness and impact of solar appliances in the evaluation. In the surveys of MSMEs in Benin and Senegal, self-assessments were conducted on the development of the economic situation of the companies and the living conditions of the beneficiary entrepreneurs and their families since using the appliances promoted by GIZ; this was done without comparison with a control group. In the focus groups, both the assessments of the beneficiaries and the predictions of those who were not yet using solar appliances were collected. The self-assessments in the survey and the assessments of the focus-group participants thus provide information on the mechanisms behind causally proven outcomes and impacts, help to make these effects plausible and provide information on barriers to access to solar appliances. As the causal attribution of these reported effects and forecasts is less reliable than in the quasi-experimental analysis of business performance indicators, the latter flows more strongly into the assessment of the benchmarks 3.1, 3.2 and 3.3.

4.4 Limitations

Limitations arise due to restrictions in data availability; however, these are optimally compensated for by suitable analysis methods and triangulation. The document analysis and individual analyses of the portfolio analysis are based on the sample of submitted project documents described in Chapter 4.2.2. Concept documents were available for 87.5 percent of the analysis units. Data delivery was complete for 19 of the 72 projects; documents were available for all implementation phases, while the final report or evaluation was missing for 20 projects, and only concept documents were available for a further 26 projects. These gaps in the data made it difficult to assess individual requirement levels, particularly with regard to the criterion of relevance. Any limitations in robustness are indicated in Chapter 6 on the results. The effectiveness of

individual approaches was evaluated using quasi-experimental methods. Against the background of existing interests of the reference group, identified evaluation gaps (see Chapter 1.2) and the potential for productive use emphasised by German DC, stand-alone solar appliances were prioritised. As no baseline data were available, the situation prior to the time of the interventions in the surveys had to be reconstructed. Possible distortions in the results due to the use of recall data are disclosed in particular in Section 6 on impact.

A rigorous portfolio comparison between different donors is hardly possible on the basis of currently reported funding area codes. MeMFIS data are more up-to-date and contain more detailed information on budget items, for example, than the OECD's data in the Creditor Reporting System (CRS data). At the same time, however, they only contain information on projects that have been approved using BMZ funds. MeMFIS data are therefore not suitable for a comparison of donors. Although CRS data are suitable for donor comparisons in principle, neither the MeMFIS nor the CRS data contain information with sufficient detail to map the share of cooking energy and other technical approaches such as decentralised approaches or the promotion of productive energy use. The evaluation can therefore only describe the portfolio of different technical approaches for a selection of 72 in-depth analysed projects on access to rural energy supply and access, and for the share of cooking energy via coding using key terms for the BMZ portfolio in Africa (see also Chapter 4.2.2 and the online appendix).

5.

THE GERMAN PORTFOLIO FOR IMPROVING ENERGY ACCESS IN RURAL AFRICA

Germany is one of the most important donors to the financing of interventions in the energy sector – also in Africa. According to CRS data, Germany committed 35.7 billion US dollars to the energy sector between 2000 and 2021; only the International Development Association (IDA) of the World Bank (42.1 billion US dollars) and Japan (36.7 billion US dollars) committed more. In the Africa region, Germany is actually the largest bilateral donor with 8.8 billion US dollars. Only the IDA (25.2 billion US dollars) and EU institutions (9.8 billion US dollars) made higher commitments.[32] Germany's important position in the African region, as shown by international comparison, is primarily due to its commitments for interventions in the sub-sector "Energy Generation, Renewable Sources" (6.1 billion US dollars, 69.7 percent) and "Heating, Refrigeration, Energy Distribution" (1.9 billion US dollars, 22.1 percent).[33]

Another actor in Africa's energy sector is China, which, with 148 billion US dollars, accounted for about a fifth of all loan commitments to Africa between 2000 and 2018 (Bräutigam et al., 2020). A large proportion of these loan commitments were channelled into energy and infrastructure interventions (IEA, 2022). However, as China is not a donor that reports to the OECD DAC, no portfolio reconciliation can be carried out using the CRS data. Since China's far-reaching declaration in September 2021 – that it would not support any new coal-fired power plants, but would instead increasingly support renewable energy sources – a key source of funding for fossil fuels is no longer available, in line with the withdrawal of many development banks and multilateral ODA. China also intends to reduce its public financing by a third, but at the same time expand the role of Chinese private investment, which could mean more renewable-energy projects via Chinese developers (IEA, 2022).

The Africa funding region plays an important role in the DC energy portfolio.[34] Africa is an important region, accounting for an average of 34.7 percent (43.7 billion euros) of the total German DC financial volume for which the BMZ was responsible in the period 2000 to 2022. The energy sector's average share of this funding in Africa is 9.7 percent (4.2 billion euros), following a rising trend from 6.9 percent in 2000 to 11.7 percent in 2022 on average. Only Asia received more commitments in the energy sector than Africa. North and sub-Saharan Africa receive the same levels of funding commitments.[35]

The energy sector makes up a large proportion of the BMZ's German portfolio and is becoming increasingly important in the Africa funding region. In the Africa funding region, the energy sector is the third-largest sector with 9.7 percent (4.2 billion euros) after the sectors "government and society" (14.6 percent) and "agriculture" (9.8 percent). Since 2000, financial commitments from BMZ funds for this sector have increased from 6.9 percent in 2000 to 11.7 percent in 2022. While commitments in absolute figures for the energy sector in Africa totalled 60.1 million euros in 2000, they had reached 380.2 million euros by 2022. This increase highlights the importance of the energy sector in the BMZ's portfolio inasmuch as the energy sector's share of total BMZ-financed development cooperation has decreased in recent years.

Most of funds for the energy sector in Africa are spent via Financial Cooperation, while off-grid and cooking-energy interventions are mostly implemented via Technical Cooperation. While KfW's commitments for the energy sector in Africa amounted to 4.6 billion US dollars (65.9 percent of German commitments for the energy sector), GIZ only spent a small proportion of the funds: 43.7 million US dollars (0.5 percent).[36] These figures relate to funds from all ministries; however, the distribution in the BMZ portfolio is similar. Here, KfW's share (including the Deutsche Investitions- u. Entwicklungsgesellschaft, DEG) is 4 billion euros (73.5 percent) and GIZ's 900 million euros (16.9 percent). In the case of decentralised, off-grid interventions, most of the financing volume of 402.5 million euros (52.7 percent)

32 Other major donors (more than 1 billion US dollars) are the African Development Fund, the Arab Fund (AFESD), France, Japan, Kuwait, Norway, Spain and the United States.

33 Sub-sectors with lower financial volumes in the German portfolio were "Energy Production, Distribution, Efficiency in General" (664 million US dollars, 7.6 percent) and "Energy Production, Non-Renewable Sources" (59.8 million US dollars, 0.7 percent).

34 The figures in euros refer to the BMZ's MeMFIS reporting system and include the BMZ's budget funds (commitment amount including reprogramming and approval amount) in constant euros compared to the 2015 baseline.

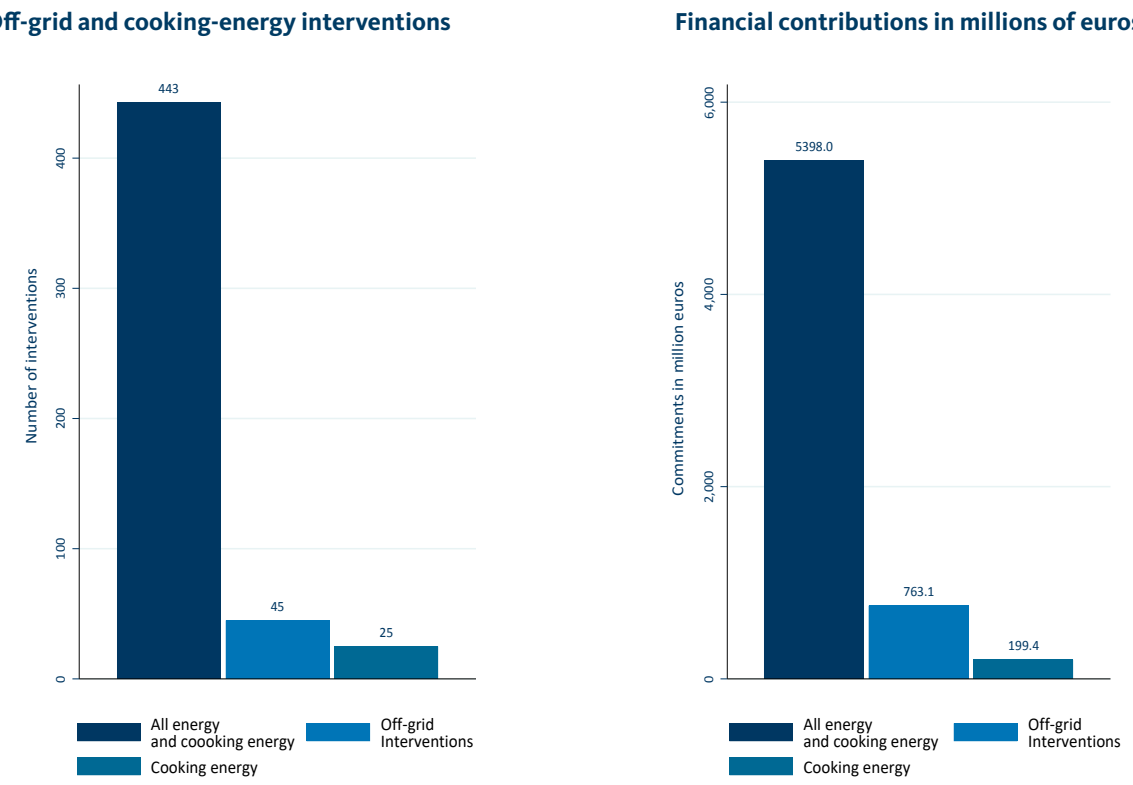
35 North Africa received 4.1 billion US dollars in commitments (46.8 percent of commitments), sub-Saharan Africa 4.0 billion US dollars (45.1 percent), and unspecified areas of Africa 0.7 billion US dollars (8.1 percent).

36 The CRS data also classify 2.8 billion US dollars (33.6 percent) as BMZ funds without specifying them further.

is implemented by GIZ and only 359.6 million euros (47.1 percent) by KfW.[37] In the field of cooking energy in Africa, too, Technical Cooperation's share clearly predominates. For example, 183.3 million euros (93.4 percent) is implemented by GIZ and only 10.5 million euros (5.3 percent) by KfW.[38]

The share of decentralised energy and cooking energy in the BMZ's energy portfolio in Africa is relatively small; however, it has risen slightly in recent years. Over the entire period under review from 2000 to 2022, 443 interventions (5.4 billion euros) were implemented in the energy and cooking-energy sector in Africa (see Figure 4).[39] 45 of these (10.2 percent) were off-grid interventions, and 25 (5.6 percent) related to cooking energy. During this period, 763.1 million euros (14.1 percent) was spent on off-grid interventions and 199.4 million euros (3.7 percent) on cooking energy.

Figure 4 Off-grid and cooking-energy interventions in the energy sector



Source: DEval, own visualisation based on MeMFIS data from 2000 to 2022 in Africa, 443 energy and cooking-energy interventions; eight interventions were counted twice as they included both off-grid and cooking-energy implementations; amounts in euros include reprogramming and approved amounts; calculations were made in constant euros (base year 2015)

BMZ's annual commitments for decentralised energy in Africa fluctuate. They totalled 12.4 million euros in 2000, 3.5 million euros in 2001 and grew to 103.7 million euros in 2021 and 59.2 million euros in 2022 (see Figure 5). The share of commitments for decentralised energy interventions rose from 10.6 percent between 2000 and 2002 to 13.5 percent between 2019 and 2022. By contrast, the comparatively low financial commitments for cooking energy from BMZ funds increased

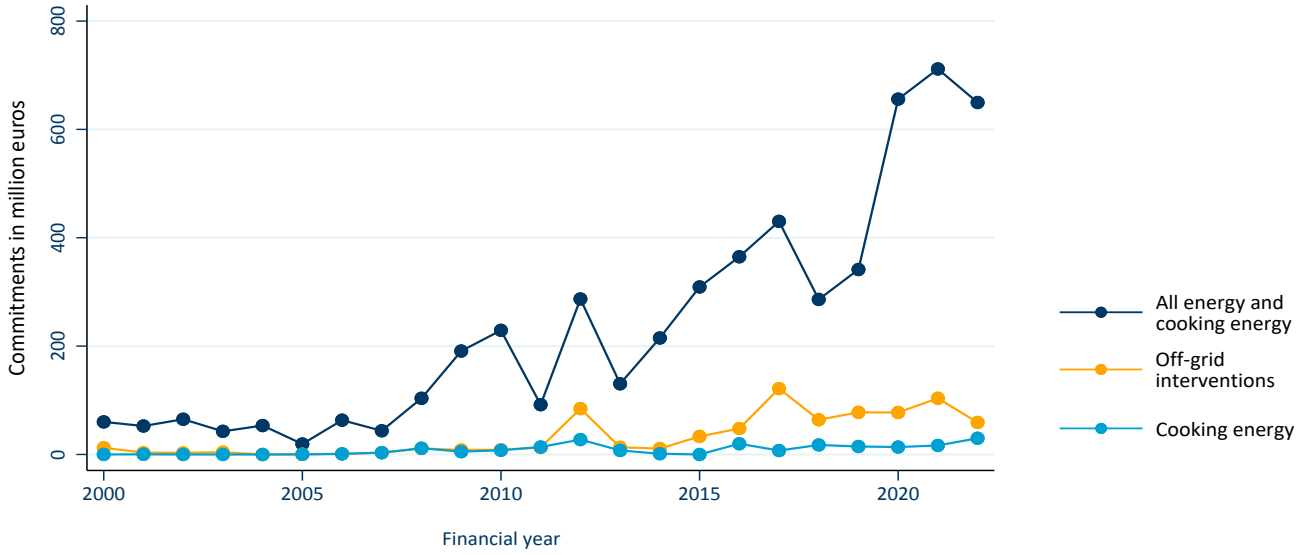
37 A further 0.9 million euros (0.1 percent) is spent by the Physikalisch-Technische Bundesanstalt (PTB) and 0.1 million euros (< 0.1 percent) by the Catholic Central Agency for Development Aid (KZE).

38 Other implementing organisations include the United Nations Foundation (UNF) with 1.5 million euros (0.8 percent), Lernen-Helfen-Leben e.V. with 0.4 million euros (0.2 percent), the Centre for International Migration and Development (CIM) with 0.3 million euros (0.2 percent) and other donors with 0.3 million euros (0.15 percent).

39 This includes the interventions for the Africa funding region as well as sector and global interventions with relevance for Africa.

only slightly and also fluctuated greatly over the years: while the commitments in 2000 and 2001 were 0.1 and 0.3 million euros respectively, they rose to 16.7 million euros in 2021 and 29.9 million euros in 2022. Overall, commitments for off-grid interventions as a percentage of total commitments in this sector has tended to increase, while the share of cooking energy has only risen slightly over time.

Figure 5 BMZ funds for energy and off-grid interventions in the years 2000 to 2022 in millions of euros



Source: DEval, own visualisation based on MeMFIS data from 2000 to 2022 in Africa, n = 443; eight interventions were counted twice since they included both off-grid and cooking-energy implementations; amounts in euros included reprogramming and approved amounts; the calculations were made in constant euros (base year 2015)

The GBE initiative and the EnDev multi-donor intervention are among the interventions for decentralised energy access with the largest financial volumes. The interventions for decentralised energy access with the largest financial volumes in the period under review (2000-2022), evaluated according to BMZ project numbers and taking BMZ funds into account, include the "FC Programme on Renewable Energies and Energy Efficiency (Investment)" (115.6 million euros, Côte d'Ivoire, 2019-2024)[40], the global multi-donor intervention "Energising Development" (91.6 million euros, 2014–2025; 45.9 million euros, 2008–2018)[41] and the "Green People's Energy for Africa" initiative with the "Green People's Energy" interventions (58.6 million euros, GIZ, 2018–2023) and the citizen energy fund "Facility for Energy Inclusion – OnGrid" (FEI-OnG) with 41.7 million euros.[42] Another intervention with a comparatively large financial volume is the Financial Cooperation intervention "Clean Energy and Energy Inclusion for Africa Foundation" (CEI Africa): Crowdlending/Smart Outcomes Fund with 43.6 million euros (2021-2038, not allocated to a funding region).[43] Thus, compared to the energy sector as a whole, the major off-grid and cooking-energy interventions are small. The ten percent of the largest energy interventions in the entire sector each spent between 28 and 304.6 million euros.

40 Interventions are identified by allocation to a BMZ project number. The "Renewable Energies and Energy Efficiency" programme comprises interventions relating to the subject of the evaluation totalling 146.1 million euros (constant euros). These are divided across five BMZ project numbers.

41 Interventions are described by allocation to a BMZ project number. The "Energising Development" (EnDev) programme comprises interventions totalling 149.4 million euros (constant euros) in BMZ funds. These are divided across three BMZ project numbers. The portfolio analysis is based only on BMZ funds, although EnDev's total mandate including co-financing from other donors is significantly higher (approx. €450 million).

42 Interventions are described by allocation to a BMZ project number. The "Green People's Energy" (GBE) initiative comprises interventions totalling 154.5 million euros (constant euros). These are divided across eight BMZ project numbers, three of which were implemented by KfW and four by GIZ.

43 Interventions are identified by allocation to a BMZ project number. The "Clean Energy and Energy Inclusion for Africa" (CEI Africa) programme comprises interventions totalling 48.3 million euros (constant euros). These are divided across three BMZ project numbers.

6.

FINDINGS

This chapter presents and discusses the empirical results produced by all methods, organised according to the evaluation criteria of relevance, effectiveness, impact, sustainability and coherence. Findings on efficiency are not assessed separately, but are summarised in Chapter 6.6 due to their usefulness.

6.1 Relevance

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

Evaluation dimensions relating to the evaluation criterion of relevance:

1) alignment with the BMZ's international and German policies and strategic priorities;[44]
2) alignment with the development needs of groups affected by energy poverty in rural areas.[45]

Sub-question a): To what extent are the objectives of the interventions aligned with the 2030 Agenda and relevant for the target group?

To answer this sub-question, the evaluation considers, among other things, the technical approaches that have been implemented – embedded in the respective interventions. To this end, the approaches are first compared with regard to the three key characteristics defined in SDG 7 (Access to energy):[46] affordability, reliability and modernity (understood here as wattage or tier level) on the basis of the literature reviews. Affordability is context-specific and depends in particular on the subsidies for end users and also, in the case of grid expansion, on the electrification rate and the size of the national territory. Table 3 provides the broadest possible assessment.

Table 3 Evaluation of technical approaches with regard to SDG 7.1

Technical approach	Modern	Affordable (for end users, costs in US dollars per connection)	Reliable
Off-grid			
PicoPV systems	Partially	Yes	Probably yes
	Low capacity, sufficient (with restrictions) as a primary source for lighting Tier 1	Low costs even without subsidies 20–50	Replacement/repair possible, low wattage and capacity Service life (L) = 2–5 years Maintenance (M) = low
Stand-alone systems for productive use (including irrigation pumps)	Yes	Partially	Probably not
	PUE possible Tier 1–2	Mainly because often tied to productive use (MSMEs/agriculture)	Cost of repairing individual systems, short operating time L = at least 5 years M = medium

44 This applies in particular to the "Core Strategy on Climate and Energy".
45 Alignment with the policies and priorities of the partner countries is examined under the evaluation question EQ5 (coherence).
46 ESMAP defines the "affordability" of the energy supply as the capacity of end users to pay for a defined package of energy consumption. "Reliability" refers to the absence of unforeseeable supply interruptions in the provision of energy. Higher wattages are labelled "modern" if energy sources other than biomass, coal or inefficient stoves can be used for cooking (Bhatia and Angelou, 2015)..

Stand-alone systems for households	**Yes**	**No**	**Probably not**
	PUE partially possible Tier 1–2	Subsidies required 100–700, depending on capacity	Repair of individual systems costly compared to mini-grids L = at least 5 years M = medium
Mini-grids	**Yes**	**Partially**	**Probably not**
	PUE possible Tier 3–5	Depends on the administrative design of connection costs and consumption 750–2,000	Limited wattage/daily capacity, susceptible to defects, but easier to repair in a network than in the case of individual systems L = 10–20 years M = high
On-grid			
Grid expansion	**Yes**	**Yes**	**High reliability**
	PUE possible Tier 4–5	With subsidies, affordability depends on consumption and national design of connection costs 500–1,500	State/utility company for repair L = at least 20 years M = low/medium
Cooking energy			
Electric cookstove		**No**	**Yes**
	Tier 4–5	But depends on the (mini-)grid	Depends on the grid
Biogas stove/ biogas digester		No	No (frequent technical faults)
	Tier 4–5	Subsidies required 500–1,500	L = 10–20 years M = high
Liquid petroleum gas cookstove (LPG)		**No**	**Yes (where available)**
	Tier 4–5	Hardly available in rural areas 20–100 plus gas costs	L = at least 5 years M = low
Advanced biomass cookstove		**Yes**	**No**
	Tier 2–3	75–100	Susceptible to faults, difficult to repair L = 2–5 years M = medium
Improved energy-efficient biomass cookstove (EEBC)		**Yes**	**Yes**
	Tier 0–2	5–30	L = 2–5 years M = low/medium

Source: DEval, own visualisation based on the literature reviews; PUE = productive use of energy; L = service life; M = maintenance costs

Benchmark 1.1: With its current priorities, German DC is relevant with regard to SDG 7.1: access to affordable, reliable and modern energy services for all by 2030, especially for energy-poor target groups.

According to project documents and interviews, German DC interventions are partially aligned towards SDG 7 and the priorities of development partners. Most of the BMZ-funded interventions analysed aim to make a contribution to energy access. It often remains unclear to what extent the aspects "affordable", "reliable" and "modern" are taken into account. In individual interventions, the contribution to SDG 7.1 is shown via the promotion of framework conditions. A small number of the interventions (8 out of 72) set ambitious additional targets for renewable energies (SDG 7.2) or energy efficiency (SDG 7.3).[47]

47 The evaluation recognises that the goals of the 2030 Agenda are reflected in the programming with a time lag. A robustness test was therefore conducted. Of the 20 interventions implemented since 2018, 13 aim to contribute to SDG 7.1, and five to SDGs 7.2 and 7.3. As a result, the number of interventions contributing to SDG 7.1 has increased significantly from 50 percent to 65 percent since 2018.

The conception phase of 54.2 percent of the interventions (39 out of 72) reveals a specific objective to increase the number of beneficiaries to receive initial access or improved existing access. Furthermore, two interventions formulate targets for growth rates. In addition to energy access, all the other interventions pursue objectives such as in the fields of strengthening capacity and raising awareness of the importance of renewable energies, or else aim to strengthen regulatory framework conditions. Representatives of German DC and the partner side see varying degrees of consensus between the foci of German DC and SDG 7.1 (QUAL 12-13, 15, 34, 36, 41, 43, 45, 48). They say that the target for initial access is only achievable for lower tier levels (QUAL 16).

The relevance of the technical approaches for SDG 7.1 depends on the context; the affordability of energy access is key for end users. The evaluation regards technical approaches for initial access as relevant if they are "affordable", "reliable" and "modern" for the population and companies in rural Africa, in accordance with SDG 7. The evaluation concludes that affordability is particularly relevant from the end users' perspective for increasing the initial access rate, especially among energy-poor population groups. In countries with a small surface area and high grid coverage, households and villages might often be reached by means of moderate grid-densification investments, so that expansion is particularly relevant if accompanied by subsidies for connection fees. In territorial states with a lower grid coverage in rural areas and no significant subsidies (for end users), off-grid approaches would be more relevant and more cost-efficient. Since the suitability of the various technical approaches depends on the context, their share of the portfolio – just like the assessment of the interviewees and the analyses of the intervention documents – is not conclusively evaluated in terms of Benchmark 1.1.

BMZ funding to promote energy access in rural Africa increased between 2000 and 2022. Off-grid approaches gained in importance, while cooking energy is not a priority area of German DC despite its relevance for women in particular (see Figure 5). Between 2000 and 2022, German DC implemented a total of 443 interventions in the fields of energy and cooking energy in Africa, involving commitments amounting to 5.4 billion euros.[48] Only 14.1 percent of the portfolio of energy and cooking-energy interventions included off-grid approaches – with commitments totalling 763.1 million euros. Interventions in the field of cooking energy accounted for 3.7 percent of the portfolio with a financial volume of 199.4 million euros. Nevertheless, the financial volume of off-grid approaches in the BMZ portfolio rose slightly between 2000 and 2022: from 8.6 percent to 11.6 percent. Like the energy sector as a whole, the number of interventions with off-grid approaches has risen sharply: in absolute terms it has more than quadrupled on average since 2000. By comparison, cooking-energy interventions' share of the energy portfolio has fallen significantly: from 8.6 percent to just 1.7 percent from 2019 to 2022. Since 2000, cooking-energy projects have also declined in absolute terms, and have been overtaken by all other technical approaches since the mid-2010s. As with the technical approaches for electricity, the relevance of individual cooking-energy approaches varies with regard to SDG 7.1 (see Table 3), but overall they can be regarded as important contributions to supporting energy access and, in addition, to climate-change mitigation (Ankel-Peters et al., 2023).

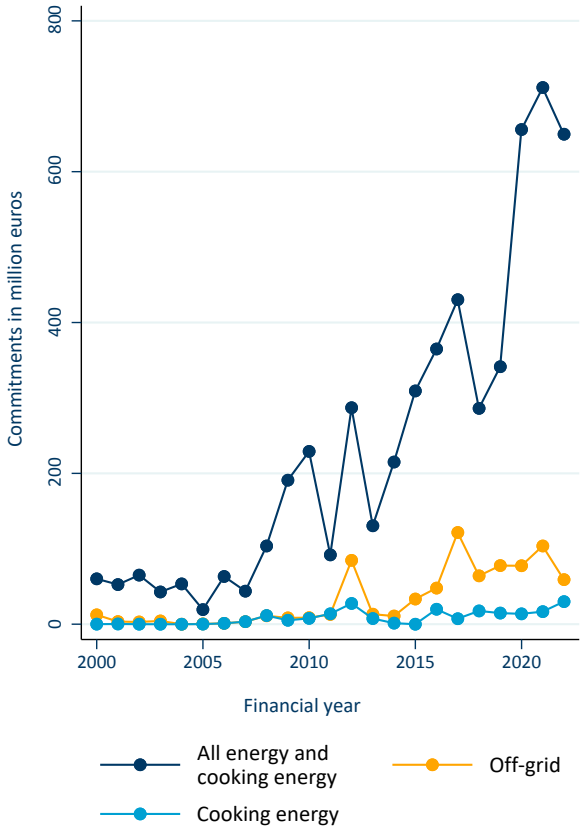
The growth in the German energy portfolio and its relevance for SDG 7.1 vary within the group of off-grid approaches (see Figure 6). Among the off-grid approaches, the number of interventions involving mini-grids has risen proportionately the most in the portfolio since 2000 and especially since 2007, followed by stand-alone systems. Hardly any PicoPV systems are being implemented. Interventions to promote mini-grids and expand grids (the latter embedded in the portfolio data in interventions that also promote off-grid approaches) have increased the most since 2000. With regard to the potential contribution to SDG 7.1, the limitations of mini-grids are the poor reliability of the systems (such as susceptibility to defects, high maintenance costs) and their affordability for end users, which is often not guaranteed without subsidies from governments or donors. The supply of electricity via the central grid is generally very reliable, and repairs are more likely to be carried out than in the case of small-scale systems. However, the grid-expansion

48 Even when the population includes all energy interventions implemented by German DC in the period under review, a large proportion of these interventions can be attributed to the energy-access portfolio. When operationalizing energy-access interventions, the evaluation is based on the funding area codes which, according to Bazilian et al. (2011), can be attributed to energy access. In addition, it assumes that the funding areas relevant for energy access are those contained in the interventions for which the implementing organisations have provided intervention documents. These were the interventions that the implementing organisations had classified as relevant for energy access in rural Africa (see the online appendix for details).

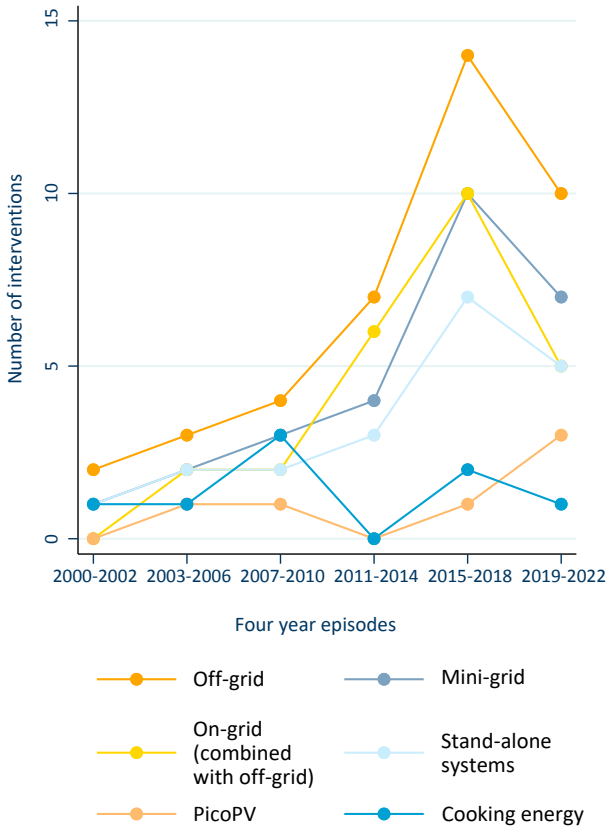
approach is more relevant for SDG 7.1 in smaller, densely populated states with an advanced, well-developed grid, but in sparsely populated territorial states (and those with large, very sparsely populated areas) it is often almost impossible to finance due to the distances involved. Even stand-alone systems for productive use are hardly affordable without subsidies; they are also expensive to maintain and repair. As a rule, they are not suitable as a primary source for lighting. Smaller PicoPV systems, on the other hand, are often not powerful enough. It therefore remains questionable to what extent stand-alone systems and smaller PicoPV systems – unlike all the other approaches listed in Table 3 – are relevant for SDG 7.1. However, more powerful PicoPV systems can contribute to SDG 7.1 thanks to their affordability and reliability, but they are rarely promoted, and their share of the portfolio is hardly growing. As explained in Chapter 2, initial access using PicoPV systems can have positive effects on the well-being of end users.

Figure 6 **Energy interventions with implemented off-grid approaches from 2000-2022**

BMZ funding for energy and off-grid interventions from 2000 to 2022 in millions of euros



Implemented technical approaches in off-grid interventions from 2000 to 2022



Source: figure left DEval, own visualisation based on MeMFIS data from 2000 to 2022, in Africa, n = 443; eight interventions were counted twice because they included both off-grid and cooking-energy implementations; amounts in euros include reprogramming and approved amounts; the calculations were made in constant euros (base year 2015); figure right: DEval, own visualisation based on MeMFIS data from 2000 to 2022 with document analysis, n = 68; some interventions also implement several technical approaches

As already explained, the technical approaches are of varying relevance for the target groups. It is questionable whether the focus on market-based approaches without subsidies meets the needs of the energy-poor population groups. The financially precarious situation of the poor population groups increases the need for affordable energy access (QUAL 43, 48; FOKG 1, 8, 10). Affordability, in turn, depends on subsidies to cover end-use costs across all technologies. This is because studies show that poorer sections of the population – poverty correlates with energy poverty – often do not connect to the grid when villages are electrified (Golumbeanu and Barnes, 2013). Similarly, poorer groups are hardly represented among those who acquire stand-alone systems (see Barry and Creti, 2020; Bensch et al., 2018; Mukoro et al., 2022) or improved biomass cookstoves (Beltramo et al., 2015; Bensch and Peters, 2020; Munyehirwe et al., 2022). By focusing on market-based approaches, therefore, German DC is not meeting the benchmark of affordable energy access. Discussions with the target group in Uganda, Senegal and Benin bring to light the criticism that the end users addressed can hardly afford the subsidised solar appliances, if at all (QUAL 42-43, 48). Similarly, the scientific discussion points out that decentralised energy access is often not in line with the financial capacities of energy-poor population groups because they have to contribute to the costs via connection fees or else pay cost-covering market prices (Barry and Creti, 2020; Bensch et al., 2018; Mukoro et al., 2022). The promotion of improved biomass cookstoves is usually market-based. In particular, poor households in rural areas cannot afford even the comparatively cheap, improved biomass cookstoves, since, although cooking technologies lead to time savings, they do not generate income for reinvestment (Ankel-Peters et al., 2024a; Beltramo et al., 2015; Bensch and Peters, 2020; Litzow et al., 2019; Rose et al., 2022).

Although the needs of most target groups are analysed, the financial capacities and needs of energy-poor population groups are hardly taken into account. 53 percent of the interventions in the document analysis contain detailed and target-group-specific analyses (including needs analyses) of the needs of the end users. They look at the need for reliable and favourable prices as well as financing services such as subsidies. Although many of the interventions examined (35 out of 72) emphasise the relevance of affordability for the respective target group, only a few interventions (22 out of 72) carry out analyses, for example on the end users' ability to pay, and take this into account when calculating affordable personal contributions. The analysis of financial capacities therefore remains unspecific. Many of the interventions analyse the needs of the immediate target group, including institutions, governments and private-sector actors. However, the needs of the energy-poor population groups are rarely analysed and addressed in the intervention documents: only seven percent of interventions take them into account in their objectives, for example by analysing their ability to pay, and address their needs appropriately, for example when calculating the individual contributions to be charged. Even so, a majority of interventions neither formulate an objective of this kind, nor do they address the population groups most affected by energy poverty in their conception and implementation. Target group needs therefore appear to be secondary to other priorities, both in the objectives and in the conception and implementation.

Benchmark 1.2: Energy-access interventions are relevant for productive energy use.

In the case of productive energy use, stand-alone systems, such as solar irrigation pumps, are relevant for households, as are certain cooking technologies (when used in restaurants or for food production) (see Table 1 and Table 3). Among other things, the distribution of solar irrigation pumps and grain mills is promoted. All focus-group discussions confirm their relevance and see solar energy as an opportunity to reduce energy costs and increase production. There is criticism of the fact that solar appliances and mini-grids do not provide a reliable and uninterrupted energy source of a sufficient tier level, which impairs productive use (FOKG 1-2, 4, 6, 10). This form of energy access can promote economic development, provided that the production potential is specifically identified in advance, and there is market access with a corresponding demand for the products and services generated by the energy.[49] The productive use of energy therefore also requires support along the entire value chain. Despite the relevance of the interventions analysed, there are major obstacles in sub-Saharan Africa to translating energy use into economic development. This is because access to markets with corresponding demand is largely inadequate in rural areas (Ankel-Peters et al., 2023).

49 Compared to interventions in which everyone within a geographical area, household or population group is given access to energy, customers who are most likely to use it for economic purposes can be supplied with energy in a more targeted manner. So-called anchor customers are frequently identified in localities to ensure that the energy from a mini-grid is used economically before one is installed there.

Relevant interventions for productive energy use make up only a small percentage of the portfolio (see Figure 6 right). As shown, only 50 percent of the interventions for off-grid energy access implement stand-alone systems that are expected to have a high level of productive use.[50]

Benchmark 1.3: The energy-access interventions take the needs of girls and women into account.

In order to take the needs of women and girls into consideration, cooking energy, household electrification and approaches for productive use are needed that consider their relatively limited financial capacities. Access to energy improves the quality of life for women and girls in rural areas (see Ankel-Peters et al., 2023). Improved cooking technologies are particularly relevant for women due to traditional role distributions. Above all, they can lead to time savings (Ankel-Peters et al., 2023). Although such interventions in DC are highly relevant for the living conditions of women, because they address their specific needs, they frequently lack the kind of gender-transformative character that dismantles gender-specific norms, power structures and the causes of related inequalities (see IEO and UNDP, no date). Women express a pronounced need for productive energy use, including for refrigerators that make it possible to sell chilled products, or for grain mills for processing agricultural products (FOKG 5-6, 10). Further needs include a connection to the grid or solar energy for cooking, lighting, charging mobile phones, ironing, watching TV, doing laundry or accessing the internet (FOKG 3, 7, 10). The ability of women and girls to pay is generally lower than that of men, however, so that they can hardly afford stand-alone solar appliances without considerable or complete subsidization.

DC actors' assessments of the extent to which the needs of girls and women are taken into account range from appropriate (QUAL 34, 36-38, 40-43) to largely appropriate (QUAL 12–14) as regards target formulation, capacity strengthening and the inclusion of women in planning processes. EnDev places a relevant focus on household electrification, GBE on productive energy use (DOK 107, 114, 192). However, GBE's productive focus means that household electrification is implemented less, as MSMEs (whether women-led or not) rarely gain initial access in private homes through stand-alone systems. German DC's provision of modern cookstoves, street and house lighting, targeted sensitization and training interventions, and collaboration with women's cooperatives in the agricultural sector to promote the productive use of energy do take this target group's needs into account (QUAL 34, 36-38, 40-43). According to the focus groups, however, people's financial capacities are hardly taken into account at all (FOKG 3).

Approaches that are particularly relevant for women, such as cooking energy, are not a focus of the German portfolio. Although financial commitments for cooking energy have increased slightly in recent years (see Figure 6 left), their share of the portfolio is still small. This is also indicated by the number of interventions, which, at two percent, is very low (see also Benchmark 1.1). It is also worth noting that the majority of the cooking-energy interventions (13 out of 25, including 11 GIZ and one KfW intervention) are not implemented by state implementing organisations – but five by the Centre for International Migration (CIM), three by the United Nations Foundation (UNF), two by Lernen-Helfen-Leben e. V. and three by other organisations.

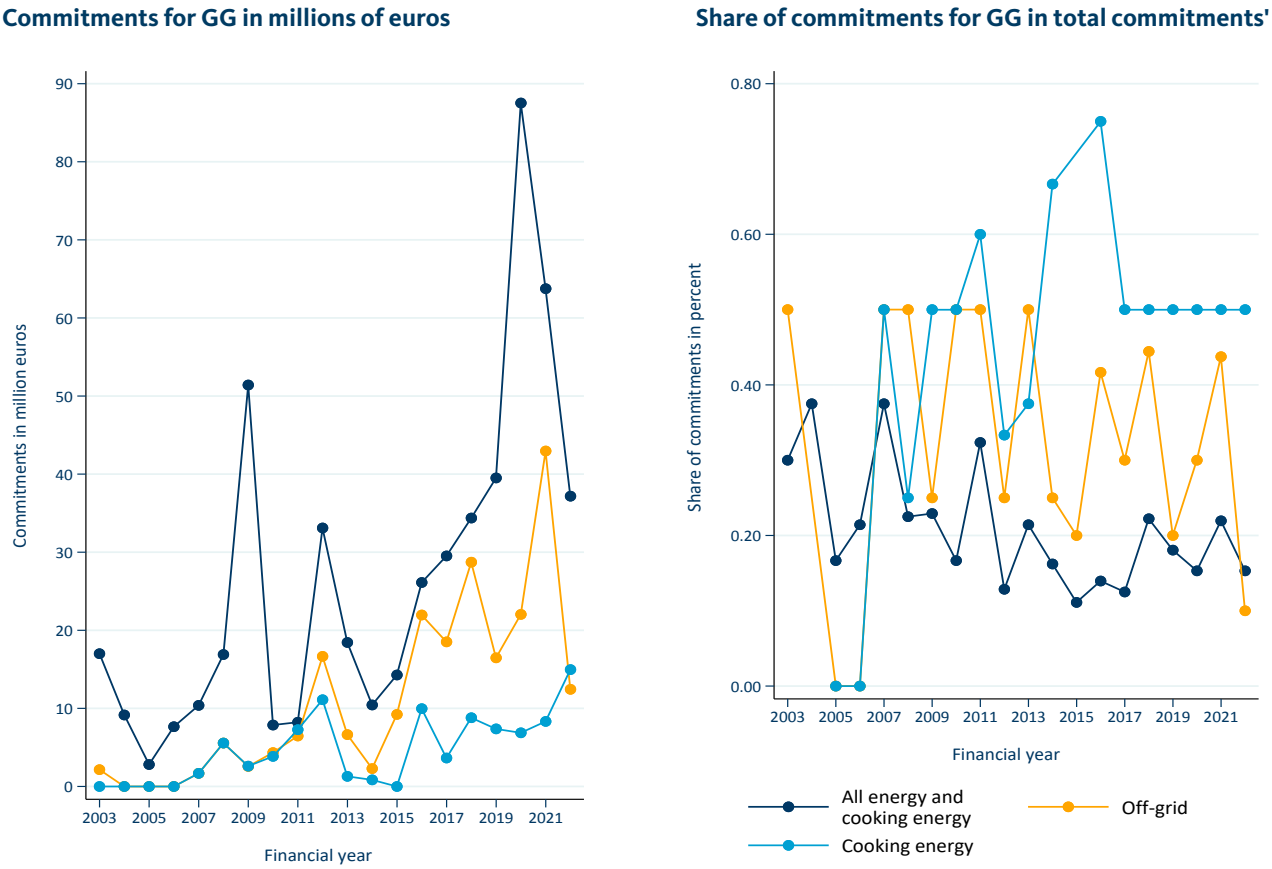
With the exception of cooking energy, energy interventions surprisingly rarely have gender-equality objectives and are well below the average of the overall German DC portfolio in terms of financial volumes. Energy access for women and women-led companies are explicit objectives in only six of the 72 interventions whose content was analysed. These include GBE, which aimed to promote 225 women-led MSMEs internationally by providing access to green energy. The evaluation also looks at the proportion of interventions in the portfolio which, German DC claims, contribute to gender equality. The identifier GG2 is assigned when gender equality is the intervention's primary objective. GG1 is awarded if the intervention is intended to make a significant contribution to gender equality.

According to development strategies for gender equality, 85 percent of development interventions are supposed to have a GG1 marker and eight percent a GG2 marker by 2025. The portfolio for the evaluation subject does not foreseeably fulfil these requirements – not even compared to the German DC portfolio in general. Only 32.1 percent of

50 It should be noted that there is a considerable discrepancy between the potential and actual productive use of a technical approach. Among other things, this is a result of the technical reliability of the systems, their acceptance by the target groups, their financial affordability and their practical benefits.

the energy interventions aim to promote gender equality; only 1.2 percent define this as a primary objective and 30.9 percent as a secondary objective. The inadequate gender-relevant targeting is also illustrated by the low share of funding, which is less than half the average of the rest of the portfolio. The proportion for cooking-energy and off-grid projects with a GG marker is significantly higher. 64.3 percent of off-grid projects pursue this as a secondary objective but zero percent as their main objective. In the case of cooking-energy projects, 13.6 percent promote gender equality as a primary objective and 68.2 percent as a secondary objective, which emphasises the relevance of cooking-energy projects for women. It can be deduced from the allocation of the GG marker that the absolute financial contributions in euros for gender equality in the energy sector in Africa are generally increasing – albeit with large fluctuations (see Figure 7 left). However, this does not apply to their share of the energy portfolio (see Figure 7 right). To make matters worse, the proportion of contributions to GG-marked interventions in the energy sector has been falling since 2003. It is highest for cooking-energy projects. Since 2014, it has always been above the other areas and since 2017, consistently at 50 percent (see Figure 7 right).

Figure 7 **Commitments for gender equality (GG) in energy and cooking-energy interventions**



Source: DEval, own visualisation based on MeMFIS data from 2000 to 2022 in Africa, n = 319 energy and cooking-energy interventions; eight interventions were counted twice as they included both off-grid and cooking-energy implementations. Contributions in euros include reprogramming and approved contributions. GG2 contributions were credited at 100 percent, GG1 at 50 percent; the calculations were made in constant euros (base year 2015).

Sub-question b): To what extent are the objectives of the interventions in line with low-carbon and transformative development paths?

Benchmark 1.4: The current priorities of German DC are relevant for transformative low-carbon development paths.

According to its own reports to the OECD, German priorities in the energy sector are relevant for climate-change mitigation, for example by promoting low-emission and energy-efficient technologies. In the years 2011 to 2022, an average of 73.6 percent of the funds were designated as being relevant for climate-change mitigation. In an analogous way to the gender-equality marker, it is stated whether an intervention pursues climate-change mitigation as a principal or significant objective – identified by a so-called Rio marker. The share of interventions in the energy portfolio for climate-change mitigation (KLM marker[51]) as a primary and secondary objective has averaged 87 percent since 2019 and has risen over the years. All (100 percent) off-grid projects pursue climate-change-mitigation objectives, while 75 percent of projects in the field of cooking energy have corresponding primary or secondary objectives. The corresponding financial volumes have also increased in proportion to the number of interventions recognised as contributing to climate-change mitigation. Since 2018, for example, over 80 percent of funds in the energy sector have been allocated to climate-change mitigation. This is the case for all energy interventions as well as off-grid and cooking-energy projects when considered separately. In addition, almost no fossil fuels have been subsidised since 2015 (only one intervention since 2015). At the same time, research on the topic shows that the KLM-Rio marker, like the adaptation marker (KLA), is susceptible to overreporting and thus mitigation-relevant contributions are sometimes overestimated (Borst et al., 2022; Michaelowa and Michaelowa, 2011; Weikmans and Roberts, 2019). Building on this, the DEval evaluation "Climate-change Mitigation through Development Cooperation" provides assessments of awarding the KLM marker based on machine learning (Wencker et al., 2024).

According to German DC's self-assessment, a contribution to climate-change mitigation is evident. The main aim is to contribute to climate-change mitigation by means of climate-neutral energy access or energy efficiency. A contribution to SDG 13 is also seen by the interviewees (QUAL 12, 15, 34, 36, 39, 41-42). This is similarly confirmed by a survey of the partner side (QUAL 35, 48).

The contribution to a just transition is only partial. For example, about 42 percent of the intervention documents mention a socially just transition to sustainable industrial policies, while all other documents provide no information in this regard.[52] Interviewees see the implementation of a just transition particularly in "Leave No One Behind" and "Pro-Poor Approaches", which rely on needs-oriented technical solutions for the various target groups (QUAL 13-14, 43). However, this assessment is not confirmed by surveys of MSMEs in rural areas (see Benchmark 1.1). The analysis on a just transition is not included in the assessment of Benchmark 1.4, as the relevant objectives were not anchored in the BMZ core-area strategy until 2021. It is therefore still too early for a final assessment.

It is questionable whether off-grid approaches (excluding cooking energy) on initial energy access in rural Africa can reduce emissions on a significant scale. IInterviewees with a broad overview see the contribution of decentralised approaches such as mini-grids (QUAL 13) or stand-alone approaches (QUAL 50) to climate-change mitigation as small in some cases, partly because solar energy often does not completely replace fossil fuels (QUAL 18). This is also consistent with the results of the surveys of MSMEs in Benin and Senegal. Most MSMEs used fossil fuels for their economic activities prior to the interventions. However, their absolute contribution to global emissions is insignificant. Moreover, according to the surveys, most MSMEs have not completely abandoned the use of their previous appliances. For example, most farmers still have their diesel-powered irrigation pumps in operation alongside the solar irrigation pumps. In conjunction with the scientific findings on overreporting based

51 According to the Rio markers, the climate marker "mitigation" (KLM) includes both primary (principal objectives, KLM2) and secondary objectives (significant objectives, KLM1). Interventions without a mitigation reference have the identifier KLM0. The Rio markers are also the basis for the 2011-2017 study period, as the Rio markers for "adaptation" (KLA) and "mitigation" (KLM, including KLM2, KLM1 and KLM0) contain reliable data from 2011 onwards.

52 As described above, just-transition objectives were first anchored in the BMZ core area strategy in 2021. The evaluation therefore took a closer look at interventions that were promised after 2021. One of these projects has a just-transition objective, the other does not.

on the KLM markers, the true contribution to climate-change mitigation in the portfolio for energy access in rural Africa is therefore estimated to be lower than that shown above in the description of the portfolio. The evaluation nevertheless assumes that a high proportion of interventions in the energy portfolio are relevant for climate-change mitigation, not only due to the high financial volumes that are identified as relevant for climate-change mitigation, but also in view of the fact that more interventions with climate-change mitigation as a primary than as a secondary objective are implemented, and that fossil fuels are no longer subsidised.

The interventions analysed are barely relevant for transformative development paths – also in view of the large number of small-scale approaches (Noltze et al., 2023a). Furthermore, the results indicate that the approaches studied do not contribute to economic transformation, not even through productive use.

Summary of the findings for the relevance criterion

- The relevance of the technical approaches for initial access to energy varies depending on the context and is contingent, among other things, on the grid coverage and area size of the countries and on subsidies. Affordability is key from the end users' perspective.
- The implemented interventions are barely in line with the financial capacities of energy-poor population groups and MSMEs.
- Few projects have gender equality as an objective. Despite their relevance for women in particular, cooking technologies make up only a small proportion of the portfolio.
- According to the reported markers, the priority areas of German DC have a high proportion of KLM markers and are relevant for climate-change mitigation. However, the actual contribution to mitigation is likely to be lower in the case of lower tier levels.
- The relevance for and contribution to transformative development paths is low.

6.2 Effectiveness

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

Evaluation dimensions related to the evaluation criterion of effectiveness:

1) achievement of the intended objectives,

2) contributions to achieving the objectives defined for the respective target group.

Sub-question a): To what extent are the objectives of the interventions being achieved as planned (or being adapted to new developments)?

Benchmark 2.1: The interventions are achieving their objectives in terms of expanding or improving energy access.

According to German DC's self-assessment and the assessable projects, the interventions are largely achieving their objectives in terms of expanding energy access. Within the German energy portfolio, relatively few interventions (39 out of 72) formulate the explicit goal of expanding initial access to energy, which limits the relevance of the German portfolio for SDG 7.1. Nevertheless, the assessable interventions are effective. According to the document analysis, the targets on initial access are being met, even though only 17 interventions are assessable. Although 39 of the 72 interventions analysed formulate targets relating to initial access, no audit or final reports are available for 22 of these interventions, so that their level of target achievement remains unclear.[53] Another restriction in the reliability of this finding is that it is not always clear from the intervention reports how the reported assessment was arrived at and whether it was based on the implementing organisations' own assessments or on independent evaluations. Of the 17 assessable interventions, eight achieved their targets and three even exceeded them. According to the intervention documentations, only two interventions failed to achieve their targets, or else the assessment was contradictory.[54] The interviews with stakeholders from German DC and partners in the case-study countries also show that energy-access interventions in rural Africa make an important contribution to providing access to energy for all. The respondents from German DC stated that a significant contribution was being made at the global level to expanding or improving energy access, for example as a result of EnDev's ambitious targets and target achievement in several countries (QUAL 36). However, the partner side in Uganda emphasised the need to scale up the targets on initial access and improved energy access (QUAL 45). One partner also suggested that a different focus was needed to facilitate households' initial access to electricity, and that the GBE and EnDev components that were analysed in depth were relevant for MSMEs but not for the supply of electricity to private households (QUAL 18).

The evaluation results on stand-alone solar appliances suggest a lower contribution to initial access to energy; this is also apparent from the surveys on mini-grids. According to interviews in Benin, initial access to energy (especially for households) is not the aim of the GBE country interventions (QUAL 1). GBE's main objective was to promote economic development, it was said. However, concrete aims included supplying MSMEs with energy, and this aim was achieved. The descriptive results of the survey of final beneficiaries of stand-alone solar appliances for productive use in Benin suggest that only around eight percent of beneficiaries have no access to modern energy in their homes. This means that only a maximum of eight percent of the final beneficiaries can have gained initial access to modern energy by using solar appliances as a result of the interventions studied.

53 According to MeMFIS, twelve of the 22 interventions are ongoing projects. While neither final reports nor evaluations can be available for these ongoing interventions, such reports or evaluations were not provided for the remaining ten interventions. It should be noted that MeMFIS does not record any changes to the interventions, such as an extension or postponement of the duration, so that deviations can occur.

54 This applies to interventions that formulate targets for both the access rate and the number of households, and that achieve the targets to varying degrees, fail to achieve the targets, or for which no statement can yet be made in this regard.

The data also show that only 3.5 percent of these companies did not previously use modern energy for their economic activities. In Senegal, the contribution to energy access for MSMEs is significantly larger. Around 29 percent of the final beneficiaries stated that they had not used modern energy for their economic activity before purchasing their solar appliances. Therefore, the results generated by the evaluation in primary data surveys are only partially consistent with German DC's assessment.

Benchmark 2.2: German DC is achieving the targets set by the BMZ with regard to increasing the number of (women-led) MSMEs with initial energy access and improved energy access.

The few interventions (6 out of 72) for rural energy access that aim to supply women and female entrepreneurs with energy are successful. GBE's target achievement is positive. The GBE country interventions in Benin, Senegal and Uganda are also meeting their targets in this regard – or are likely to do so in the future. EnDev has also formulated a corresponding target indicator in its repeat project proposal; however, results on target achievement were not yet available at the time of the evaluation. Apart from EnDev and GBE, however, there is only one other intervention – "Get Access" – with a corresponding focus that also meets its targets.[55] The few interventions with an explicit objective are therefore effective. However, with such a low proportion of interventions with corresponding targets, the BMZ is not fulfilling its benchmark of pursuing a development policy that focuses more on promoting gender equality (as also expressed in the strategy on feminist development policy).

According to the surveys in Benin and Senegal and the monitoring data in Uganda, the targeted number of women-led companies is being supplied with energy. The interventions for the productive use of stand-alone solar appliances in the nine GBE countries aim to supply 750 MSMEs with energy – 30 percent of which are run by women. This target was met by the different country interventions. By 2022, GBE has reached a global figure of 530 women-led MSMEs. The EnDev intervention (phase 3) also aims to contribute to this target by supplying 65,300 MSMEs (20 percent of which are run by women) with stand-alone solar appliances for productive use. The interventions analysed in depth in Benin, Uganda and Senegal confirm the global picture. According to the survey in Benin, approximately 28 percent of MSMEs that have acquired appliances for productive use via GBE are run by women. This figure is in line with GBE's 2022 progress report.[56] According to monitoring data from GBE and EnDev, roughly the same number of women-led and men-led companies were supplied in Uganda (47 percent).[57] The survey of MSMEs in Senegal, where 36 percent of women-led MSMEs were reached,[58] is also in line with the information provided in GBE's 2022 progress report.[59] The target of reaching about 30 percent of women-led companies is therefore confirmed by the surveys in Benin and Senegal. The survey on mini-grids in Senegal was used as a comparison with an alternative technology. On average, only around a quarter of MSMEs that use a mini-grid for economic activity are run by women.

55 PERACOD in Senegal can be cited as another example of a positive intervention. It promoted 15 women-led MSMEs, even without gender-differentiated target indicators in the concept documents.

56 Up until September 2022, 99 MSMEs used stand-alone solar appliances acquired via GBE, of which 18 percent of the MSMEs were run by women. The slight deviation is perhaps due to the fact that the proportion of companies run by men has increased more than that of those run by women since September 2022. Or it may be due to the fact that men were slightly overrepresented in the evaluation sample. Another possibility is that respondents may have told the evaluation team who de facto runs a business rather than who is on the purchase contract for the equipment, which is likely to be the basis of the GBE monitoring data.

57 The evaluation did not conduct a quantitative survey in Uganda. According to monitoring data from EnDev and GBE, 139 companies run by women were supported, while 154 of the final beneficiaries were MSMEs run by men.

58 61 out of 168 of the MSMEs surveyed are run by women.

59 41 commercial enterprises had invested in renewable-energy technologies up until September 2022 and were using them for productive purposes. The proportion of women was 31 percent, slightly above the expected 30 percent (DOK 171).

Benchmark 2.3: MSMEs are using their energy access productively.

The supported irrigation pumps, refrigerators and other stand-alone solar appliances are being used almost exclusively for economic activities. The surveys among entrepreneurs show that 93 percent of beneficiaries in Senegal and 97 percent in Benin are making productive use of the appliances subsidised by EnDev and GBE. The remaining seven percent of beneficiaries in Senegal and three percent in Benin use their appliances for non-commercial household activities. This shows that the interventions analysed, which explicitly aim to disseminate appliances for use in economic activities, typically achieve a much higher level of productive energy use than that reached by household electrification without providing appliances (Ankel-Peters et al., 2024b).

The level of supported productive energy use via stand-alone solar appliances is markedly higher than in the case of the mini-grids studied; however, it is not yet possible to judge conclusively whether they will be used for productive purposes in the long term. At the time of the evaluation, only nine of the 82 mini-grids analysed in Senegal were still in operation (see also Chapter 6.4). Their productive potential is therefore severely limited. The survey in Senegal shows that there were already difficulties with the mini-grids even before they were decommissioned, largely due to regular power outages and fluctuations. For example, only about half of the mini-grids are said to have functioned 24 hours a day. The village leaders surveyed cited the lack of reliability, combined with fees that were sometimes perceived as excessive (in nine percent of the villages), as further reasons why some MSMEs and households did not connect to the stand-alone grid in the first place (when it was still functioning). At the same time, in many villages there was a higher demand for connections than the mini-grid could have served (in 22 percent of the villages). According to the survey data, each village has an average of 20 businesses, of which an average of only four used the energy from the mini-grid, according to the village leaders. MSMEs used the electricity from the mini-grids most frequently to operate lamps and refrigerators for their businesses.

The potential for impacts and economic development depends not only on reliable functionality but also on whether there is supra-regional demand, enabling higher profit margins to be achieved than in local markets (Ankel-Peters et al., 2024b). In many places in Senegal, however, the accessibility of villages for traders is limited. Only five percent of the villages are connected to asphalted roads and 51 percent of the villages – according to their village leaders – are difficult to reach during the rainy season. Details of these findings can be found in the online appendix.

The evaluation findings on approaches specifically targeting access to stand-alone appliances, compared to the productive use of mini-grids, confirm study results that estimate productive use to be comparatively high for programmes with well-developed targeting (Ankel-Peters et al., 2024b). Nevertheless, by way of a caveat, it should be noted that the mini-grids surveyed are older than the oldest implementations of the analysed stand-alone solar appliances, so that the durability of the effects of targeted energy access programmes must be further evaluated in the future.

The evaluation's results on relevance and effectiveness reveal trade-offs between the contributions made by the analysed energy interventions towards different goals of the 2030 Agenda. The approaches that are relevant and effective in terms of initial access are not necessarily the same as those that contribute to climate-change mitigation or poverty reduction and economic development. As the surveys of MSMEs show, the interventions have the potential to contribute to poverty reduction and economic development (SDG 1 and 8). At the same time, a moderate contribution to climate-change mitigation is recognizable. This is because most MSMEs used fossil fuels before the interventions and are reducing the use of their conventional appliances in favour of solar appliances. However, it should be noted that the absolute mitigation potential of switching from fossil fuels to renewable energy sources among the MSME target group in sub-Saharan African countries is not

very significant from a global perspective, as sub-Saharan Africa is responsible for less than three percent of global greenhouse-gas emissions (see Climate Watch, 2022). At the same time, supporting the low-emission growth of MSMEs can prevent negative developments. However, the approach of supplying energy via access to stand-alone appliances hardly contributes to SDG 7.1. This is due to the high investment costs for the appliances. MSMEs that did not use modern energy for their economic activities prior to the interventions cannot afford the solar appliances. If more energy-poor MSMEs were able to purchase and use the supported appliances on the basis of lower purchase prices, this would contribute to achieving SDG 7.1 but not SDG 13, as the switch to solar energy would not result in any significant reduction in emissions in this case.

Summary of the findings on the effectiveness criterion

- The results of promoting access to stand-alone solar appliances indicate a higher potential for productive use than conventional energy-access interventions such as mini-grids, solar home systems or expansion of the central grid.
- However, the promotion of stand-alone solar appliances in the case-study countries is only making a small contribution to the goal of access to energy for all by 2030 – just like the mini-grids examined.
- The interventions examined have contributed to the productive use of energy by women and achieved the targets they set themselves in terms of numbers.

6.3 Impact

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

Evaluation dimensions related to the evaluation criterion of impact:

1) detectability and likelihood of (intended) developmental changes at target-group level;

2) avoidance of negative, unintended impacts.

Sub-question a): To what extent do the interventions contribute to achieving their objectives at target-group level and to overarching development-policy changes?

Benchmark 3.1: MSMEs can (foreseeably) improve their economic situation by means of productive energy use.

The productive use of the supported solar appliances reduces energy expenditure in Benin and for farmers in Senegal. The quantitative results for the "impact" criterion are summarised in Table 4. In this chapter, the identified effects are discussed in particular detail; zero effects are presented in more detail in the online appendix. The quasi-experimental analyses of the surveys in both countries suggest that the use of solar appliances pays off for rural businesses. Although energy expenditure rose for all MSMEs in Benin and for the control group in Senegal in the period between the reference year before the start of the intervention and the time of the survey (summer 2023), the increase in Benin was significantly weaker among the final beneficiaries than in the control group. In Senegal, energy expenditure among the final beneficiaries of the interventions actually fell over time. In both countries, it can also be shown that the interventions have led to a reduction in energy expenditure for the final beneficiaries compared to the control group as a counterfactual.[60] As the example of Figure 8 shows for Benin, companies can also reduce their energy costs by switching to solar appliances

60 This can be seen in the descriptive analysis. The intervention's negative effect on energy costs (their reduction) is confirmed in the statistical cross-sectional comparison and in the difference-in-differences analysis. While the effect in Benin is evident for all company types, in Senegal it does not exist among all subgroups in the difference-in-differences.

if they have not acquired them through GIZ. The effects are the same, as illustrated by the "Solar" and "GIZ" treatment effects shown. This is also the case in Senegal. The reported impacts on energy costs in Benin and Senegal are robust, whether the companies are contrasted with the control group in a 2023 cross-sectional comparison or in the difference-in-differences analysis. For both analyses, the experimental group (beneficiaries) and the control group were first made comparable using a matching procedure.[61] The difference-in-differences analysis represents an even more conservative, stricter test of the benchmark than the cross-sectional comparison. It takes into account both the cross-sectional comparison between the beneficiaries and the control group and the development of both groups over time. In Senegal, statistically robust effects on energy expenditure can only be seen for the subgroup of farmers, specifically the users of solar pumps. In the overall sample, including users of solar refrigerators, the variations in the difference-in-differences are not statistically significant.[62] It also remains to be seen whether the levelised cost of electricity has also fallen and whether economic activities are therefore more profitable for end users after switching to solar energy than they were before. The levelised cost of electricity includes, among other things, the acquisition costs of the appliances. These are around three times as high as the acquisition costs of comparable appliances powered by diesel generators or conventional electricity. Furthermore, the costs of maintenance and repairs must also be taken into account in the levelised cost of electricity. Nevertheless, Xie et al. (2021) show that, with the exception of countries where diesel has been very cheap in the past – such as Angola, Nigeria or Sudan – solar irrigation is more cost-effective in the long term than irrigation using diesel pumps in many areas of sub-Saharan Africa (Xie et al., 2021). In addition, the life-cycle costs of diesel pumps in most sub-Saharan African countries are estimated to be lower than those of solar irrigation pumps (Xie et al., 2021).

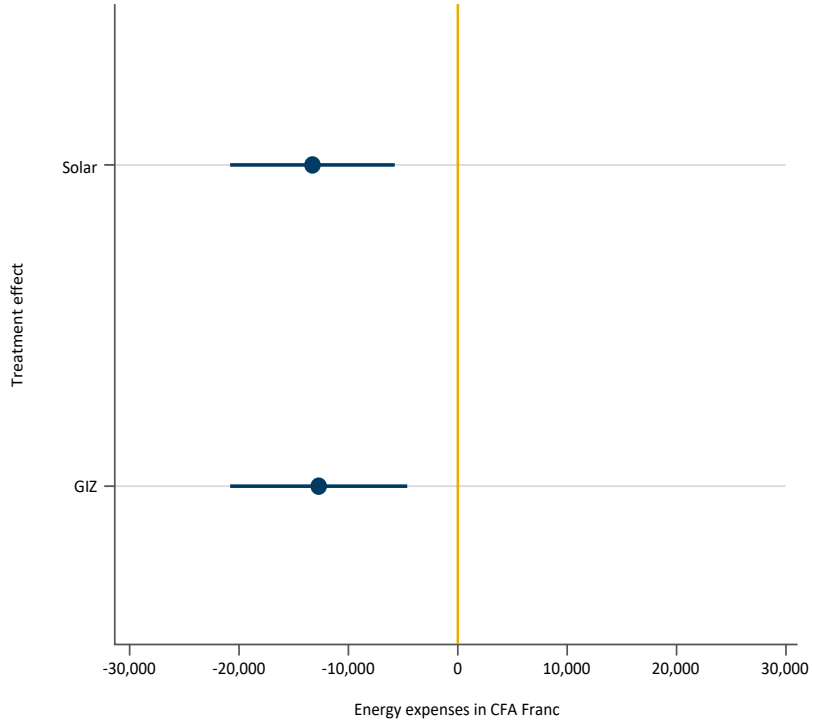
The interventions also reduce energy costs among MSMEs run by women in Benin and (with restrictions) in Senegal. There is also a negative impact on energy expenditure (lower energy expenditure) when certain types of companies are analysed separately. These include women-led businesses and farms that use solar irrigation pumps.[63] Only in Senegal – presumably due to the small sample size – are there fewer statistically robust effects on energy expenditure when women are considered separately. The impacts on energy expenditure are also confirmed by the statements made by the interviewees. They state that the main reason for purchasing a solar appliance is the desire to cut their energy costs (54 percent in Benin), which is also in line with the statements from the focus-group discussions in Benin. The participants want to save costs compared to other stand-alone appliances such as diesel-powered pumps or the use of energy from the central grid.

61 Companies were compared which are located, for example, in the same agricultural zone with a similar climate and similar cultivation; they also operate in rural or urban areas whose owners have a similar income level and a similar age and education level (see the online appendix for further details).

62 One possible reason for these zero effects could be that the beneficiaries had not used refrigerators before and therefore did not benefit from any cost savings compared to the period before the intervention. In fact, only one of the 25 beneficiaries in Senegal was already operating a refrigerator before the intervention.

63 In Senegal, the impact in companies run by women is only significant in the cross-sectional comparison and the difference-in-differences analysis if all female users of solar appliances are compared with the control group. If only the female entrepreneurs who purchased solar appliances as part of the GIZ interventions are considered, the effect is not evident – presumably due to the small sample size.

Figure 8 Impact of the interventions in Benin on companies' energy expenditure (in CFA francs)



Source: DEval, own visualisation based on survey data from Benin. The treatment effect of the intervention is shown on the basis of the difference-in-differences analysis on energy expenditure in CFA francs. The "GIZ treatment effect" compares GBE and EnDev beneficiaries with the control group, which uses fossil fuels for its economic activity. The "solar treatment effect" compares all users of solar appliances – including those who acquired the appliances outside of the interventions studied – with the same control group.

In Senegal, users of solar irrigation pumps tend to grow their crops in the dry season. Farmers who have practised rainfed agriculture in the past 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 by introducing artificial irrigation.[64] Increases in profitability could also be achieved as a result of the much higher prices that can be realised for agricultural produce in the off-season than in the rainy season.

Few short-term developments can be observed among end users of solar appliances. In Benin, an additional before-and-after comparison was carried out because of the comparatively long observation period (2015–2023). Within the group of final beneficiaries, it was analysed whether the companies were in a better economic position one year after the installation of their solar appliance than a year before the installation. The study analysed the development of energy costs, income, the proportion of customers from outside the community, the sales figures for agricultural products, the number of employees, and the food security of the entrepreneurs and their families. Only income and the number of employees showed statistically significant increases in this period.

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. The analyses show that the interventions have led to a reduction in energy costs and an increase in company revenues in Benin[65] but not in Senegal. According to the cross-sectional comparison, the beneficiaries in Benin and Senegal also have more employees

64 This effect was only analysed in Senegal and only in a cross-sectional comparison. Unfortunately, no statements can be made for Benin due to a lack of data on cultivation in the dry season.

65 This result is robust in the cross-sectional comparison and in the difference-in-differences analysis.

at their disposal than the control group. However, it remains uncertain whether the interventions are the cause of this difference because the effect does not prove to be robust in the difference-in-differences analysis.[66] There are fewer robust positive trends in Senegal than in Benin. They are only available for subgroups and in the cross-sectional comparison. According to the cross-sectional comparison,the number of employees and the sales figures (in tonnes) are higher in the case of female beneficiaries than in the control group. Neither in Benin nor in Senegal do the interventions have additional robust positive effects on the proportion of customers from outside the community, which suggests that there are barriers to access to more distant markets. Nor do the quasi-experimental analyses show any causal impacts on production or the likelihood of further processing agricultural products before they are sold.

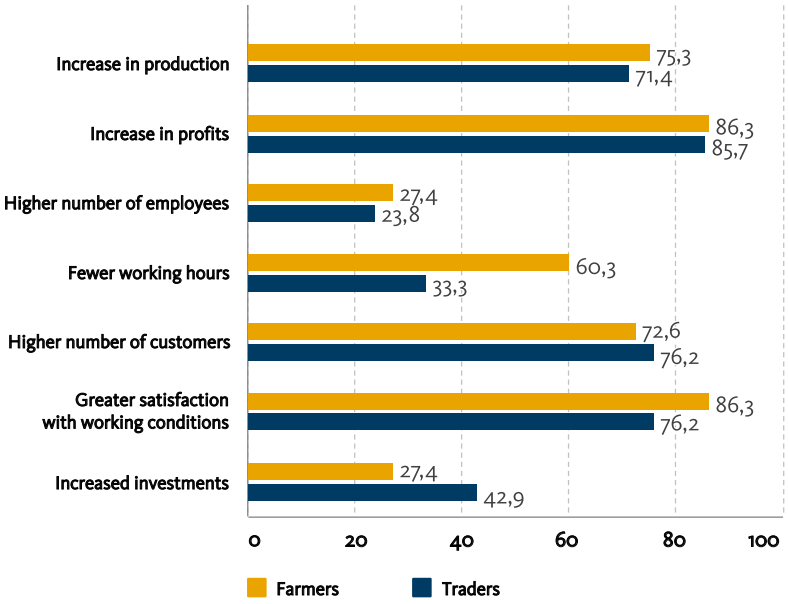
There appear to be isolated negative effects in Senegal. For example, the beneficiaries appear to have fewer personal possessions, and farmers cultivate a smaller area of land than the control group. However, only the effect on property is robust (although not for farmers).[67] In Benin, there is no statistically significant impact on the area under cultivation in the cross-sectional comparison, but, in contrast to Senegal, the area under cultivation of the beneficiaries tends to be larger than that of the control group.

According to the self-assessment of the beneficiaries, the use of the GIZ-supported solar appliances primarily resulted in higher profits, an increase in the number of customers and a higher level of satisfaction among entrepreneurs with their working conditions (see Figure 9 and Figure 10). These assessments are based on direct questions about the perceived effects of the intervention and not on a quasi-experimental study of economic indicators before and after the start of the intervention, as reported above. For the three most prominent impacts, more than 70 percent of the beneficiaries reported positive effects. According to the beneficiaries, other positive effects in Benin were primarily production increases (see Figure 9) and in Senegal higher investments (see Figure 10). As Figures 9 and 10 show, the impacts reported by farmers, traders and others are very similar. Overall, 90.4 percent of respondents in Benin stated that the interventions had had an impact; in Senegal the figure was 93.4 percent. The focus-group participants in Benin primarily reported lower energy expenditure (FOKG 31-36) but also increased turnover (FOKG 39), the possibility of growing crops in the dry season (FOKG 34) and diversifying production and livestock farming (FOKG 31, 35). Similarly, the participants in Senegal emphasised lower energy (FOKG 11-13, 18) and production costs (FOKG 11-12, 20) as well as increases in production (FOKG 13, 18).

66 In Senegal, moreover, the positive effect on the number of employees is only evident in the subgroup of women-led companies.

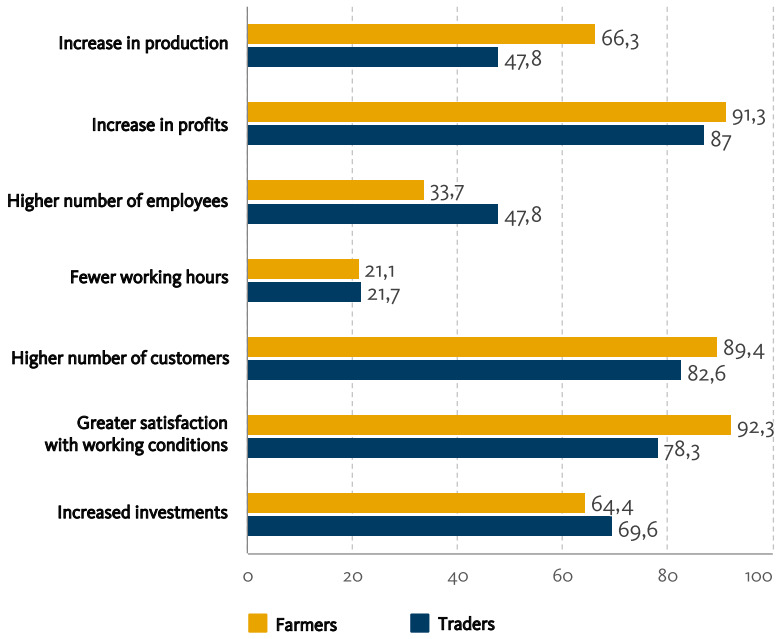
67 The size of the fields was only surveyed at one point in time and was therefore only analysed in a cross-sectional comparison.

Figure 9 Self-assessment by beneficiaries of solar appliances on economic impacts in Benin as a percentage



Source: DEval, own visualisation based on survey data from Benin. The figure shows the percentage of beneficiaries who state that the respective economic indicator in their company has improved since they have been using the GIZ-supported solar appliances. Those who reported no improvement stated either that there had been no change or that the respective indicator had worsened. The number of farmers surveyed was 73, the number of traders 21.

Figure 10 Self-assessment by beneficiaries of solar appliances on economic impacts in Senegal as a percentage



Source: DEval, own visualisation based on survey data from Senegal. The figure shows the percentage of beneficiaries who state that the respective economic indicator in their company has improved since they have been using the GIZ-supported solar appliances. Those who reported no improvement stated either that there had been no change or that the respective indicator had worsened. The number of farmers surveyed was 104, the number of traders 23.

Wealthier entrepreneurs have benefited more from the interventions. This can be inferred both from the differences in the various indicators of the companies before the start of the intervention and from the qualitative interviews with the target group (with the exception of female entrepreneurs in Benin, who had fewer possessions than the control group in 2023). The focus-group discussions show that the group of beneficiaries includes a disproportionately large number of wealthier MSMEs. In a focus group in Benin, for example, the argument was put forward that investing in a solar pump was not worthwhile for smaller farmers or herders of small numbers of livestock, as it would take too long to amortise the purchase costs of the pump (FOKG 35). A recent review article on the use of solar irrigation pumps in sub-Saharan Africa also confirms that solar pumps are often too expensive for smallholder farmers, and are therefore mainly purchased by wealthier entrepreneurs (Durga et al., 2024).[68]

MSMEs run by women largely benefit from the same positive impacts on economic indicators as companies run by men. The impacts on energy expenditure are similar to those in the overall sample, as discussed above. In addition, positive impacts can be observed in Senegal on the volume of agricultural products sold and on the number of employees in women-led businesses. With regard to revenues, it remains unclear whether the positive effects for female entrepreneurs are the same as in the overall sample, or whether the small sample does not lead to any statistically significant effects. In the focus groups, female entrepreneurs in Senegal and Benin reported lower energy costs (FOKG 11, 13, 36, 38), higher production and opportunities to diversify their production (FOKG 11). In addition, the mechanization of tasks meant that fewer workers were needed (FOKG 11). However, some of the focus-group participants did not see any impact on their income either (FOKG 15).

Benchmark 3.2: The energy-access interventions improve the living conditions of the target group, especially in the case of women.

According to the self-assessment of the participants in the surveys and focus-group discussions, individual aspects of the target group's living conditions have improved thanks to the use of solar appliances. However, these impacts cannot be confirmed by the quasi-experimental analyses. In addition to the economic performance of MSMEs, the evaluation analysed the impact on the material prosperity of entrepreneurs and their families. In the quasi-experimental causal analyses, no robust positive impacts on the material prosperity or food security of the entrepreneurs and their families can be documented.[69] In Senegal, there is even a negative impact on the property of female entrepreneurs.[70] In Benin, according to the cross-sectional comparison, the female entrepreneurs who benefited from the interventions also have poorer food security than the control group. However, this effect is not robust and should therefore not be interpreted as unreservedly causal.[71] At the same time, the participants in the focus groups in Uganda reported increased crop yields and resulting higher incomes. The latter enabled them to pay medical bills and school fees, build up assets and secure their own and their families' supply of food (FOKG 1-10).

According to the respondents' self-assessment, as a result of the interventions women spend less time fetching water and doing housework, and their decision-making power has increased, although fewer respondents reported such impacts than on the economic effects of the interventions. In addition to material prosperity, the surveys in Benin and Senegal asked beneficiaries whether and to what extent individual aspects of women's lives had improved (see Figure 11). Between 53 and 60 percent of the women reported that they spent less time fetching water (by using solar irrigation pumps),

68 There are similar findings for smallholder agriculture in the Philippines (Falchetta et al., 2023; Guno and Agaton, 2022).

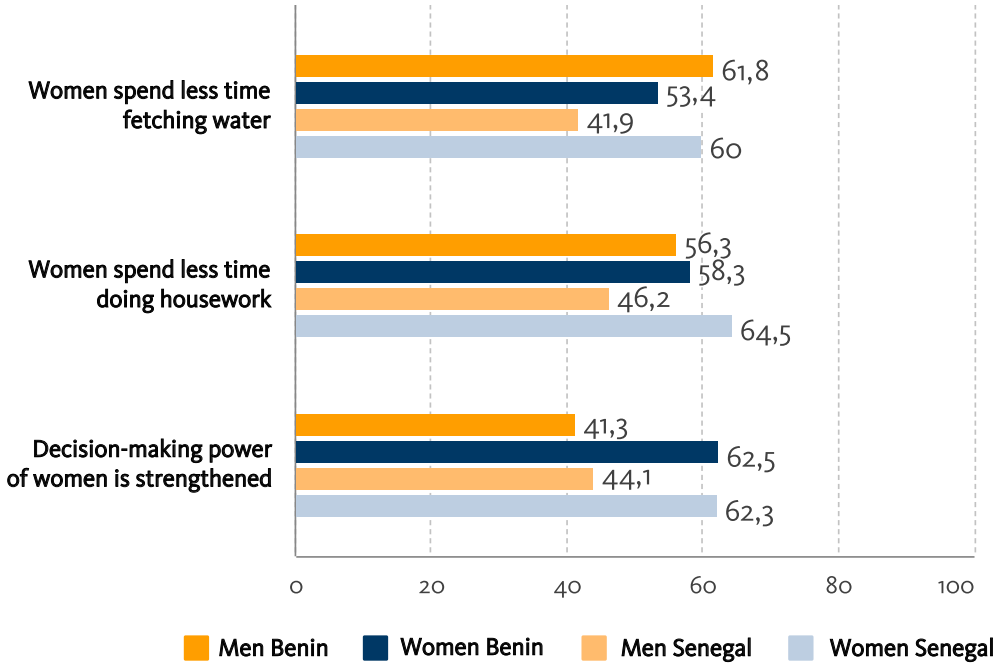
69 Only in Benin does a cross-sectional comparison show a positive impact on food security in the overall sample of all MSMEs.

70 This negative impact on property also exists in the overall sample of all companies in Senegal, albeit only in the difference-in-differences analysis.

71 The negative impact on the food security of female entrepreneurs is only evident in a cross-sectional comparison. Contrary to this, the literature assumes that irrigation systems increase their users' food security (Durga et al., 2024).

and 58 to 65 percent of women that they spent less time doing housework as a result of using solar appliances.[72] About 62 percent of the women interviewed also have the impression that their decision-making power has strengthened. Improved decision-making power was also emphasised by the focus groups in Benin (FOKG 31). In addition, the female participants in the focus groups in the case-study countries generally emphasised that they had high hopes for the use of solar appliances in terms of not only expanding their business opportunities but also improving their economic situation. It is interesting to note that, according to the surveys, these gender-specific impacts are stronger in Senegal than in Benin, and that fewer men than women seem to notice these effects.

Figure 11 Self-assessment by the beneficiaries of solar appliances on female-specific impacts



Source: DEval, own visualisation based on survey data from Benin and Senegal. The figure shows the proportion of female beneficiaries who state that their living conditions have improved since using the appliances supported by GIZ. Those who reported no improvement either stated that there had been no change or that the respective indicator had worsened. The number of interviewees was 24 women and 80 men in Benin and 45 women and 91 men in Senegal. Only the farmers were interviewed on the question on fetching water (15 women and 68 men in Benin; 30 women and 81 men in Senegal).

72 If women travel shorter distances to fetch water, they can use the time they save for other things, 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.

The results of the analyses of the target groups in Benin, Senegal and Uganda show that the interventions analysed on access to stand-alone solar appliances have achieved individual steps of the theory of change outlined in Figure 2, Chapter 3, while other interventions have not (yet). MSMEs reduce their energy costs by switching from fossil fuels to solar appliances. Farmers who previously practised rainfed agriculture are now more likely to grow crops in the dry season as a result of the introduction of artificial irrigation using solar pumps.[73] However, no increase in production (measured as the volume of agricultural products sold)[74] or higher value added (measured as the probability of agricultural products being further processed before they are sold) could be deduced from the lower energy costs in the quasi-experimental analyses. However, according to the self-assessments from the surveys, production and yield increases through the use of solar appliances are plausible. The evidence from the focus groups is again unclear: some participants emphasised that they were able to lengthen the irrigation time with solar pumps, unlike diesel pumps, because it was not limited by the cost of diesel, so that they expect – and have already observed – increases in yields. Farmers were also able to expand their acreage or switch to crops that required more irrigation. This enabled them to increase their income. Other participants were of the opinion that only smaller areas could be irrigated with solar pumps than with conventional pumps (FOKG 34) because the water pressure was lower, and the pumps did not work well when there was no sunshine. Fundamentally, it cannot be ruled out on the basis of the surveys that there were increases in yields that were not reflected in the sales figures, for example due to a lack of market access. The lack of market access could also be the reason why no increase in the proportion of customers from outside the respective community or increases in turnover (measured in monetary terms) could be quantitatively demonstrated (although the companies' self-assessment on this is positive, see Figure 9 und Figure 10).[75] Nevertheless, the interventions in Benin have led to an increase in income for MSMEs. Higher-value impacts such as increased personal prosperity among entrepreneurs or improved food security could not be confirmed. However, women certainly consider their decision-making power to have strengthened.

73 Whether or not new crops are cultivated was not analysed.

74 It was not possible to measure the harvest or yields.

75 Turnover was not analysed in Senegal.

Table 4 Overview of the results of the quantitative analyses on impact

IMPACT		RESULTS	
Benchmark 3.1: MSMEs can (foreseeably) improve their economic situation by means of productive energy use.			
3.1.1	The productive use of solar appliances leads to a reduction in energy costs.	+	+ o
3.1.2	The productive use of solar appliances promotes cultivation in the dry season.		+ o
3.1.3	The productive use of solar appliances leads to increases in production.		o
3.1.4	The productive use of solar appliances leads to an expansion of the cultivation area.	o	− o
3.1.5	The productive use of solar appliances leads to more employees being hired.	+ o	+ o
3.1.6	The productive use of solar appliances has a positive impact on revenue.	+	o
3.1.7	The productive use of solar appliances leads to more further processing of agricultural products.	o	o
3.1.8	The productive use of solar appliances has a positive impact on the proportion of customers from outside the municipalities.	o	o
Benchmark 3.2: the energy-access interventions improve the living conditions of the target group, especially for women.			
3.2.1	The interventions have a positive impact on the material prosperity of the target group.	o	− o
3.2.2	The interventions have a positive impact on the food security of the target group.	+−o	− o
3.2.3	The interventions make housework easier for women and strengthen their decision-making power.	✓	✓
Benchmark 3.3: the interventions avoid negative, unintended impacts.			
3.3.1	Unintended negative impacts are analysed.	✓	✓
3.3.2	The interventions avoid unintended negative impacts.	✓	✓

+ = positive effect, robust; - = negative effect, robust; o = no effect, +o = positive, but not robust; -o = negative, but not robust; +-o = heterogeneous effect, but not robust (robust between cross-sectional comparison and difference-in-differences)

Source: DEval, own visualisation 3.1.1 up to and including 3.2.2 refer to the results of the quasi-experimental analyses. Where a cell has no symbol, no quasi-experimental analysis was carried out. The presentation of the results for 3.1.2 and 3.1.4 is based only on a cross-sectional comparison; data were only collected for farmers. 3.1.7 in Senegal is based only on a cross-sectional comparison. 3.2.3 was only analysed descriptively. 3.3.1 and 3.3.2 refer to overarching results and not solely to the surveys on solar appliances

Limitations

Although it cannot be ruled out that there may have been distortions in interviewees' reporting, the results, particularly with regard to the lower energy expenditure, should nevertheless be interpretable in a causal manner. The survey analyses are based on indicators reported by the entrepreneurs themselves. Various distortions can occur here. These include social desirability bias (see Fisher, 1993). For example, beneficiaries may have portrayed the situation of their company as worse before the intervention and better after the intervention than is the case in reality. This can happen to fulfil the interviewees' expectations of positive results from the intervention, or to encourage a continuation of the intervention. The evaluation countered this potential distortion by making it clear that the survey was being conducted by independent evaluators and was not commissioned by GIZ. Nevertheless, it could be that the survey institutes' interviewers were associated with GIZ in the perception of the interviewees. However, it can be assumed that a possible distortion alone does not explain the positive effects. After all, the economic recession caused by the COVID-19 pandemic and the war in Ukraine are likely to have influenced the responses in the opposite direction – inasmuch as the respondents would have reported a negative trend over time. In addition, the prices of oil and diesel in Benin had risen immediately before the survey because Nigeria had cut fuel subsidies. This fuel is usually imported to Benin and used for generators and diesel-powered irrigation pumps. This means that the distortion caused by strategic misreporting would have had to be very large to fully explain the results on the fallen energy prices and further positive impacts.

A further limitation is associated with the fact that the control group had to be reconstructed retrospectively; the positive effects of the interventions could be even stronger because of this limitation. In order to maximise comparability between the control group and the beneficiaries, a matching procedure was used to compare companies that were as similar as possible in the reference year (before the intervention). In addition, a procedure was already chosen in the field, specifically when selecting the control group, in which the beneficiaries were asked to name to the interviewers companies that were particularly similar to them at the time of the reference year (see Chapter 4.2.4). This means that, in theory, companies that have since stopped trading might also be included in the analysis. Nevertheless, it cannot be ruled out that some beneficiaries were more likely to have named companies that were still active at the time of the survey. If this were the case, the control group would contain more successful companies, which could have led to an underestimation of the positive effects on the beneficiaries. In view of this possibility, the positive effects of the measures could be even stronger than the analyses suggest.

Finally, the fact that it was necessary to rely on the respondents' recollections due to a lack of baseline data represents a further limitation. In addition to strategic distortions in the answers due to social desirability, measurement errors can occur due to difficulties in remembering correctly. However, as long as these are similarly pronounced in both the beneficiaries and the control group – which can be assumed – this should not lead to a distortion of the results. As the beneficiaries acquired and installed their appliances at different times, there was no common date when the intervention began to which reference could have been made. For the control group, the time when the intervention began would have been of no value for prompting memories anyway. For this reason, 2019 was chosen as the reference year in Senegal, and it was pointed out in the questionnaire that this was the year before the COVID-19 pandemic. This is a significant point in time for both the beneficiaries and the control group. In Benin, 2015 was chosen as the reference year, and reference was made to the time before a change of political power in the country, which both groups could also remember similarly well.

Sub-question b): To what extent do the interventions avoid negative impacts?

Benchmark 3.3: The interventions avoid negative, unintended impacts.

The majority of interventions (79 percent) were reviewed for unintended negative impacts with regard to various environmental and social risks. An analysis of possible, unintended negative impacts is regularly part of interventions' conception. A review of unintended negative effects was carried out for 79.4 percent of the interventions. Potential environmental and social risks cited included health and safety risks for workers during the installation and operation of new technologies, practices that are harmful to the environment and health (scrapping electrical appliances, use of lead in photovoltaic batteries), and conflicts over resources, land and access to energy services. In 19 percent of the interventions, no review of negative, unintended effects is recognizable in either the conception or the implementation. 2.6 percent of the interventions specify how to deal with unintended impacts, for example by applying "do-no-harm approaches", social management plans or recycling strategies, while 37.1 percent of the interventions do not appear to deal with negative, unintended impacts in their conception.[76] Yet analysing possible unintended impacts is a prerequisite for avoiding negative impacts. In the spirit of an impact analysis, however, the evaluation only assesses the actual impacts of implementing the interventions.

The interviews with stakeholders in German DC confirm that negative impacts are systematically dealt with in the conception phase, but cannot always be avoided in the course of implementing the interventions. The interviewees confirmed that possible negative impacts were analysed in the conception phase of the interventions and that attempts were made to prevent them during implementation (QUAL 38-39, 41).[77]

Nevertheless, it was not always possible to avoid some of these possible negative impacts. For example, there had been conflicts over access to energy in refugee camps (QUAL 36). In some cases, mini-grids had caused electrical waste. Furthermore, there had been insolvencies among operators of mini-grids because they had not been able to cover their costs for lack of customers (QUAL 40).[78] [79]

There are barely any unintended negative impacts caused by the promotion of stand-alone solar appliances. In the case of the solar appliances, deteriorations in the material prosperity of the target group in Senegal and in the food security of women in Benin were identified, although neither effect proved to be robust. In addition, according to the self-assessment of the beneficiary farmers, there was an increase in working hours, especially in Senegal. There was also a decline in investment in companies in Benin.

The results of the focus-group discussions suggest that there were isolated negative impacts caused by the promotion of mini-grids. Focus-group participants in a village in Senegal, where GIZ had supported a mini-grid, reported that they pay high monthly fees to use the mini-grid (in this case 5,000 CFA francs, equivalent to around eight euros), although their mini-grid often breaks down. They expressed the impression that the GIZ intervention had made them even poorer than they had been before the mini-grid was installed (FOKG 20). Others reported that their (conventional) appliances had broken down as a result of using electricity from the mini-grid (FOKG 27). These focus-group participants also stated that they no longer wanted to use solar energy in the future. They expressed an urgent need for their village to be connected to the central electricity grid.

76 The results of the design serve to categorise the results of negative impacts.

77 Only two interviewees had no idea of possible negative impacts of the interventions (QUAL 7, 48).

78 Since too few statements on dealing with negative impacts are available from the interviews in Benin and Senegal, these are not used to assess the benchmark.

79 It must be mentioned, however, that the examined off-grid approaches to energy access do not have the same negative impacts as larger infrastructure projects such as dams or the construction of motorways, which can lead to resettlements, for example.

Summary of the findings on the impact criterion

- The use of stand-alone solar appliances leads to a reduction in energy costs and, with restrictions, to foreseeable increases in yields and turnover among MSMEs.
- MSMEs largely rate the impacts of the interventions for productive use as positive.
- The use of stand-alone solar appliances improves the economic performance of MSMEs, whether run by women or men; in some cases, the impacts are even stronger for women-led companies in Senegal.
- According to the women interviewed, the interventions also helped to make housework easier or to strengthen their decision-making power.
- The foreseeable improvement in the economic situation of MSMEs is not (yet) leading to greater prosperity among entrepreneurs and their families.
- Interventions to provide decentralised energy access sometimes have negative impacts such as conflicts over energy access, insolvencies of mini-grid operators, electronic waste or a loss of public confidence in renewable energies.
- The impact analyses on stand-alone solar appliances do not suggest any significant negative impacts of the interventions.

6.4 Sustainability

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

Evaluation dimensions related to the evaluation criterion of sustainability:

1) capacities of those involved and affected to make positive outcomes and impacts more durable;
2) contribution to supporting sustainable capacities;
3) foreseeable durability of outcomes and impacts over time.

Sub-question a): To what extent do the interventions on decentralised approaches contribute to the actors feeling responsible and accountable (ownership), maintaining the positive outcomes and impacts of the intervention over time, and stemming any negative outcomes and impacts that may occur; to what extent do they have the necessary capacities to do so?

Benchmark 4.1: There is clear, institutionalised ownership and adequate capacities among the partners for maintaining the outcomes and impacts of the interventions on off-grid approaches over time.

In its strategies, German DC identifies the takeover of responsibility by partners[80] (institutionalised ownership) as a decisive prerequisite for the durability of outcomes and impacts (BMZ, 2007). As part of the evaluation, interviews were conducted with representatives of the energy ministries and the agencies responsible for rural electrification and renewable energies among the German DC partners.

Ownership on the part of the relevant partner actors has been supported in the analysed interventions that promote access to solar appliances. For example, German DC in Uganda has developed sustainability plans together with partner institutions, promoted public-private partnerships and built up institutional processes (QUAL 14, 34, 43, 48). Strategic plans, roadmaps, as well as training and awareness-raising interventions were developed jointly with the private sector and

80 The partners of the respective interventions are primarily partner governments, but sometimes public institutions and private actors involved in energy access.

energy associations in Uganda (QUAL 34). Partner institutions assumed responsibility for the implementation of DC activities, for example for the realization of training and awareness-raising interventions (QUAL 34). In Benin, the RBF mechanism for the sale of solar appliances for productive energy use was transferred from GBE to the state agency for rural electrification, ABERME, at the end of its term. The final beneficiaries praised the fact that the interventions had been jointly planned with the target groups in a needs-oriented manner, thus promoting their ownership. They stated that they themselves felt largely responsible for maintaining the appliances (FOKG 1, 6, 9, 10), but also included village leaders and representatives of the cooperatives in shouldering responsibilities (FOKG 1-2, 4-6). In addition, the final beneficiaries emphasised that the responsibility for maintenance, servicing and repairs also lay with the manufacturers or suppliers of the appliances (FOKG 1, 3, 5, 7).

However, ownership of these interventions to promote solar appliances still needs to be improved. Clear, institutionalised ownership on the part of the partners was not fully confirmed in the interviews (QUAL 44-46). At the local level in particular, it was said, the interventions needed to be more closely integrated into local development plans (QUAL 46). Frequently changing responsibilities in the partner institutions were making continuous ownership difficult (QUAL 42). Furthermore, the financial contributions of the partner countries were insufficient due to limited financial resources, which restricted ownership (QUAL 16, 42).

The interventions to promote solar appliances have strengthened the technical capacities of the relevant actors but not to a sufficient extent. The administrative and technical capacities of the partner institutions, such as the Ugandan Ministry of Energy and Mineral Development, were strengthened by the interventions (QUAL 34). Moreover, the partner institutions considered their capacities to be sufficient to continue the GBE component of productive energy use with stand-alone solar appliances (QUAL 18). In other cases, however, the partner institutions' administrative capacities were still limited, such as those of the state electrification agency for rural areas in Benin (QUAL 1). Training courses for technicians in installing and maintaining the appliances had also strengthened the capacities of final beneficiaries and private actors (FOKG 1, 4; QUAL 34, 36, 42-43). This was key because the availability of technicians to maintain the systems was a basic prerequisite for the interventions having durable outcomes and impacts (QUAL 15, 35, 45, 47). In one specific case, final beneficiaries who received training on solar irrigation pumps by German DC trained other target groups independently of German DC, which was emphasised as particularly positive (FOKG 4). In general, however, final beneficiaries had wished for more training,[81] because some of them lacked the skills needed to use and maintain their appliances properly (FOKG 1, 3, 6, 8, 10).

Also on the part of the solar companies that distribute the solar appliances and install them on the end users' premises, ownership would be helpful for the long-term operation of the appliances, although it is proving to be weak. The supported solar appliances have a manufacturer's three-year warranty. During this time, the sales companies are responsible for repairs. Interviewees from the target group therefore expect the appliances to function for at least three years. However, it is difficult for end users to claim the warranty from the manufacturers of the appliances because they are often located a long way away and difficult to reach (FOKG 7). This is consistent with the results of past research on the topic.[82]

According to German DC's self-assessment, mini-grids and the central electricity grid also contribute to institutionalised ownership; however, the short project cycles are a hindrance. The long-term supply contracts with project developers, utility companies or state agencies over many years are seen as a positive influencing factor on ownership (QUAL 40, 43). Accompanying interventions for maintenance, operation and training were agreed in contracts with utility companies for whose implementation private actors were responsible (QUAL 37, 42). In all interventions, however, the short project durations of German DC were perceived as an obstacle to ownership. As a rule, this resulted in follow-up costs for which neither private nor public actors in the partner country felt sufficiently responsible (QUAL 16).

81 According to the survey of MSMEs in Senegal, 46 percent of GIZ's final beneficiaries have taken part in training courses, although these also included 34 percent of those who did not receive solar equipment from GIZ. However, the focus of GBE was on the training and further education of technicians, not on the end users.

82 According to Kinally et al. (2022), repair services provided by manufacturers in rural areas in sub-Saharan Africa are often not available due to limited geographical accessibility, even if they should actually be covered by the manufacturer's warranty. Wassie and Adaramola (2021) come to a similar conclusion in their survey of four rural districts of Ethiopia. Respondents stated that they had not received any maintenance services from manufacturers – even when there was a warranty.

There are major challenges relating to technical and financial capacities in interventions implementing mini-grids. Mini-grids are often not financially viable (QUAL 39-40) because maintenance costs are frequently not covered by the electricity tariffs (QUAL 39). International evidence estimates the costs per connection at between 750 and 2,000 US dollars and regards the risks for mini-grids as high because – unlike the central grid – the established electricity suppliers do not assume any responsibility for their operation, such as maintenance costs (see Ankel-Peters, et al., 2024a). For this reason, maintenance costs for mini-grids should on principle be included in the financing to ensure that the operators can keep them running after the intervention ends (QUAL 15). In one case, the project developer of a mini-grid had to file for insolvency because of high maintenance costs and low productive use of energy (QUAL 40). Local companies such as project developers who want to work with German DC also had to fulfil high contractual requirements and conditions (QUAL 13). These actors often lacked the necessary technical capacities (QUAL 13). Partners and project developers were also confronted with capacity bottlenecks. In Benin, these had led to delays in the implementation of GBE mini-grids (QUAL 12). In general, maintenance structures were less developed in the case of off-grid approaches than with a central electricity grid. Similarly, maintenance was often not an attractive business model for suppliers of solar appliances or operators of mini-grids (QUAL 16). However, one positive aspect was that German DC was implementing accompanying interventions to strengthen the actors' technical capacities (QUAL 13).

In the case of energy-access interventions via the central power grid, such as in Uganda, the technical and financial capacities are usually available. The maintenance costsin Uganda were generally covered by the electricity tariffs (QUAL 39), and technical knowledge on this technology was generally available. However, Uganda had a special pioneering role in sub-Saharan Africa because here the electricity tariffs of the central electricity grid covered costs (QUAL 39). In most sub-Saharan African countries, although this cost coverage is not a given, the government or the state electricity supplier usually assumes political responsibility.

Sub-question b): To what extent are the outcomes and impacts durable?

Benchmark 4.2: In the case of energy interventions for decentralised approaches, there are durable outcomes and impacts at least over the expected service life of the appliances and infrastructure.

The basic prerequisite for lasting outcomes and impacts is that the appliances are used over their expected service life. The technically possible service lives of the various systems are shown in Table 5.

The supported solar appliances are used for economic activities and largely still functional after several years. A prerequisite for the durability of the outcomes and impacts is that the appliances are used. Both the surveys in Benin and Senegal and the focus-group discussions 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,[83] in Senegal in autumn 2022[84] and in Uganda in summer 2021. A consideration of use in terms of durability is therefore most meaningful in Benin. Respondents in Benin purchased their appliances between 2015 and 2022, and 84 percent of respondents were still using them in summer 2023. Participants in the focus groups reported that their appliances were still functional in the first one to two years after purchase (FOKG 4-5, 10). No assessments can be made regarding the service life of the appliances and their long-term use for productive purposes.

Nevertheless, there are difficulties with regard to the functionality, maintenance and repair of the systems, and this can adversely affect how long they continue to have outcomes and impacts. Even in the case of recently acquired appliances, however, analysing the factors that help or hinder maintenance, servicing and new purchases can provide information on the foreseeable durability of possible outcomes and impacts. The durability of the outcomes and impacts is jeopardised if maintenance, repairs or new purchases are

83 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.

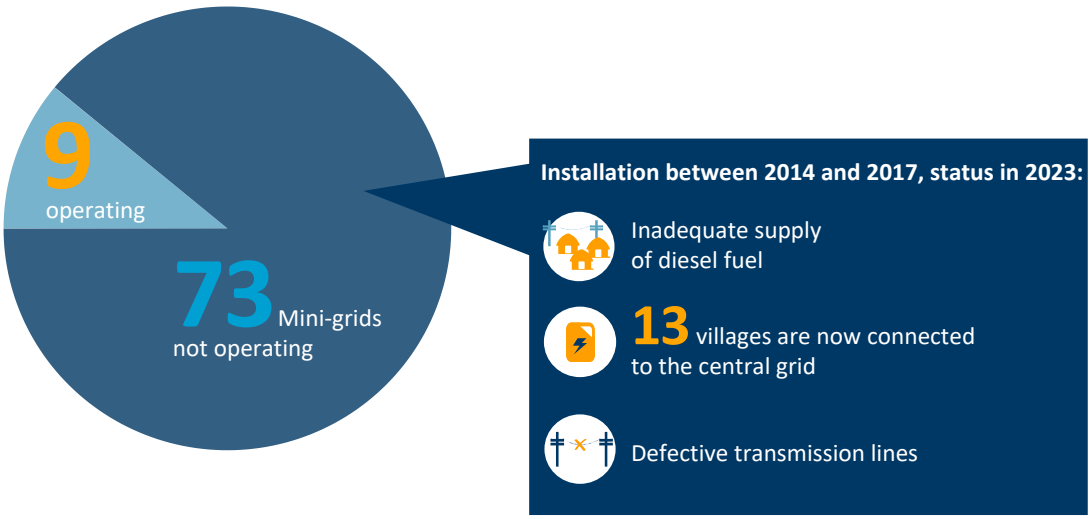
84 At the time of the survey in Senegal in September 2023, 95 percent of the solar appliances purchased under EnDev and GBE were in use.

not possible when new appliances are defective due to a lack of technical and financial capacities on the part of the final beneficiaries (see Benchmark 4.1). This was exacerbated by a lack of technicians, as a result of which the final beneficiaries attempt to repair appliances themselves, despite a lack of knowledge and skills (FOKG 7). In addition, according to the final beneficiaries, some appliances (such as solar irrigation pumps) have technical defects.[85]

The limited financial capacities of the final beneficiaries represent a key challenge for the sustainability of promoting solar appliances. For example, some final beneficiaries simply could not afford the maintenance, repair or purchase of new supported solar appliances (QUAL 36). This can be confirmed by international evidence, which estimates the acquisition costs of solar appliances such as irrigation pumps or refrigerators at between 100 and 700 US dollars (see Ankel-Peters et al., 2024a). Furthermore, often no technicians were available. The dependence of end users on high subsidies for repairs, maintenance and new procurement could also call into question the durability of the outcomes and impacts (FOKG 4), especially if subsidies expire after the end of the intervention (QUAL 36). On the positive side, however, it should be noted that German DC promotes the market development of such approaches, which should cut purchase prices and thus enable new purchases or repurchases (QUAL 36). However, it can be assumed that substantial scaling would be necessary to reduce market prices in the case-study countries.

The manufacturer's warranty for the solar appliances and their use for income-generating activities should be conducive to the long-term functionality of the solar appliances, although the manufacturer's warranty is difficult to claim (see Benchmark 4.1). Productive use of solar appliances can improve the financial capacities of the final beneficiaries. By generating income, reserves could be built up to cover maintenance, repairs and replacement costs, which in turn could have positive effects on the durability of the outcomes and impacts (QUAL 14, 42; FOKG 5, 10). Indeed, 70 percent of final beneficiaries build up reserves for repairs and maintenance, according to survey results in Benin, although 47 percent feel able to carry out repairs themselves. However, this may also indicate that end users have little confidence in the support provided by dealers under the manufacturer's warranty.

Figure 12 Missed durability of mini-grids



Source: DEval, own visualisation based on the survey on mini-grids

85 The water pipes are said to be too short, often blocked and break easily (FOKG 2, 4, 12). The tyres of the mobile irrigation pumps were unstable, small and lost air quickly (FOKG 2, 4, 10). This made it difficult to transport the pumps, also because the roads were of poor quality and the pumps relatively heavy (FOKG 4, 10). There was concern about faster wear and tear where many final beneficiaries shared one solar irrigation pump (FOKG 1). Spare parts were either not available or only with difficulty, and their procurement involved long waiting times despite high levels of demand (FOKG 1, 3-5).

The benchmark for the durability of the outcomes and impacts of mini-grids is likely to be missed (see Figure 12). The survey on mini-grids in Senegal revealed that only eleven percent (9 out of 82 villages surveyed) of the mini-grids that were funded by German DC and installed between 2014 and 2017 were still in operation in September 2023. The nine mini-grids currently in operation have been running for an average of 4.8 years. There are various reasons for these findings: 1) 17 percent of the villages were connected to the national grid by SENELEC; 2) in other villages, 94 percent of the mini-grids were not regularly supplied with diesel by the operators, which was important for the power supply when there was insufficient sunlight; and 3) the transmission lines were broken and unreliable, especially in the rainy season (FOKG 1, 7-8). The reason for the inadequate maintenance and supply of mini-grids by the operators could be a lack of incentives and therefore unsustainable operator models. GIZ certainly tried to promote the productive use of the energy provided by the mini-grids via so-called anchor customers; access to refrigerators and other appliances that were to be powered by the grid was supported for this purpose. Furthermore, kiosks were set up to facilitate the invoicing of the electricity provided, among other things. However, despite these accompanying interventions, energy consumption appears to have remained so low that the long-term operation of the mini-grids was not profitable for the operators. In addition, the initial investment in the installation of the network infrastructure appears to have been high. This may have motivated operators to initially start operations in some areas, but then to discontinue them when they turned out to be unprofitable.

The observations in Senegal are consistent with structural problems in the mini-grid sector elsewhere (see Duthie et al., 2023; Peters et al., 2019). Nevertheless, mini-grids are of key importance for the rural energy supply on the African continent (Adamopoulou et al., 2022; ESMAP, 2022; Harrison and Adams, 2024; Tenenbaum et al., 2024). German DC is aware of the challenges related to the sustainability of mini-grids and is taking these into account in the ongoing implementation in Senegal (EnDev, 2023) and in knowledge products on interventions in other countries such as Ethiopia, Nigeria, Sierra Leone and Uganda (Holzigel, 2021; Holzigel et al., 2020; Pérez-López, 2020; Wearne and Tiwari, 2021).

Summary of the findings on the sustainability criterion

- The interventions to implement solar appliances have contributed to ownership on the part of the partners; however, their financial capacities are not always sufficient to ensure maintenance and servicing without the support of German DC.
- Mini-grids in particular present major challenges to technical and financial capacities. This applies especially to capacity bottlenecks among partners and project developers, as well as insufficient financial viability caused by lower electricity consumption and high maintenance costs.
- The approach of providing energy access via solar appliances is still at too early a stage of implementation to enable a conclusive assessment to be made on the durability of its outcomes and impacts.
- A lack of financial capacities on the part of end users, inadequate enforceability of manufacturer warranties and, in some cases, an absence of technicians and a lack of spare parts jeopardise the durability of the outcomes and impacts of solar appliances, while their productive use is conducive to sustainability.
- Durable outcomes and impacts of mini-grids are not achieved in Senegal.

6.5 Coherence

The coherence of the German contribution is analysed with a view to the partners' priorities (partner coherence, see Benchmark 5.1) and the priorities of other donors (donor coherence, see Benchmark 5.2).

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

Evaluation dimensions related to the evaluation criterion of coherence:

1) complementing and supporting the efforts of the (development) partners that are involved and affected;

2) complementarity and division of labour between German interventions and those of other donors.

Sub-question a): To what extent do the interventions complement and support the efforts of the development partners that are involved and affected (subsidiarity principle)?

Benchmark 5.1: The interventions appropriately complement and support the partners' priorities.

The conception of energy access in rural Africa, its implementation and related reporting to the BMZ is designed to take account of partners' priorities. Development plans, energy-related partner strategies and priorities manifested in discussions are laid out in particular in the conception. Where there is a match with German priorities on energy and development policy, partner priorities are realised during implementation. A Technical Cooperation project in Tunisia aimed at strengthening the market for PV systems is a positive example of this. It is aligned with the partner government's five-year plan and its targets for expanding renewable energies by 2030. It also shows flexibility towards evolving partner requirements in order to cushion economic consequences. For example, the project volume was increased by a million euros during the global COVID-19 pandemic (DOK 88). The actor representatives who were interviewed in Senegal emphasised the pronounced proximity to partners and willingness to engage in dialogue as being a strength of German DC compared to other donors (QUAL 27). Germany was the only donor in Senegal to be represented in all relevant committees of the Ministry of Petroleum and Energy to provide technical advice in strategic-institutional discussions on the energy sector. This also applied to orientation committees for rural electrification, for example. Germany was also involved in preparing the ministerial annual report (QUAL 28). There thus seems to be a good basis for a coherent contribution above and beyond technical support.

Partner strategies include diverse energy sources and technical approaches to energy access. Off-grid approaches, rural energy access and strategic targets for gender equality are not the partners' sole focus. Together with SDG 7 and its own strategic objectives and targets on gender equality, these are a strategic priority of German DC, even if the financial volumes of the portfolio do not yet reflect this (see Chapter 5 und 6.1). Overall, the interviews conducted in the German DC central offices confirm a partner preference for grid expansion (QUAL 12). The case study in Benin shows preferences for grid expansion, while lower-tier interventions such as PicoPV systems in particular are seen more as interim solutions on the road to electrification. The interviews show that the partners see no conflict with their interests in terms of the feasibility, economic viability and urgency of meeting the population's energy needs promptly (QUAL 1, 6-7). In addition, economic development in urban areas and industrial centres is also considered relevant. The electrification of rural areas is not one of the Benin government's recognizable priorities. One partner saw energy access as a comprehensive development priority that should go beyond mere electrification in order to strengthen local economic development – and thus also promote the development of other sectors such as agriculture (QUAL 32). Gender aspects were emphasised; for example, electrification had made it easier for women to market products and achieve higher added value. The needs orientation and good, rapid cooperation with the inclusion of political guidelines and sector policies were confirmed (QUAL 31). In terms of implementation,

German DC was active in niches to provide coherent support to partners (QUAL 22). However, from the perspective of German DC (QUAL 21), the German portfolio, which is regarded as broad, was also a weakness, for example when it came to different parallel orders for activities and tenders.

The partner preferences outlined above are also reflected in the national development plans. According to the document analysis, Benin is prioritizing an increase in (central) energy production and diversification based on renewable energy sources as well as the modernization of the central grid (Ministère d'État Chargé du Plan et du Développement, 2018). Benin's development plan (Plan National de Développement, PND) for the years 2018 to 2025 envisages an increase in the number of households using improved cookstoves from 17.64 percent (2015) to 53 percent (2025). Rural energy access is not prioritised over urban or peri-urban areas. The "Plan Sénégal Emergent" (PSE) development plan places universal energy access in the forefront in order to offset the inequality between urban and rural areas in Senegal. Electrification is given priority for this (Direction générale du Trésor, 2014). The "Programme d'Actions du Gouvernement 2021-2026" aims primarily to improve cooking energy in Benin. However, the PSE development plan for the years 2019 to 2023 also focused on energy access in peri-urban and rural areas, as well as the expansion of renewable energy sources in Senegal (Direction générale du Trésor, 2014). In the "Energy Policy for Uganda", Uganda addresses, among other things, rural electrification and the sustainable use of biomass to reduce poverty and make economic development possible. The promotion of modern cooking energy is one of the goals that are relevant for rural areas in Uganda. Rural energy access is to be achieved through grid expansion, mini-grids and the distribution of PV systems (National Planning Authority, 2020).

In the interests of coherence, areas where partner strategies on fossil fuels and nuclear energy contradict German positions are not supported. The German portfolio does not include fossil fuels or nuclear power, although they are complementary to other energy sources and, together with grid expansion, are considered relevant by some partners such as Senegal and Uganda. The data from Senegal emphasise the government's interest in gas extraction, so that the aspiration towards partner coherence is not met here.[86] Only the Agency for Renewable Energies names priorities that correspond to the focal points of the German contribution. From the partners' perspective, local energy resources such as offshore oil and gas – but also solar energy and the potential of wind power on the coast and hydropower – should be prioritised in order to secure energy independence and access (QUAL 30). From the perspective of Financial Cooperation, the Senegalese *gas-to-power* strategy to strengthen generating capacity cannot be coherently supported, but the solar and wind energy potential can continue to be used coherently. Partner governments also have preferences for off-grid approaches. One international donor also confirmed complementarity, as universal access to cheaper energy is to be realised by means of the *gas-to-power* strategy and an expansion of renewable energy sources (see PSE; Direction générale du Trésor, 2014). According to Financial Cooperation, there was no tension between the partner preference for fossil fuels and Germany's focus on renewable energies or even German energy-policy interests. Energy access could be realised via a diverse electricity mix with German support for renewable energy sources. From the partners' point of view, there were divergences between the higher political level and the working level with which German DC cooperates (QUAL 52). According to the document analysis, there were potential trade-offs, as the regulatory policy of the countries is often geared towards fossil-fuel markets. Constellations of interests, power relationships and insufficient capacity for change in the public sector could then prevent the broadly based expansion of renewable energies (DOK 66).

The efficiency of German DC's internal processes is partially criticised by the partners. Compared to other donors, the German processes for developing and planning Financial Cooperation programmes are regarded as too time-consuming by the Senegalese partners (QUAL 31). At the same time, the focus on needs and strengthening ownership through workshops, needs analyses and similar activities before implementation begins are rated as positive (QUAL 32). Energy-related databases have the potential to be more closely followed up and harmonised (QUAL 51) in order to strengthen external coherence with partners and donors.

86 The discussion on possible cooperation between Senegal and the German Federal Government in the exploitation of a gas field off the coast of Senegal and Mauritania was not included in the evaluation.

Sub-question b): To what extent are the interventions of German DC coherent with the interventions of other donors?

Benchmark 5.2: In their conception and implementation, German DC interventions are complementary to those of other donors and based on a division of labour.

The fundamental willingness of German DC to exchange information and cooperate is recognised. Existing round tables at the embassy level are also used for the energy sector – albeit with varying intensity. According to the document analysis, the participation of partners in the donor sessions varies, as does the frequency of formalised exchange. The intervals between the meetings range from monthly to semi-annually. In some cases, specific coordination meetings such as the South African "Friends of RE" exchange sessions have been set up (DOK 51). Other interventions that are not embedded in a formalised process of coordination and harmonization take place at an individual level (DOK 75-76, 84). In countries with a relatively large number of donors in the energy sector, such as Morocco, there is a risk of overlapping or contradictory activities (DOK 40). For other countries such as South Africa, there is no formal donor coordination in the sector; it only takes place on a person-by-person basis (DOK 47, 49).

The effectiveness of the coordination mechanisms among the donors is rated differently. The donors have implemented complementary interventions in Benin, with German DC focusing on an off-grid approach and other donors on grid expansion (QUAL 6, 8). In Senegal, for example, redundancies in studies and delays in the implementation of interventions were avoided by coordination sessions (QUAL 22, 52; DOK 181-182). Strengthening donor and partner coherence in Senegal was also achieved by supporting German implementing organisations in drawing up policy papers on energy-sector development with strategic guidelines upon which actors in the energy sector rely. The basis for improving donor coherence was also the energy-information system supported by Germany, whose data was used for decision-making (QUAL 22). In Senegal, KfW is seen as playing a leading role in international donor coordination in the renewable-energy sector, promoting an open, constructive and target-oriented exchange between donor organisations (DOK 147). The contributions to rural electrification in Senegal are cited as an example of successful partner and donor coherence. Here, the state had developed three approaches (electrification via grid expansion, mini-power stations, mini-grids and individual systems) and, with the close support of German DC, had set up the Agence Sénégalaise d' Électrification Rurale in line with the World Bank's recommendations, with which German DC is working closely (QUAL 22). Other donors, by contrast, requested in interviews a more active German role in technical donor-coordination groups. Fragmentation also existed from an international donor perspective as a result of the three "entry points" into German DC (embassy, Technical and Financial Cooperation) (QUAL 25).

A quantitative analysis of coherence based on a donor comparison was not possible within the framework of the evaluation. It is not possible to systematically analyse the activities and financial promotion of energy access by other donors on the basis of the MeMFIS data used in the portfolio analysis, as these relate exclusively to interventions financed by BMZ funds. A donor comparison based on CRS data would have been disproportionately resource-intensive. In order to identify approaches such as off-grid or cooking energy, it would also have been necessary to code the titles and provide brief descriptions of the projects using keywords – as in the portfolio analysis presented in Chapter 5 and 6.3 – supplemented by a content analysis of intervention documents that would have had to be requested from other donors. A more rigorous comparison of donors would nevertheless be suitable for revealing duplications and incoherences and might have led to more critical findings, particularly with regard to the effectiveness of donor coordination.

The further harmonization of processes in particular offers potential for strengthening donor coherence. From the partners' perspective, implementation planning, feasibility studies and tenders continue to differ from donor to donor, and this is seen as challenging (QUAL 30, 33, 48). According to the document analysis, there is strategic cooperation with international donors in the cooking-energy sector at the global level (DOK 192-193). Despite coordination mechanisms, however, there are also unconscious overlaps, which reveal weaknesses both in donor coordination and in the planning

processes on the government side (DOK 141). One potential result of coordination processes that has not always been achieved to date is the harmonization of reporting and procurement procedures (DOK 162). Topics such as change processes, effectiveness and impact expectations, as well as positions could also be addressed to a greater extent (DOK 66, 126). Another criticism was that donors could take on more responsibility for the long-term objective than for innovative outputs such as productive energy use (QUAL 16).

Potential donor conflicts arise primarily from differing positions on fossil fuels and market-based approaches. Donors in South Africa, such as the China Development Bank, have focused (in the past) on expanding fossil fuels rather than supporting partners on a low-carbon development path (DOK 18, 96-97). For example, a German intervention uses market- or subsidy-policy approaches to expand solar energy, whereas the United Nations Development Programme (UNDP) and the EU bear the investment costs of comparable systems (DOK 73). Technical Cooperation with Germany on mini-grids is also perceived as less effective (see also Chapter 6.4), which in Benin, for example, can lead to conflict with other donors active in this area (QUAL 9).

The EnDev multi-donor project pools conceptual, political and financial resources and competences for the joint contribution to achieving SDG 7. At the same time, a multi-donor project can boost international visibility, effectiveness and impact. Donor coherence could generally be strengthened by further consideration of their respective priorities and policies in coordination and prioritization (DOK 112). German DC is already successfully implementing mandates from other donors (Norway, UK, Netherlands, EU) in the energy sector. Further delegated forms of cooperation and co-financing are being sought, particularly with the aim of expanding successfully tried-and-tested approaches in Uganda. However, the BMZ's sometimes restrictive attitude towards co-financing by other donors makes it difficult to expand cooperation with others on a broad scale. With regard to the broad effectiveness and impact, there is still room for improvement in using complementary potential with projects from other donors and actors (DOK 144).

Summary of the findings on the coherence criterion

- German DC, especially Technical Cooperation, predominantly also uses existing processes and dialogue formats for its contribution to rural energy access in order to consider partner strategies and priorities promptly and to support ownership.
- The fundamental proximity to partners, especially during implementation, enables German DC to respond flexibly to changing needs.
- Partners also prioritise fossil fuels or nuclear power, the promotion of which is not included in the cooperation as a matter of consistency in line with Germany's priorities.
- Energy access in rural areas is not always recognizable as a partner priority. The German DC interventions also address off-grid approaches and include lower tiers in the process. Some partners see them as a preliminary stage to rural electrification and as complementary to their own priorities.
- To strengthen donor coherence, German DC uses formalised and informal exchange and dialogue formats, some of which go beyond the energy portfolio.
- National platforms that centrally document data on electrification or support national policy papers and guidelines are helpful in strengthening donor coherence. There are sometimes differing positions, for example on fossil fuels or market-based approaches.
- Multi-donor interventions can further strengthen donor coherence.

6.6 Efficiency

Although no separate benchmarks were formulated and tested for the efficiency criterion, the evaluation generated results on production and allocation efficiency. Production efficiency refers to the appropriateness of the relationship between inputs and outputs, while allocation efficiency refers to the appropriateness of the relationship between the inputs and the outcomes and impacts achieved by the intervention (project objective and development objective; outcome and impact level).

6.6.1 Production efficiency

The literature review on efficiency shows that the financial inputs differ greatly depending on the technical approach to energy access (Ankel-Peters et al., 2024a) (see Table 5). While connection costs are lowest for PicoPV systems and biomass cookstoves, they are highest for the central electricity grid, mini-grids and biogas plants. Table 5 shows average connection costs as reported in international research for rural Africa (not specific to German DC interventions). Apart from the costs, the technical approaches also differ greatly in terms of the support required, for example from Technical Cooperation (TC inputs). TC inputs or activities include the design of capacity-development formats and the provision of information, such as technical training, information services, awareness-raising, market development or quality standards, as well as the promotion of framework conditions – the latter by means of offers of policy advisory services or support of the regulative framework. In the case of PicoPV and stand-alone systems, the required support from Technical Cooperation lies between that of mini-grids and biogas cookstoves. Here, support is particularly needed for market development. By contrast, electricity supply via the central grid requires fewer TC inputs or activities because national energy suppliers generally have the necessary expertise with regard to this technology. The TC requirement for supporting energy access via mini-grids is regarded as high. The analysed interventions on cookstoves required a medium to very high level of TC input, especially in market development.

The technically possible service lives of these approaches vary. For PicoPV systems and improved biomass cookstoves, it is two to five years, for off-grid systems at least five years. Mini-grids can be functional for 10 to 20 years. The infrastructure of the central grid generally lasts longer than 20 years. The technical approaches also differ in terms of the costs incurred by partners and donors. The costs to partners and donors for the power supply via the central grid and mini-grids are significantly higher than for off-grid systems. For, in the latter case, the end users usually purchase the appliances or PV systems out of their own funds (although these purchases can also be subsidised).

Table 5 Overview of costs, need for Technical Cooperation, service lives and maintenance requirements of the different approaches

Technical approach	Costs per connection (in US dollars)	Need for technical support	Technically possible service life (years)	Operating and maintenance requirements
PicoPV systems	20–50	Medium (market)	2–5	Low
Stand-alone systems	100–700	Medium (market)	5+	Medium
Mini-grids	750–2,000	High (regulation)	10–20	High
Central network	500–1,500	Low (knowledge)	20+	Low to medium
Improved energy-efficient biomass cookstoves	5–30	Medium to high (market)	2–5	Low to medium
Advanced biomass cookstoves	75–100	Very high (market)	2–5	Medium
Liquefied petroleum gas (LPG) cookstoves	20–100	Very high (market)	5+	Low
Biogas digester	500–1,500	Very high (behaviour)	10–20	High

Source: DEval, own visualisation based on Ankel-Peters et al. 2024a, see also online appendix

6.6.2 Allocation efficiency

The literature review on efficiency suggests that the technical approaches reach the target groups with different degrees of efficiency (Ankel-Peters et al., 2024a) (see Table 6). Stand-alone systems require high subsidies due to the low financial solvency of all target groups, but they are effective and impactful in terms of the productive use of their energy. Mini-grids are comparatively expensive, not financially viable and have sustainability problems. Mini-grids are likely to be most efficient where there is more demand for the commercial use of off-grid energy than solar home systems could provide; especially where the central grid is too far away to efficiently cover the energy requirements via the central power supply. Supplying electricity via the central grid is rarely financially viable for operators because electricity tariffs often do not cover costs. At the same time, the contribution to productive energy use is low, as in the case of mini-grids. This is due to poor conditions such as a lack of market access and expensive transport routes, regardless of the technical energy-access approach. Electricity supply via the central grid is efficient in urban areas with a high population density because economies of scale can be achieved on the connection costs. High, almost complete subsidies are necessary to provide social institutions with energy access because they generally do not generate any income via the energy access. PicoPV systems and improved energy-efficient biomass cookstoves have the best benefit-cost ratios and are the most efficient in reaching women.

Table 6 Overview of the allocation efficiency of technical approaches by target group

Technical approach	Energy-poor population groups	PUE	Women
PicoPV systems	Cheap input (h)	No PUE impact (l)	Cheap input (h)
Stand-alone systems	Expensive input (subsidy) but high impact (m)	Expensive input (subsidy) but high impact (m)	Expensive input (subsidy) but high impact (m)
Mini-grids	Expensive input (l)	Expensive input and low PUE impact (l)	Expensive input (l)
On-grids	Expensive input (l)	Expensive input and low PUE impact (l)	Expensive input (l)
Improved energy-efficient biomass cookstoves	Cheap input and high impact (h)	No PUE impact (l)	Cheap input and high impact (h)

Source: DEval, own visualisation; PUE = productive use of energy; high efficiency = h, medium efficiency = m, low efficiency = l; the input refers to the total costs of provision, regardless of who pays; however, the cost sharing varies with the technology, with different levels of subsidization for the end users.

7.

CONCLUSIONS AND RECOMMENDATIONS

This chapter assesses the relevance, effectiveness, impact, sustainability and coherence of German DC in its support for rural energy access in Africa. The assessment follows the evaluation dimensions listed under the evaluation questions in Chapter 1.4. The evaluation team develops recommendations and implementation guidelines from its assessment of the evaluation questions.

7.1 Relevance

To answer the evaluation question on the extent to which the interventions to expand rural energy access in Africa are relevant, an assessment was made of the alignment of German DC with the development needs of groups affected by energy poverty in rural areas. An overarching assessment is not possible because of strong context dependencies, as described in Chapter 6.1: the grid-expansion approach, which dominates the German portfolio, is relevant in smaller countries with high electrification rates and comparatively high subsidies for end consumers, while off-grid approaches are more significant in territorial states with low electrification rates.

In addition, the evaluation assesses the interventions' relevance for the needs of the target groups, specifically the end users and, in particular, the people affected by energy poverty. The literature suggests that affordable access to energy is the most important aspect for these population groups. However, the interviews and document analysis show that the implemented interventions are only partially in line with the needs and financial capacities of the target group.

The benchmark that German DC with its current priorities is relevant with regard to SDG 7.1, specifically for access to affordable, reliable and modern energy services for all by 2030, is partially fulfilled for target groups with particularly pronounced energy poverty.

The literature on the productive use of energy access shows that energy interventions alone do not contribute significantly to economic development. However, more promising approaches with an explicit component for promoting the productive use of energy make up only a small proportion of the portfolio. Components relating to the targeted productive use of energy can, for example, promote the spread of solar irrigation pumps or grain mills. The relevance of these off-grid systems is confirmed by focus-group discussions and surveys among MSMEs. However, relevant interventions make up only a small proportion of the portfolio of off-grid approaches. Consequently, the evaluation assesses the relevance of energy-access interventions for productive use as partially given.

The benchmark that the focal points of the German interventions are relevant for productive energy use is partially met.

As regards consideration given to the needs of women and girls, the results are very heterogeneous. The portfolio analysis makes it clear that the needs of women and girls for cooking energy are not being met. Although these needs are not of a transformative nature, they are highly relevant for women because they address their specific requirements under the currently predominant distribution of roles. Energy interventions, on the other hand, only partially take gender-specific needs into account. For example, the proportion of energy interventions with a focus on gender equality is only 32 percent, with a downward trend during the period under review. Although the assessments given by the interviewees from German DC and by actors in the partner countries regarding the relevance of implemented approaches for women and girls are more positive, the evaluation assesses the prioritization of the BMZ's energy portfolio as only partially relevant for women and girls after an overall synthesis of the information and data sources.

The benchmark that German DC takes girls and women into account is partially met.

The priorities of German DC are partially relevant for transformative low-carbon development paths. Based on the portfolio analysis, the priorities according to German DC's own reporting on the basis of the Rio markers are relevant for climate-change mitigation. According to this, the energy portfolio itself and the off-grid interventions contribute fully to climate-change mitigation as a principal (primary) or significant (secondary) objective. Interventions relating to cooking energy also largely promote climate-change mitigation. Furthermore, climate-change mitigation is more often pursued as a primary than as a secondary objective. Proportional to the share of interventions on climate-change mitigation, the funds spent on climate-change mitigation in the energy sector have also been considerable, accounting for 87 percent of total funds in the energy sector since 2019. The evaluation therefore regards the promotion of low-carbon development paths without the use of inefficient or fossil-fuelled technologies as confirmed. At the same time, the evaluation subject's contribution to reducing emissions is likely to be low. The literature refers to overreporting in the use of Rio markers (Borst et al., 2022; Michaelowa and Michaelowa, 2011; Weikmans and Roberts, 2019). Furthermore, experts and interviewees estimate that initial energy access in rural Africa offers little potential for climate-change mitigation. One exception would be to focus on cooking energy, although this is losing importance in absolute and relative terms according to the portfolio analysis. However, as there is no promotion of fossil or inefficient technologies, the evaluation sees support for the partner countries on a climate-friendly development path as given, albeit at a low level. The interventions analysed are barely relevant for transformative development paths – also because of the large number of small-scale approaches (Noltze et al., 2023a). The results also indicate that the approaches studied do not contribute to economic transformation, not even through productive use. To date 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 benchmark regarding the relevance of the current priorities of German DC on energy access in rural Africa for transformative low-carbon development paths is partially met.

The final assessment of the relevance criterion is carried out separately according to the evaluation questions. 1) To what extent are the interventions' objectives aligned with the 2030 Agenda and relevant for the target groups? 2) To what extent are the interventions' objectives in line with low-carbon and transformative development paths? With regard to the first question, the evaluation assesses the relevance of the energy and cooking-energy portfolio for energy-poor population groups, for women and girls and for productive use as partially given. The relevance for low-carbon development paths is also assessed as partially given.

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 promoting innovation spaces for the identification and development of transformative energy interventions.

7.2 Effectiveness

To answer the evaluation question on the extent to which the interventions analysed make an effective contribution to energy access in rural areas, an assessment was made of how well the intended objectives were met and what contributions were made to meeting the objectives for different groups.

The assessment of the extent to which the measures make an effective contribution to energy access for all by 2030 and the extent to which German DC achieves its targets for increasing the number of (women-led) MSMEs with energy access is based on several data sources. For example, not only was the reported target achievement of selected interventions assessed in a document analysis, but the evaluation also included the assessment of German DC stakeholders on the contribution to initial access. In addition, the surveys among MSMEs in Benin and Senegal and monitoring data from EnDev and GBE in Uganda were also analysed.

Only a few of the interventions analysed pursue the goal of creating initial access to energy or in particular of supplying women-led MSMEs with energy. The interventions with explicit objectives in this regard largely meet them in terms of initial access. They fully meet their targets in terms of the number of companies and female entrepreneurs supplied with energy. The surveys and monitoring data on MSMEs in the case-study countries also show that the target for women-led MSMEs is being met. By contrast, the interventions for access to stand-alone solar appliances which were analysed in the case studies only make a limited contribution to achieving SDG 7.1.

The benchmark for increasing the number of (women-led) MSMEs with energy access or improved energy access is being met.

The benchmark for expanding initial or improved energy access is being partially met.

The surveys among the target groups suggest that the supported irrigation pumps, refrigerators and other appliances are used almost exclusively for economic activities. The survey data from Benin and Senegal and focus-group discussions among MSMEs from all three case-study countries were analysed in order to evaluate the extent to which the stand-alone solar appliances are being used for commercial activities by the final beneficiaries.

The benchmark for productive energy use is being met.

Overall, the evaluation rates the contribution to energy access in rural areas as fulfilled. A recommendation from the joint results on effectiveness and impact is formulated in Chapter 7.3.

7.3 Impact

Impacts on different target groups and unintended negative impacts of the interventions were analysed. This helps answer the evaluation questions regarding the extent to which the interventions analysed achieve their objectives at target-group level. It also aims to contribute to questions about overarching developmental changes.

The result was that the interventions achieve higher productive energy use than other approaches to energy access (see Ankel-Peters et al., 2024a). This emphasises the relevance of the targeted promotion of productive energy use. This funding currently accounts for only a small proportion of the BMZ portfolio (especially in Financial Cooperation; see Chapter 6.1). Furthermore, the interventions analysed in the case studies are still comparatively small-scale, with a maximum of 250 final beneficiary MSMEs each in Benin, Uganda and Senegal. The high acquisition costs of the stand-alone solar appliances promoted by EnDev and GBE represent an obstacle to extending access.

The productive use of the stand-alone solar appliances leads to a reduction in energy costs for companies in Benin and Senegal. In addition to the use of stand-alone solar appliances for commercial activities, quasi-experimental impact analyses and self-assessments by rural entrepreneurs in the case studies were used to investigate the contribution to the economic situation of MSMEs and their families. Companies that have gained access to stand-alone solar appliances through GIZ-implemented interventions are in a better economic position than comparable companies. However, this does not apply to all indicators as a consequence of the interventions. It can be seen that MSMEs that were already economically better-off ex-ante were disproportionately represented in the intervention group. Nevertheless, in their self-assessments the MSMEs rate the impacts as predominantly positive.

The benchmark that MSMEs can (foreseeably) improve their economic situation through the productive use of energy is largely fulfilled.

The impacts noted in male-run companies are also evident among female entrepreneurs; according to the beneficiaries' self-assessments, there are also gender-specific effects. Small rural businesses run by women benefit just as much from reduced energy expenditure as all other MSMEs analysed in Benin, and, with restrictions, also in Senegal. According to the self-assessments in the surveys and focus-group discussions, the use of stand-alone solar appliances also makes things easier in the household and strengthens women's decision-making power. According to the quasi-experimental impact analyses, however, there were no other positive, causally demonstrable impacts with regard to the food security of the entrepreneurs and their families or their material prosperity.

The benchmark that the energy-access interventions improve the living conditions of the target group, especially women, is partially met.

It remains to be seen, however, to what extent the supported solar appliances will be used productively in the long term. In addition to the high acquisition costs, the maintenance and servicing of the supported stand-alone solar appliances pose a further challenge. Despite capacity-strengthening Technical Cooperation interventions, the intervention regions often lack the technical expertise needed to repair the high-quality, technically sophisticated solar appliances. In addition, there is a lack of spare parts. MSMEs have difficulty enforcing manufacturers' warranties. Nevertheless, in Benin, where the first final beneficiaries purchased stand-alone solar appliances at the end of 2015, most of these appliances were still in use in 2023. At present, no conclusive assessment can be made of the durability of the outcomes and impacts in Uganda and Senegal. More information, also from other country contexts, is therefore advisable before scaling up the approach.

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 the 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, 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 analysed area of rural energy supply and access.

The promotion of stand-alone solar appliances for productive use has had hardly any unintended negative impacts, with the exception of isolated cases among mini-grids. In order to investigate the extent to which the interventions avoid negative, unintended effects, the assessments of the stakeholders of German DC and its partners were obtained in interviews; the impact analyses on stand-alone solar appliances and the focus-group discussions from the case studies were also evaluated. Even though the interventions undergo systematic analysis in the conception phase, negative impacts cannot always be avoided. These include conflicts over access to energy in refugee camps, electronic waste and insolvencies among mini-grid operators. While there is no reliable evidence of negative impacts on the target group from surveys in Benin and Senegal (with the exception of possible negative impacts on property ownership among entrepreneurs in Senegal), some focus-group participants reported negative impacts of the mini-grids analysed in Senegal. These include damage to household appliances connected to the mini-grid. This also led to a loss of confidence in renewable energies.

The benchmark that the interventions avoid negative impacts is partially met.

In conclusion, the evaluation assesses the evaluation question on achievement of the intervention objectives at target-group level and the level of overarching developmental changes as largely fulfilled. The evaluation question on the extent to which the interventions avoid negative impacts is rated as partially fulfilled.

7.4 Sustainability

The interventions partially meet the benchmark of contributing to institutionalised ownership and to the capacities of the partners. The evaluation examined the extent to which the interventions contribute to the actors feeling responsible and accountable (ownership) for maintaining the positive outcomes and impacts of the respective intervention over time, and for containing possible negative outcomes and impacts. The extent to which they have the necessary capacities to maintain the outcomes and impacts was also analysed. The results show that the interventions to implement solar appliances have promoted ownership among the partners. However, the financial capacities of the national authorities for the (rural) energy supply, the private operators and the target group are insufficient to ensure maintenance and repairs without support from German DC. Mini-grids face even greater challenges as regards technical and financial capacities, especially due to capacity bottlenecks among partners and project developers. Furthermore, mini-grids are often not financially viable due to their high maintenance costs. Overall, the evaluation assesses the contribution of the interventions to institutionalised ownership and the capacities of the partners as partially fulfilled.

The benchmark of there being clear, institutionalised ownership and adequate capacities among the partners for maintaining the outcomes and impacts of the interventions relating to off-grid approaches over time is partially fulfilled in the case-study countries examined.

The durability of the effects at outcome and impact level is also partially fulfilled. The results show that the stand-alone appliances for productive use remain functional and in productive use up to eight years after installation.[87] For solar appliances, the target group's lack of financial capacities and the difficulty of enforcing manufacturers' guarantees inhibit the durability of the outcomes and impacts.

87 The assessment of the durability of the outputs, outcomes and impacts of the stand-alone solar appliances analysed is based on the data collected in Benin. The installations in Uganda and Senegal are still too young for an assessment of the service lives of the appliances or the durability of the outcomes and impacts achieved.

The lack of guarantees is also an obstacle to the development of a circular economy as part of an ecological economic transformation (BMUV, 2023; BMZ, 2023b; EU, 2020; BMUV, 2023). The aim of mini-grids having durable outcomes and impacts is not being achieved in Senegal. Overall, the evaluation assesses the durability of the outcomes and impacts as partially fulfilled.

There is potential for improvement in the project durations of energy interventions and the operator models of mini-grids. In the basic services sectors – water, health, energy – an uninterrupted and long-term supply for the target group is required. Longer project durations for energy interventions and their interaction – such as between EnDev and GBE – could promote the durability of the outcomes and impacts. The continuity of interventions is guaranteed by multi-donor interventions such as EnDev. They allow longer project durations than bilateral interventions. The literature also shows that innovative operator models can improve the durability of the outcomes and impacts of mini-grids. Integrating mini-grids into local value chains offers financial incentives for operators, and enables them to permanently generate profits from their long-term operation (Haney et al., 2019; Trotter and Brophy, 2022; BMZ, 2023b). If greenhouse-gas emissions are reduced or mitigated – for example by switching from polluting fossil fuels such as paraffin, diesel and charcoal to solar energy – operators can benefit from the sale of carbon credits as an additional source of financing (GIZ, 2021b).

The benchmark that the outcomes and impacts of completed interventions for off-grid approaches are durable is rated as partially fulfilled.

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 project 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 consider 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.

7.5 Coherence

The priorities of the German interventions largely complement and support the efforts made by the partners involved and affected in the case-study countries. Partners emphasise the need for grid expansion more strongly than German DC, even if it is supported through fossil fuels. The partner coherence of German DC in Senegal is confirmed by the data from the country portfolio review. This applies to those DC areas that do not contradict German positions.[88] 63 percent of the content-analysed intervention documents on conception, implementation and reporting mention partner priorities and refer to them in the preparation of the German contribution. Contrary to expectations, 19 percent of the documents make no reference to partner strategies or do not indicate any consequences for German priorities. These are therefore assessed as unsuccessful. The partners do not formulate any priorities for technical approaches at low tier levels. This also applies to the prioritization of individual groups affected by energy poverty or the promotion of productive energy use in rural areas, for which no explicit partner priorities can be identified. The evaluation assesses the priorities of the German interventions as largely coherent with the partner priorities.

The benchmark that the priorities of the German interventions correspond to the partner priorities is largely met.

German DC interventions for energy access in rural Africa are largely coherent, they are complementary to the efforts of other donors and are based on a division of labour. This is confirmed by the document analysis and the interview data. However, interview data from the case study in Benin show a broader range in the assessment; overall, however, the benchmark is also largely met in this case. In the partner countries, German DC uses exchange and dialogue formats with other donors, usually at the embassy level, sometimes with the participation of partner institutions. Support from national platforms for energy-related data collection or in the formulation of strategies is emphasised as particularly helpful in strengthening external coherence, provided that these are followed up. Overall, there appears to be a low risk of donor competition for the subject of the evaluation. This is partly because German DC is making a coordinated contribution by promoting the multi-donor intervention EnDev. The evaluation assesses the priorities of German DC as largely coherent with the efforts of other donors.

The benchmark that the priorities of German DC are coherent with the efforts of other donors is largely met.

7.6 Insights on efficiency

In relation to production efficiency, PicoPV systems and improved biomass cookstoves are the most efficient. The evaluation developed findings on production efficiency and allocation efficiency from the data collections and literature reviews (see Ankel-Peters et al., 2023, 2024a, 2024b). The connection costs for PicoPV systems and improved biomass cookstoves are low, and the required technical inputs moderate. By contrast, central grids, mini-grids and approaches for cooking energy that rely on more efficient technologies and are based on international air-quality standards for cookstoves have a lower production efficiency because the connection and maintenance costs are considerably higher.

The results on allocation efficiency also suggest that PicoPV systems and improved biomass cookstoves have the best benefit-cost ratio. Improved biomass cookstoves in particular are also the most effective way of reaching women and girls. Off-grid approaches are the most efficient for productive energy use. Central grids and mini-grids have a low allocation efficiency across all target groups and impacts examined. Access for the energy-poor can only be achieved by means of comprehensive subsidies.

88 Nevertheless, the interview transcripts of the country portfolio review with their reference to the overall German portfolio in Senegal and a lack of differentiation of rural areas, are only of limited use for the subject of the evaluation.

7.7 Contributions to the Agenda 2030 for Sustainable Development

The evaluation's findings are mixed with regard to the contributions of the analysed energy interventions to achieving the SDGs. Through its international commitment to providing access to (green) energy in its partner countries, the German government aims to support the social, economic and ecological transformation to implement the 2030 Agenda (BMZ, 2021). The evaluation of the contributions of the analysed German DC portfolio to the implementation of the 2030 Agenda reveals trade-offs and synergies. For example, the approaches implemented in EnDev and GBE to promote the productive use of energy via solar appliances contribute to a limited extent to the economic growth of MSMEs (SDG 8) but little to climate-change mitigation (SDG 13), because the target group is only responsible for a negligible amount of global CO_2 emissions. The contribution of approaches aimed at market-based solutions and productive energy use to create initial access to energy is also low. This also means that the interventions analysed are only partially in line with the principle of the 2030 Agenda of "leaving no one behind". At the same time, the implemented approaches promote the economic situation of female entrepreneurs and thus have the potential to contribute to gender equality (SDG 3). Given that cooking-energy promotion and energy interventions – which, according to their markers, support gender equality – only make up a small proportion of German DC, its energy portfolio in Africa has a lot of catching up to do in terms of its contributions to SDG 3.

8.

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9.

ANNEX

9.1 Rating scale in DEval evaluations

Table 7 Rating scale

Categories	Meaning
Exceeded	The intervention clearly exceeds the benchmark for the applied evaluation criterion. Findings demonstrate a result well above the benchmark.
Fulfilled	The intervention meets the benchmark for the applied evaluation criterion. Findings demonstrate that the benchmark is met.
Largely fulfilled	The intervention largely meets the benchmark for the applied evaluation criterion. Findings which demonstrate that the benchmark is met predominate.
Partially fulfilled	The intervention partially meets the benchmark for the applied evaluation criterion. The numbers of findings demonstrating that the benchmark is met, and those demonstrating it is not, are (more or less) equal.
Barely fulfilled	The intervention barely meets the benchmark for the applied evaluation criterion. Findings which demonstrate that the benchmark is not met predominate.
Missed	The intervention does not meet the benchmark for the applied evaluation criterion. Findings demonstrate that the benchmark is not met.

Source: DEval, own visualisation

9.2 Evaluation matrix

Table 8 Evaluation matrix

Evaluation question	Benchmark	Sources	Indicator (for evaluation 'fulfilled')	Methodology
OECD-DAC relevance criterion **Evaluation question 1: To what extent are the interventions relevant for rural energy access?**				
Sub-question a): To what extent are the objectives of the intervention geared towards the 2030 Agenda and relevant for the target group?	Benchmark 1.1: With its current priorities, German DC is relevant to SDG 7.1: ensuring access to affordable, reliable and modern energy for all by 2030, especially for energy-poor target groups.	(BMZ, 2006, 2017, 2021; IPCC, 2022; OECD, 2021; UN, 2015)	1.1.1 The priorities of German DC are in line with SDG 7.1.	1.1.1 PA, QUAL (EXP, DEV, GOV), DOKA
		(BMZ, 2007, 2019)	1.1.2 In the conception, needs and financial capacities are analysed and appropriately addressed in line with the priorities.	1.1.2 DOKA, QUAL (EXP, DEV, DDP)
			1.1.3 The objectives take account of population groups that are particularly affected by energy poverty, and their needs are appropriately analysed and addressed in the conception.	1.1.3 DOKA, LIT, QUAL (BEN, EXP, DEV, DDP)
	Benchmark 1.2: The energy-access interventions are relevant for productive energy use.		1.2 The relevance of the implemented approaches for productive use for interventions aiming to achieve this is confirmed by the interviewees, documents or literature.	1.2 PA, LIT
	Benchmark 1.3: The energy-access interventions take the needs of girls and women into account.		1.3 The needs of girls and women are taken into account in the objective and conception.	1.3 LIT, possibly PA, QUAL (BEN, EXP, DEV, DDP), DOKA
Sub-question b): To what extent are the objectives of the interventions in line with low-carbon and transformative development paths?	Benchmark 1.4: The current priorities of German DC are relevant for transformative low-carbon development paths.	(BMZ, 2021)	1.4.1 Climate-change-mitigation and transformation aspects are recognizable in all strategies and concepts for energy access.	1.4.1 QUAL (EXP, DEV, GOV), PA
			1.4.2 Since 2015 (Paris Agreement), no support for fossil-fuels has been evident in the portfolio.	1.4.2 PA
			1.4.3 All interviewees confirm that the interventions contribute to the avoidance and/or reduction of emissions.	1.4.3 QUANT (BEN)

OECD-DAC effectiveness criterion **Evaluation question 2: To what extent do the interventions make an effective contribution to energy access in rural areas?**				
Sub-question a): To what extent are the objectives of the interventions being achieved as planned (or being adapted to new developments)?	Benchmark 2.1: The interventions achieve their objectives in terms of expanding or improving energy access.	(BMZ, 2006, 2007, 2017a; IPCC, 2022; OECD, 2021; UN, 2015)	2.1 According to the interviewees' assessment and the survey results, the target number of beneficiaries with initial and improved access has been achieved.	2.1 LIT, DOKA, QUAL (DEV, DDP, EXP)
	Benchmark 2.2: German DC is achieving the targets set by the BMZ with regard to increasing the number of (women-led) MSMEs by providing or improving energy access.		2.2 The targets of German DC with regard to the number of (women-led) MSMEs with energy access or improved energy access have been achieved.	2.2 DOKA, QUANT (BEN)
	Benchmark 2.3: MSMEs are using their energy access productively.		2.3 Beneficiary MSMEs use the energy for commercial activities (instead of for consumption or non-use).	2.3 QUANT (BEN), LIT, QUAL (BEN)
OECD-DAC impact criterion **Evaluation question 3: To what extent do the interventions for rural energy access make an impactful contribution for the target groups?**				
Sub-question a): To what extent do the interventions contribute to achieving their objectives at target-group level and to overarching developmental changes?	Benchmark 3.1: MSMEs can (foreseeably) improve their economic situation by means of productive energy use.		3.1 An improvement in the economic situation of the beneficiary MSMEs can be determined on the basis of indicators (including productivity, turnover, profit, profitability) and/or the manifest perception of the interviewees.	3.1 QUANT (BEN), QUAL (BEN)F
	Benchmark 3.2: The energy-access interventions improve the living conditions of the target group, especially for women.	(BMZ, 2006, 2007; OECD, 2021)	3.2 All interviewees state that their living situation has improved OR that there is causal evidence of positive impacts.	3.2 if applicable QUANT (BEN), QUAL (BEN), FOKG
Sub-question b): To what extent do the interventions avoid negative impacts?	Benchmark 3.3: The interventions avoid negative, unintended impacts.		3.3 The interventions have no negative, unintended impacts on the target group or its environment.	3.3 DOKA, QUAL (DDP; DEV)

OECD-DAC sustainability criterion **Evaluation question 4: To what extent are the interventions for rural energy access sustainable?**				
Sub-question a): To what extent do the interventions based on decentralised approaches contribute to the actors feeling responsible and accountable (ownership), maintaining the positive outcomes and impacts of the intervention over time, and stemming any negative outcomes and impacts that may occur; to what extent do they have the necessary capacities to do so?	Benchmark 4.1: There is clear, institutionalised ownership and adequate capacities among the partners to maintain the outcomes and impacts of the interventions relating to off-grid approaches over time.	(BMZ, 2007)	4.1 Relevant actors (public institutions, users or private actors) have recognizable institutional ownership, and their capacities are assessed as being adequate for planning, implementing and operating sustainable energy systems independently.	4.1 QUAL (DEV, GOV, DDP), QUANT (BEN)
Sub-question b): To what extent are the outcomes and impacts achieved durable?	Benchmark 4.2: In the case of energy interventions for decentralised approaches, there are lasting outcomes and impacts at least over the expected service life of the appliances and infrastructure.	(BMZ, 2007; OECD, 2019; Ankel-Peters, et al., 2024a, Efficiency Review)	4.2 Energy interventions have lasting outcomes and impacts beyond the expected service life of the appliances and infrastructure.	4.2 QUANT (BEN), QUAL (BEN, DDP)
OECD-DAC coherence criterion **Evaluation question 5: To what extent are the energy-access interventions coherent with the partners' own efforts and other donors' interventions?**				
Sub-question a): To what extent do the interventions complement and support the efforts of the development partners that are involved and affected (subsidiarity principle)?	Benchmark 5.1: The interventions appropriately complement and support the partners' priorities.	(OECD, 2019)	5.1 It is recognizable in the portfolio and confirmed by all interviewees that the partners' priorities are fully complemented and promoted.	5.1 PA, QUAL (GOV, DEV, DDP), DOKA For Senegal: Senegal country portfolio review
Sub-question b): To what extent are the interventions of German DC coherent with the interventions of other donors?	Benchmark 5.2: In their conception and implementation, German DC interventions are complementary to those of other donors and based on a division of labour.		5.2 The complementary design and implementation based on the division of labour is confirmed by all interviewees and can be seen in the documents.	5.2 QUAL (GOV, DEV, DDP), DOKA For Senegal: Senegal country portfolio review

Source: DEval, own visualisation

9.3 Evaluation schedule

Timeframe	Tasks
02–04/2023	Conception and inception phase
04/2023	First reference group meeting to discuss inception report
03–08/2023	Portfolio analysis
06–07/2023	Case study Benin
07–08/2023	Case study Uganda
08–09/2023	Case study Senegal
09–11/2023	Analysis and synthesis of results
11/2023–03/2024	Report writing
03/2024	Second reference group to discuss report draft
07/2024	Dispatch of the final evaluation report to the BMZ

9.4 Evaluation team and contributors

Core team	Function	CRediT-Statement[89]
Alexandra Köngeter	Evaluator	Conceptualization, methodology, data curation, formal analysis, investigation, writing – original draft, visualisation, review and editing
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Sylvia Nowack	Project administrator	Project administration, data curation

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89 The CRediT statement (Contributor Roles Taxonomy, *https://credit.niso.org/)* indicates the roles of the authors of this evaluation report in the evaluation. The CRediT taxonomy distinguishes between 14 different roles to show the specific contribution of the individual authors.

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