Modern Energy Services in Low- and Middle-Income Countries
How to Facilitate Sustainable Access to Electricity

PROJECT DATA

PARTNER ORGANIZATION:
German Development Cooperation: GIZ/BMZ

ORGANIZATION TYPE:
Government

DELIVERY CHALLENGE:
Human resources and organizational capacity

DEVELOPMENT CHALLENGE:
Access to energy

SECTOR:
Energy and extractives

COUNTRIES:
Kenya, Mali, Mozambique

REGION:
Africa

PROJECT DURATION:
2005–current

PROJECT TOTAL COST:
€286.36 million

ORGANIZATIONAL COMMITMENT:
€283.36 million for 24 countries in total since 2005, provided by seven donor countries

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In Brief

• Development Challenge: About 18 percent of the world’s people were without access to modern energy services in 2011. The problem is particularly severe in Sub-Saharan Africa, where two-thirds of the population lack access to electricity.

• Development Solution: Using a market-based approach, Energising Development (EnDev) facilitates access to modern energy services for people in 24 low- and middle-income countries in Africa, Asia, and Latin America.

• Program Results: Globally, EnDev has helped almost 13 million people obtain access to sustainable energy since 2005. In Kenya alone, for instance, EnDev has provided some 3.56 million people with access to improved cookstoves.
Executive Summary

How can strategies and technologies be developed to provide poor people in remote areas with sustainable access to modern energy? What lessons can be learned from the experience of Energising Development (EnDev), which facilitates access to modern energy services for people in 24 low- and middle-income countries in Africa, Asia, and Latin America?

Since 2005, EnDev has helped 12.95 million people obtain sustainable energy. This case study examines how it did so. It contrasts three interventions—in Kenya, Mali, and Mozambique—in order to learn from its successes and failures.

The cases address three main questions:

1. How can last-mile deliveries be designed to expand services to a large number of people in rural areas?
2. How did implementers develop potential solutions when confronted with unexpected delivery bottlenecks?
3. How did implementers ensure the sustainability of their projects, especially when confronted with delivery bottlenecks?

EnDev follows a market-based approach in most of its activities. It helps small and medium-size enterprises increase their market opportunities in order to create sustainable local energy markets. These businesses operate in villages, where they tackle the “last mile” by directly engaging with households, especially in remote, rural areas. EnDev also adopts a performance-based approach to identify the most efficient way to target beneficiaries. These diffusion structures make the EnDev approach unique in development cooperation.

In addition to studying successes, the case study examines EnDev’s failures. It shows how it modified projects where the measured welfare gains of citizens turned out to be substantially lower than expected. EnDev’s original approaches for photovoltaic-driven communal battery-charging stations in Mali and microhydro in Mozambique, for example, proved unsuitable. In response, EnDev Mozambique closed the microhydro component and is trying to find a way to end the project in Mali. Both experiences were painful, but scaling down cost-intensive and inefficient projects and reallocating funds to other projects and countries allows EnDev to concentrate on more successful projects.

The case study shows how EnDev deals with both successes and failures, reporting them transparently and measuring their impact and performance. The delivery insights are intended to serve as an inspiration to all donors active in the field of access to modern energy technologies and energy services, who can learn from the implementation of results-based approaches and promote more flexible implementation of programs.

Introduction

About 18 percent of the world’s people were without access to modern energy services in 2011, and at least 2.6 billion lacked clean cooking facilities. Modern energy services are crucial to human well-being and to economic development; lack of access to modern energy services adversely affects health, restricts opportunities for income-generating activities, and widens the gap between the rich and the poor. For these reasons, the UN World Summit on Sustainable Development in Johannesburg in 2002 underlined the importance of energy and placed access to affordable and reliable energy as a prerequisite for meeting the Millennium Development Goals.

Energy poverty is a pressing issue in Sub-Saharan Africa, where more than 620 million people—two-thirds of the region’s population—are without access to electricity (OECD and IEA 2014). The situation is especially dire in rural areas.

Two key delivery challenges prevent countries from translating technical solutions into results on the ground. First, most governments lack the resources to address all of their vast development needs simultaneously. They therefore channel their limited financial resources to other development sectors, such as health and food security. Second, within the energy sector, rural access and cooking energy are given less priority than large infrastructure projects in urban areas. Moreover, even where they would like to address the problem,
governments often lack the technological know-how and implementation structures to improve rural populations’ access to modern energy services.

Given these constraints, how can strategies and technologies be developed to provide poor people in remote areas with sustainable access to modern energy? The delivery challenge lies in how to structure “last-mile” strategies to reach beneficiaries.

The Energising Development (EnDev) program facilitates access to modern energy services in 24 low- and middle-income countries in Africa, Asia, and Latin America, with minimum energy poverty ratio (no access to electricity and/or improved cooking system) of 30 percent on the national level. At least half of its funds are committed to Least Developed Countries. Funded by the Netherlands, Germany, Norway, Australia, the United Kingdom, Switzerland, and most recently also Sweden, this impact-oriented initiative promotes the supply of modern energy technologies to poor households, social institutions, and small and medium-size enterprises. By June 2014, it had provided access to electricity or improved cooking technologies to more than 12.95 million people.

EnDev does not simply connect households and institutions to power. It applies results-based incentives that are intended to maximize the impact of energy access by taking into account energy use and target group demand. The selection process for measures it supports combines competition with needs assessment and focal areas, as defined by its donors. This competitive approach allows for a rapid scaling up of successful activities and flexible reallocation of funds across countries based on performance. Experiences with the program show that competition among projects and technologies stimulates local contributions and leads to cost efficiency.

EnDev employs a mix of approaches and technologies, and its activities differ across countries and projects. Through its global activities and positive impact, the program has built a treasure trove of experience, knowledge, and competence in the energy sector.

### EnDev Success Factors

EnDev builds on a strong results-based approach, pursues rigorous monitoring and impact assessment, and focuses on long-term sustainability:

- **EnDev’s results-based approach** combines a results-based approach with competition and flexible allocation of funds. EnDev encourages competition among projects, technologies, and strategies. To achieve long-lasting results, EnDev follows a market-based approach for most of its activities. While at the global level, EnDev has a clearly defined global outcome goal and a global budget, country goals and budgets remain flexible. The overall budget contains a budget to finance promising pilot projects at the country level and a budget dedicated to scaling up successful projects (demonstrating high outcomes and effects together with high cost efficiency). EnDev’s financial mechanism comprises financing pilot projects for 2–3 years, rough guidelines determining where funds are to be disbursed, and an accumulation of successful projects. Its dynamic organizational structure allows for additional donors to join. As such, EnDev is an example of successful donor harmonization.

Projects at the country level are evaluated based on the cost of access per person with access to modern sources of energy. On average, €20 is allocated per person for sustainable access to energy. Hence, country-specific measures compete with one another. In order to identify projects that promise success, EnDev supports projects that can prove successful strategies (performance), meet criteria determined by a needs assessment, and match focal areas defined by financiers. This approach allows implementers to quickly and efficiently scale up successful activities and be flexible in reallocating funds among countries according to performance.

- **Rigorous monitoring and evaluation** is a fundamental requirement for the results-based approach. Showing that many poor people in various countries have gained access to energy is a challenge, particularly when they live in remote areas, dispersed over wide territories. But without credible data about a project’s progress, the program cannot validate the impact of activities, confidently reallocate funds, or make good management decisions. EnDev invests about 5 percent in monitoring and evaluation. It conducts baseline studies before project intervention and systematic impact studies after program beneficiaries gain access to modern energy. Every six months it looks at results and updates its data.

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2 Technologies include photovoltaic systems, microhydropower plants, improved cookstoves, biogas plants, and digesters. The choice of technology depends on the situation in each country. In areas close to power grids, EnDev facilitates grid extension or densification. In remote areas with no access to a central grid system (and no plans to be connected to the grid in the near future), it supports decentralized or mini-grid energy solutions.
Each country has its own way of counting beneficiaries. Through this continuous and detailed monitoring system, every person provided with access can be traced or sales specified and attributed to certain areas (see EnDev’s outcome monitoring procedure (figure 1) in annex A).

EnDev also measures impact and sustainability of energy access. Measuring sustainability is complex. Only figures that can be fully attributed to EnDev are reported. Hence, EnDev takes into consideration the “replacement factor” (the fact that, for various reasons, people do not keep using modern energy services), the “windfall gain factor” (the fact that some households would have gained access to modern energy services without EnDev), and the “double energy factor” (the fact that some households and social institutions were already benefiting from another modern energy service).

**Long-term sustainability is a core criterion** for activities supported within the EnDev framework. Special attention is paid to the broader developmental impacts of the energy activities implemented. EnDev measures are not limited to providing and installing technical equipment. EnDev aims to ensure that systems have the necessary resources to work in the long term and that market structures are in place for dissemination.

Therefore, it is essential to ensure there are people on location who are able to solve technical problems, as well as consumers who can pay for services after EnDev support ends. Finding technical and market solutions that are suited to the local context is critical. Ownership and local contributions are important indicators of the successful and long-lasting implementation of energy systems. EnDev activities clearly focus on energy services and resources that are reliable, affordable, socially acceptable, and environmentally sound.

This case study contrasts interventions in Kenya, Mali, and Mozambique, to learn from failures, successes, and scaling-up models. Because of differences in technologies

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**Figure 1 EnDev Kenya’s Solar Component Approach**

- Identify potential solar entrepreneurs in rural areas
- Train and build their capacity
- Link the entrepreneurs to dealers or distributors
- Distribute products in rural areas

- GIZ
- Solar companies
- GIZ
- Energy centers
- Trained LMEs

- Create awareness
- Monitor
- Increase access to finance
- Improve enabling environment
- Enhance technical/after-sales service

**Source:** EnDev Kenya 2014c.

**Note:** EnDev Kenya (a) creates a value chain within the stove sector by providing linkages between producers and distributors and (b) links supply and demand by raising awareness, by increasing access to finance and by enhancing technical/after-sales services for the clients.
applied, the phases of project processes, and contextual conditions, the three project experiences cannot be fully compared with one another. The case study nevertheless highlights features and priorities that are inherent to the EnDev program and that might be of special interest for the Global Delivery Initiative.

In tracing the implementation of the three EnDev activities, the case study addresses the following research questions:

1. How can last-mile deliveries be designed to expand services to a large number of citizens in rural areas?
2. How did implementers develop potential solutions when confronted with unexpected delivery bottlenecks?
3. How did implementers ensure the sustainability of their projects, especially when confronted with delivery bottlenecks?

**Contextual Conditions**

Energy poverty is a major development challenge, especially in Sub-Saharan Africa. Although EnDev is active in 24 low- and middle-income countries in Asia, Latin America, and Africa, its focus is on Sub-Saharan Africa. This section describes the most relevant conditions and trends in Kenya, Mali, and Mozambique.

**Energy Situation in Kenya**

The energy sector in Kenya is dominated by petroleum and electricity, with wood providing the basic energy needs of rural communities, the urban poor, and the informal sector. Traditional biomass accounts for 97 percent of Kenya’s domestic energy requirement and is used mainly for cooking. Annual firewood demand is about 3.5 million tons, and annual supply is estimated at about 1.5 million tons. This deficit leads to high rates of deforestation in both exotic and indigenous vegetation, resulting in desertification, land degradation, and potentially droughts and famine.

The health of people doing the cooking, mainly women and girls, is a serious concern. Two-thirds of Kenya’s people—most of them living in rural areas—are exposed to indoor air pollution, resulting in an estimated 14,300 premature deaths a year. The risks to both the environment and health are largely attributed to cooking with three-stone fires, which is both inefficient and polluting.

The proper use of biomass energy is not the only energy challenge Kenya is facing. Kenya has an electrification rate of just 23 percent nationally and a mere 5 percent in rural areas. The government aims to have all villages connected by 2022. It remains questionable whether households will find the means to afford the (relatively high) connection and running electricity costs.

However, Kenya has high insolation rates with an average of six to seven peak sunshine hours a day. In rural areas, solar power may provide leeway. In 2012, the government zero-rated the import duty and removed the value added tax on renewable energy equipment and accessories. Kenya now has one of the most active commercial photovoltaic (PV) system markets in the developing world. Stand-alone PV systems represent the least-cost option for electrifying homes in rural areas, especially the sparsely populated arid and semiarid lands.

**Energy Situation in Mali**

Despite substantial oil (and uranium) reserves in the north of the country, Mali remains fully dependent on imports for fossil fuels, which cost the country 16 percent of the national budget, increasing by 10 percent a year. Biomass plays the dominant role in the Malian energy balance, mainly in the form of wood and charcoal for domestic use.

Total annual electricity production is used mainly to electrify urban and peri-urban areas: the national utility serves some 60 urban municipalities through the national grid. With a third of its 16 million people living in urban areas, approximately a quarter of the Malian population is provided with electricity (59 percent in urban areas and 14 percent in rural areas).

Mali’s energy policy aims to contribute to the country’s sustainable development by making energy services available to as many people as possible. The government set a rural electrification target of 55 percent by 2015. So far, rural electrification has been achieved through mini-grids or individual systems. The quantity, quality, reliability, and affordability of rural access are often questionable. Diesel generators still supply most off-grid electricity, although PV-generated electricity is becoming available.

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4 Facts and figures on the energy situation in the three countries come from Energypedia, a wiki-based platform for collaborative knowledge exchange on renewable energy and energy access issues in the context of development cooperation. The platform includes more than 2,300 free articles contributed by the growing community of about 4,300 registered users, comprising energy practitioners, experts, academics, and other interested parties.
increasingly available. National electrification policies are not yet sufficiently developed and implemented to respond adequately to the rising demand for electricity.

The rural electrification strategy of Mali’s Agency for Domestic Energy and Rural Electrification (AMADER) focuses on the creation of a private sector in which local public-private partnerships take a lead role in the electrification process. It seems vastly overburdened by the task of providing most of the off-grid power to more than 700 rural communes (11,000 villages) with access to electricity. National institutions have neither the capacity nor the resources to implement the ambitious programs and there is also a lack of local capacity. Considering the country’s high rate of poverty, sheer size, and low population density, covering large parts of Mali by the national grid cannot be expected for a long time.

Against this background, the country’s potential for renewables is high. Mali has significant solar, wind, and hydro energy potentials, which have not been exploited. The recent trend in solar power, and especially the price of PV panels, is vital for EnDev’s project in Mali. When the EnDev project started, PV panels were relatively expensive and small solar systems (PicoPV) were virtually nonexistent. With the recent drops in PV panel prices, PV-generated electricity, ranging from PicoPV devices to several PV power plants, is becoming increasingly available.

Mozambique has considerable but underexploited energy resources, including natural gas, coal, hydro, oil, solar, biomass, and wind, with an estimated hydropower potential of 12,000 megawatts. The market situation of hydropower technologies and services is still at a very incipient stage. In the case of micro and pico hydropower, only some components are available, which makes prices prohibitive for communities and households. There is strong potential for the local manufacture of water wheels and pico turbines, although the market is still very limited and local services tend to be expensive.

Mozambique is a vast country, in which the majority of the population lives in rural communities dispersed throughout the provinces. Energy solutions must consider this reality and combine the rollout of the national electricity grid with off-grid solutions for remote areas, using sustainable biomass, solar, and hydropower resources.

Tracing the Implementation Process

EnDev Kenya

EnDev Kenya focuses on facilitating access to clean energy for the rural population by promoting improved energy-efficient cookstoves and PicoPV systems, using a market approach. Promoting improved cookstoves for household use was one of EnDev’s first projects. As part of an early household energy project (1983–94), German development cooperation implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) invested in the development of a stove sector. About 28 producer groups produced and distributed some 500,000 stoves, at an annual rate of about 50,000. After the project ended, the production rate dropped to 12,000–14,000 stoves a year (EnDev 2012). The decline reflected organizational, pricing, and transport problems.

In 2005, GIZ was involved in an agricultural program, together with the Kenyan Ministry of Agriculture, called Private Sector Development in Agriculture (PSDA). PSDA was asked to include EnDev in its activity portfolio. From 2005 until 2009, EnDev Phase 1 was implemented as component of the bilateral PSDA program. After 2009 until today in Phase 2, EnDev Kenya is implemented as

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5 GIZ was known as Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH before it merged with Deutscher Entwicklungsdienst (DED) and Internationale Weiterbildung und Entwicklung (InWEnt).
a country intervention of the global EnDev multidonor program. Before starting its activities, EnDev conducted an assessment of what remained of the previous GIZ program on energy and cookstoves, as it had used approaches similar to the ones EnDev planned to implement (EnDev Kenya 2014b). It found the following:

- The stoves were of low quality and suffered from technical problems.
- Training was not conducted systematically.
- Production capacity was very limited.
- Market structures were barely in place, and almost no marketing was done. Stove production centers would wait for customers to purchase their products, as they were used to the Ministry of Agriculture purchasing and marketing their products.
- Production centers with ambitions to expand their activities could not do so because of lack of access to finance.

EnDev Kenya addressed each of these problems by introducing a market approach with capacity development support. It is trying to overcome the delivery challenge of expanding services to a large number of people in rural areas by encouraging small and medium-size enterprises to engage in the improved cookstoves sector. Marketing of the improved cookstoves aims to support the rural population in accessing clean energy services in a sustainable manner by making the stoves available, accessible, and affordable. This emphasis stems from the recognition that households are more likely to adopt products when they actively chose them themselves. Under EnDev, households decide to buy a stove, at a price that is affordable for a large part of the target group yet profitable for the producer. The intention is to develop a sustainable market for modern cooking devices by supporting sustainable production and marketing while focusing on education and awareness.

The predecessor Private Sector Development in Agriculture program aimed at value chain development within the Kenyan agricultural sector. EnDev Kenya adopted the same fundamental idea of market-based private sector development. EnDev Kenya encourages small and medium-sized enterprises to increase their market opportunities by producing or using improved cookstoves. This is realized by building the technical, organizational, and business capacity of stove producers, marketers, builders, and installers following the value chain approach, aiming at full commercialization of production and marketing activities.

EnDev Kenya creates a value chain within the stove sector by providing linkages between the people involved in producing the ceramic liners and inserts and the people who install and market the stoves. Initiating this market required two simultaneous interventions: raising awareness by informing people about the advantages of modern stoves to increase demand and training enough stove builders and installers who could then meet this demand.

**Raising Awareness**

Many people in Kenya’s rural areas are not aware of the dangers of cooking with biomass (wood, animal dung, and crop waste) and of the positive effects of improved cookstoves, which reduce the emissions of traditional wood stoves. EnDev provides sensitization and information at local public meetings (called barazas) that bring the entire community together and by organizing field days or information desks at markets. It also targets tea and coffee growers, who usually employ several thousand workers. EnDev also promotes stoves at annual agricultural shows at the district level. Stove producers, installers, and marketers play a big role in sensitizing potential consumers. All of these activities have been very successful. A 2011 study revealed that 97 percent of people were aware of the advantages of improved stoves, despite not using them (EnDev 2012).

**Building Capacity**

EnDev Kenya’s approach is strongly oriented toward mobilizing and involving local resources, authorities, and initiatives to transfer their knowledge and skills to appropriate actors on the supply side. Its close cooperation with the Kenyan Ministry of Agriculture allows for wide outreach through its agricultural extension network. Together with the Ministry of Agriculture and local representatives, EnDev selects the people to be trained during public gatherings and occasions, such as barazas, using various selection criteria. Selected individuals receive training that lasts for four or nine days (depending on the stove type).

EnDev Kenya expands its reach through train-the-trainer programs. It is working with 50–60 trained trainers, who are contracted on a fee basis. These trainers are stove producers who displayed good technical and communication skills. Whenever there are new technical developments, trained trainers are retrained before they conduct training with stove producers on the ground. In
Global Delivery initiative

this way, acquired skills remain within the community, bringing the service closer to the people.

Overall, these hundreds of stove builders and marketers are the driving forces behind the project’s success; by June 2014, 2,415 active stove builders were reportedly active, marketing their products in their own interest of income generation. Stove builders compete with one another to win customers. EnDev Kenya also offers entrepreneurship and business training to stove builders who perform well.

The uniqueness of this delivery model lies in the fact that it enables EnDev Kenya to overcome last-mile delivery bottlenecks. EnDev’s stove producers are active in the villages and bridge the last mile by directly engaging with households, especially in rural and remote areas. EnDev Kenya is also able to collect monitoring data at the household level to provide evidence of the development outcomes for clients.

Delivery Insights, Outputs, and Results

EnDev Kenya’s cookstove activities have been very successful: project implementation can be seen as a showcase for good project management and well-established delivery structures. There have been no reports of serious delivery bottlenecks, changes in policies, or moments when implementation moved critically forward.

Success partly reflects the program planning and implementation structure: the country office in Nairobi centrally manages the project. EnDev’s activities in the stove sector are divided into western, central, and northern clusters. The three cluster managers lead teams that directly interact with stove operators. These teams are also responsible for monitoring and training. The large contingent of employees involved in project activities enables micromanagement, another success factor in project implementation.

The EnDev Kenya team and EnDev headquarters regularly assess the project’s progress, with the help of its extensive monitoring system and additional external evaluations (feedback loops). The EnDev team sees these feedback mechanisms as part of good project management, as every evaluation issues recommendations and operations are adjusted accordingly.

As one example, stove construction has been adapted to use more durable materials (fired bricks) to increase the stoves’ lifespan. Although doing so increases the unit cost per stove, slowing the rate of stove uptake, this adaptation favors quality and sustainability (adaptation).

EnDev Kenya has set its interventions on the right track toward sustainability by making pragmatic decisions in the early phases of the project and then coherently following a demand-driven strategy that limits its interference in the market. The sustainability of its cookstove activities looks promising, as its efforts are transforming into self-sustained development of local markets. Because of high demand, the project has been scaled up several times. Since the start of the project, there has been a steady increase in the number of households, social institutions, and enterprises using improved cookstoves. As of December 2013, 3.56 million people had benefited from improved stoves, about 20 percent of the target population.

Responding to a lack of commitment at the national level, EnDev Kenya addressed the delivery gap in energy access and contributed to initiating a market for modern cooking devices. As a result, stove production has become a real business model. By December 2013, the project had contributed to the creation of more than 2,780 private businesses. The stove business has created employment in the production, marketing, and installation segments, increasing incomes.

An ongoing concern is replacement, a central sustainability criterion. In 2014, an external evaluation revealed that 90 percent of the surveyed households using improved stoves did not need to replace their stove yet. Of the 10 percent who did need to replace their stoves, only 44 percent actually did so. It is worrisome that more than half of households whose stoves stopped functioning properly discontinued usage even while the EnDev project was still ongoing. EnDev Kenya has been alerted to monitor and tackle the issue of replacement by stressing consumer education.6

It is not yet clear whether the EnDev approach to stove technology is sufficient to sustain local markets, as established structures are likely to cease when operations end. Stove vendors may find it increasingly difficult to gain sufficient numbers of customers to maintain their businesses. However, this shall be assessed in a market sustainability study in 2016, which will focus on the market dynamics in so called “pull-out areas”—counties

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6 A follow-up study found that three-quarters of people who did not replace their EnDev cookstove went back to traditional stoves; the remaining quarter replaced it with another improved stove. The main reasons given for not using an EnDev unit were that the EnDev stove could not accommodate different pan sizes, breakdowns were frequent and repair costs high, and the stove was too difficult to operate.
where the coverage rate was 70 percent and higher, so that EnDev decided to pull out with their activities and observe how stove businesses maintain their structures.

In 2014, EnDev Kenya began moving to new project areas (scaling up to new regions). This effort coincided with its exit from areas with a good saturation of stoves (“pull-out areas”), where EnDev no longer directly intervenes but still collects reports from stove builders through the Improved Stove Association of Kenya (ISAK) for monitoring purposes (map 1).

EnDev Kenya emphasizes the following factors as the main success factors behind its approach:

- Its stoves are adapted to customs in rural areas and use locally available material.
- Its stoves are affordable: depending on the type, material, and size, they cost about €3–€20.
- Technical support people are accessible and available; they live in the community and build capacity at the local level.

In addition, Kenya provides a favorable context for the EnDev cookstoves program. It has densely populated target areas, high purchase power compared with other Sub-Saharan countries, and a very active informal sector, in which many people are looking for job opportunities.

**Promoting Solar Energy for Rural Households**

Since mid-2012, EnDev Kenya has focused on energy for lighting activities and supported access to modern lighting by promoting high-quality, affordable, and efficient PicoPV systems. These systems provide good-quality lighting and basic electricity services, such as mobile phone charging and powering of small radios and entertainment devices. To provide quality products, EnDev requires that the systems supported have to be Lighting Africa tested and qualified.
EnDev Kenya aims to establish and strengthen sustainable and commercially viable supply and distribution models for PicoPV products, particularly in rural areas. Its efforts include capacity development for last-mile entrepreneurs, the linking of these entrepreneurs to financing institutions, contributions to ongoing discussions on policy and regulation, and networking with other stakeholders.

When the project started, there was no distribution network or way to reach out to very remote villages. Distributors were simply not interfacing with retailers. EnDev Kenya, including GIZ and Stichting Nederlandse Vrijwilligers/Netherlands Development Organization (SNV), were well positioned to fill this gap because of their established cookstove networks.7 Adding the PicoPV component to existing stove activities reaped synergies. Stove actors were trained to work as last-mile entrepreneurs for solar products. The EnDev cluster managers identified among the cooperating stove actors those who had the capacity to also sell solar products. Most stove actors were interested, because it allowed them to offer other products to consumers they were already in contact with. By June 2014, some 60 percent of the 400 EnDev-trained PicoPV retailers were also involved in the EnDev cookstove component.

Solar energy is a completely different business from stoves. Solar lanterns are much easier to sell, which implies stronger competition among retailers. Monitoring revealed that until 2014, more than 65 percent of solar products acquired and sold by last-mile entrepreneurs in rural areas cost less than €20 apiece (simple products with limited service). Accessing financing to purchase the more expensive solar products remains a challenge. EnDev’s market mechanism is not yet assured, but monitoring reported a steadily increasing number of entrepreneurs taking up solar energy as a business as well as the number of products sold. However, to date the number of last-mile entrepreneurs has not reached a critical mass.

EnDev Mali

When the project Electrification Communale (ELCOM) was planned in 2008, rural electrification in Mali stood at roughly 3 percent, PV panels were relatively expensive, and PicoPV was virtually nonexistent. Mali’s Agency for Domestic Energy and Rural Electrification (AMADER) seemed vastly overburdened by the task of providing off-grid power to most of the residents of the more than 11,000 villages with access to electricity. Households that could afford a battery for basic electrification often had to undertake long journeys to charge their batteries in the nearest town. Charging was often done poorly, jeopardizing the batteries’ life span.

Because the national grid will not be available in most rural areas for a long time, EnDev Mali focused on providing energy for lighting and household applications for private households in rural municipalities through PV-driven communal battery-charging stations. At that time, mini-grids could not be run economically in the relatively small villages concerned, and PV panels were still more expensive than batteries, making ownership of PV panels for rural households unlikely. Installing individual systems and operating them on a fee-for-service basis would have benefitted only a few households.

EnDev Mali promoted 50 solar battery-charging stations in 17 rural municipalities in southern Mali. Additional solar home systems for rural social institutions, such as administrative buildings and town halls, clinics, and schools, were set up in the same villages. These projects were carried out in close cooperation with local communities. The municipalities contributed 10–20 percent of the initial investment costs (in cash or in kind), with the remaining 80–90 percent covered by EnDev. The stations remain communal property, operated on a fee-for-service basis and contracted to a private operator, selected by the communal authorities from among local competitors. The technical setup of the systems installed is fairly simple: with a basic module consisting of a 65 Wp PV panel, a 70 or 100 Ah battery (giving roughly two days of autonomy), and a matching regulator, various social infrastructure facilities were electrified, based on their needs. Up to five modules were installed in some establishments. On the demand side, and depending on the type of infrastructure, some lamps, fans, a refrigerator to store vaccines in a clinic, and/or an inverter with some sockets (for printers and computers in city halls) might be installed.

The operational model assigned private operators to ensure technical maintenance and financial management of these stations. A fixed percentage of the revenues achieved from the operation of battery-charging stations is deposited in a communal maintenance fund to cover costs for the repair and replacement of hardware at both the

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7 EnDev Kenya’s solar component is implemented in cooperation with SNV Kenya, because the governing board preferred to get implementing agencies other than GIZ involved.
battery-charging stations and social institutions. Under
this concept, the operators’ commercial interest is linked
with public interest; through the battery-charging stations
household electricity supply is integrated with public
service delivery. This “mix” was thought to be the gateway
to, and incentive for, acceptance of this service among the
village population and a key factor for ensuring its long-
term sustainability for operation and maintenance through a
participatory checks and balances structure. With
revenues from battery charging as the sole source of income
for operation, repair, maintenance, and replacement of
hardware at the battery-charging stations, as well as the
social institutions, economic viability required fairly high
utilization of the battery-charging stations.

During project implementation, the approach turned
out to be unsuitable, as real conditions were somewhat
different from the assumptions made during planning. 8
Although in some stations the needed usage rate was
achieved, demand turned out to be much lower than
expected, as was soon revealed by EnDev’s monitoring
system (pain point). 9 The main reason for this development
were the market and price developments in the solar
energy business, which undermined the rationale for
battery-charging stations (inflection point). As the prices
of PV panels declined rapidly, customers who previously
could afford only a battery could now often also afford a
PV panel, creating their own individual system, leaving
the battery-charging stations unused. The drop in the
prices of PV panels also reduced the costs of battery
charging elsewhere (in the neighborhood, for example).
With PV panels becoming more widely available,
competition increased, necessitating price adaptations
at the battery-charging stations, which in turn increased
the economic risk for the underlying business model. The
demand-driven rationale for battery-charging stations
quickly became obsolete.

Other factors also contributed to the model’s failure. The
system provided for an intrinsic incentive for operators
not to report charged batteries, because it enabled battery-
charging station technicians to pocket the unreported
revenues. Although EnDev Mali addressed the issue by
installing data loggers, the problem was hard to combat.
Another problem was that battery-charging stations were
insufficiently dynamic: many stations opened up briefly in
the morning to receive batteries, after which they closed,
missing out on potential clients. EnDev Mali addressed
this issue by converting the stations into energy kiosks,
where additional energy services were available.

Overcoming these delivery bottlenecks would not
have been sufficient to stave off the effects of declining
demand caused by the low costs of PV panels. A revision
in EnDev’s market approach to ensure the project’s
sustainability was needed.

For its next phase, EnDev tried to reorient its focus
and develop potential solutions by introducing small
PV devices (solar lanterns and small plug-and-play
individual systems) for sale at battery-charging station
counters. Over time, the stations that had been erected
earlier will be converted into multiservice energy kiosks
(adaptation), and PV diesel hybrid mini-grids will be set
up in larger villages.

In the project’s third phase (2014–17), ELCOM’s
strategy shifted toward wider support of the distribution
of PicoPV in rural areas and conversion of battery-
charging stations into multiservice energy kiosks. In the
first half of 2014, the transformation of some stations
into energy kiosks started with the introduction of solar
lamps to increase usage and thereby their functionality
and profitability of these establishments. This approach
did not fully consume the surplus of energy produced.
In addition, villagers had no significant interest in
buying solar lamps, particularly given their traditional
consumer behavior of visiting local markets or
interacting with mobile vendors rather than using the
newer retail industry in the villages to buy solar devices
over the counter (key inflection point).

As the project in Mali was still in its infancy, when
it became evident that price developments in the solar
energy business led to low demand for battery charging,
the number of originally planned charging stations (50)
was not scaled up. The project was not able to design last-
minute deliveries to expand services to a large number of
people in rural areas.

EnDev Mali is now trying to find strategies to exit
the project in a sustainable manner. The charging
stations remain communal property; together with

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8 Because of the Mali crisis and the need to hire new staff, the project was
temporarily suspended and project activities paused for about two years.

9 During the first two phases of ELCOM, 36 schools, 36 health centers, 17 city
halls, and 84 solar street lamps were electrified and installed with stand-alone
PV/solar home systems. As suggested in the operational concept, electrifying
social institutions should improve the living conditions of the population and
strengthen the local government’s performance and legitimacy. Incidental
impact monitoring suggests that the quality of communal services benefitted
from the provision of electricity. However, the revenues of the battery-charging
stations did not suffice to support the replacement of hardware. Infrastructure
providers are advised to raise fees and/or make their own contribution for the
eventual replacements of batteries, inverters, and solar panels, and installations
generating power for key public buildings.
the municipalities, EnDev Mali is trying to identify additional communal energy needs to ensure a third option of sustainable use of the stations’ energy facilities and buildings (behavior change). Business models that use the buildings and the power generated by the stations were tested. Refrigerators were installed for commercial use (storage and sales of meat, dairy products, and cool drinks), and a 220-volt system was installed that allows for DC phone charging. As an additional option, the community should incentivize local businesses (such as hair salons) to use the power generated by the stations. This will put the communities in a position to use the business rental takings to cover the repair and maintenance costs of the solar equipment.

EnDev Mozambique

EnDev Mozambique is involved in grid densification, improved cookstoves, pico and microhydropower plants, and small plug-and-play PV systems. Its experience with hydropower is of special interest, because it highlights a painful learning experience in the attempt to promote sustainable access to modern energy services.

The EnDev hydropower component works in Manica province (in central Mozambique, along the Beira corridor), where geographic and climate conditions were assessed as favorable for implementing up to 20 microhydropower mini-grid sites, providing access to electricity for unconnected villages. The basic technology was not new to the region; the use of small and microhydropower generation dates back to colonial times. One local nongovernmental organization (NGO) that was already active in the field of hydropower was identified as an implementing partner for the microhydropower component. The regional capital Chimoio hosted a local metalworking industry that was integrated into EnDev’s approach to produce simple turbines locally.

EnDev Mozambique promoted a commercial operator model in which the future local operator of the mini-grid and power plant obtains financing for the hydropower plant, mini-grid, and related productive use installations. Financing was expected to come from local banks or the rural renewable energy agency (Fundo de Energia [FUNAE]). EnDev had originally aimed for a maximum 50 percent grant share of the entire investment cost. However, the project did not succeed in getting local banks interested in the sector. Priorities in FUNAE regarding hydropower have varied over time and have not resulted in financing opportunities for mini-grids.

Implementation of the EnDev activities was delayed, because the communal counterparts were unable to raise their 50 percent of financing. To overcome this challenge, the local NGO working with EnDev Mozambique in implementing the hydro component channeled EnDev funds and provided the necessary financing through a revolving fund setup. This solution was a backup in the absence of commercial financing. Project implementation started in 2007, with the first newly constructed microhydropower sites reported in the monitoring system in 2010.

EnDev supported a total of 16 microhydropower sites. The project provided both financing and capacity development support to 11 sites with total installed capacity of 226 kilowatts. In addition, EnDev provided capacity development for pico hydrosite of 2.5 kilowatts entirely financed by a private investor. As a result of cooperation with the international NGO (Practical Action), four additional hydropower sites, with a total capacity of 74 kilowatts, were added.

During project implementation, the original approach turned out to be unsuitable, because the reality was different from assumptions made during planning. There were compelling reasons to question the design and sustainability of this approach (pain points):

- Working through a local NGO did not work out as planned. Despite training, the NGO lacked the administrative and technical capacities it was originally believed to have had (although it was highly skilled in socioeconomic and community mobilization competencies). Therefore, EnDev Mozambique abandoned the cooperation in 2014 (organizational change).
- Local co-funding from national sources did not materialize, and government ownership for promoting microhydropower varied. The interest of cooperation partners FUNAE and Belgian Technical Cooperation (BTC) shifted toward larger hydro systems, which require substantial investment capital and are not covered by EnDev’s technology portfolio.
- The project did not succeed in interesting local banks in the sector, despite constant engagement and initially expressed interest.
- The aim of keeping investment costs as low as possible (at an average of $30,000 per site of 20–30 kilowatts) proved unsustainable. This low-cost approach was originally established to achieve a maximum 50 percent grant share provided by EnDev in the commercial operator model. It turned out that the grids of
all sites needed improvements and rehabilitation after five years of operation. The low-cost approach had resulted in low quality of manufacturing materials and technical installation of the microhydropower sites.

Decision makers became aware of these issues over time:

- From the beginning, in 2007, EnDev Mozambique gave the local NGO much responsibility for project implementation. Because of its technical capacity constraints, a local technical advisor (EnDev staff) supported the project. Knowledge of the NGO’s very limited administrative capacities for accounting and financial reporting was disregarded for a long time. EnDev’s local project officers first identified these shortcomings and problems in 2010, after which the NGO was closely monitored. Eventually, EnDev Mozambique commissioned a consultant to develop a concept for balancing the administrative shortcomings (inflection point).

- At both EnDev Mozambique and headquarters, this new awareness motivated staff to scrutinize other responsibilities the NGO had assumed (such as its capacity to monitor output and outcome indicators). In 2013 and 2014, EnDev Mozambique conducted extensive work on verifying outcome figures and the financial status of the microhydropower sites, and it evaluated the work done by the NGO. As a result, previously reported outcome figures, especially in the field of productive use and social infrastructure, had to be reduced (inflection point).

- By June 2014, 6 of the 16 microhydropower sites were not working because of technical problems. They were excluded from the reported outcome figures. EnDev Mozambique also identified necessary rehabilitation interventions directly with operators. Rehabilitation was needed in 4 of 11 sites, and minor investments were needed in the rest. The grids of all sites needed improvements, which are already being implemented by operators who are receiving training and financial support from EnDev.

- These technical problems were reflected by the monitoring system. Hydropower is the most expensive technology in the EnDev program. Hydro activities in Mozambique were about one-tenth as cost-efficient as the average hydro projects in the global EnDev program. Compared with the other technologies promoted by EnDev Mozambique (grid densification, improved cookstoves, and small PV systems), average per capita costs for microhydropower were very high. This effect was eased by high cost-efficiency in the remaining components. It was the task of the country manager at headquarters to constantly alert the project manager to these unbalanced distributions of costs.

- As a result of various bottlenecks in the delivery chain and the absence of long-term financing options for private investments in hydropower mini-grids, EnDev decided to end its involvement in the hydro sector in Mozambique. The decision to fully exit the sector was made by EnDev Mozambique and headquarters after repeated and intensive discussions and analysis of different scenarios.

- Further EnDev involvement in the microhydropower sector in Mozambique is not expected. Experiences have been documented in an internal lessons learned study and are being discussed with other projects engaged in providing support to mini-grids and hydropower within EnDev and GIZ in general (behavior change).

Now that a clear picture of the technical status of the hydro sites is available, the remaining activities focus on making the operation of existing sites technically and financially sustainable. EnDev will ultimately facilitate and finance technical improvements of the 16 hydro sites and focus on further capacity building of operators in maintenance to ensure their long-term operation and sustainability. The hydro component is expected to fully close by December 2015. EnDev engagement in Mozambique continues and has shifted to the successful and cost-efficient components promoting grid densification, improved cookstoves, and small solar systems.

### Lessons Learned

#### Designing Last-Mile Deliveries to Expand Services to a Large Number of Citizens in Rural Areas

To initiate self-sustaining local energy markets that will be independent of EnDev and other donors in the long run, EnDev helps local small and medium-size enterprises increase their market opportunities. These cooperation partners are active in the villages. They challenge the last mile by directly engaging with households, especially in rural and dispersed areas.

EnDev’s delivery activities, such as training entrepreneurs, financing, and monitoring implementation, are very detailed interventions that tie up considerable
personnel and financial resources. This close and comprehensive implementation might not be undertaken through national sector policies and corresponding implementers. Furthermore, close cooperation with small-size enterprises that challenge the last mile in rural areas is unusual in development cooperation. Because of the high personnel and financial costs, comparable diffusion structures are hardly used by international development agencies.

EnDev handles these constraints of micromanagement with its performance-based approach, through which the program identifies the most efficient way to target beneficiaries. It identifies beneficiary groups appropriately (demand-driven) and ensures that the budget is spent efficiently. This approach enables the program to scale up successful projects.

The same idea of market-based private sector development showed success in EnDev’s activities in the stove sector in Kenya. As of December 2013, 3.56 million people had benefited from EnDev’s improved cookstoves, and the project had contributed to the creation of more than 2,780 private businesses. Adding the PicoPV component to the existing stove activities yielded synergies.

Developing Potential Solutions When Confronted with Unexpected Bottlenecks

The case study illustrates positive project management in Kenya, where interventions were set on the right track and no serious delivery bottlenecks or changes in policies were reported. The comparably large contingent of employees involved in the project activities was a key success factor. Staff are available in the field, and responsibility is delegated to plan and implement activities within the three regional clusters. If required, staff are encouraged to quickly adjust individual approaches. Following this strategy of general flexibility, dedicated and competent people and their corresponding individual interventions and decisions determine success. Thanks to this flexibility, delivery bottlenecks are followed by nonbureaucratic adjustments of the project approach.

In Mali and Mozambique, individual interventions and decisions, followed by adjustments of the project approach, were not sufficient to critically shift the project (or component in the case of Mozambique) toward positive outcomes at an early stage. These experiences suggest that the projects’ processes are not generally applicable to other contexts. It is very important to support appropriate technical and market solutions that are suited to the specific local context, to continuously scrutinize market demand, and to closely and continuously monitor project processes.

Ensuring the Sustainability of a Project When Delivery Bottlenecks Emerge

Sustainability is one of the guiding criteria of the EnDev Partnership. With its goal of creating self-sustaining local energy markets, EnDev’s scaling-up model aims to become redundant in the long run.

The outcome figures of the Kenyan improved cookstove project are impressive, but it is still unclear whether EnDev’s approach is sufficient to sustain the local market. Stove actors may find it increasingly difficult to gain sufficient numbers of customers to maintain their businesses, especially in regions with good stove saturation, once EnDev no longer conducts direct interventions. An ongoing concern about sustainability is the replacement rate, which is being monitored closely and tackled by providing consumer education.

After several project adaptations, EnDev Mali is in the process to come up with strategies to exit the ELCOM project in a sustainable manner. Together with the community, EnDev Mali is trying to identify additional energy needs to ensure sustainable use of the battery-charging stations it constructed.

EnDev is also disengaging from microhydropower in Mozambique. Because of various delivery bottlenecks, EnDev decided to close down this component; further involvement in the Mozambican hydro sector is not expected. Its remaining activities focus on making the operation of existing sites technically and financially sustainable. The project will continue to work in Mozambique on the other components.

Both projects/components ended painfully. But the possibility of scaling down cost-intensive and ineffective projects and allowing for the reallocation of funds to other projects offers EnDev the opportunity to concentrate on successful projects.

This mechanism of reallocating funds based on performance also reduces the risks inherent in investments made with small and medium-size enterprises. Starting with the financing of promising pilot projects and stepping up well-performing projects
positively affects EnDev’s risk management as a global program, as failures and ineffective projects can be balanced with well-performing approaches.

This case study cannot answer the question of how the vast engagement of EnDev affects national policies or implementation structures to improve access to modern energy services at the national level. Unlike other donor institutions though, which directly support national stakeholders and corresponding ministries, EnDev influences government policy by working on implementation that directly results in access at the field level (bottom-up approach); influencing national policies is a secondary goal of EnDev. Moreover, it focuses on establishing economically sustainable energy solutions, mainly for rural communities, and giving local producers and customers a voice. Furthermore, the EnDev program documents its practical experience and approaches, allowing its donors and others in the sector to engage in political dialogue on an informed basis.

**Evidence to Achieve Results**

EnDev’s detailed monitoring system delivers evidence about projects’ progress. Without these data, the program could not validate the impact of activities or confidently reallocate funds. Successful approaches are scaled and transferred across countries. As new interventions are pursued as small-scale pilots, EnDev also commits to experimentation with innovative approaches.

**Leadership for Change**

As a global program, EnDev is highly committed to creating and sharing knowledge among its 24 cooperation countries. The cultural diversity represented in the program is a key for innovation. As a constantly learning institution, it is able to cope well with both successes and failures, to report them transparently to its governing board, and to measure impact and performance. Sharing experience and learning are viewed as key to success.

Being in the field with a project team encourages delegated responsibility to plan and implement activities among staff in the field offices and fosters a bottom-up approach to planning. Learning events such as technical and strategic meetings among field offices and headquarters staff also promote the sharing of implementation experiences in the field. As the program is primarily locally driven, leadership of national actors is not a central tenet of the EnDev program.

**Adaptive Implementation**

The three projects showcased exhibited flexibility by addressing delivery bottlenecks with appropriate adaptations or scaling-up models. With its flexible reallocation of funds between technologies and countries...
based on performance, EnDev supports the most efficient, effective, and sustainable projects in the field. It is generally not bound by strict policies, guidelines, treaties, or bilateral agreements with partner countries, which allows for flexibility and nonbureaucratic changes.

EnDev’s multidonor governing board does not prioritize national interests over its overarching goal of providing individuals, social institutions, and small and medium-size enterprises in developing countries with modern energy technologies.

### Annex A  EnDev’s Outcome Monitoring Procedure

1. **Data collection on target group level by partners**
   - List of customer/beneficiaries from NGO/salesman or counting of beneficiaries in villages
   - Beneficiary must be identifiable (minimum information: full name and address; if possible, GPS data)

2. **Data quality control by country project**
   - Spot checks in the field and plausibility checks of gross figures

   → Data transfer to EnDev Head Office through wiki entries and excel files

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**Source:** EnDev 2013b

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### Annex B  People Interviewed

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<thead>
<tr>
<th>Name</th>
<th>Title</th>
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<tbody>
<tr>
<td>Carsten Hellpap</td>
<td>Program Director, Energising Development Partnership (EnDev), Germany</td>
</tr>
<tr>
<td>Verena Brinkmann</td>
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<tr>
<td>Bernhard Herzog</td>
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<tr>
<td>Marco Hüls</td>
<td>Coordinator Eastern and Southern Africa (Mozambique), EnDev, Tanzania</td>
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</tbody>
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### Bibliography


Modern Energy Services in Low- and Middle-Income Countries


GIZ operates throughout Germany and in more than 130 countries worldwide. Their registered offices are in Bonn and Eschborn. They have 16,410 staff around the globe, almost 70 percent of whom are employed locally as national personnel. There are also 785 development workers currently carrying out assignments for GIZ. In addition, CIM—which is jointly run by GIZ and the German Federal Employment Agency—places experts with local employers. At the end of 2014, GIZ had concluded subsidy agreements with 481 integrated experts, while 473 returning experts were receiving financial support and advice. GIZ’s business was more than €1.9 billion as of December 31, 2013.

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