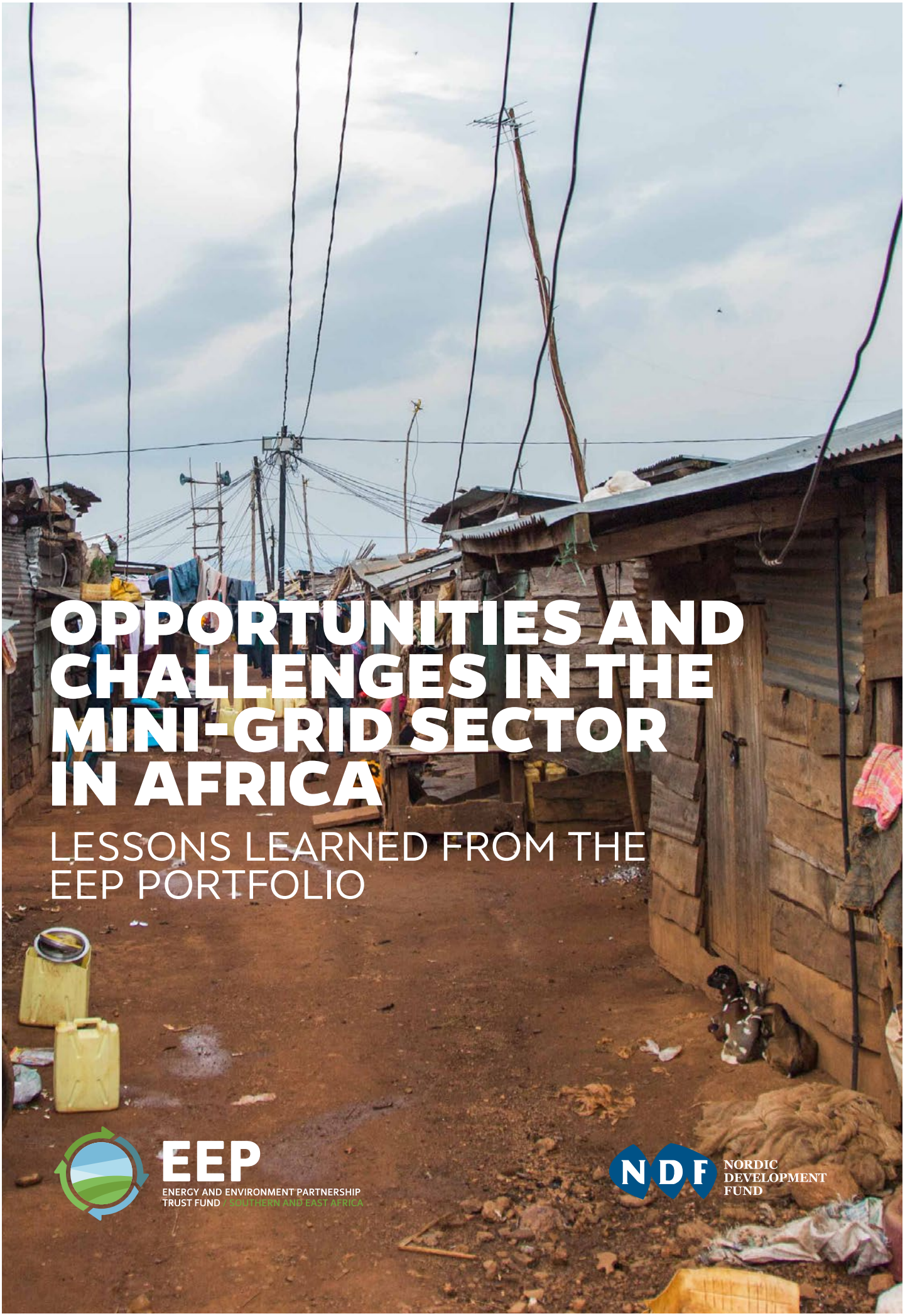

OPPORTUNITIES AND CHALLENGES IN THE MINI-GRID SECTOR IN AFRICA

LESSONS LEARNED FROM THE EEP PORTFOLIO

EEP
ENERGY AND ENVIRONMENT PARTNERSHIP TRUST FUND / SOUTHERN AND EAST AFRICA

NDF
NORDIC DEVELOPMENT FUND

Disclaimer

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CONTENTS

GLOSSARY & ABBREVIATIONS LIST

AC	Alternating current: The form in which electric power is delivered to businesses and residences.
AMDA	African Mini-grid Developers Association
Anchor client	A business or institution that has a steady load profile and an ability pay. An anchor client can ensure a predictable source of revenue for mini-grids and thereby reduce financial risk.
ARE	Alliance for Rural Electrification
ATP	Ability to Pay
CAPEX	Capital expenditures: Funds used by companies to purchase or upgrade equipment and other physical assets.
Cost reflective tariff	A tariff (user fee) that reflects the full cost of providing electricity to consumers, including the installation, maintenance and operation of the mini-grid.
Cross subsidised tariff	Charging higher electricity prices to one group of consumers in order to cover the cost of charging lower prices to another group.
DC	Direct current: Sources producing direct current are for example batteries, thermocouples and solar cells.
DSM	Demand-side management: The modification of consumer demand for energy - through technologies, financial incentives or education – to reduce the use of energy during certain times of day.
EEP	The Energy and Environment Partnership covering Southern and East Africa
EIA	Environmental Impact Assessment
IPP	Independent Power Producer: A private or non-profit entity that owns or operates a facility that generates electricity for public use. (Government utilities are not IPPs.)
Load	Use of energy
Load limiter	A device that limits the supply of electricity to ensure a customer does not use more than their allocated/paid amount.
Mini-Grids	Systems involving small-scale electricity generation (up to 10 MW) that serve a limited number of consumers via a distribution grid and can operate in isolation from the national transmission networks. Systems with the smallest generation capacity (up to 15 kW) are called pico or micro-grids.
Mobile money	Payments made or accepted using a cell phone or handheld device.
NEP	National Electrification Plan
Offtaker	A purchaser of electricity
OPEX	Operating expenses: Funds used by a company to run daily business operations.
PAYG	Pay-as-you-go: A system that allows consumers to pre-pay for energy or energy services.
PPA	Power Purchase Agreement: A contract between an electricity producer and an offtaker/purchaser. PPAs include a long-term agreement on tariffs and other terms and conditions.
PUE	Productive use of energy: An activity that uses energy to generate income or other benefits to business.
RBF	Results-based financing: Funding based on a set of agreed results (such as number of connections) that shifts some risks from the donor/investor to the recipient/developer.
REA	Rural Electrification Agency
SHS	Solar Home System
Smart meter	A metering device that electronically records information about consumption and communicates that data to the operator.
SMEs	Small and medium-sized enterprises
WTP	Willingness to Pay

ABOUT EEP AFRICA

The Energy and Environment Partnership covering Southern and East Africa (EEP Africa) is a multi-donor fund providing early stage grant and catalytic financing to innovative clean energy projects, technologies and business models.

WHERE

Botswana, Burundi, Kenya, Lesotho, Mozambique, Namibia, Rwanda, Seychelles, South Africa, Swaziland, Tanzania, Uganda and Zambia. (Malawi and Zimbabwe recently joined EEP and are not covered in this study.)

Since 2010, EEP Africa has been at the forefront of efforts to fast track clean energy access and sustainable and inclusive green growth, with positive impacts on lives and livelihoods. To date, EEP has channeled more than EUR 57 million to 225 pioneering projects in all fields of renewable energy and energy efficiency.

EEP Africa provides early stage and catalytic financing and other forms of support to a diversified portfolio of clean energy projects, with a particular focus on reaching poor and underserved groups. Projects are selected through competitive calls for proposals that look for strong concept innovation, development impact and sustainable business models. In addition to funding, project developers receive capacity building training and business development support. They also have the opportunity to participate in EEP knowledge exchange and investor forums.

EEP Africa's overall goal is to contribute to sustainable and inclusive green growth and achievement of the Sustainable Development Goals (SDGs). The Fund aims to support countries across the region toward the realisation of a climate resilient, zero-carbon future with particular focus on support progress toward: No Poverty (SDG 1); Gender Equality (SDG 5); Affordable and Clean Energy (SDG 7); Decent Work and Economic Growth (SDG 8); and Climate Action (SDG 13).

EEP Africa is hosted and managed by the Nordic Development Fund (NDF). Since 2010, it has received funding from Austria, Finland, NDF and the UK.

Objective of this Study

The EEP portfolio contains a wealth of information on a variety of mini-grid technologies, business models, and types of financing. Within the EEP portfolio of 225 projects, a total of 43 mini-grid projects were awarded funding. The objective of this study is to provide an overview of the EEP mini-grid portfolio, highlight observations and lessons learned about challenges and opportunities in the mini-grid sector, and provide recommendations for mini-grid developers and the programmes that support them.

The study consisted of three data collection methods:

1. Desktop review of EEP project documents: proposals, monitoring and evaluation assessments, progress and completion reports.
2. Questionnaires and interviews with selected project developers and mini-grid experts.
3. Review of other analyses and studies on the mini-grid sector in Africa.

The EEP Coordination Office thanks all the EEP project developers and other partners who generously offered their time and expertise during the development of this study. Particular gratitude goes to the experts who reviewed and commented on drafts of this report: Emmanuel Biririza and Jeff Felten (African Development Bank), Victor Ndiege and Edwin Obiero (African Enterprise Challenge Fund Renewable Energy and Adaptation to Climate Technologies), Daniel Shepherd (International Finance Corporation), Carolina Barreto (Power Africa Transactions and Reforms Program), William Brent (Power for All), and Steven Hunt (UK Department for International Development).

EXECUTIVE SUMMARY

Countries in Africa are struggling to balance an increasing demand for electricity with the high cost of extending national electricity grids with limited government budgets.

Major efforts have been made in recent years to increase access to energy, improve energy efficiency and deploy renewable energy resources. And yet, an estimated 600 million people in Sub-Saharan Africa are currently living without access to modern energy services.

With rapid technological development, renewable energy mini-grids are a practical solution to the challenge of electrifying rural areas. In many cases mini-grids are the most effective way to provide access to energy as they are flexible, easily installed, and can be connected to the main grid if and when the national network expands. They also offer long-term development impact by reducing carbon emissions and creating new jobs and business opportunities.

Funding initiatives have an important role to play in supporting the transition of mini-grid models and technology from proof-of-concept to scale. To date, the Energy and Environment Partnership (EEP) has provided funding to 43 renewable energy mini-grids projects in 10 countries in Southern and East Africa. The objective of this report is to examine the EEP mini-grid portfolio to provide some observations and lessons learned about the challenges, opportunities and successes that mini-grid developers experience in Africa.

Many countries in Africa still lack specific policies for mini-grids in their national electrification plans, which makes planning difficult for private developers. Regulatory issues impact site selection, licensing and permitting procedures, future grid integration, and the access of developers to national subsidy schemes. Projects are often delayed due to the long lead time required to apply for concessions, licenses and environmental approvals. Regulatory requirements are often fixed costs, independent of the size of the project, and can be very expensive.

Regional associations have an important role to play in the renewable energy sector in improving coordination and closing the information gap between practitioners, investors and policymakers. They offer valuable platforms for private and public-sector stakeholders to consult and collaborate on building enabling regulatory and financial frameworks for the sector. In countries where the processes are clear, such as in Tanzania, development proceeds more quickly and smoothly. There is also increasingly widespread support from local governments and rural electrification agencies (REAs), including some co-funding for infrastructure.

Funding initiatives have an important role to play in supporting the transition of mini-grid models and technology from proof-of-concept to scale.

The consumer cost of electricity from mini-grids remains higher than tariffs for the national grid, which are generally cross-subsidised and not cost-reflective. Smart meters, remote monitoring and demand-side management tech-

A mini-grid provides electricity to this busy village hub.

nologies are reducing costs and improving the efficiency of mini-grids in rural areas. However many developers still find it difficult to become profitable and seek grants or subsidies to cover capital costs and sometimes operational costs. In order to spur private investment, countries need to have clear and transparent guidelines for mini-grids to be connected to the national grid and compensated accordingly.

To reach financial sustainability, most mini-grid developers are focusing on productive use of energy – such as providing energy efficient appliances or forming local business hubs – as a means to increase demand and generate sufficient revenue. The most financially sustainable mini-grids use an "ABC" strategy: first, identify and negotiate an agreement with an anchor load client (often in agro-processing); then identify, or help develop, small local businesses; and only last target domestic consumers. Targeting business clients offers a more secure customer base and attracts private investors, but many donor agencies focus more on the number of households connected in the short-term rather than long-term viability.

Most developers are making an effort to increase employment opportunities, especially for women and youth, spur local economic activity and support small businesses.

Another factor that is critical to success is to train a skilled and dedicated local team and to build strong relationships in the community. Most developers are making an effort to increase employment opportunities, especially for women and youth, spur local economic activity and support small businesses. Thus the development impact goes well beyond rural electrification.

Houses connected to a solar PV mini-grid by overhead lines installed by local workers.

1. ROLE OF MINI-GRIDS IN AFRICA

One of United Nations' Sustainable Development Goals (SDG 7) is to "Ensure access to affordable, reliable, sustainable and modern energy for all". Countries in Africa are struggling to balance an increasingly high demand for electricity, both in rural and urban areas, with the high cost of extending national electricity grids with limited government utility budgets. Major efforts to increase access to energy, energy efficiency and use of renewable energy resources have been made in recent years. And yet, more than 600 million people in Sub-Saharan Africa still lack access to basic electricity.

Rapid technological development and operational efficiencies in recent years have made mini-grids a practical and viable solution to electrifying rural areas. Mini-grids fill an important space between individual solutions, such as solar home systems, and extensions of the national grid. By utilising renewable energy sources – including solar, wind, hydro and biomass – they reduce pollution and combat climate change. They can also generate sufficient capacity to support industrial and agro-processing operations and stimulate local economic development. As a result, mini-grids offer an appropriate and cost effective way to provide electricity for rural and low-income communities.

Mini-grids offer long-term energy solutions and development impact. Most systems have a productive life span of 15-25 years, which is longer than many other clean energy technologies such as cookstoves. As the technology becomes more standardised, mini-grids can be rapidly replicated and disseminated after a successful test pilot, if sufficient financing is available. Mini-grids can also be connected to the main grid, from the beginning or when it arrives in that region.

MINI-GRIDS:

Systems involving small-scale electricity generation (up to 10 MW) that serve a limited number of consumers via a distribution grid and can operate in isolation from the national transmission networks [EUEI mini-grid policy toolkit]. Mini-grids covered in this study use different sources of renewable energy and may be stand-alone systems or connected to the main grid. Systems with the smallest generation capacity (up to 15 kW) are called pico or micro-grids.

The International Energy Agency (IEA) considers mini-grids and other distributed renewable energy solutions the least cost option for three-quarters of all new connections needed in Sub-Saharan Africa. The IEA predicts that mini-grids offer a EUR 170 billion investment opportunity between now and 2030, and expects at least 40% of new power connections in the region during the next decade to be provided by mini-grids. Some countries are aiming even higher – in the new draft of their national energy strategy, Rwanda plans to provide over 90% of the country's electricity supply through mini-grids by 2024.

2. OVERVIEW OF MINI-GRIDS IN THE EEP PORTFOLIO

Over the past seven years, EEP has funded a wide variety of renewable energy and energy efficiency projects.

A total of 43 mini-grid projects spread over 10 different Southern and East African countries have been awarded EEP funding. This represents 19% of the overall EEP portfolio. The full list of projects, including the project developers and other key data, can be found in Annex 1.

The EEP mini-grid portfolio includes a variety of technologies. EEP projects range from small initiatives (total budget of EUR 30,000) to commercial-sized installations (budget of over EUR 10 million) and utilise a range of energy sources. The mini-grids vary from pico-systems that generate less than 5 kW of electricity to grid-connected units providing up to 10MW of energy. EEP-funded mini-grid projects are reducing carbon emissions, creating green jobs, and delivering clean energy services to households and businesses.

Among the projects contracted under EEP, some faced challenges during implementation and had to be terminated. Since EEP targets innovative concepts, it is to be expected that some were not able to fully realize their plans. Within the mini-grid portfolio, 15 projects (35%) ended before the completion of all planned activities. These are included in this study because projects that face challenges also offer valuable lessons learned.

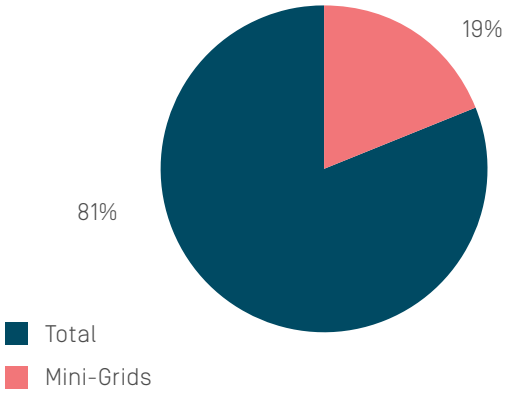

Figure 1: Mini-grid projects in EEP portfolio

Project Types

Mini-grid projects are found in all EEP project type categories: feasibility studies, pilot and demonstration projects, and scale-ups of successful models.

A bit less than 20% of the mini-grid portfolio (8 projects) have been feasibility studies. Some of these were early stage studies assessing potential sites and models, while others were bankable studies that resulted in actualized construction contracts. Feasibility studies are not a main focus in this study but they are included in the analysis of the overall mini-grid sector.

Mini-grids support the commercial activity of small kiosks and workshops.

FEASIBILITY STUDY:
Analysis and evaluation to determine technological, commercial, social, environmental and economic viability. The main outputs are agreements needed to move on to a testing or demonstration phase.

PILOT PROJECT:
Testing of an RE/EE product, service, business or delivery model for the first time or in a new market. Testing conditions and developing operational details on a small scale before a large roll out or commercialisation.

DEMONSTRATION PROJECT:
Implementing a tested product/service or technology in an actual market context to establish evidence that it is a viable concept and could be applied elsewhere in similar circumstances.

SCALE-UP PROJECT:
A project that has a high probability of reaching commercial viability with EEP "bridging finance".

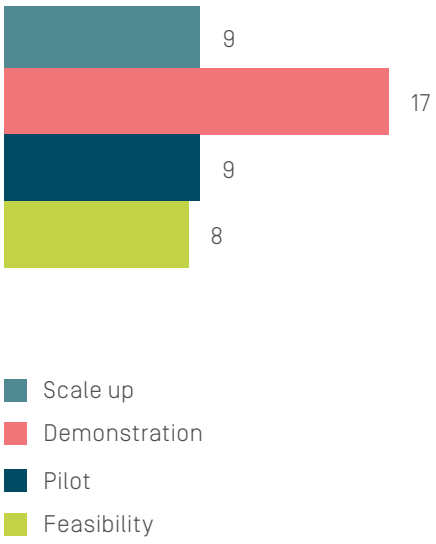

Figure 2: EEP mini-grid project types

The largest number of projects supported by EEP are in the demonstration stage. These account for almost 40% of the portfolio (17 projects). This is a category in which grant financing, capacity development and knowledge sharing can be very valuable. The remaining projects are divided evenly between pilots and scale-ups of successful models.

Project Locations

The EEP mini-grid portfolio extends to 10 countries in Southern and East Africa: Botswana, Burundi, Kenya, Mozambique, Namibia, Rwanda, South Africa, Tanzania, Uganda and Zambia. Most are implemented in just one country but they may include multiple project sites. Two of the projects are Regional, meaning activities are occurring in more than one country.

Within the EEP region, mini-grids are used to address the most pressing needs. In East Africa, where basic access to electricity is still a widespread challenge, solar and hydropower mini-grids are the most common.

Figure 3 shows that Tanzania is the dominant country in the mini-grid portfolio, with 17 projects (40%). This reflects a regulatory and economic environment that is favourable to small-scale energy producers. Kenya and Rwanda have the next largest groups of mini-grid projects, with five in each country.

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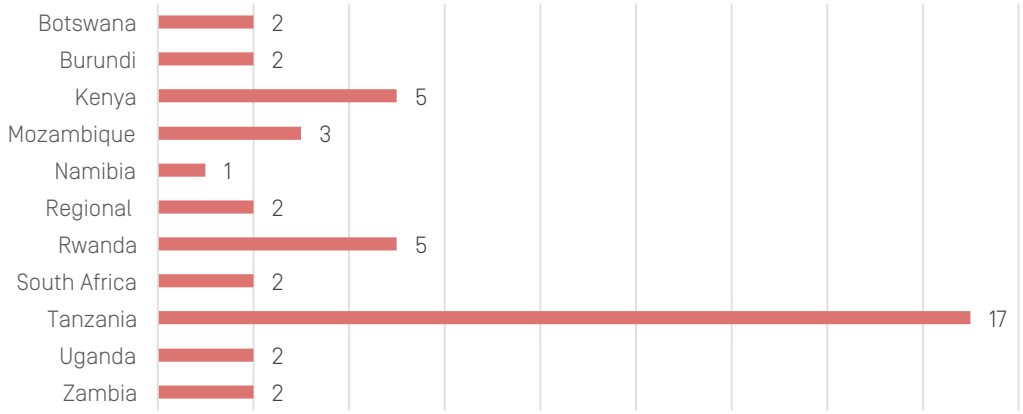

Figure 3: EEP mini-grid projects by countries

widespread challenge, solar and hydropower mini-grids are the most common. In the countries of Southern Africa, where national utility grids have wider reach and reliability, projects focus more on biomass and waste-to-energy.

Project Financing

Access to affordable financing is one of the most significant barriers to the development of mini-grids. Thus programmes like EEP are critically important for project developers, especially those entering new markets or testing new strategies or technologies. Most of the project developers in the EEP portfolio (about 70%) are private businesses that are aiming for commercial sustainability but currently still rely on grant funding to pilot mini-grid models. The remaining projects are led by non-profits, government institutions or universities.

The average total budget of mini-grid projects in the EEP portfolio is EUR 900,000 with EEP financing of about EUR 350,000, or just under 40% of the project budget. As can be seen in Figure 4, over half of the projects have a total budget of less than

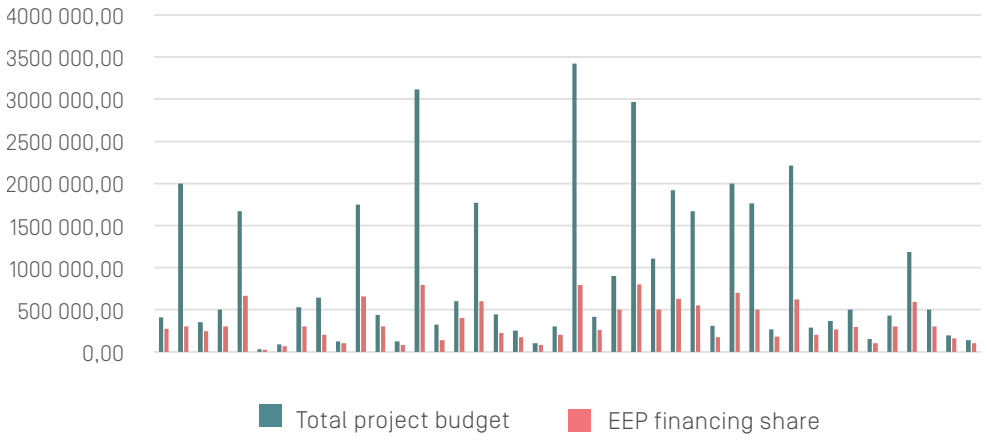

Figure 4: EEP funded mini-grid projects budgets

EUR 500,000. (There was one very large project with a budget of EUR 15 million but it was terminated at an early stage and is excluded from the average budget calculations.) This average is slightly higher than budget sizes in the overall EEP portfolio of 225 projects, which is EUR 760,000 with EEP financing of EUR 255,000.

All EEP projects are required to secure co-financing in the form of other grants, loans, government funding, equity or assets of the project partners.

EEP projects are required to secure co-financing in the form of other grants, loans, government funding, equity or assets of the project partners. In-kind contributions are not acceptable. The minimum co-financing share has been 30% of the total budget. During early funding rounds, co-financing expectations increased progressively, reaching up to 90% of the total budget for the largest grants in the portfolio.

Mini-grid Systems

Mini-grids are generally categorised in tiers according to their installed capacity and service reach. Tier 5 projects are referred to as PPA mini-grids because they usually need to have a power purchase agreement (PPA) with the national utility or an anchor client in order to be financially viable. The table below summarises the tier definitions used in this study.

Categories	kW	Tier	Services	Peak Capacity		Duration	
				Power	Daily Capacity	Hours per day	Hours per evening
Pico-grids (DC)	0-5 kW	Tier 1	Task light and phone charging	Very low power, min. 3 watts	Min. 12 watt-hrs	Min. 4 hours	Min. 1 hour
Micro-grids (AC)	5-15 kW	Tier 2	General lighting and television and fan	Low power, min. 50 watts	Min. 200 watt-hrs	Min. 4 hours	Min. 2 hours
Medium mini-grids (AC)	15-60 kW	Tier 3	Tier 2 and low-power appliances (ex. refrigerator, sewing machine and grinder)	Medium power, min. 200 watts	Min. 1 kW-hrs	Min. 8 hours	Min. 3 hours
Large mini-grids (AC)	60-350 kW	Tier 4	Tier 3 and medium power appliances for productive use	High power, min. 800 watts	Min. 3.4 kW-hrs	Min. 16 hours	Min. 4 hours
PPA mini-grids	350 kW - 10 MW	Tier 5	Tier 4 and any high power appliances, covers all needs	Very high power, min. 2 kW	Min. 8.2 kW-hrs	Min. 23 hours	Min. 4 hours

Table 1: Multi-tier framework for access to household electricity supply (adapted from IEA and World Bank, 2015)

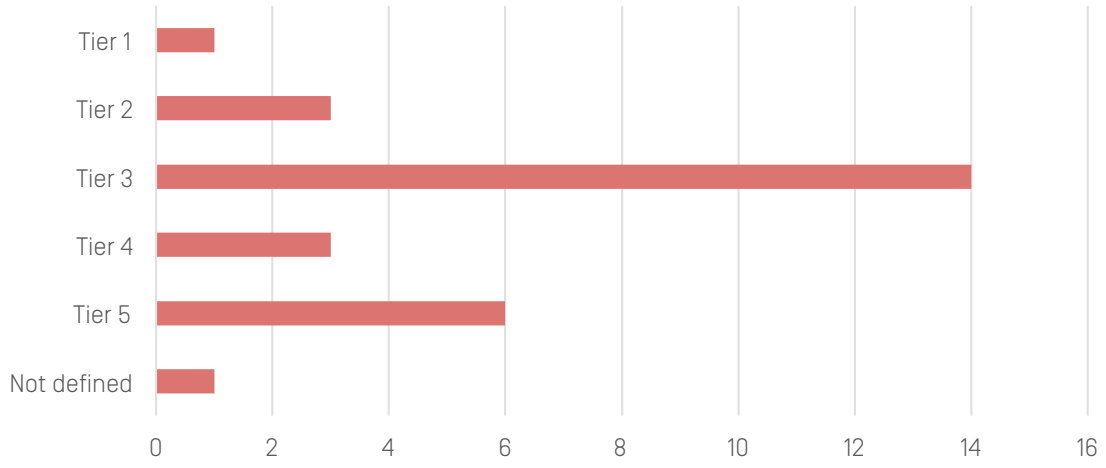

Figure 5: EEP Mini-grid projects by Tier categories. Completed and ongoing projects only.

EEP projects encompass all five tier levels. Tier 3 projects clearly dominate the portfolio of completed and ongoing projects. Tier 5 projects are the next most common, but half of these are feasibility studies so not all of them will actually be constructed.

Mini-grid systems can be stand-alone, operating independently of the national grid, or grid-connected, feeding some of their power into the national distribution network. Stand-alone systems are currently more common and feasible due to lengthy and often difficult negotiations needed to secure licensing and PPAs with the national utility. Indeed, the majority of projects in the EEP portfolio, a total of 36 projects (over 84%), are stand-alone systems. However, many small and medium-sized stand-alone systems are being built according to national standards so that they have the option to connect to the main grid if and when it expands into the project area. Many project developers see this as a vital aspect of long-term project sustainability.

Large Tier 5 mini-grids, those that generate over 1 MW of energy, are more likely to be grid-connected. They are in a variety of countries – Botswana, Kenya, Mozambique, Rwanda, and Tanzania and one regional project – and represent all the different energy technologies discussed below.

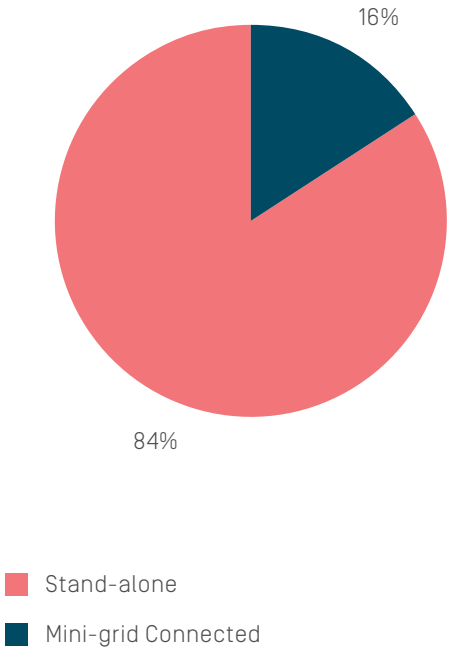

Figure 6: EEP Mini-grid projects system set up.

Energy Technologies

EEP-supported projects are utilising a diverse set of technologies to generate energy from a variety of renewable resources, including solar, hydro, wind, biomass and waste-to-energy.

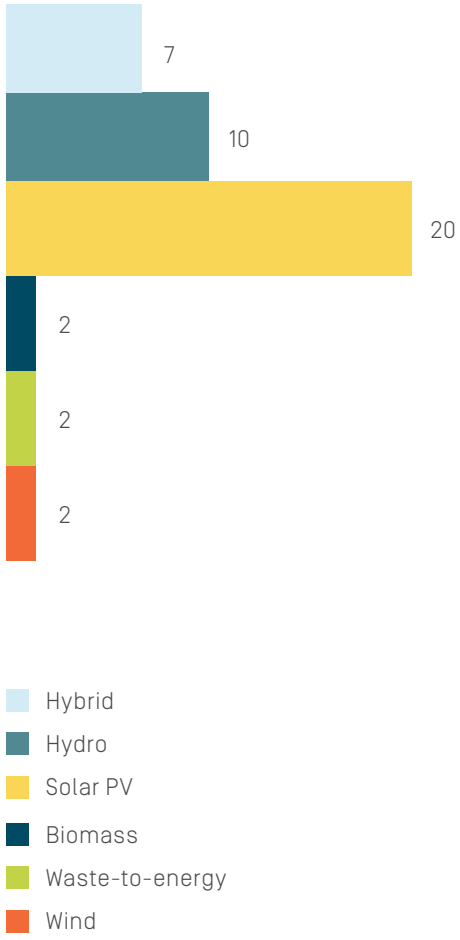

Figure 7: Mini-grid technologies in EEP portfolio.

Solar PV Mini-grids

Almost 50% of EEP-supported mini-grids are solar photovoltaic (PV) projects. Typically, the projects are relatively small units that provide electricity to a few hundred rural households, institutions and businesses. Such mini-grids play an important development role, often providing a community with reliable and affordable electricity for the first time. Projects that have multiple sites might reach up to 2000 households in total. The largest solar PV projects have a planned capacity of over 1 MW, which usually requires difficult licensing and PPA negotiations. One such project, for a "solar power village" concept in Botswana, has successfully concluded PPA negotiations and is now proceeding to the construction phase. The average investment budget for solar PV mini-grid projects was around EUR 1 million with an EEP contribution of about 40%.

Almost 50% of EEP-supported mini-grids are solar photovoltaic (PV) projects.

Solar photovoltaic (PV) projects play an important development role, often providing a community with reliable and affordable electricity for the first time.

Hydro and Wind Power Mini-grids

Hydropower mini-grids supported by EEP are located mainly in East Africa. There are multiple projects in Rwanda, Kenya and Tanzania, and one in Zambia. The only hydro project in the portfolio outside of East Africa has been in KwaZulu-Natal, South Africa. Hydropower mini-grids are relatively large compared to the overall mini-grid projects in the EEP portfolio, with over half falling in the Tier 5 category. Hydro projects range from a 23 kW plant that produces electricity for a school to a 1.7 MW plant that powers 4,000 customers. Unlike other projects, hydro mini-grids are often grid-connected and depend on successful negotiations with the national utility.

There have been only two wind power mini-grid projects. One of these was a feasibility

A local businessman in front of his electrified shop.

study in Mozambique and the other was a demonstration project in Namibia that now provides service to 200 households.

Biomass and Waste-to-Energy Mini-grids

Bioenergy and waste-to-energy mini-grid projects utilise various types of biogas, biofuel, biomass, green charcoal or briquettes derived from agricultural by-products. In the EEP portfolio, two mini-grid projects are categorised as solid biomass and two as waste-to-energy. Waste-to-energy projects mainly focus on green waste, using leftovers from agricultural production as raw material and producing either biogas or solid biomass clean energy products.

Hybrid Mini-grids

Some mini-grids include more than one source of energy. In the EEP portfolio there have been seven hybrid projects, of which six are solar PV/biomass hybrids. The final project was a completed feasibility study for an energy cyclone tower in Mozambique.

A local restaurant attracts customers with electricity supplied by a mini-grid.

3. RESULTS: STAND-ALONE MINI-GRIDS

The vast majority of mini-grids in the EEP portfolio (84%) are set up as stand-alone systems. During project implementation, EEP carries out systematic monitoring and evaluation (M&E) visits. Among the stand-alone mini-grid projects that are not feasibility studies, 19 projects had been visited as of early 2018. Results from this group show that renewable energy services have been provided to a total of 5,821 households, an average of 306 households per project. The projects have created 685 direct jobs, many of which employed women and youth. The mini-grids also created other significant income generation and entrepreneurial opportunities, further expanding their development impact.

Mini-grid projects have performed well in comparison with other renewable energy projects, such as those focusing on the sale and distribution of systems intended for use by a single household. On average, mini-grid projects have generated 117 MWh of electricity annually per project. This means that the mini-grids can generate approximately 380 kWh for the annual consumption of each connected household. This is significantly higher than other solar PV projects that, based on EEP results, are producing on average 52 kWh/year per household. Most mini-grid projects also provide power for AC appliances, whereas many solar home systems (SHS) can only power lighting and phone/USB charging. In many rural villages mini-grids support energy for productive use, such as agro-processing industries and small businesses. The EEP experience demonstrates that mini-grids enable an electrified village to become a local “business hub”.

The results for EEP stand-alone mini-grids indicate that access to renewable energy has brought annual savings of up to EUR 93 per household. Results for SHS projects show EUR 57 in annual savings, although this may be partly due to higher upfront cost and monthly fees before the customer fully owns the SHS. Reductions in CO_2 emissions achieved through the mini-grid projects amount to 9,329 metric tons by the time of completion of the projects.

Outcome indicators	Project type: Mini-grids
Potential cumulative t CO_2 emission reductions achieved over the life time of the installed technology and/or project	9,329
Number of households with improved access to off grid clean energy	5,821
Number of direct jobs	685
Amount of electricity generated (MWh/year)	2,219

Table 2: Results of the evaluated stand-alone mini-grids.

4. OBSERVATIONS AND LESSONS LEARNED

The EEP portfolio encompasses a broad spectrum of mini-grid projects that span a range of grid sizes, energy sources, and countries of operation. An assessment of the portfolio offers some general and specific observations about the regulatory, technical, financial and socio-economic landscape. From these observations, key lessons learned can be identified.

General Observations

Many countries still lack specific policies for mini-grids in their national electrification plans, which makes project planning and implementation difficult for private developers. However, this is starting to change and there is increasingly widespread support from local governments and rural electrification agencies (REAs), including co-funding for infrastructure in some places. In terms of regulatory policy and access to finance for small power producers, Tanzania is a leading country in the EEP region. The mini-grid market is developing especially quickly in Uganda and Rwanda.

The cost of electricity from mini-grids remains higher than tariffs for the national grid, which are generally cross-subsidised and not cost-reflective. Many developers seek grants or subsidies to cover initial capital costs. To further improve financial sustainability, project developers are increasing their focus on productive use of energy. This often includes a negotiated off-taker agreement with a local agro-processing company. New options like smart metering and demand-side management technologies are also reducing costs. Targeting business clients offers mini-grid developers a more secure customer base and helps attract private investment. Many donor agencies, however, focus more on the number of households connected in the short-term rather than long-term viability. Thus project goals may differ depending on the source of financing.

The increased focus on productive use and local capacity spurs economic activity and supports small businesses. Thus the development impact goes well beyond rural electrification.

As mini-grid technology has become more standardised and conventional, innovation in the sector can be found more in terms of business models and community engagement that seek to increase demand and expand productive use of energy. Most developers are also making an effort to increase training and employment

opportunities, especially for women and youth, as a key component of long-term sustainability. The increased focus on productive use and local capacity spurs economic activity and supports small businesses. Thus the development impact goes well beyond rural electrification.

Regulatory Issues

The regulatory environment can be quite different depending on the country. Tanzania has a fairly clear set of policies and requirements that favour independent power producers (IPPs). Kenya has a vibrant mini-grid sector but the private market in the country has recently stalled; according to African Development Bank experts, the government is concentrating its mini-grid efforts under Kenya Power and the REA. Uganda is developing a mini-grid framework with the support of donor programmes, such as Power Africa, and its main power company, Umeme, is collaborating with private developers. Rwanda has consulted with private mini-grid companies, including an EEP partner, on the draft of its new National Electrification Plan (NEP), which includes a goal of producing 90% of the country's total electrification through mini-grids (mainly solar and hydro) by 2024.

There is an increasing understanding and awareness in the region about the value added by mini-grids in terms of service reliability and socio-economic stimulation.

Licensing requirements generally depend on the size of the mini-grid's installed capacity. In Tanzania, for example, there is no licensing requirement below 1 MW and no tariff approval needed below 100 kW, but all projects must be registered with the Energy and Water Utilities Regulatory Authority (EWURA) and obtain an environmental clearance. In Rwanda, no environmental clearance or license is currently needed for mini-grids under 500 kW but new draft regulations may change this. In Uganda, most small mini-grids are exempt but requesting the exemption can be as difficult as requesting a full license.

However, tariff frameworks often do not account for the additional costs that mini-grid developers incur.

The regulatory process can be expensive and time consuming. Some projects use temporary structures or carefully select size and location to avoid formal requirements. Another option is to seek programmatic permits, under which all projects of a similar size and technical standard are covered by one permit. (Many countries already use this type of approach for telecommunication projects.) One EEP developer in Uganda spent two years working to secure a concession for their project site; but the concession is scalable to up to 20 sites so the time and effort was viewed as being worth the investment.

Many developers in the EEP portfolio have been positively supported by the REAs (including some co-funding for infrastructure), local governments (for land permits, etc.), and the communities in which they operate. There is an increasing understanding and awareness in the region about the value added by mini-grids in terms of service reliability and socio-economic stimulation. However, tariff frameworks often do not account for the additional costs that mini-grid developers incur. In many countries, privately-owned and operated mini-grids are expected to sell electricity at rates similar to the national grid, which is usually not financially sustainable.

Some mini-grids are designed from the start to be connected to the national grid. These projects negotiate PPAs with the national utility to feed electricity into the main grid. The PPA process can be quite lengthy and more than one

Solar PV mini-grid in the heart of a village.

project has closed before construction due to a failure to reach an equitable agreement. When successful though, this arrangement can offer a mini-grid developer long-term financial stability. One EEP partner in Burundi is building a grid-connected solar PV plant and has signed a 25 year PPA with Regideso, the national utility company. The new power plant will provide a 15% increase in the generation capacity of the national grid and represents the largest private sector investment in Burundi during 2017.

A growing number of developers are joining national and regional associations to lobby for regulatory and policy frameworks that are favourable to private sector mini-grid investments.

Many projects in the EEP portfolio, however, are stand-alone grids that are not initially connected to the national grid. These have faced challenges in countries where grid extension plans are unpredictable, and several projects have been forced to change location. Rural electrification strategies often do not include details on how mini-grids will be connected to the national grid, if and when it arrives in the region of operation. This uncertainty often restricts private investment. Tanzania adopted new rules in 2017 that include compensation for private developers for the value of their mini-grid, minus any subsidies the developer received. But most other countries do not have specific guidelines or, if they do, the rules have yet to be tested in practice.

A growing number of developers are joining national and regional associations to lobby for regulatory and policy frameworks that are favourable to private sector mini-grid investments. The Rwanda Energy Private Developers (EPD) association has about 100 member companies, of which 20 are mini-grid developers. In the recently-established African Mini-grids Developers Association (AMDA), five of the founding members – Ensol, E.On Off-Grid Solutions (Rafiki Power), Husk Power, PowerGen, and Redavia – are recipients of EEP funding.

Lessons Learned - Regulatory Issues

1. Specific policies on mini-grid development and integration into national electrification plans do not exist or are still under development in many countries. This impacts site selection, licensing and permitting procedures, and future grid integration. It also restricts the access of developers to national subsidy schemes for rural electrification activities or cross-subsidies for grid extension.

2. Regulatory bodies tend to push for mini-grid tariff ceilings as close as possible to national grid tariffs to protect the customers. However, national tariffs are often not cost-reflective (i.e. cover costs and generate a return on investment) due to cross-subsidisation. This results in the need for mini-grid developers to secure grants or subsidies for their capital expenditures (CAPEX), and in some cases also their operating expenses (OPEX).

3. The time required to apply for required concessions, licenses and environmental approvals is substantial and has often delayed project development. Although most mini-grids are exempt from generation and distribution licenses, they may still need to go through a process to secure this exemption. Regulatory requirements can also be very expensive. Many environmental impact assessments (EIAs) are fixed costs, independent of the size of the project. In countries where the processes are clear and developers have gained experience, such as in Tanzania, development proceeds more quickly and smoothly.

4. In order to spur private investment, countries need to have clear and transparent guidelines for mini-grids to be connected to the national grid and compensated accordingly. There should be a mechanism for either the developer to maintain and operate the mini-grid and sell power to the national utility through a PPA, or for the national utility to buy the mini-grid from the developer at fair value and take over operations.

5. Regional associations have an important role to play in improving coordination and closing the information gap between practitioners, investors and policymakers. Groups such as the Alliance for Rural Electrification (ARE), African Mini-grids Developers Association (AMDA), and SEforALL Mini-Grids Partnership (MGP) offer valuable platforms for private and public-sector stakeholders to consult and collaborate on building enabling regulatory and financial frameworks for the sector.

6. Based on an analysis of the EEP portfolio, AMDA and other such groups should prioritise activities related to permitting policies and tariff frameworks. In terms of scaling up projects, the main priority under regulatory issues is grid integration frameworks.

African Mini-grid Developers Association (AMDA)

AMDA was established in 2018 as the first trade association for mini-grid developers in Africa. It has country-level chapters in Kenya and Tanzania, with plans to add chapters in Nigeria, Ethiopia and Uganda. The association's purpose is to facilitate business environments that support the acceleration of a sustainable private sector for mini-grid systems in African markets. AMDA aims to achieve this through activities focused on advocacy, promotion and coordination.

AMDA has identified eight core issues divided into two categories:

- **Regulatory issues:** permitting policies; tariff framework; grid integration framework; and technical and safety standards.
- **Financial issues:** infrastructure financing; subsidy parity; hybrid energy systems; and off-taker bankability.

AMDA's near-term objectives include:

- **Mobilise finance for mini-grids:** working with donors, national governments and other stakeholders to develop a smart Results Based Financing (RBF) fund to support scale-up of mini-grids, as well as finding ways to unlock lower-cost debt capital;
- **Equalise public-private incentives:** achieving a level playing field, both regulatory and financial, for mini-grids that is on par with other grid-based solutions;
- **Make integrated planning the norm:** establish national grid integration frameworks that are inclusive of mini-grids;
- **Better inform market support activities:** highlighting useful areas for public interventions and providing market information to organizations funding R&D and innovation;
- **Unify and expand voice of the sector across Africa:** grow the number of members, with a long-term goal of representing all private sector developers across the continent.

Electrified schools improve learning results as children can do schoolwork into the evening.

Technical Highlights

Most mini-grid projects in the EEP portfolio focus on providing 220-240V AC grid power (single and three phase), aiming for 24 hours per day of service. Very few EEP projects focus on 24V DC power. While DC power and AC pico grids (3-5 kW) generate enough electricity for personal use (lights and phone/USB charging), they have a hard time generating enough revenue to be financially sustainable. Medium-sized mini-grids offer more options (such as refrigeration) for end users and are the most common type in the EEP portfolio. However, Tier 3 and higher grids often produce more power than there is demand for during the initial stages of operation. Many EEP projects initially sold only about 30% of their produced energy.

The most common renewable energy source is solar PV, on its own or as part of a hybrid system. In order to provide 24 hour service, solar PV mini-grids must include a battery or a back-up generator (usually diesel or biomass) for night-time use.

The most common renewable energy source is solar PV, on its own or as part of a hybrid system. In order to provide 24 hour service, solar PV mini-grids must include a battery or a back-up generator (usually diesel or biomass) for night-time use. Most sites are designed to allow for future expansion in the number of solar panels as daytime demand increases, but expanding battery capacity has been expensive. Storage costs are starting to decrease with new technology, which will offer developers more flexibility in scaling up projects.

Hydro power is the second most popular renewable energy source in Africa. However, hydro mini-grids have higher CAPEX costs (up to 70% of total project costs) and can have higher environmental and social risks. Biomass projects are popular in countries where the focus is less on spreading basic electricity and more on improving environmental outcomes. Biomass mini-grids generally aim at producing commercial by-products – in the form of heat, briquettes, and organic fertiliser – in addition to electricity. Only one wind power project has succeeded in moving on to the construction phase under EEP.

Standardised mini-grid models allow for quicker deployment and expansion.

The decision of which size and type of mini-grid to construct needs to correspond to local market conditions. One project in Burundi planned to develop a mini-grid for both businesses and households, but then discovered that the machinery used in the village could only run on diesel. In order to benefit from the mini-grid, the businesses would need to purchase completely new machinery.

Many developers also ensure their systems are compatible with the national grid so there is an option to move on-grid if/when grid expansion arrives in the region.

Standardised mini-grid models allow for quicker deployment and expansion. One EEP developer produces small AC mini-grids (6-30 kW) that are integrated into containers and manufactured in Nairobi. The standardised container model reduces logistics, manufacturing, and development costs, while also offering flexibility to easily expand as demand rises. Many developers also ensure their systems are compatible with the

Solar Home Systems (SHS) and Solar PV Mini-grids

Both Solar Home Systems (SHS) and solar PV mini-grids are widely used in Africa as a means to increase access to energy. The choice of which system should be developed in any given area depends on the local context and desired goals.

SHS offer a good option when the goal is to reach as many off-grid households as possible for a low initial cost. SHS can be quickly distributed and installed in rural homes, and they usually require no licensing or tariff frameworks. The same level of capital expenditure required to fund SHS for about 1500 customers might only bring power to 200 customers if used for a mini-grid. SHS is also a good option in areas where the population density is low.

Solar PV mini-grids offer a good option when the goal includes sustained impact and local business development. Most mini-grids are designed and constructed to provide access to energy for the whole village and also support productive use of energy. They can generate enough capacity to stimulate and support small and medium-sized businesses and they can continue operating for 20 years or more. Due partly to improving technology, the operating costs are also becoming more competitive. Once a mini-grid is installed and operational, it can save households EUR 5-20 per month compared with the cost of diesel generators, kerosene lamps or SHS. Mini-grids therefore offer consumers affordable access to energy in densely populated areas.

Integrated IT systems that enable data collection on usage and remote monitoring of the grid ensure that project developers can track operational capacity and maintenance needs.

national grid so there is an option to move on-grid if/when grid expansion arrives in the region.

Smart metering and pay-as-you-go (PAYG) schemes, generally via mobile money, are widely used throughout the region. Integrated IT systems that enable data collection on usage and remote monitoring of the grid ensure that project developers can track operational capacity and maintenance needs. Projects are also introducing more demand-side management (DSM) technologies that help control system loading to reduce costs and increase battery life.

Lessons Learned - Technical Highlights

1. Solar PV grids producing AC power remain the most popular type of mini-grid in the region. They are the easiest to install and operate. Improvements in battery life and storage are helping reduce the cost of providing 24 hour service with a solar grid.

2. Mini-grids often struggle with the demand side and initially sell far less than the amount of energy produced. An in-depth assessment of local energy needs and usage is essential before determining which type and size of mini-grid to construct. Systems that can start small and then be easily expanded as demand rises offer developers the greatest flexibility.

3. Most private sector developers are moving away from grids that only provide basic electricity for households, and increasing their focus on grids that can support productive use of energy for small and medium-sized enterprises (SMEs). Tier 1 connections (lighting and phone charging) have a development impact but are generally not financially sustainable without grant funding for infrastructure and fixed costs.

4. Smart meters, remote monitoring and demand-side management technologies are improving the efficiency and profitability of mini-grids in rural areas.

5. Mini-grids continue to offer technical value when connected to the main grid, as they can store energy and ensure a more stable supply for the local community. Systems that are compatible with the national grid have less risks in terms of long-term sustainability.

6. Funding programs such as EEP have an important role to play in supporting the transition of proof-of-concept to scale mini-grid models and technology.

Financial Issues

Mini-grids require significant infrastructure investments and there is still a significant "viability gap" in project finances. Nearly all projects start off with a grant, subsidy or other type of infrastructure financing to reduce capital costs. There is substantial donor interest in mini-grids in Africa at the moment and many EEP projects also receive some type of financial or in-kind support from government authorities. This can be through co-funding for infrastructure (Uganda), grants from the Rural Energy Fund (Tanzania), incentive support via Results Based Financing

Nearly all projects start off with a grant, subsidy or other type of infrastructure financing to reduce capital costs.

(RBF), or through assistance with licensing and permits. In Rwanda, the national utility is planning to establish a low-interest loan facility (5-6% interest rates) for private mini-grid developers with support from the World Bank's Scaling-Up Renewable Energy Program (SREP).

In most cases a one-time connection fee is charged prior to delivery of any power. This fee is generally much lower than the connection fee to the national grid but is higher than initial costs for diesel generators or kerosene lamps.

The cost per connection – calculated as total programme costs divided by the number of connections realised – for mini-grids in the EEP portfolio ranges between EUR 500 and EUR 1,800. This is not the same as the cost of connecting individual customers to a grid, as these program-level costs may include the regulatory process and other preparatory work in addition to the cost of equipment and installation. One small (48 kW) mini-grid project in Tanzania, for example, connected about 250 customers at a cost of EUR 200-300 per household (including in-house wiring). And the cost of connecting additional customers to an existing mini-grid network is significantly lower.

In most cases a one-time connection fee is charged prior to delivery of any power. This fee is generally much lower than the connection fee to the national grid but is higher than initial costs for diesel generators or kerosene lamps. As part of market data analysis, mini-grid developers need to assess the willingness to pay (WTP) and ability to pay (ATP) of potential customers. The level set for the connection fee can help with this assessment. One developer sets the connection fee at about half the expected monthly cost to determine interest from those with a WTP. They use a connection fee of three times the expected monthly cost to identify those with an ATP. Another developer established a credit policy to cover some connection costs as a way to bridge the gap between WTP and ATP; residents were offered a two-year repayment plan, but many did not repay within that timeframe.

The consumer costs of electricity from a mini-grid are higher than national grid costs, especially for the smallest users. As noted earlier, this is because national grid tariffs are not cost-reflective and can be highly cross-subsidised. In Tanzania, for example, the national utility TANESCO charges customers less than EUR 0.10/kWh but it costs the utility more than EUR 0.20 to deliver each unit of electricity. In the EEP portfolio, tariffs for consumed units predominantly range from EUR 0.18-1.00/kWh. For some pico-grids, which have more difficulty covering costs due to their small size, tariffs of up to EUR 4.50/kWh have been charged.

For solar PV mini-grids, the high costs of night-time power from the battery or back-up generator are leading developers to invest more in demand-side management technology and policies.

Some mini-grids must follow a uniform tariff set by the Regulator and REA. One project in Uganda, for example, was only allowed to charge EUR 0.20/kWh for industrial customers and EUR 0.23/kWh for domestic use. In countries where private developers are allowed to set their own (cost-reflective) rates, there is incentive to keep rates low to attract customers but this often requires some form of grant or subsidy. In Rwanda, the national gird tariff ranges from EUR 0.10-0.20/kWh. An EEP partner with a medium-sized

Mini-grid projects offer jobs and training for local workers, such as technicians and maintenance staff.


MWENDAMSEKA
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CHOMA
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grid in the country has managed to be successful with a rate of about EUR 0.25/kWh but their EEP grant helped cover the grid's CAPEX. The most extreme differences between mini-grid and national grid tariffs occur in countries where power is highly subsidised, such as Burundi.

For solar PV mini-grids, the high costs of nighttime power from the battery or back-up generator are leading developers to invest more in demand-side management technology and policies. By encouraging users to consume the bulk of their electricity during daytime hours, the company is able to keep the overall tariff rate reasonable.

The most successful method for payments is pay-as-you-go (PAYG), where customers pre-pay for energy.

Within the EEP portfolio, there are two main payment models for electricity consumption:

- Payment for consumed units: Customers are charged based on the amount of energy they actually consume. As mentioned above, rates in the EEP portfolio predominantly range from EUR 0.18-1.00/kWh, though they may be significantly higher for pico and micro-grids. This payment model requires that the system includes smart meters to manage demand and track usage.

- Fixed monthly fee: Customers are charged a set fee for a monthly energy bundle. Developers often offer a choice of plans (Tier 1, 2 or 3) similar to options available for mobile phone plans. For basic energy use (lighting and phone charging) fixed fees in the EEP portfolio began at about EUR 3.50/month. For projects in Tanzania, fixed charges for a 1-1.6 kWh monthly service are in the range of EUR 7.50-11.50. This payment model requires a load limiter.

The most successful method for payments is pay-as-you-go (PAYG), where customers pre-pay for energy. Payment across the region is most often collected through mobile money and prepaid tokens. Scratch cards can also be used but are less common.

The strategy of one pico-grid developer in Tanzania is to identify about 15 customers – a large enough group to be worthwhile but small enough to minimize costs – and charge only for consumed units. If the grid is successful at that level, then they expand to more households and shift customers to fixed monthly bundles.

To ensure profitability, nearly all mini-grid developers in the EEP portfolio are moving towards targeting customers with productive use of energy (PUE) as a means to increase demand and establish a stable base of revenue.

Mini-grids that do not have PPAs with the national grid need to ensure off-taker bankability. A portfolio of energy users that can produce sufficient and predictable cash flows is needed to secure financing and become profitable. This is complicated in rural areas where consumption patterns are not consistent and may be dependent on seasonal variations.

To ensure profitability, nearly all mini-grid developers in the EEP portfolio are moving towards targeting customers with productive use of energy (PUE) as a means to increase demand and establish a stable base of revenue. Many developers are providing energy efficient appliances – through direct sales, lease-to-own schemes or fee-for-service partnerships – together with the electricity. For example, a customer might pay a monthly fee that includes both electricity and a refrigerator for a certain period (say an 18-month

lease timeframe) after which they own the refrigerator in full and their payments are reduced to just the electricity costs. This leasing arrangement ensures that the customer has an incentive to keep paying the monthly fee. The customer also earns income from the refrigeration, which increases their ability to pay the fee. This scheme requires an initial outlay of financing for the refrigerators, or other appliances to be leased, but offers a more sustainable model for both the developer and customer.

The most financially sustainable mini-grids in the EEP portfolio employ some form of the ABC strategy of connections. First, negotiate a PPA with an anchor client that has a sufficient load profile. Then identify, or help develop, small local businesses. And only after that target domestic consumers.

A few developers invest enough in agro equipment to become their "own anchor". These companies are investing significant CAPEX in productive assets and OPEX in business training in order to directly strengthen agro-business value chains and growth. This model ensures that costs are covered but it requires the developer to diversify beyond just energy production.

The most financially sustainable mini-grids in the EEP portfolio employ some form of the ABC strategy of connections.

ABC Strategy: Anchor – Business – Consumers

The most successful business model in use by mini-grid project developers is the ABC strategy: first Anchor client, then Business clients, and then domestic Consumers.

The anchor client is often an agro-processing facility and should be active enough to ensure economic viability. The anchor should have a predictable electricity load profile and, ideally, be willing to adjust its demand profile to match supply. Such a client significantly reduces distribution grid costs.

The secondary business clients should also have revenue sources that provide sustainable demand and encourage local economic growth. The energy developer may choose to foster business opportunities by also selling energy efficient appliances and machines to local entrepreneurs.

Domestic consumers are important for spreading rural electrification but are generally not able to significantly contribute to profitability. Project viability should not be dependent on domestic customers except in densely populated locations.

Lessons Learned - Financial Issues

1. Most mini-grid projects receive support from international donors or government authorities to pay for or reduce initial capital costs. This includes a wide range of grants, subsidies, loans, public-private partnerships, and other types of financing.

2. Referring to AMDA's set of core financial issues, an analysis of the EEP portfolio indicates that priority should be given to infrastructure financing and subsidy parity. In terms of scaling up projects, the priority issue is off-taker bankability.

3. Public and donor resources for clean energy access must be leveraged to attract private sector capital. This is especially true for wind and hydro hydro mini-grids. Such projects often require significant upfront investment, even as they benefit from low operating costs. Events like the EEP Investor Forum are critically important to the long-term development of the sector.

4. There are different tiers of financing needed to establish a profitable mini-grid: project finance for capital investments; business finance for small enterprises involved in construction and operations; and end-user finance to enable consumers to connect to the mini-grid and purchase electric appliances.

5. Private sector companies need to develop and implement a business model that allows tariff rates to remain low in order to remain competitive. The only proven way to do this without relying on grants/subsidies is by stimulating productive use of energy among consumers.

6. Developers need to invest in smart technology and demand-side management to reduce costs, while also investing in local business development to secure predictable and sufficient revenue. PAYG with mobile money is the best payment model for the region.

7. The most sustainable business model for mini-grids is the ABC strategy of anchor, business, and consumer clients.

Socio-economic Considerations

The mini-grid sector in Africa is still dominated by European and American entities. Many expert panels at regional and international conferences do not include any voices that represent local users or beneficiaries. However, many international developers are establishing a continuous local presence or representation in the region and African companies, such as Neseltec in Rwanda and Ensol in Tanzania, are becoming successful players in the energy market.

A more stable and affordable electricity supply increases the anchor client's revenues and feeds them back into the community.

Robust community involvement is now understood to be a critical component of successful mini-grid projects. All project developers in the EEP portfolio engaged with the local community before beginning construction, but many underestimated the length of time needed for this part of the process. Beyond the expected investments in site identification and market analysis, there is a need to sufficiently sensitise and inform local residents and businesses, as well as to solicit their input on planning. It can take 6-9 months to build local relations and convince potential customers.

Beyond the expected investments in site identification and market analysis, there is a need to sufficiently sensitise and inform local residents and businesses, as well as to solicit their input on planning.

VIRTUAL MINI-GRIDS:

Expanding distribution grids to remote and low-consumption customers remains a challenge for rural mini-grid projects. In order to achieve wider impact without needing to install more voltage lines, some projects are incorporating battery charging stations into their system design.

Battery charging stations allow residents who are too far from the mini-grid, or too poor to pay for a permanent connection, to re-charge a portable battery a few times a week. This works well in towns with weekly market days that attract people from the surrounding area. It also offers entrepreneurial opportunities, enabling someone to take the charged battery to smaller villages and provide others with power for phones and rechargeable lights.

One of the most direct development impacts is job creation. Local residents are offered temporary employment during the construction phase and some permanent jobs are created to manage and operate the system. Training is needed in technical skills for operation and maintenance, as well as in sales/marketing and ethical behaviour. New field agents are often poorly educated and do not initially understand the system of costs and payments, so they can not accurately convey this information to customers. Many of the sales and payment collection jobs go to local women and youth.

Many mini-grid projects centre on an anchor client, usually an agro-processing business. A more stable and affordable electricity supply increases the anchor client's revenues and feeds them back into the community. For example, fish processing and preservation through locally-produced ice has increased overall revenues for fishing communities. For rural farming communities, a grinding mill is an excellent mini-grid anchor in terms of broad economic benefit.

The whole community also benefits when a school or hospital is the anchor client. Access to secure lighting and electricity for such entities improves health and social services, boosts education, and increases access to information. One project in Uganda started by selling 20% of its electricity to a hospital and is now 100% utilised by customers in the surrounding community. Electrified villages are also better able to retain youth, as they have improved access to schooling and sources of income.

Mini-grids are also stimulating the creation of business hubs in rural areas. Small enterprises such as workshops, hair salons, kiosks, internet cafes, bars and restaurants have sprung up around EEP-supported mini-grids. The impact

can also extend beyond the physical distribution network through battery charging stations and sales of energy efficient appliances and machinery. By spreading the availability of modern appliances, mini-grid developers are not only developing a more sustainable customer base for themselves, but also broadening overall socio-economic development.

Lessons Learned - Socio-economic Considerations

1. The spread of reliable access to energy improves the lives of rural people. Mini-grids offer communities that are not connected to the national grid a cheaper and cleaner source of electricity than current alternatives (such as diesel and kerosene).

2. It is important to reserve sufficient time at the start of a project to engage substantively with the local community and build strong relationships with potential customers.

3. A key success factor is to recruit and train a dedicated local team for mini-grid operations and maintenance, including sales and marketing. Investments in training are needed to fill knowledge gaps in technical issues, cost and payment structures, and ethical behaviour. Job opportunities have more development impact when they are targeted at women and youth.

4. The development impact of a small and medium-sized AC grid is substantial to the village it targets. Not only does it provide clean and consistent electricity to households, it also stimulates economic development by providing sufficient power for productive use.

5. An improved electricity supply for agro-processing facilities brings increased revenues that are fed back into the community. Local business hubs develop around mini-grids, bringing new business development opportunities.

6. Secure connections for lighting and electricity improves local social services, including education and health care, and increases access to information.

7. The linkages between mini-grids and sustainable socio-economic development need to be made clear. Both qualitative and quantitative facts are needed to raise awareness and stimulate public and private investment in the sector.

Mini-grids can be life-changing to remote island villages where the national grid is unlikely to arrive.

5. KEY ELEMENTS OF COMMERCIALLY VIABLE MINI-GRIDS

- A mini-grid project has the best likelihood of being successful where: A) A functioning policy and regulatory framework is in place. This should include a rural electrification subsidy or tariff mechanism that is favorable to mini-grids. B) Locations have been identified that are far from the main grid and have a vibrant local economy. Potential customers should include industrial or agro-processing companies, small businesses and densely-populated residential households.

- Investments in site identification, surveying and market analysis are generally more time-consuming than planned. It is also highly important to prepare the mini-grid in such a way so that it can be easily integrated with the national grid if and when it arrives.

- The commercial viability of mini-grids strongly depends on three key factors: 1) the share of electricity used for income-generating purposes, 2) the share of electricity consumed versus electricity generated, and 3) the electricity price negotiated and/or fixed by regulation.

- The cost of building distribution grids to low-consumption customers remains a challenge for all rural mini-grid projects. These costs can account for 30-45% of total project costs, depending on whether medium voltage lines are included. Larger consumers such as anchor and business customers allow higher sales with a smaller grid. Figure 8 provides the cost breakdown for a hybrid (50 kW solar PV – 10 kW diesel) mini-grid in Rwanda.

- One of the most visible parts of a solar mini-grid is the PV array generating the power, although these only form a small percentage (7-10%) of the overall cost of the system. With a relatively minor investment it is possible to scale up the installed capacity in line with demand growth. However, increasing storage capacity remains a technical challenge and increases investment costs significantly if nighttime demand for power is high.

- One-third of the entire project cost (or approximately two-thirds of CAPEX) is spent on infrastucture. Support for this is often sought from donors, rural electrification agencies, or anchor clients. Many projects receive some sort of support from government authorities for mini-grid development.

- Many donors look for impact in terms of the number of households reached. But the most successful mini-grid developers focus on anchor clients, designing and building a distribution network to service and provide them with power. Other commercial businesses are secondary and residential customers follow when housing density is sufficient.

- Seasonal revenue streams in predominantly agricultural areas have a substantial impact on the cash flow of the mini-grid operator. This is not only the case for anchor customers, but also for businesses and residential customers who have seasonal income in line with agricultural activities.

- Currently, it is challenging to operate mini-grids on a fully commercial basis if/when regulators insist that tariffs are set at national grid levels, which are subsidised and not cost-reflective.
- The most successful payment method is pay-as-you-go (PAYG) for pre-paid energy bundles.
- Productive use of electricity has to be promoted to ensure financial sustainability and profitability of the mini-grid by increasing the demand for electricity.
- A rapidly increasing number of project developers are involved in selling appliances and machinery to the customer base. Energy efficient appliances that help reduce night-time demand for power are particularly important for solar PV mini-grids.
- More developers are stimulating local economic activities and supporting small businesses. Electrified villages are becoming business hubs. In addition to increasing demand and revenues, this brings wider development impact to the community.
- A key success factor in the business model is to recruit and train a skilled and dedicated local team and to build strong relationships with the community.

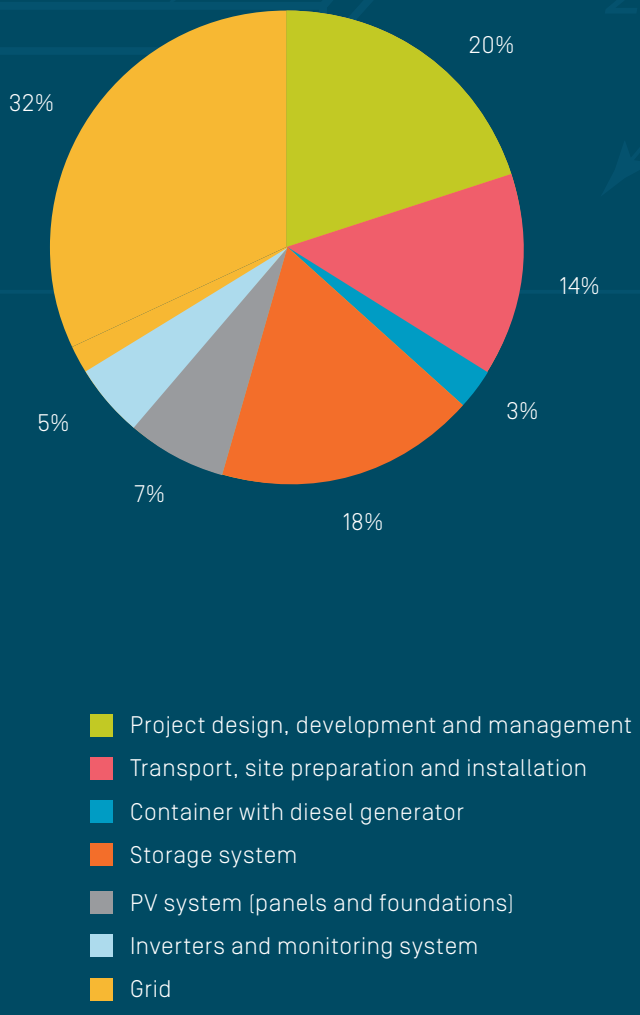

Figure 8: Cost breakdown example of a 50kW PV - 10kW diesel hybrid mini-grid project (source RECP)

This mini-grid generates 24/7 electricity and distributes it to an entire island community through low-voltage three-phase lines.

6. RECOMMENDATIONS

The EEP portfolio demonstrates that renewable energy mini-grids perform well in terms of electricity generation. They offer stable connections that are cleaner and more affordable than diesel generation and provide a significantly higher capacity than SHS.

Mini-grids stimulate long-term development impact. In addition to providing energy access to rural households and institutions, they create new income generation via business opportunities and job creation. The consumer tariffs for electricity from mini-grids are still higher than national grids but positive improvements in regulations and technology are bringing costs down. Most importantly, the sector is beginning to develop financially sustainable business models, such as the ABC strategy, that increase demand and generate sufficient levels of revenue.

While the mini-grid sector in Southern and East Africa is growing rapidly, the observations and lessons learned detailed in this report also show that significant challenges and barriers remain.

The following key issues need to be promoted in order to accelerate the pace of mini-grid development and increase impact:

- **Encourage governments to develop enabling policies and regulatory frameworks** – specifically related to tariffs, licensing and permits, and grid connectivity – and implement such policies in a predictable and transparent way.
- **Improve coordination** among government institutions, power sector utilities, donors, private sector developers and local communities; including better linkages between mini-grid development and national (rural) electrification plans.
- **Increase access to market data** and conduct analyses of consumer demand to help determine load profiles as well as willingness/ability to pay.
- **Disseminate information** about successful business models and strategies for each tier of mini-grids.
- **Improve access to affordable finance** such as tailored loans through risk finance companies with lower interest rates and longer payback periods.. Stimulate public and private investment in the sector by making clear, both qualitatively and quantitatively, the linkages between mini-grids and sustainable development.
- **Increase local capacity and community engagement** to strengthen positive socio-economic impact and increase awareness of the benefits of mini-grids among end users.

7. CASE STUDIES

Sustainable Energy and Agro Hubs in Kamwenge District

Project Costs	EUR 461,471,000
EEP Funding	EUR 300,000 (69%)
Renewable Technology Used	Waste to energy
Installed Capacity	75 kVA
Number of Beneficiaries	approximately 600 connections with 3200 people (planned)
CAPEX per Connection	EUR 770 (planned)
OPEX per Month	EUR 1,930 (planned)
Cost to Customer - Euro/kWh	EUR 0.22/kWh (domestic) and EUR 0.18/kWh (industrial)
Estimated payback period	6 years

This demonstration project in Uganda, implemented by Pamoja Cleantech AB, developed a biomass gasification plant that serves as an energy hub. In addition to producing electricity, the plant also provides other services such as heat for agro-processing. Located at the Bukurungo trading centre in the Kamwenge District, this stand-alone mini-grid is a closed loop system using locally-available resources. The project is based on an innovative concept centred on a highly efficient biomass-to-energy conversion system. The core of the business is an energy generating agro-hub of 75 kVA. Local farmers bring their produce to hubs, where it is sorted, dried and processed. The resulting crop residue is used as fuel in the energy-hub to produce electricity, heat and bio-char. The electricity produced powers agro-processing and other local economic activities, as well as local households. The heat is sold and used for drying the agro-produce.

"The project is based on an innovative concept centred on a highly efficient biomass-to-energy conversion system."

Sustainable Energy Services for Kitobo Island

Project Costs	EUR 1,118,726
EEP Funding	EUR 594,363 (50%)
Renewable Technology Used	Solar PV with battery and diesel backup
Installed Capacity	229 kW, plus 520 kW battery and 70 kW diesel
Number of Beneficiaries	1500 people and 50 SMEs
CAPEX per Connection	EUR 2,189
OPEX per Month	EUR 2,415
Cost to Customer - Euro/kWh	EUR 0.23/kWh
Estimated payback period	8 years

This demonstration project by Absolute Energy constructed a stand-alone solar PV with battery storage system on Kitobo Island in Uganda. The economy of this remote island in Lake Victoria is based on fishing and associated value chains, and the village had no prior electricity supply. The new mini-grid has a customised engineering design and cutting-edge components and is able to generate and distribute 24/7 electricity through low-voltage three-phase lines.

The developer faced some challenges during implementation, such as long licensing and authorisation procedures, as well as delays in supply shipments and customs for the batteries, but managed to complete the project successfully. The mini-grid now provides energy to over 90% of the village thanks to an affordable tariff rate, strong community inclusion and an active promotional campaign. The project has created local permanent jobs both directly (customer care officers, technicians, security staff) and indirectly, by fostering the productive use of energy among local entrepreneurs.

The project promoted a holistic socio-economic approach with the motto "our customers' growth is our growth". Activities were designed to empower local residents through business skills trainings and organised awareness campaigns. The project established an Energy Fund and promoted Business Savings and Loan Associations (BSLAs). The BSLA groups fostered an entrepreneurial mind-set within the community and supported start-up business efforts.

The project's technical and business models have resulted in a reliable electricity generation and distribution facility that is ready to meet the energy needs of the island for the next 20 years.

"Marketing campaigns need to be adjusted to meet local expectations and not to exclude the poorest parts of the population. The strength of our marketing campaign was its flexibility."

"Just providing lighting is not enough; there is a need to drive productivity in order to move out of poverty."

Solar PV mini-grid sites are often designed to expand in response to growing consumer demand.

Beyond Lighting: AC Solar Micro-Grids for Rural Kenya and Tanzania

Project Costs	EUR 2,647,142
EEP Funding	EUR 794,756 (30%)
Renewable Technology Used	Solar PV with battery back-up
Installed Capacity	164 kW from 18 micro-grids (3-30 kW each)
Number of Beneficiaries	8,220 estimated (1,644 connections)

To increase access to AC electricity in rural areas, PowerGen has successfully installed 65 micro-grids in off-grid communities in Kenya and Tanzania. EEP funding helped catalyse 18 of the earliest micro-grids that PowerGen completed and enabled the developer's expansion to its current scale of operation. PowerGen now manages 5,000 customers across their micro-grid portfolio. Through these scale-up projects, the developer has positioned itself for future growth by refining its processes for project execution and system maintenance and improving on its customer service and offering.

PowerGen has leveraged smart meter technology connected to mobile money platforms to remotely manage payment collection and monitor power usage, significantly reducing operational overheads. The developer also established practices to improve customer relations, ranging from consumer satisfaction surveying to the establishment of a local sales agent in each village. Additionally, PowerGen has worked to enable productive use of electricity by its customers by selling appliances to households and productive use equipment, such as welders or milling machines, to local businesses. These initiatives create shared value for both customers and the developer by improving customer satisfaction with the power service and improving project financial sustainability through increased usage.

"Micro-grids are capital efficient and provide affordable pay-as-you-go AC electricity at high levels of reliability for a lower connection fee than a grid extension."

Rubagabaga Mini-Hydro Project

Project Costs	EUR 1,770,000
EEP Funding	EUR 600,000 (34%)
Renewable Technology Used	Hydropower
Installed Capacity	445 kW (planned)
Number of Beneficiaries	300 households and SMEs/institutions (planned)
OPEX per Month	EUR 4,300
Cost to Customer - per month	EUR 0.11/kWh

This on-going demonstration project in Rwanda is being implemented by East African Power, in partnership with Practical Action. The project established a new Private-Public-Community Partnership (PPCP) to install a 445 kW hydro-electric power station that will provide clean electricity to both the local community and to the national grid, helping to offset the country's reliance on fossil fuels. Project implementation was initially delayed due to a lengthy PPA process but construction is now progressing.

The core goals of the project are to spur socio-economic development and create long-term economic growth for people in the region. In order to achieve this, the project has devoted significant time and resources to developing a "micro-industrial park" adjacent to the hydropower plant. The developers spent more than a year building relations with local businesses, identifying entrepreneurs and organising business training and internships. The village entrepreneurial team has already engaged 10 full-time staff working on more than 20 different projects. The design for the micro-industrial park and a new community centre is being finalised alongside construction of the power station.

By emphasizing community buy-in and development, the PPCP management model has the potential to radically transform the provision of electricity to households, schools, clinics and micro-businesses throughout Rwanda and the region.

ANNEX 1: LIST OF EEP MINI-GRID PROJECTS

For more information about all EEP projects, please visit eepafrica.org and search by project code or country.

Project Code
BTS9001
Project Country
Botswana
1 MW Solar Power Village Concept
Project Budget
2 000 000 €
EEP Funding
300 000 €
Project Developer
Kgalagadi Resources Development Company (PTY) LTD
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
BTS12103
Project Country
Botswana
Project Title
Transformative Off-Grid Community Energy Hub - Qangwa Botswana
Project Budget
410 000 €
EEP Funding
275 000 €
Project Developer
Videre Botswana
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
BUR9053
Project Country
Tanzania
Project Title
MASES Burundi (Mini-grids in Africa for Solar Energy Service)
Project Budget
500 000 €
EEP Funding
300 000 €
Project Developer
Trama Tecnoambiental SL (TTA)
Project Type
Pilot
Mini-grid technology
Hybrid

Project Code
BUR12004
Project Country
Burundi
Project Title
Gigawat Global Mini-grid Pilots, Burundi
Project Budget
355 003 €
EEP Funding
248 493 €
Project Developer
Gigawat Global Cooperatief
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
KEN4002
Project Country
Kenya
Project Title
Feasibility of 300kW Hydro-Electricpower Generation and Integrated Fish Farming in Vihiga
Project Budget
29 290 €
EEP Funding
21 967 €
Project Developer
Kenya Industrial Research and Development Institute (KIRDI)
Project Type
Feasibility
Mini-grid technology
Hydropower

Project Code
KEN5008
Project Country
Kenya
Project Title
Solar Energy for Rural Telecom Towers and Surrounding Villages
Project Budget
88 325 €
EEP Funding
65 324 €
Project Developer
African Solar Designs
Project Type
Feasibility
Mini-grid technology
Solar PV

Project Code
KEN5018
Project Country
Kenya
Project Title
River Kapkateny Community Hydro-Power Project
Project Budget
530 725 €
EEP Funding
299 530 €
Project Developer
A.M. Ventures, Ltd.
Project Type
Feasibility
Mini-grid technology
Hydropower

Project Code
KEN5033
Project Country
Kenya
Project Title
Powerhive: Technology and Business Platform for Rural Electrification via Pay-as-You-Go Solar Microgrids in Kenya
Project Budget
643 600 €
EEP Funding
200 000 €
Project Developer
Powerhive Inc.
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
KEN13072
Project Country
Kenya
Project Title
Ndurumo Sustainable Energy Partnership
Project Budget
166 9753 €
EEP Funding
663 693 €
Project Developer
Absolute Energy S.r.l.
Project Type
Scale-up
Mini-grid technology
Hydropower

Project Code
MOZ1
Project Country
Mozambique
Project Title
Rural Electric Smart Grid, Mozambique (Feasibility Study)
Project Budget
125 400 €
EEP Funding
100 000 €
Project Developer
Eltel Networks Corporation
Project Type
Feasibility
Mini-grid technology
Windpower

Project Code
MOZ7033
Project Country
Mozambique
Project Title
Energy Cyclone Tower
Project Budget
440 225 €
EEP Funding
300 000 €
Project Developer
EON Consulting (Pty) Ltd
Project Type
Feasibility
Mini-grid technology
Hybrid

Project Code
MOZ10044
Project Country
Mozambique
Project Title
Demonstrating the Commercial Viability of Clean Energy Rural Mini-grids in Mozambique
Project Budget
1 750 000 €
EEP Funding
660 400 €
Project Developer
Sociedade Algodoeira do Niassa JFS, SA (SAN-JFS)
Project Type
Demonstration
Mini-grid technology
Hybrid

Project Code
NAM204
Project Country
Namibia
Project Title
Benguela Wind Demonstration Project
Project Budget
126 600 €
EEP Funding
85 000 €
Project Developer
University of Namibia
Project Type
Demonstration
Mini-grid technology
Windpower

Project Code
REG218
Project Country
Regional
Project Title
Scalable and Sustainable Renewable Electricity Production in Rural Tanzania and Zambia
Project Budget
322 647 €
EEP Funding
140 000 €
Project Developer
World Relief Corporation
Project Type
Pilot
Mini-grid technology
Hydropower

Project Code
REG11059
Project Country
Regional
Project Title
Beyond Lighting: AC Micro-Grids for Rural Kenya and Tanzania
Project Budget
3 115 971 €
EEP Funding
794 756 €
Project Developer
PowerGen Renewable Energy East Africa Limited
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
RWA8007
Project Country
Rwanda
Project Title
Rubagabaga Mini-Hydro PPCP Project
Project Budget
1 770 000 €
EEP Funding
600 000 €
Project Developer
Practical Action
Project Type
Demonstration
Mini-grid technology
Hydropower

Project Code
RWA9010
Project Country
Rwanda
Project Title
Clean, Reliable and Affordable Energy-as-a-Service for up to 1,300 Offgrid Households, Small Businesses and Community Services across Rwanda Using Smart Solar-Powered Microgrids.
Project Budget
443 386 €
EEP Funding
221 693 €
Project Developer
MeshPower Limited
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
RWA9083
Project Country
Rwanda
Project Title
Solar Mini Grid Development in Rwanda
Project Budget
251 000 €
EEP Funding
175 000 €
Project Developer
Neseltec LTD
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
RWA11089
Project Country
Rwanda
Project Title
Bihongora Hydropower & Sustainable Aquaculture Hybrid Project
Project Budget
15 784 750 €
EEP Funding
900 000 €
Project Developer
Afritech Energy Ltd
Project Type
Demonstration
Mini-grid technology
Hydropower

Project Code
RWA13042
Project Country
Rwanda
Project Title
Solar Mini Grids Scale-up in Rwanda
Project Budget
600 000 €
EEP Funding
400 000 €
Project Developer
Neseltec Ltd.
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
SA332
Project Country
South Africa
Project Title
Biomass Gasification for Combined Heat and Power (CHP) Generation for MERU Eco-Campus, Mpumalanga/Gauteng South Africa
Project Budget
300 000 €
EEP Funding
200 000 €
Project Developer
Community Individual and Development Association
Project Type
Demonstration
Mini-grid technology
Solid biomass

Project Code
SA2070
Project Country
South Africa
Project Title
Mkhomazi Run-of-River Hydro-Electric Feasibility Study
Project Budget
104 105 €
EEP Funding
82 684 €
Project Developer
uMgungundlovu Municipality, KZN
Project Type
Feasibility
Mini-grid technology
Hydropower

Project Code
TAN604
Project Country
Tanzania
Project Title
Mpanda Solar Hybrid Project
Project Budget
2 000 000 €
EEP Funding
700 000 €
Project Developer
Solea AG
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
TAN607
Project Country
Tanzania
Project Title
Micro Power Economy Demonstration Project in Rural Tanzania
Project Budget
1 760 192 €
EEP Funding
499 931 €
Project Developer
Energy 4 Impact (Global Village Energy Partnership (GVEP) International)
Project Type
Demonstration
Mini-grid technology
Hybrid

Project Code
TAN4019
Project Country
Tanzania
Project Title
Prepaid Electricity Micro-Grids for Rural Villages in Tanzania
Project Budget
309 657 €
EEP Funding
174 657 €
Project Developer
Devergy
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
TAN7082
Project Country
Tanzania
Project Title
Provision of Clean and Affordable Electricity and Green Charcoal Production from Rice Husk Gasification for Off-Grid Areas in Tanzania
Project Budget
263 950 €
EEP Funding
184 765 €
Project Developer
ONGAWA - Engineering for Human Development
Project Type
Demonstration
Mini-grid technology
Waste-to-Energy

Project Code
TAN8037
Project Country
Tanzania
Project Title
Rental Solar Power for Food Processing in Tanzania
Project Budget
2 211 578 €
EEP Funding
623 343 €
Project Developer
Redavia
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
TAN8042
Project Country
Tanzania
Project Title
Solar Utility for Off-Grid Electricity Services
Project Budget
285 715 €
EEP Funding
200 000 €
Project Developer
Istituto Oikos
Project Type
Pilot
Mini-grid technology
Solar PV

Project Code
TAN8056
Project Country
Tanzania
Project Title
JAPO - Smart Mini-grid Metering and Management System
Project Budget
370 000 €
EEP Funding
265 000 €
Project Developer
Jamii Power Limited
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
TAN9023
Project Country
Tanzania
Project Title
Demonstration of an Innovative Results-Based Business Model for the Rapid and Cost-Effective Installation of Decentralized Rural Energy Solution
Project Budget
504 930 €
EEP Funding
296 530 €
Project Developer
Devergy East Africa Ltd.
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
TAN9043
Project Country
Tanzania
Project Title
Icreasing access to modern energy services in Nzihi Ward - Iringa District
Project Budget
151 000 €
EEP Funding
105 700 €
Project Developer
CEFA Onlus
Project Type
Feasibility
Mini-grid technology
Hydropower

Project Code
TAN9081
Project Country
Tanzania
Project Title
Shared Solar Tanzania Esxo
Project Budget
430 000 €
EEP Funding
300 000 €
Project Developer
Sustainable Energy Solutions
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
TAN10021
Project Country
Tanzania
Project Title
Hydroelectric Energy in Lugarawa District, Tanzania.
Project Budget
3 426 160 €
EEP Funding
796 120 €
Project Developer
Fondazione ACRA-CCS
Project Type
Demonstration
Mini-grid technology
Hydropower

Project Code
TAN10030
Project Country
Tanzania
Project Title
50kW Solar Hybrid Micro-grid to Electrify Mpale Village
Project Budget
418 257 €
EEP Funding
263 502 €
Project Developer
Ensol Ltd
Project Type
Demonstration
Mini-grid technology
Hybrid

Project Code
TAN11008
Project Country
Tanzania
Project Title
Roll-out Mini-Grid Based Rural Electrification Tanzania
Project Budget
900 000 €
EEP Funding
500 000 €
Project Developer
E.ON Off Grid Solutions
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
TAN11039
Project Country
Tanzania
Project Title
Clean-energy Mini-grids in Rural Tanzania
Project Budget
2 967 000 €
EEP Funding
800 000 €
Project Developer
Helios Foundation for Sustainable Development
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
TAN11071
Project Country
Tanzania
Project Title
Scaling up Geita Biomass Gasification project in 5 Neighboring Villages in Geita Disrtict
Project Budget
1 110 541 €
EEP Funding
500 000 €
Project Developer
Husk Power Systems
Project Type
Scale-up
Mini-grid technology
Solid biomass

Project Code
TAN11072
Project Country
Tanzania
Project Title
Malolo Electrification Initiative
Project Budget
1 922 522 €
EEP Funding
630 000 €
Project Developer
Continental Energy Corporation
Project Type
Demonstration
Mini-grid technology
Hybrid

Project Code
TAN13050
Project Country
Tanzania
Project Title
Making Minigrids Multiply
Project Budget
1 670 375 €
EEP Funding
550 000 €
Project Developer
Redavia GmbH
Project Type
Scale-up
Mini-grid technology
Solar PV

Project Code
UGA11085
Project Country
Uganda
Project Title
Sustainable Energy Services for Kitobo Island
Project Budget
1 188 726 €
EEP Funding
594 363 €
Project Developer
Absolute Energy Servizi S.r.l.
Project Type
Demonstration
Mini-grid technology
Solar PV

Project Code
UGA12079
Project Country
Uganda
Project Title
Sustainable Energy and Agro Hubs in Kamwenge district
Project Budget
499 349 €
EEP Funding
300 000 €
Project Developer
Pamoja Cleantech AB
Project Type
Demonstration
Mini-grid technology
Waste-to-Energy

Project Code
ZAM201
Project Country
Zambia
Project Title
Luangwa Rural Electrification
Project Budget
198 205 €
EEP Funding
158 205 €
Project Developer
Power Link Solutions Limited Zambia
Project Type
Pilot
Mini-grid technology
Hybrid

Project Code
ZAM301
Project Country
Zambia
Project Title
Mambilima Mini-Hydro Project
Project Budget
142 328 €
EEP Funding
106 746 €
Project Developer
Copperbelt University (CBU)
Project Type
Feasibility
Mini-grid technology
Hydropower

ANNEX 2: DONOR SUPPORT

An overview of the main donor programmes supporting mini-grid development in Southern and East Africa.

Programme Name:
EEP Africa Trust Fund
Brief Description:
The Energy and Environment Partnership covering Southern and East Africa (EEP Africa) is a multi-donor fund providing early stage grant and catalytic financing to innovative clean energy projects, technologies and business models. Since 2010, EEP Africa has been at the forefront of efforts to fast track clean energy access and sustainable and inclusive green growth, channelling more than EUR 57 million to over 200 pioneering projects with positive impacts on lives and livelihoods. EEP operates as a results-based delivery channel with a dynamic evolution of the facility, bringing on board new financing instruments, strengthened focus on the 2030 Sustainable Development Goals (SDGs) and closer engagement with the downstream investor community. EEP Africa organizes successful initiatives, such as the EEP Investor Forum and EEP Knowledge Exchange Forum, to facilitate investments and to collect and disseminate policy, development and market-related products, recommendations and lessons learned to advance the sector.
Website:
eepafrica.org

Programme Name:
Africa-EU Renewable Energy Cooperation Programme (RECP)
Brief Description:
The Africa-EU Renewable Energy Cooperation Programme (RECP) is a multi-donor programme that supports the development of markets for renewable energy in Africa. It was launched by more than 35 African and European Ministers and Commissioners under the Africa-EU Energy Partnership (AEEP).
Website:
africa-eu-renewables.org

Programme Name:
Scaling-Up Renewable Energy Program (SREP)
Brief Description:
Funded by the World Bank's Energy Sector Management Assistance Program (ESMAP), SREP is providing USD 50 million to Rwanda to fund a Renewable Energy Fund which will finance, amongst others, mini-grid developers. Rwanda has committed to developing 100 Solar PV mini-grids as part of their climate change mitigation strategy.
Website:
esmap.org

Programme Name:
Green Mini-Grids Africa
Brief Description:
The partners in the Green Mini-Grids Africa programme include DFID, AFD, SIDA, AfDB and the World Bank through ESMAP. There are country programme in Kenya, Tanzania, Sierra Leone, the DRC, Mozambique, Rwanda, Niger, Burkina Faso, and the Gambia. Phase 2 of the Green Mini-Grid Market Development Programme (GMG MDP) kicked off in November 2017.
Website:
se4all-africa.org/seforall-in-africa/regional-initiatives/green-mini-grids/

Programme Name:
Electrification Financing Initiative (ElectriFI)
Brief Description:
ElectriFI is a flexible financial facility managed by the Association of European Development Finance Institutions (EDFI). ElectriFI was created to bridge the gaps in structuring and financing, stimulate the private sector, and mobilise financiers. It supplies development finance, debt, quasi-equity, equity and guarantees in order to grow viable businesses and projects that create new connections to reliable and sustainable energy. ElectriFI is funded by the European Commission and Power Africa with an initial amount of EUR 115 million.
Website:
electrifi.eu

Programme Name:
Clean Energy Mini-Grids Partnership
Brief Description:
The United Nations' SE4ALL Mini-Grid Partnerships provides a coordination framework around which donors can structure their mini-grid development programmes. Steering Committee members include AfDB, Power Africa, GIZ, Alliance for Rural Electrification (ARE), the UN Foundation, etc. The group has a new strategic plan for 2018-2019 and is restructuring to include private mini-grid developers, represented by the African Mini-grid Developers Association (AMDA), and governments, represented by the African Association for Rural Electrification (CLUB-ER).
Website:
seforall.org/hio_clean-energy-mini-grids

Programme Name:
Power Africa
Brief Description:
Launched in 2013 by the US government, Power Africa brings together technical and legal experts, the private sector, and governments to work in partnership to increase the number of people with access to power. The programme's Beyond the Grid initiative, led by the US Agency for International Development in collaboration with National Renewable Energy Laboratory (NREL), aims to provide support to mini-grid developers and public stakeholders operating across sub-Saharan Africa.
Website:
usaid.gov/powerafrica

Programme Name:
Sustainable Energy Fund for Africa
Brief Description:
The Sustainable Energy Fund for Africa (SEFA) is a multi-donor trust fund administered by the African Development Bank to support small- and medium-scale Renewable Energy (RE) and Energy Efficiency (EE) projects in Africa. Anchored by a USD 60 million commitment from Denmark and the United States, SEFA is structured as a flexible multi-donor/multi-purpose platform to support the access to sustainable energy agenda in Africa.
Website:
afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa/

Programme Name:
Energising Development (EnDev)
Brief Description:
TEnDev is a multi-donor fund that focuses on the development of energy markets to foster the diffusion of renewable energies and more efficient technologies for households, social institutions and businesses. The programme is supported by six government donors: Germany (BMZ), the Netherlands (DGIS), Norway (MFA), the UK (DFID), Switzerland (SDC), and Sweden (SIDA). EnDev is currently implemented in 15 countries in Africa. Priority is placed on the least developed countries and sub-Saharan Africa. Systemic solutions promoted by EnDev in the context of country measures include solar systems, such as photovoltaics, Pico PV systems and solar thermal energy, grid densification, micro-hydropower plants, energy-efficient stoves and biogas.
Website:
giz.de/en/worldwide/40417.html

Programme Name:
Promotion of solar-hybrid mini-grids within the framework of the German Climate Technology Initiative (DKTI)
Brief Description:
This solar-hybrid mini-grid programme in Kenya aims to improve the overall framework, the technical expertise of government actors and the implementing capacity of private businesses for the sustainable installation and operation of climate-friendly solar-hybrid village power systems. Support is provided to government agencies to develop expertise, the private sector to improve commercial and technical skills, and to rural populations to operate and maintain the plants.
Website:
giz.de/en/worldwide/25332.html

Programme Name:
Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP)
Brief Description:
This programme works with the Ministry of Energy of Uganda to support strategies to increase access to renewable energy while enhancing energy efficiency. PREEEP is promoting the use of mini-grids for rural electrification to encourage development in rural areas of Uganda. The programme is supporting the Rural Electrification Agency (REA) in developing an off-grid/mini-grid electrification strategy.
Website:
giz.de/en/worldwide/19268.html

Programme Name:
Energy Sector Management Assistance Program (ESMAP)
Brief Description:
ESMAP is a partnership between the World Bank Group (WBG) and 18 partners to help low and middle-income countries reduce poverty and boost growth, through environmentally sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the WBG's country financing and policy dialogue in the energy sector. Through the WBG, ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 to ensure access to affordable, reliable, sustainable and modern energy for all. In Africa the priorities of the Program include strengthening utilities, regulation and power system planning, regional integration of infrastructure, renewable energy scale up (particularly hydropower and solar), grid and off-grid electricity, and facilitating private sector investment. In Kenya, ESMAP has helped to strengthen country capacity to transition to a competitive wholesale market and enhanced the Energy Regulatory Commission's capacity to undertake a regulatory impact assessment.
Website:
giz.de/en/worldwide/19268.html

ANNEX 3: RESOURCES

Mini-Grids on the Trajectory of Rural Electrification in Africa; An AMDA Position Paper By John Kidenda
http://www.powergen-renewable-energy.com/wp-content/uploads/2018/07/Mini-grids-on-the-trajectory-of-rural-electrification-in-Africa.pdf

Benchmarking Study of Solar PV Mini-girds Investment Costs, Preliminary Results; The World Bank, December 2017
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