



AEEP Energy Access Best Practices 2016



Africa-EU
Energy Partnership

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The **Partnership Dialogue Facility (EUEI PDF)** is an instrument of the EU Energy Initiative (EUEI). It currently receives contributions from the European Commission, Austria, Finland, Germany, Italy, the Netherlands and Sweden. The EUEI PDF acts as the Secretariat of the Africa-EU Energy Partnership.

The **Africa-EU Energy Partnership (AEEP)** constitutes one of the initial eight partnerships under the Joint Africa-EU Strategy (JAES), a long-term framework for cooperation between the two continents. The work of the Secretariat is steered by the AEEP co-chairs, the European Commission (EC), the African Union Commission (AUC), Italy and Germany as the European partners and Egypt and the Common Market for Eastern and Southern Africa (COMESA) on the African side.



The **Africa-EU Energy Partnership Energy Access work stream (EA WS)** is composed of the Alliance for Rural Electrification (ARE), the African Association for Rural Electrification (CLUB-ER), Practical Action and Strathmore University Energy Research Centre (SERC).

Cooperation Partners



AEEP Steering Group





AEEP Energy Access

Best Practices 2016

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LIST OF ABBREVIATIONS

AC	Alternating current	kWp	Kilowatt Peak
ADPP	Ajuda de Pesenvolvimeno de Povo para Povo	LCOE	Levelized Cost Of Electricity
AEEP	Africa-EU Energy Partnership	LED	Light-Emitting Diode
Ah	Ampere Hour	LV	Low Voltage
AMADER	Malian Rural Electrification Agency	mm	Millimetre
ARE	Alliance for Rural Electrification	mW	Milliwatt
ASER	Senegalese Agency for Rural Electrification	MV	Medium Voltage
BDT	Bangladeshi Taka	MW	Megawatt
BOSS	Business Opportunities with Solar Systems	MWh	Megawatt hour
CAPEX	Capital expenditure	NESP	Nigerian Energy Support Programme
CO₂eq	Carbon Dioxide Equivalent	NGO	Non-Governmental Organisation
CSO	Civil Society Organisation	NITA	National Industrial Training Authority (Kenya)
DAAD	German Academic Exchange Service	PEER	Partnership for Enhanced Engagement in Research
DC	Direct Current	PV	Photovoltaic
DFID	Department for International Development (UK)	OPEX	Operating Expense
EA WS	Energy Access work stream	RBF	Results-Based Financing
EE	Energy Efficiency	RE	Renewable Energy
EEE	Renewable Energies Export Initiative (Exportinitiative Erneuerbare Energien)	REA	Rural Electrification Agency/Authority
EE&C	Energy Efficiency & Conservation	RENAC	Renewables Academy AG
EnDev	Energising Development	RLI	Reiner Lemoine Institut
ERC	Energy Regulatory Commission	SERC	Strathmore Energy Research Centre
ERP	Enterprise resource planning	SDG	Sustainable Development Goals
EU	European Union	SDG 7	Sustainable Development Goal Number 7
EUR	Euros	SE4All	Sustainable Energy for All
FRES	Foundation Rural Energy Services	SEPS	Sustainable Energy Project Support
GDP	Gross Domestic Product	SHS	Solar Home System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	SME	Small and medium-sized enterprises
GIZ DPP	GIZ Development Partnerships with the Private Sector (DPP)	SNV	Stichting Nederlandse Vrijwilligers
GmbH	Gesellschaft mit beschränkter Haftung (Company with Limited Liability)	T1/T2	Technical Training level 1/2
GoK	Government of Kenya	ToT	Training of Trainer courses
GSM	Global System for Mobile Communications	TTI	Technical Training Institutions
HNU	Hochschule Neu-Ulm University of Applied Sciences	UN	United Nations
JICA	Japan International Cooperation Agency (JICA)	UNFCCC	United Nations Framework Convention on Climate Change
KES	Kenyan Shilling	UNIDO	United Nations Industrial Development Organization
kg	Kilogramme	USADF	US African Development Foundation
kW	Kilowatt	USD	US Dollars
km	Kilometre	UV	Ultraviolet
kWh	Kilowatt Hour	V	Voltage
		W	Watt
		Wp	Watt-peak

FOREWORD

Access to sustainable energy, especially through off-grid and mini-grid electricity supply and improving the efficiency of stoves, is paramount to achieving overall sustainable development. Different sources indicate that 600 million people in Africa lack access to electricity and that 87% of those lacking energy access globally live in rural areas. Given the expected high population growth for Africa, this figure is likely to further increase if no result-driven action will counter this very challenging development. Meanwhile, African families must make do with firewood for cooking food; the daily consumption is 6 to 10 kg per family, 2 to 4 tons per year per family. These statistics call for further efforts to achieve the SDG and SE4All objectives and they also require us to correct actions to improve inclusive growth.

The Alliance for Rural Electrification (ARE), Practical Action, Strathmore University Energy Research Centre (SERC) and the African Association for Rural Electrification (CLUB-ER) together form the Energy Access work stream (EA WS), which supports the Africa-EU Energy Partnership (AEEP) by contributing to the advancement of the AEEP 2020 energy access target; to bring access to modern and sustainable energy services to an additional 100 million Africans. The work stream contributes to this target by:

- closing the gap between public, private, NGO and academic sector;
- promoting business and technology solutions to effectively tackle energy access;
- raising public interest for clean energy access as a topic and
- where necessary, contributing to the SE4All and SDG 7 processes on energy access.

To achieve these objectives, the activities of the Energy Access work stream revolve around policy dialogue, stakeholder engagement and mobilisation, as well as capacity building. This publication is one of the many activities of the group. It brings together the best practices in the field of access to energy and aims to help stakeholders carry out projects or programmes effectively.

As mentioned above, the members of the Energy Access work stream represent all stakeholder groups in the energy access sphere: private sector, public sector, civil society and academia.

It is essential to establish links between these actors for a better result on access to sustainable energy. In this regard, this “Best Practices Africa 2016” publication showcases concrete projects and programmes that the Energy Access work stream members and their constituents have and are carrying out, so as to learn from each other, strengthen partnerships between and within stakeholder groups, and ultimately demonstrate concrete activities that help achieve the objectives of SDG 7, SE4All and the AEEP alike.

We hope these experiences will provide practical assistance to governments, rural development agencies, businesses, NGOs and academics to ensure close cooperation at the level of access to energy, conservation and poverty reduction. Indeed, the spread of sustainable energy access throughout Africa requires urgent measures for the consolidation of expertise.

In short, we welcome this publication on best practices in the field of sustainable access to energy, which builds on the 2014 ARE-AEEP Best Practices¹ publication and the activities of a multitude of actors in the sector. In many ways, the projects and programmes presented support the messages delivered in the guidelines addressed to stakeholders by the AEEP on a wide range of related issues, including the need to put in place adequate training, integrate the notion of productive use in energy projects, to develop integrated comprehensive approaches to raise awareness through education and participatory management techniques and, often, to strengthen international cooperation.

A thank you to all colleagues who have worked hard to give us this reference publication.



Hary Andriantavy
*Executive Secretary African Association
for Rural Electrification/CLUB-ER*

¹ Can be retrieved from www.euei-pdf.org/en/aEEP-and-alliance-for-rural-electrification-best-practices-for-clean-energy-in-africa

INTRODUCTION

“Best Practices Africa 2016” is a compilation of 24 project case studies and programmes on access to clean energy in Africa, implemented by the four members of the Energy Access work stream (EA WS): The Alliance for Rural Electrification (ARE), the African Association for Rural Electrification (CLUB-ER), Practical Action and Strathmore Energy Research Centre (SERC).

The publication draws upon experiences from the private and public sector, as well as from NGOs and research institutions and showcases the latest innovations with a unique focus on renewable energy projects in Africa. A vast portfolio of projects using different technologies such as bioenergy, small hydro, PV and wind energy, are covered in the publication.

The aim of the publication is to support and incentivise decision-makers to continue improving framework conditions for the implementation of business models based on renewable energy solutions, while enabling project developers and financiers to further boost the quality and quantity of rural electrification projects. The “Best Practices Africa 2016” publication thus goes hand in hand with the EA WS’ goals as mentioned above in the first editorial by Hary Andriantavy, Executive Secretary of Club-ER.

The timing of the publication could not have been more contemporary, as the new Sustainable Development Goals have put access to clean and affordable energy at the forefront of the international development agenda.

Despite significant advances, today 1.1 billion people² remain without access to electricity and the population, also in rural areas, is rapidly growing. 600 million³ people without electricity live in Africa and it is expected that the vast majority of the additional generation capacity needed to reach universal access to electricity by 2030 will be through off-grid and mini-grid systems.

The undeniable conclusion is that renewable energy implemented through sustainable business models which are based on a partnership approach and allow for local social-economic development, is a large part of the answer to power the needs of Africa’s poor and a prerequisite for human development on the continent.

While the situation of people without energy access is unacceptable from a humanitarian standpoint, the energy market’s potential is very appealing from a business perspective. As the following projects and programmes will show, the available technologies are able to serve the market needs and hence improve living conditions, by offering a competitive range of solutions and products with break-even periods of sometimes less than two years.

Renewable energy solutions should thus become the central element of rural electrification roadmaps and working programmes in Africa, as they are sustainable from an economic, environmental and humanitarian point of view. In other words, it is vital to keep developing the still young rural electrification markets until they become mature with self-sustainable business models.

In this light, we encourage all interested parties to get in touch with us and make use of the best practices showcased in this publication in order to upscale off-grid markets for renewable energies.

Wishing you a productive and pleasant reading.



Marcus Wiemann
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David Lecoque
*Policy and Business
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ARE is the Custodian of the Energy Access work stream.

2 SE4All, Global Tracking Framework 2015

3 IEA, Africa Energy Outlook 2014

THE AEEP ENERGY ACCESS WORK STREAM

About the Energy Access Work Stream (EA WS)

The Energy Access work stream under the Africa-EU Energy Partnership (AEEP) was initiated in April 2016 and is mandated to: close the gaps between public, private, NGO and the academic sector; promote business and technology solutions to effectively tackle energy access; raise public interest for clean energy access as a topic; where necessary, contribute to the SE4All and SDG 7 processes on energy access.

The work stream is part of the Africa-EU Energy Partnership (AEEP), a long-term framework for strategic dialogue between Africa and the European Union (EU) aimed at sharing knowledge, setting political priorities and developing joint programmes on the key energy issues and challenges in the 21st century. The overall objective of the AEEP is to improve access to secure, affordable and sustainable energy for both continents, with a special focus on increasing investment in energy infrastructure in Africa.

Concrete activities of the EA WS include:

Engaging stakeholders from public and private sector, NGOs and academia to feed into policy dialogue (e.g. national Dialogue Events and AEEP Stakeholder Forum); keeping energy access high on the political agenda & raise awareness for the AEEP and its targets; providing input to AEEP processes, meetings and dialogues; ad-hoc support to contribute to the AEEP's monitoring of the Energy Access political target and thematic studies on best practices.

Working structure of the Energy Access work stream



Private sector: Alliance for Rural Electrification (ARE)

Established in 2006, the *Alliance for Rural Electrification (ARE)* is the

only global business association that represents the whole decentralised renewable energy sector for integrating rural electrification in developing and emerging countries. www.ruralelec.org



Public Sector: The African Association for Rural Electrification (CLUB-ER)

The African Association for Rural Electrification

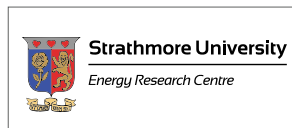
(CLUB-ER) is a network of around 40 African national agencies and structures in charge of rural electrification. Through experience-sharing and feedback, CLUB-ER works to reinforce capacities of its members and functions as a platform to discuss the different issues linked to rural electrification. Furthermore, CLUB-ER is evolving as the voice of African institutions in charge of rural electrification. www.club-er.org



NGO/CSO: Practical Action

Practical Action is an international non-governmental organisation (NGO) that uses technology to

challenge poverty in developing countries. Practical Action aims to find out what people are doing and help them to do it better. Through technology Practical Action enables poor communities to build on their skills and knowledge to produce sustainable and practical solutions – transforming their lives forever and protecting the world around them. www.practicalaction.org

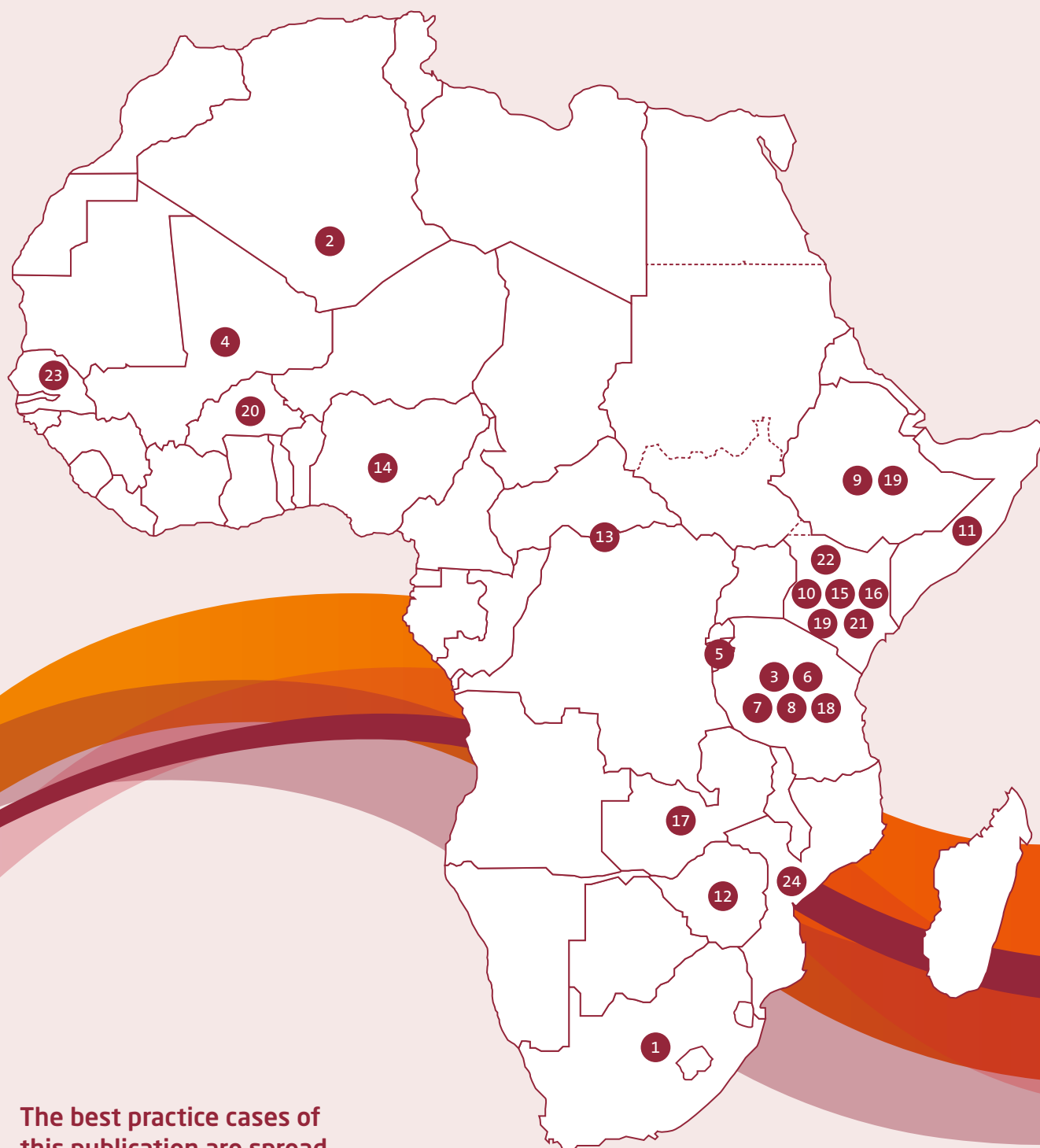


Academia: Strathmore University Energy Research Centre (SERC)

The Strathmore Energy Research Centre (SERC) is an

institution that was established in July 2012, with the aim of carrying out high quality research and technical training as well as consultancy services in the energy sector in Kenya. The institution effectively offers its services to the government, private sector and the general public. <https://serc.strathmore.edu/>

THE CASE STUDIES



The best practice cases of this publication are spread throughout 14 countries on the African continent.

1. ABB

- **Organisation:** ABB
- **Title:** Longmeadow micro-grid
- **Location:** Johannesburg, South Africa
- **Year of completion:** 2016



The Organisation

ABB (www.abb.com) is a leading global technology company in power and automation that enables utility, industry, and transport & infrastructure customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in roughly 100 countries and employs about 135,000 people. ABB is a pioneer in micro-grid technology with more than 30 global installations across a diverse range of applications serving remote communities, islanded grids, utility grid support and industrial campuses.

The Challenge

With a total of 96,000 square meters, ABB's facility in Longmeadow (Johannesburg, South Africa) is the company's country headquarters and a key manufacturing site for the firm. The power load is approximately 750 kW and the facility is grid-connected, but suffers from frequent grid outages that impact its operations and the power quality on site. Due to this, the facility has a set of diesel generators installed to cover for those disturbances. However, this is hardly an optimal and sustainable solution and so alternatives were being sought.

Opportunities for Renewables

Given the good solar resource on site, a 750 kW rooftop PV plant was installed to supply most of the facility's electricity needs during the day. At the same time, and in order to maximise renewable energy penetration and reliability of power supply, a 1 MVA/380 kWh battery-based PowerStore solution was installed. This system allows for high renewable energy penetration and for smooth transitioning from grid-connected to off-grid mode in the event of a grid outage.

The solution results in a significant reduction in the use of the backup diesel generators and in secure, reliable power supply provided by sustainable renewable energy generation.

Renewable Solution

The ABB team studied the situation in detail to come up with an optimal design in terms of solar and battery sizing. In addition to system size optimisation, the main challenges were integrating different energy sources and ensuring automatic system operation to balance energy loads from solar, battery, diesel as well as the grid and to provide overall power stability in the micro-grid.

The solution includes a cloud-based remote service system that allows for continuous real-time monitoring of system performance and for early detection of events and required maintenance activities. Technical support is available locally and site visits are available on demand to interested parties.

Project Financing and Costs

The project was financed by ABB's own resources and proves the economic viability of such systems in the region.

Project Outcome

The project has proven the technical viability of complex system integration in micro-grids, as well as the benefits of integrating renewable energy and battery-based solutions for an optimal energy mix and increased reliability.

With many commercial and industrial applications in Africa suffering from low power quality and high reliance on backup diesel generation, grid-connected micro-grids provide a strong solution that addresses those challenges in an effective way.

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2. AFRICAN ASSOCIATION FOR RURAL ELECTRIFICATION/CLUB-ER

- **Organisation:** African Association for Rural Electrification/CLUB-ER
- **Title:** Strengthening of CLUB-ER
- **Location:** Sub-Saharan Africa
- **Programme period:** 2011–2014
- **Total programme budget:** 1,988,869 EUR

The Organisation

The African Association for Rural Electrification / CLUB-ER is a network of around 40 African national agencies and structures in charge of rural electrification. Through experience-sharing and feedback, CLUB-ER works to reinforce capacities of its members and functions as a platform to discuss the different issues linked to rural electrification. Furthermore, CLUB-ER is evolving as the voice of African institutions in charge of rural electrification.

The Objectives

The vision and mission of CLUB-ER is translated into three objectives:

- *Development of capacities and expertise* of members in order to be in a position to fully participate in the formulation of policies and the harmonisation of institutional frameworks, in view of elaborating and implementing investment programmes in rural electrification;
- *Share, capitalise and disseminate knowledge and lessons learned* on best practices to support the implementation of programmes by national operators;
- *Pooling resources* to implement innovative actions and pilot projects demonstrating new technical, financial or organisational rural electrification models

Target Country and Status

The programme is active in 30 countries in sub-Saharan Africa (French, English and Portuguese speaking countries). The last cycle has been completed in December 2014 and another one is in preparation.

Type of Support

The purpose of CLUB-ER is to accelerate the development of access to electricity services in rural areas of Africa through the development/strengthening of capacities of its staff members through: (i) Experience-exchange workshops to learn from other members' best practices and avoid errors in the implementation of rural electrification policies and

programmes and (ii) South-South exchanges, as twinning and study tours.

Target Audience

African national agencies and structures in charge of rural electrification such as: Rural Electrification Agencies, Rural Electrification Funds, Regulators, Utilities, Ministries of Energy, Renewable Energy Agencies.

Programme Outcome

Between 2002–2014, CLUB-ER has organised 22 workshops and nine technical trainings. Around 480 technical staff of the members' structures have benefitted from these trainings and workshops.

In 2011, a five-day visit was organised for selected CLUB-ER members that are advanced in a particular rural electrification practice (policy and regulatory framework, technical issues, financing, etc.) and that can be taken as examples from other members. Between 2011 and 2014, five exchanges were organised hosted by Burkina-Faso, Mozambique, Kenya, Madagascar, and Senegal. 26 member institutions participated at least in one exchange.

It is to be noted that a working group within CLUB-ER focuses on increasing socio-economic impact of rural electrification so as to foster economic growth, job creation as well as reduction of poverty. This group organised two workshops on this subject and released a publication entitled "Multi-sectorial Coordination to improve the impact of rural electrification"⁴.

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⁴ Can be retrieved from www.club-er.org/images/slideHomePage/Bleu%20CoordMultiSect_GB_BD.pdf

3. E.ON OFF GRID SOLUTIONS

- **Organisation:** E.ON Off Grid Solutions GmbH
- **Title:** One of eight installations: Itaswi 6 kW-peak Solar-PV/Battery hybrid mini-grid
- **Location:** Itaswi, Dodoma region, Tanzania
- **Year of completion:** 2016



The Company

E.ON Off Grid Solutions (“EOGS”) was founded within E.ON’s corporate start-up programme “:agile”, in July 2013. Under the brand name *Rafiki Power*, the company operates as a service provider for off-grid energy solutions in East Africa with offices in Düsseldorf (Germany) and Arusha (Tanzania). The current focus is on Tanzania, but it is foreseen to extend operations into other countries post-2016.

Customer segments are villages and businesses without access to the national electricity grid. The technology focus is Solar Hybrid Systems (currently PV/Battery/Diesel).

The Challenge

Itaswi is a village of 1,000 people and is far away from the electricity grid and major infrastructure. Only inefficient and cost-intensive solutions, e.g. small diesel generators and kerosene lighting (so high fuel costs), were used for lightning, phone charging and electrical appliances. The situation was thus costly and hindered development.

Opportunities for Renewables

There is a high amount of solar radiation in the region.

Renewable Project Solution

EOGS developed a containerised hybrid system including a 6 kWp Solar PV array (~40 kWh/day) and battery storage with 20 kWh useful capacity. The system runs on 230 V AC allowing customers to connect “standard appliances” being flexible in their consumption and enable the connection of productive use systems.

The recycled 20-foot container is divided into two parts: the back houses all electrical equipment and in the front is a kiosk (with a refrigerator, battery charging station etc.), enabling the community access to products as well as providing a first access point for customers. A mini-grid including smart metering has been built to connect 130 households. EOGS uses aluminium underground cables as poles are expensive in Tanzania (25 mm backbone cable and 10 mm customer connection cable).

The whole system is based on mobile money prepaid electricity sales. This allows avoiding cost inefficient cash handling and customers to always be informed of their consumption and balance as well as being able to purchase energy 24/7 at their own convenience. Moreover, added value sales (the procurement of consumer goods (e.g. TVs) and productive use application (e.g. egg incubator, circular saw etc.), either prepaid or on credit) have been implemented to allow customers access the benefits electricity brings. The alternative would be a 5–6-hour bus trip over rough roads to the next bigger village. Until now EOGS has sold freezers, lightbulbs, subwoofer, TV’s (20) and clippers.

Finally, EOGS has implemented customer services that allow people to call a hotline in case of problems or questions, regular customer meetings for education purposes and introduction of how to use appliances. Since installation in February, unconnected customers are currently lining up and based on the 60 applications so far, EOGS is currently examining a grid extension for early 2017.

Project Outcome

The installation in Itaswi is one out of eight similar projects from E.ON Off Grid Solutions in Tanzania done in the last two years. With them, EOGS has managed a steep learning curve aimed to reduce system costs, optimized the performance of operations and customer services as well as improving the overall business model.

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4. ENERGÍA SIN FRONTERAS, PLAN INTERNATIONAL

- **Organisations:** Energía sin Fronteras, Plan International, Renewable Energy Agency of Mali (AER-Mali), CAEB (Mali)
- **Title:** Access to Renewable Energy Services in Kita (PASER-K)
- **Location:** 30 villages of the Kita Cercle, Kayes region, Mali
- **Year of completion:** 2018

The Organisations

The project involves both governmental and non-governmental organisations with complementary expertise. *Plan International* is a children's rights organisation working with local communities in many countries. The Foundation *Energía sin Fronteras* supports and provides energy and water services to poor communities in developing countries. The *Renewable Energy Agency of Mali* (AER-Mali, ex-CNE-Soler) is in charge of renewable energy promotion in Mali. The Malian NGO *CAEB* promotes participative development through capacity building of local communities.

The Challenge

Kita circle's population, predominantly rural, has very limited access to electricity services (2%). This situation is not expected to improve despite grid development in the region. Community services (health centres, schools), productive activities (agriculture, mills), communication and cooking are particularly affected by the lack of modern energy services. Barriers to overcome are the low capacity-to-pay of the population and the lack of technical and management capacities locally.

Opportunities for Renewables

Solar photovoltaic systems are particularly relevant to the type of energy services, in quantity and quality, needed by communities.

Renewable Solution

The project provides solar energy services in 30 communities: lighting of 24 schools and five health centres (100 Wp modules); 200 litre water heater and 124 litre refrigerator in four health centres; 60 public lighting systems (35 W); 30 kiosks for battery charging (300/600 Wp); 30 water pumping systems (up to 4000 Wp); 30 mills (1600 Wp, 100 to 150 kg cereals/day) and 60 driers (15 to 20 kg).

Locals are trained to properly use and do basic maintenance of the equipment; among them are 131 women's associations involved in agriculture. A special focus is given to the local availability of advanced maintenance services

and spare parts, hopefully stimulated by the cumulative installed capacity of equipment. Fifteen local artisans and five women enterprises are also trained to the production and promotion of improved cook stoves.

Strategic analyses of renewable scale-up in Mali, of the specific role of the Renewable Energy Agency, and of sustainability conditions of similar projects, completed the activities.

Project Financing and Costs

Total cost reaches 2,633,827 EUR, funded by the European Union (1,500,000 EUR) and Plan International (1,133,827 EUR). Investment, initial maintenance and capacity building are met by the project. End-users are asked to pay for longer-term maintenance and spare parts: a payment-for-service is required for productive uses, besides a fee for community services. Local energy committees are in charge of the economic management. The involvement of a private operator for maintenance and fee collection is under evaluation.

Project Outcome

Around 22,000 persons, half of them children, benefit from the modern energy services provided by the project. Expected outcomes are improved health, better school results, improved nutrition, local jobs and empowerment of women, all contributing to rural poverty reduction.

The integration of community, productive and cooking energy services and the high number of targeted communities are expected to increase the technical, economic and social sustainability of the project, while raising implementation challenges. The growing implementation of solar PV in Mali also raises the question of waste disposal and recycling (batteries, panels, etc.).

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5. ENERSOL

- **Organisation:** SM ENERSOL-ETRAVE
- **Title:** Installation of 150 PV off grid mini-power plants on 40 health centres and one hospital with 20 kWp
- **Location:** Eight provinces in Burundi
- **Year of completion:** 2015



The Companies

ENERSOL SPRL (Belgium) was responsible for the technical and engineering part of the project, assistance on the installation on site and logistics from Belgium to Bujumbura. ETRAVE (Burundi) was responsible for logistics and administration in Burundi, the installation of devices and the construction of cabinets with technical support from ENERSOL.

The Challenge

The challenge was to complete the project in six months, as transportation alone could take up to two months. Moreover, very specific products and large quantities of batteries, inverters and others LED bulbs had to be used.

ENERSOL and ETRAVE set up the off-grid PV system and all electrification for each building, including installation of switches for each light and power plugs. Each of the 40 health centres was installed in one day (around 17 panels and 16 batteries, as well as around one km of cables, 50 LED bulbs with sockets, 20 power plugs for each centre). A 20 kWp PV system was also set up at Kinyinya Hospital in Burundi.

Opportunities for Renewables

The installations supply energy to conserve vaccines correctly and enable future mothers to give birth in acceptable health conditions.

Renewable Solution

680 solar panels, 680 batteries of 12 V 230 Ah and 150 inverters were installed, and 100 metal cabinets were constructed to minimise the risk of burglary or destruction.

A second installation for a single hospital was realised in Kinyinya, Burundi, and consists of a 20 kWp PV system, 4000 ah-48 volts gel batteries and three phases system with three PV inverters of 6 kWp.

In each health centre, ENERSOL trained a local technician during the installation to maintain the plant. All the installations were made by two crews of eight people, two Belgian technicians, six Burundian and Rwandan technicians. ENERSOL's local partner agreed to take care of annual maintenance for three years. All the work was done in two months on site, and lasted around six months from the signature to the reception.

Project Financing and Costs

The cost of the project was around 1,300,000 EUR and was financed by the European Union (10th European Development Fund).

Project Outcome

The project was a part of the policy of improvement for health centres in remote areas, including preservation of vaccines, light during night time, electricity for medical material, increase sanitary conditions, etc.) It is estimated that the project has helped around 30,000 people at minimum. All the installations were successful and were received properly by the community.

At the Kinyinya Hospital, ENERSOL succeeded in convincing the beneficiary to make a mini-grid system and a more powerful PV system for the hospital. The hospital therefore now has the possibility to provide bigger peak energy in the aim to have bigger medical installation. This solution permits to increase the installation of 20% PV power (as its 250 Wp panels 60 cells, less expensive) and gives a sustainable solution with better lifetime batteries (1,200 cycles against 800 cycles) for the same total capacity.

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6. POWERCORNER/ENGIE

- **Organisation:** PowerCorner/ENGIE
- **Title:** Ketumbeine
- **Location:** Arusha, Tanzania
- **Year of completion:** 2016

The Company

PowerCorner is an *ENGIE* initiative to provide electricity access in rural Africa with the help of off-grid distributed energy solutions: sustainable mini-grids (MGs). The initiative is embedded in one of the axes of commitment by *ENGIE*: becoming a leading company in energy services in rural areas, enabling the economic and social development of local populations, while using renewable energies.

The Challenge

Ketumbeine is a village with 161 households (800 inhabitants) situated 36 km from the grid and three hours driving from Arusha. As many other villages in Africa, people use traditional sources of electricity (kerosene, candles, small gensets) or solar home systems offered by local companies. The demand assessment showed an energy demand of 16,000 kWh/year that will be covered with a hybrid containerised mini-grid of 16 kW of PV panels, 45 kWh of Lithium batteries and a back-up genset.

The purpose is to cover all needs of the local community and to become an enabler of economic growth. As a result, with a combination of electricity available 24/7 and proposing energy efficient appliances and machines, economic activities like agriculture, commerce, small industries and a small lodge can be supported.

The major obstacle to overcome was to make *PowerCorner* a compelling solution for the local population as several solutions were already available. A solution compatible with the dynamics of the community, while being affordable for the population thus had to be found.

Opportunities for Renewables

The use of renewable energies technologies like solar PV and storage allow us to offer the most reliable and clean solution to provide electricity to off-grid concentrated and dense populated villages.

Renewable Solution

PowerCorner's technical solutions include:

- a container including all the electronics and on top of it the PV panel array;
- a LV AC distribution network;

- indoor installations and supply of energy efficient appliances (TVs; fridges; freezers; etc.)

On top of the technical solution, *PowerCorner* proposes an innovative business model that can guarantee the reliability and life duration of the system, involving also the local community with a kiosk integrated in the container. Clients pay a deposit upfront (connection fee) and a smart meter for charging the consumption on a pre-paid basis is installed. Payments are done by Mobile Money. Finally, a local operator in the village was trained to manage the site and provide technical and commercial services to the clients.

Project Financing and Costs

PowerCorner's pilot project in Ketumbeine was financed entirely by *ENGIE*. Overall costs for the pilot were 140,000 EUR.

The pricing model for the end-users reflects their ability to pay and the costs involved in the mini-grid overtime (CAPEX and OPEX) aligned with current needs and future wills of the population.

The specific project will not pay off in terms of economic return itself but it will be tested for a roll-out of several mini-grids in Tanzania for *ENGIE* that will prove the economics and returns of the business model at scale.

Project Outcome

PowerCorner in Ketumbeine was commissioned in March 2016 and currently provides electricity to 50 clients, including households and SMEs.

The goal is to adapt and replicate the model in other towns in Tanzania as well as developing new pilots in other countries in Africa.

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7. FRES

- **Organisation:** Foundation Rural Energy Services (FRES)
- **Title:** Finance and commissioning of 8 solar PV power plants at rural trading hubs in Mali and mini-grid infrastructure at eight villages
- **Location:** Segou and Sikasso regions of Mali
- **Year of completion:** Ongoing (the solar and hybrid mini-grids were built between 2007 and 2010)



The Foundation

FRES' mission is to provide electricity to rural areas of developing countries where there is no access to grid electricity at present or in the foreseeable future and does so mainly through the use of solar energy. FRES establishes local utility companies in rural sub-Saharan Africa that provide affordable and sustainable access to electricity services in rural communities via a standardised business model. FRES currently has five companies, 230 local staff and over 35,000 customers in Mali, South Africa, Burkina Faso, Uganda and Guinea-Bissau.

FRES has 15 years of experience in the full range of activities relating to implementing rural electrification programmes with respect to mini-grids and solar home systems (SHS). The organisation also has a long-term business vision based on sustainable, long-term commitments and a standardised commercial business model that can be easily adapted, replicated and rolled out to new markets.

The Challenge

High cost of electricity production (via individual generators) for SMEs limits productivity and opportunities for business start-up and growth. Limited grid infrastructure or electricity generation capacity/intermittent supply and sharp increase in diesel fuel price characterise the local energy situation.

Opportunities for Renewables

FRES will expand its solar mini-grid activities in 2016 in Mali and in Guinea-Bissau.

Renewable Solution

FRES finances and commissions eight solar PV power plants (50–150 kWp) at rural trading hubs in Mali and mini-grid infrastructure at eight villages (new grid infrastructure and grid extension at other sites with existing (diesel) mini-grids. This comes to a total installed capacity of 550 kWp (combined total for eight PV mini-grids). The actual production level is 1,200 MWh/year (combined total for eight PV mini-grids). PV penetration ranges from 50 to 100% between the eight mini-grids. System configurations are largely PV/battery storage/diesel genset.

Project Financing and Costs

Initial CAPEX was financed by FRES, Nuon and AMADER (Malian Rural Electrification Agency)/World Bank through grant financing. The model utilises consumption based invoicing (0.38 EUR/kWh) and pre-payment for customers. Revenue from the project finances ongoing operations and replacements. Technical assistance and training for local technical staff from a grid network operator in the Netherlands is currently ongoing.

Project Outcome

1,160+ customers switched from diesel to PV hybrid mini-grids, i.e. households and SME's (e.g. tailors, bakeries, radio stations, banks, game rooms, pharmacies, ICT services, water supply and commerce).

Scale up of PV capacity will take place in 2017 to support growth in demand (approx. 10% annually) from new and existing customers.

FRES/Yeelen Kura provide 4,023 mini-grid clients (households and SME) with electricity in Mali.

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8. GERES

- **Organisation:** GERES
- **Title:** Green Business Area
- **Location:** Konseguela, Region of Sikasso, Mali
- **Year of completion:** 2016



The Organisation

Protecting the environment and limiting climate change and its consequences whilst also improving living conditions for the poorest: These are the challenges that *GERES* seeks to tackle through development engineering and specialist technical expertise. Energy efficiency, renewable energy and local economic development are at the heart of *GERES* activities.

The Challenge

Providing rural electrification with solar solutions to small businesses requires a specific design adapted towards the businesses' electrical equipment. The impact of the use of this equipment on an isolated mini-grid has to be diagnosed and assessed before providing a localised solution to meet the electricity needs of small businesses. Therefore, the need for a "Green Business Area" that is complimentary to the existing solution for household electrification.

Opportunities for Renewables

In South-East Mali, renewable energy is limited to solar photovoltaics and, in the case of existing agricultural sector, biomass (e.g. biofuel). With a solar plant, diurnal consumption is most efficient and rural businesses are able to operate during the day. There are adapted end-users to this kind of energy. Lastly, solar biofuel hybrid solutions are adapted to predictable changes in consumption.

Renewable Solution

The "Green Business Area" is an innovative solution to develop electricity access through renewable energy for landlocked territories. By grouping 11 local rural businesses on a dedicated site equipped with a mini-grid and a generation capacity of 12.5 kWp, providing productive energy users with a high quality and electrical service

becomes a reality. The technology is based on a 100% renewable energy mix, through a photovoltaic system and a generator burning agro fuels produced locally. Thus, rural businesses eliminate their dependence on fossil fuels. Built on the principles of bioclimatic construction (in partnership with the organisation Nubian Vault), the site offers tenants comfortable working conditions for the Sahel.

The project approach includes support for businesses that use electricity, and support for local authorities to understand energy access challenges and then to define their role.

Project Financing and Costs

The total project cost must be divided into three parts. The first part is the concrete project investment. The second is the support provided to rural businesses and to local authorities. The third part, specific to this first pilot project, corresponds to the research, monitoring and evaluation of the solution.

The pricing model integrates both the rental of the bioclimatic spaces, and the sale of the energy. Due to the use of solar PV, the price of electricity is higher during the night than during the day. Rural businesses require dependable high-quality electricity (power, voltage, schedule), and are willing to accept the corresponding price as in most instances they are capable of paying the actual cost of the electricity.

Project Outcome

The "Green Business Area" is an opportunity for people to access products and services previously non-existent, inaccessible, or too costly, such as a bakery, refrigeration services or community radio. It has a significant impact on local employment (7 rural businesses, 24 direct jobs at the end of the first year of operation) and an impact on improving the living conditions of the area's population.

In Mali, Senegal and Benin, *GERES* is already working on replicating this model. Discussions with national authorities and rural electrification operators aim to integrate "Green Business Area" projects into their programmes or service offers.

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9. NEU-ULM UNIVERSITY OF APPLIED SCIENCES

- **Organisation:** Neu-Ulm University of Applied Sciences
- **Title:** Solar Wagon
- **Location:** Arba Minch/Ethiopia
- **Year of completion:** 2016

The Organisation

Hochschule Neu-Ulm University of Applied Sciences (HNU) is a young and rapidly developing Business School with around 4,000 students. The Bachelor's and Master's programmes are strongly grounded in practical application of academic theory. HNU is in the process of internationalisation and therefore it runs interdisciplinary projects in several African countries.

The Challenge

The GDP per capita in Ethiopia is roughly 350 USD, which is considered as poor in a global context. 85% of Ethiopians live in rural areas in impoverished conditions. Furthermore, only 15% of Ethiopians have access to a reliable power source. On the other hand, the effectiveness of governmental institutions can be regarded as highly developed. In addition, the country showed double-digit GDP growth rates in the previous years.

Opportunities for Renewables

The unique combination of a relatively stable political environment and a large potential for decentralised electrification produces a rare opportunity for creating business models based on renewable technologies.

Renewable Solution

In this light, the developed business models were expected to incorporate the following characteristic features:

- Based on solar technology, the application should be in rural areas.
- The businesses should be developed by local groups and be locally owned and run.
- The developed enterprises should foster local employment, meaning that they should contribute to productive use of renewable energy. In order to accomplish this objective, proven methods like SWOT and Business Canvas were applied.

One of the most appealing business models developed by the students is the foundation of a company producing and selling solar wagons in Ethiopia.

A solar wagon is an assembly of a small-scaled PV system which provides mobile electricity based services. Examples include photo studios, hair salons, cafeterias and charging stations for mobiles. Prototypes of the solar wagon were successfully tested in the rural area alongside Arba Minch, Ethiopia. Currently the students are looking for an investor to found a company producing solar wagons in Addis Ababa and distribute them to rural areas in Ethiopia. According to the students' business plan, a starting capital of 30,000 EUR is needed to produce 180 solar wagons per year. Based on an assumed retail price of roughly 1,100 EUR, a profit margin of around 35% can be achieved.

Project Financing and Costs

The project is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and carried out by the German Academic Exchange Service (DAAD) within the programme 'Praxispartnerschaften 2013'. It will run from September 2013 until December 2016. The total project volume including monetary payments and payments in kinds of the universities and industry partners amounts to 500,000 EUR.

Project Outcome

The project shows how locals with an academic background in developing countries approach the challenge of entrepreneurship. With access to electric power, a positive regional economic development should be initiated, especially if the new resources are used for productive use. Thus begins a self-accelerating effect. More locals will have and use electricity, enabling employment and causing other entrepreneurs to follow suit. Furthermore, better access to communication technology will stimulate local economies by allowing for more efficient agricultural trade, higher quality education, and exposure to small business ideas and trends.

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10. MOBISOL

- **Organisation:** Mobisol
- **Title:** Mobisol Smart Solar Solutions
- **Location:** Tanzania, Rwanda, Kenya
- **Year of completion:** Ongoing



The Company

Since 2012 *Mobisol* designs, procures, markets and services large productive-use solar home systems, combining them with mobile technology and a 36-month micro finance scheme, thereby providing a clean and affordable alternative to fossil fuels.

In the future, Mobisol aspires to provide clean, reliable electricity to millions of households in low-income communities – stimulating economic and social development while simultaneously contributing to global environmental protection.

The Challenge

Approximately two billion people worldwide live without a reliable electricity source to fill their daily energy needs. Millions of households currently manage to subsist using kerosene lanterns, diesel generators and other fossil sources that are unhealthy, harmful to the environment – and very costly. In many countries, on-grid solutions have failed to address this need effectively.

Opportunities for Renewables

Mobisol provides an alternative to grid connection by serving all electricity-related needs arising in target customers' households. Mobisol's micro-financed rent-to-own payment plan allows customers to purchase high-quality systems powerful enough to run small businesses. Mobisol's custom-designed business kits enable entrepreneurial customers to start their own solar-powered enterprises such as phone and lantern charging stations, barber shops or village cinemas.

Renewable Solution

The plug'n play Mobisol system is installed by locally trained technicians. It includes a solar panel, battery, lights, as well as a cell phone/solar lantern charger. The system is available in different sizes from 80 to 200 W. The entry unit can for instance illuminate a medium-sized home with eight LED bulbs, power a radio, charge various mobile phones and run a TV. The largest system powers multiple lights and consumer appliances such as a laptop or TV, a DC refrigerator and charges up to ten mobile phones or solar lanterns simultaneously. Mobisol's systems come complete with a full service package which includes free maintenance for three years. Through the GSM modem included in the solar controller, technical data regarding the panel, battery, energy consumption and payment patterns are tracked and monitored in a web-based interface. The remote monitoring technology allows for potential maintenance problems to be addressed swiftly and enables systems to be locked automatically in case of theft or overdue payment.

Project Outcome

Since 2012 Mobisol has equipped more than 60,000 rural homes and businesses with solar home systems in Tanzania and Rwanda – making the company Africa's largest rent-to-own solar energy provider by capacity installed (more than 6 MW).

So far Mobisol has created about 1,000 new jobs (500 full-time, 500 on commission-base) and trained over 1,000 people in the local Mobisol Akademie, a training institution that teaches employees and small entrepreneurs about solar technology and the benefits of renewable off-grid electrification.

One Mobisol system saves on average 0.5 t CO₂eq per year, resulting in a total of 30,000 tons of CO₂eq per year from all systems installed to date (based on certification from myclimate and the UNFCCC standards for carbon savings from stand-alone solar units).

Contact

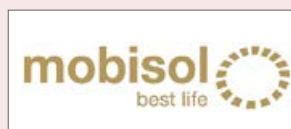
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11. PHAESUN, HORN RENEWABLES

- **Organisation:** Phaesun GmbH and Horn Renewables
- **Title:** Business Opportunities with Solar Systems
- **Location:** Somaliland (Somalia)
- **Year of completion:** 2014



The Company

Phaesun GmbH based in Memmingen, Germany has been specialising in the sale, service and installation of off-grid photovoltaic and wind power systems since the company was founded in 2001. Phaesun works as wholesaler and system integrator and has daughter companies and representations in France, Dubai, Eritrea, Panama and Ivory Coast.

Phaesun works closely together with its partner *Horn Renewables*, based in Somaliland. The company was set up in 2012 with the target to bring off-grid energy to rural areas in Somalia.

The Challenge

Somaliland is situated in the northern part of Somalia, where the electricity grid is poorly developed. It is estimated that 75% of the population have mobile phones, which are mostly used for communication, but also for banking. Thus, the need for recharge is huge for private households and businesses. The commercial sector in rural areas is often poorly developed. The main activities in coastal areas are fishing. Due to the lack of cooling opportunities, fishermen were unable to preserve their catch.

Opportunities for Renewables

Off-grid solar power systems can be an important factor to support rural development. The Phaesun Business Opportunities with Solar Systems (BOSS) solutions specifically target the commercial sector in non-electrified areas. Together with Phaesun, the local solar company Horn Renewables has been implementing BOSS solutions since 2012.

Renewable Solution

Solar charging stations were developed and set-up in different locations in Somaliland. Besides the charging of mobile phones, LED lamps with integrated battery (Lithium lamps) were rented to be charged again at the charging station. The LED lamps were either used for lighting in private households, or for the illumination of salt fields in coastal communities, where people usually work after sundown because it is too hot during the daytime.

Solar cooling and freezing kits based on the solar fridge Steca PF 166 were introduced. In 2013, shop and kiosk owners bought refrigeration kits to improve their businesses. Refrigeration kits were also introduced so that fishermen could produce ice to cool their fish and subsequently transport them in cooling boxes to the cities. As a result, the fishermen achieved higher margins because they were now able to sell fresh fish in the cities.

Project Outcome

Since the first introduction of BOSS solutions in Somaliland in 2012, the number of interested entrepreneurs has grown steadily. Until the end of 2015, more than 50 solar charging stations for cell phones and light rental shops in 23 locations have been opened. Furthermore, 33 solar cooling kits have been installed at fishermen places, shops and restaurants. Customers of kiosks and restaurants were able to experience even more services with solar-powered equipment like fans and TVs in five villages. In two agricultural communities services for blending and juice pressing are offered.

By combining many different off-grid solar systems in the village square and as the quotidian life of the locals is mainly concentrated around village squares, a potential solar market place is in the pipeline. Such a place will have a major influence on the daily life interactions and prosperity of communities. Phaesun is currently looking for a suitable area to set up the solar market place.

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12. PRACTICAL ACTION

- **Organisation:** Practical Action
- **Title:** Rural Sustainable Energy Development (RUSED)
- **Location:** Mutare/Himalaya/Southern Africa/Zimbabwe
- **Year of completion:** 2016

The Organisation

Practical Action is a charity that uses technology to challenge poverty, enabling poor communities to develop skills and knowledge to produce sustainable and practical solutions; helping them transform their lives and protect the world around them. Practical Action has worked in the energy access space for over 40 years and has been involved in over 500 mini-grid projects over this period.

The Challenge

Electricity access in agricultural communities in Zimbabwe is poor. Due to challenging global and national economic situations, the only national utility company, ZESA, has been unable to scale-up the rural electrification programme which has, to date, provided less than 25% of rural communities with electricity. The Himalayan area in particular is mountainous, remote, and far from the national grid. To the community here, electricity access was a fantasy.

Opportunities for Renewables

In Himalaya, there was huge potential to link renewable energy and productive agricultural and commercial uses. From the outset, Practical Action therefore linked the micro-hydro scheme with agricultural livelihoods; specifically including an irrigation component at the community's request.

Renewable Solution

Acknowledging that energy is a prerequisite for rural communities' development and the achievement of national and international development goals, the project aimed to increase access to modern, affordable and sustainable renewable energy services for rural people in Ruti and Himalaya, by promoting the use of micro-hydro and solar energy.

The project mobilised stakeholders to use local materials, skills, knowledge and labour; complimented by specialised skills on community based approaches, and technical expertise on renewable energy technology by the implementers. Communities were trained to maintain and operate various components of the micro-hydro and solar systems; as well as an energy kiosk charging station, equipment installed in the schools and clinics, and associated financial management.

Project Financing and Costs

The 2,000,000 EUR project was funded by the European Union ACP Energy Facility and Oxfam. It is expected that the uptake of electricity in the project areas will ensure reliable financial flows, and sustainability well beyond project conclusion.

Project Outcome

In Himalaya, the project established an 80 kW micro hydro scheme now powering two irrigation schemes totalling 25 hectares and particularly focussing on energy for small-holder farmers and community services. In addition to supplying 300 households with electricity, the micro-hydro system has helped to establish two clinics, two schools, 20 local entrepreneurs, and two agri-business centres including an energy kiosk and saw mill facilities. The community has improved their food security, incomes, and health – while also protecting the environment on which they heavily rely. At least 19,200 men, women and children will benefit from this project.

Himalaya is constrained by its geographical position, including poor road connections to potential markets and services. However, as local resident Wilson Chemwanyisa indicated, the community now feels empowered to demand road improvements, and is seeking the development of a health centre now that electricity access is available.

Key lessons include:

- how energy kiosk models can be used to reach last mile energy customers;
- market linkages are key project sustainability;
- renewable energy provision for poor rural communities is not financially viable without end-user energy literacy, capacity building and productive use training programmes.

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13. RAHIMAFROOZ RENEWABLE ENERGY

- **Organisation:** Rahimafrooz Renewable Energy Limited
- **Title:** 3E (Energy, Empower, Enterprise) SMART Platform, SMART SHS and its significant impact
- **Location:** Africa
- **Year of completion:** Ongoing



The Company

Rahimafrooz Renewable Energy Limited (RREL) is a leading solar home systems (SHS) integrator and installer with over 600,000 customers and was a key player in the largest pay-to-own rural SHS rollout in over four million homes in Bangladesh. RREL has also started a global footprint initiative with PV panel and SHS exports. The company employs over 4,000 people with extensive rural services and sells networks for access to energy using an online/ERP and SMART phone based system.

The Challenge

SHS ranging from 20 Wp to 130 Wp were introduced in Bangladesh as a means to provide energy, and to improve quality of life, education, and income generation capabilities of rural population. In case of credit sales, 10% of system price are collected as down payment and the remaining amounts on equal monthly instalments over 36 months. However, it has been observed that sales and collection efficiency reports along with other financial statements contain significant errors due to manual reporting hindering the smooth implementation of the programme. To solve this challenge, an automated business process with payment control is required.

Opportunities for Renewables

Today the global renewable energy market is expanding massively. The effect is becoming imminent in all African countries and its renewable energy market as well. As a result, Rahimafrooz has come up with its innovation of SMART 3E Platform and SMART SHS technologies to optimise the immense potential of the African market.

Renewable Solution

With a focus on Energy, Empower, Enterprise, 3E brings together technology and connectivity to a single platform. The rapidly rising demand for energy and the modality of energy consumption for both households and commercial, have channelled Rahimafrooz Solar into designing and releasing next generation Smart Solar solutions with mobile wallet and internet connection using online/ERP and smart phone based systems including remote monitoring and control. The control device ensures the systems work only for the period the payment has been made for. Workforce uses SMART phone ERP and mobile wallet based systems that provides complete rural coverage and hence customers get the service at their door step.

Project Financing and Costs

The project cost was approx. 20,000,000 BDT (equivalent 250,000 USD) and was financed by an internal resource. The project was executed with the “Pay-to-own model” in which the customers get system ownership within 12 to 36 months. Overseas technical consultancy was sourced for this purpose.

Project Outcome

The 3E platform connects and integrates customers, product/Solution providers, Green Finance Instruments and the Enterprising Village based Solar Promoters with a special focus on Women Enterprise Development Opportunity (WE DO). This seamless fully monitored, controlled, result oriented platform and system can be exported and replicated in the off-grid market in Africa. This innovative 3E platform will help create large commercialisation of access to energy opportunity, green jobs to green entrepreneurs and a complete eco system to uplift remote rural communities in overall emancipation in African countries.

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14. REINER LEMOINE INSTITUT

- **Organisation:** Reiner Lemoine Institut gGmbH
- **Title:** Electrification planning in Nigeria
- **Location:** Nigeria (Cross River, Niger, Ogun, Plateau, Sokoto)
- **Year of completion:** 2016



The Organisation

The *Reiner Lemoine Institut gGmbH (RLI)* is a German non-profit research institution founded in 2010 researching on renewable energy, integration of different energy technologies, grid management, energy storage, hybrid power plants and off-grid electrification.

The Challenge

The objective of this project is to develop electrification strategies for five Federal Nigerian states with low electrification rates. This is on the one hand challenging due to the lack of detailed data on the current status of electrification and on the existing power infrastructure. On the other hand, challenges lie within the complexity of electrification modelling when comparing hybrid mini-grids and grid extension. Finally, the present institutional structures and planning processes are not clearly defined.

Opportunities for Renewables

Nigeria has a huge untapped potential of renewable resources, especially a high solar energy potential which could be utilised by decentral and central generation options.

Renewable Solution

Within the project, the aim is to show the least-cost electrification options differentiating between grid extension, solar hybrid mini-grids and solar home systems. This is done via several GIS and energy system simulation tools developed at the RLI. During the project a subsequent series of workshops was conducted for capacity building on data collection, data management and GIS, energy demand modelling and least-cost modelling of mini-grids and grid extension. Finally, electrification plans are developed in a participatory way including the main rural electrification stakeholders.

Project Financing and Costs

The project is developed in cooperation with the Nigerian Energy Support Programme (NESP) implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in collaboration with the Federal Ministry of Power Housing and Works, Nigeria and funded by the German Government and the European Union. Other parts of that project include the construction of pilot mini-grids.

Project Outcome

The outcome of the project will be the draft of electrification plans for each state. They suggest electrification strategies to achieve 100% electrification by grid extension, hybrid mini-grids and solar home systems. This allows local governments to build their planning and implementation on evidence-based suggestions and to understand the required additional generation capacity and investment needs, for both, on- and off-grid electrification.

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15. RENAC

- **Organisation:** Renewables Academy AG (RENAC)
- **Title:** Capacity building on PV-diesel-hybrid mini-grids
- **Location:** Kenya
- **Year of completion:** 2013



The Organisation

The *Renewables Academy AG (RENAC)* is a leading international provider of training and capacity building in renewable energy and energy efficiency. Since 2008, about 6,500 participants from 145 countries have attended RENAC programmes.

The Challenge

In 2013, Kenya had an electrification rate of only 5% in rural areas. In these regions, electricity is often supplied by means of diesel generator powered mini-grids. The limited supply of spare parts, non-transparent transportation of diesel fuel, its storage in remote areas and, of course, the ever-increasing price are severe risks for a secure and reliable electricity supply in rural areas. Moreover, carbon emissions, leakages, noise and air pollution from diesel generators pose substantial threats to people, animals and the environment.

Opportunities for Renewables

In order to avoid the high costs of diesel in remote areas, the Government of Kenya (GoK) decided to look for alternative energy solutions. As a result, renewable energy was included in the plan to provide areas far from the national grid with electricity. As part of its first stage, several pilot projects were installed with GoK's funds. The state utility Kenya Power & Lighting Company (Kenya Power) and the Rural Electrification Authority (REA) undertook the design of the systems. Capacity building was necessary to scale up the electrification programme.

Renewable Solution

In November 2013, RENAC provided Kenya Power and REA with a 3-day training in Nairobi. The objective was to learn

how to optimally design tenders that incorporate solar PV in diesel mini-grids and raise awareness on state-of-the-art technology solutions for these systems.

Among the most important topics covered during the training were:

- assessment of existing PV-diesel-hybrid systems in Kenya;
- energy audits and load profile recording;
- system engineering, components, design, energy yield calculation;
- working with software design tools;
- operation and maintenance;
- Kenyan Rural Electrification policy and
- tendering.

Project Financing and Costs

The training was provided within the framework of the Project Development Program (PDP) Sub-Saharan Africa by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with the support of the Renewable Energies Export Initiative (EEE) of the German Federal Ministry of Economics and Technology.

Project Outcome

Representatives from Kenya Power, Strathmore Business School, GIZ, the United Nations Industrial Development Programme (UNIDO), the Department of Energy and the Rural Electrification Authority (REA) attended the workshop. The discussions during the event confirmed the great interest in PV-diesel hybridisation. Based on the knowledge gained, participants developed a good understanding of the technologies and its potential. The project established a solid knowledge base for the authorities to save costs and to secure and expand rural electrification throughout Kenya making it a best-practice for other countries to follow.

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16. RVE.SOL

- **Organisation:** RVE.SOL – Rural Village Energy Solutions Lda.
- **Title:** KUDURA Sustainable Development Solution (Rural Energy & Water) – “the power to change”
- **Location:** Sidonge Village, Busia Region, Western Kenya
- **Year of completion:** 2011, capacity and grid extension upgrade 2016



The Company

RVE.SOL is a triple bottom line social entrepreneurship and mini-grid project developer. RVE.SOL leverages renewable energy and water purification technology within the context of sustainable community-led business models tailored to local needs. Through affordable PAYG energy and water services the company creates opportunity for creating jobs, empowering businesses and eradicating poverty in rural Africa.

The Challenge

Demonstrate a scalable village electrification solution to step-function social and environmental change, improving local living standards and enabling new services within the community including access to clean water, mobile phone charging, hair cutting, video hall and milk refrigeration.

Renewable Solution

Containerised KUDURA technology – a sustainable integrated solution encompassing RE generation, mini-grid distribution, remote monitoring, PAYG service access and potable water production. Micro-grid reticulation after upgrade spans a total of 3,000 m and provides power to 47 small businesses and households. Total installed capacity: 7,5 kW PV – Current production level: 600 kWh/month (AC).

Project Financing and Costs

RVE.SOL has invested 87,000 USD in this pilot project to date, with a further 30,000 EUR raised through crowdfunding facilitated by www.jointrine.com. The project cash flows contemplate annual utility revenues of 17,500 EUR versus OPEX of 7,000 EUR generating average annual net cash of 5,000 EUR after expenses and debt service. Break-even is expected in 2020.

Project Outcome

Independent impact assessment in 2015 confirmed positive social and environmental impact after five years of operations:

- 47% improvement in school grades;
- 180% increase in girl-child school attendance;
- 74% increase in disposable income due to reduced kerosene usage;
- 100% increase in cassava yield (indirectly attributable);
- 66% reduction in malaria infection (indirectly attributable).

Transition from pilot to market validation and commercialisation scale-up is currently underway. The business model centres around defining sustainable financial models tailored to the local environment in which they will function. This constitutes the ABC model + potable water production and other community entrepreneurial businesses to strengthen project cash flows and reduce time to break-even.

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17. SMART HYDRO POWER

- **Organisation:** Smart Hydro Power
- **Title:** Hybrid systems with solar and micro hydrokinetic turbines
- **Location:** Chirundu and Luangwa, Zambia
- **Year of completion:** 2016



The Company

Superrich Energies, a Zambian project developer is employing hybrid PV-hydrokinetic systems from *Smart Hydro Power Germany* electrifying approximately 100 rural households within the Power Africa Off-Grid Challenge. Households will be partly integrated into a micro-grid and partly – due to distance between the houses – supplied by portable batteries charged centrally in a community house.

This project results from a partnership between the German and the Zambian company.

Smart Hydro Power is a German-based company focused on developing and implementing affordable renewable energy projects that enhance productivity and improve people's living standards.

SuperRich Energies Limited is a Zambian company that has successfully completed photovoltaic street lighting projects in Zambezi and Kabompo districts.

The Challenge

In one of the poorest districts in Zambia, Chirundu and Luangwa, rural communities have very limited access to energy. Their primary school, health and police posts, including 23 unelectrified lodges are powered by diesel generators. The objective is to not only bring basic electrification to one community but empower a central place so this could develop productive use applications like a casaba mill to increase the standard of living.

Renewable Solution

Lighting brings security, promotes apprenticeship and get-together. However, this project aims at long-term economic sustainability, so some productive use is part of it. While the technical solution installed could power an Internet point with "Internet Café" or an irrigation pump in the specific project, a casaba mill will enable the villagers to commercialise casaba more efficiently.

Project Financing and Costs

This project is financed via a *US African Development Foundation (USADF)* grant. A basic tariff will cover operational costs making the project long-term sustainable.

Project Outcome

The installation of off-grid hybrid power plants, consisting of solar panels and hydrokinetic turbines, will provide electricity to several households, with generation costs (LCOE) below 0.40 USD/kWh. As this type of turbine uses only the kinetic energy stored in the river, no dam is needed.

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18. SNV

- **Organisation:** SNV Netherlands Development Organisation (SNV)
- **Title:** Results-Based Financing (RBF) for Pico-Solar Market Development
- **Location:** Mwanza, Lake Zone, Tanzania
- **Year of completion:** 2017



The Organisation

SNV Netherlands Development Organisation (SNV) is a not-for-profit international development organisation. Founded in 1965, SNV has built a solid local presence in many of the poorest countries in Asia, Africa, and Latin America. In energy, the focus is on the themes climate change and sustainable energy markets, under which the organisation engages in clean cooking and heating, as well as off-grid electricity.

The Challenge

In rural Tanzania, access to clean and affordable energy for lighting is a major challenge. Only 20% of the rural population live within the reach of the national grid and even for those who are on-grid, the power supply has been very erratic in recent years. Most people in rural Tanzania rely on kerosene for lighting, which consumes a significant part of a typical household's monthly income and has severe health impacts.

Opportunities for Renewables

The dissemination of off-grid solar lighting solutions (solar lanterns, kits and home systems) could provide all rural households in Tanzania with clean, accessible and affordable lighting and basic electrification.

Renewable Solution

SNV supports the private sector, by providing financial incentives to import-suppliers of quality solar products, to

scale their operations into new rural markets and engage in last-mile distribution of their off-grid energy products and services. Payment of the incentives can only be claimed after the sales of approved solar products and/or services are verified. The value of the sales incentive is determined by the energy service that the product provides (brightness and runtime).

Project Financing and Costs

A competitive Results-Based Financing (RBF) Fund with 1,000,000 EUR worth of incentives – funded by the British Department for International Development (DFID) through the Energising Development (EnDev) programme – is managed by SNV and hosted by TIB Tanzania Development Bank, through which the financial incentives are transacted. SNV's main role in this project is to broker relations among actors that ensure fair, transparent and verifiable financial transactions throughout management of the fund.

Project Outcome

At mid-year 2016, 55,000 rural Tanzanians benefitted from Lighting Global approved solar products sold under the RBF project, while results keep growing due to continued presence of the companies. A mix of 23 different solar products has been sold. As a result, almost 400,000 EUR have been verified as claimable for direct payment to the private sector. Towards the end of 2017, the project expects to have provided energy for lighting and electrical applications through solar power for 181,000 people.

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19. SOLARKIOSK

- **Organisation:** POWER KIOSK Partnership, led by SOLARKIOSK AG
- **Title:** Scaling-up Rural Electrification
- **Location:** Kenya and Ethiopia
- **Year of completion:** 2017



The Company

The responsible organisation is the *POWER KIOSK Partnership*, including the lead of *SOLARKIOSK AG* for Kenya and Ethiopia territories and *ICCO Cooperation*. *SOLARKIOSK AG* developed a solar-powered kiosk, which enables the creation of commercial and impact-driven activities targeting the needs and empowering communities in off-grid areas. *ICCO* is an international NGO based in the Netherlands. The *POWER KIOSK* project will also be implemented in Madagascar in partnership with Heri Madagascar.

The Challenge

In Ethiopia, 85% of the population live in rural areas and only 2% have access to electricity. Energy is mostly generated from waste and biomass (92%). In Kenya, 90% of the rural population rely on firewood for energy supply, while 87% also use kerosene for lighting. These off-grid populations suffer from a lack of electricity, restricting business opportunities, education and health care. The energy generated in off-grid areas is mainly used for lighting, limiting the energy available for information services.

Opportunities for Renewables

POWER KIOSK will implement 80 kiosks in village communities: the solar energy generated by the solar panels on the roof of the *POWER KIOSK*, designed by *SOLARKIOSK*, will generate clean and reliable energy for the local community. The energy generated will be used for information services such as mobile phones charging, Wi-Fi, printing, copying, scanning, radio and TV powering and conservation of food in cooling rooms.

Moreover, the *POWER KIOSK* will work as a retail hub, selling solar products, clean cooking stoves, beverages as well as convenience food and health products. The *POWER KIOSK* will be the centre for raising awareness and hosting events (about solar energy, hygiene, etc.) to empower the community.

Renewable Solution

Implementation of the 80 *POWER KIOSK* in Kenya and Ethiopia will take place in 48 months: from site selection, to procurement, manufacturing and on-site construction. Selection, training and contracting of 80 agents and an additional 320 employees will also take place in this period. The hired personnel will be responsible for the long-term sustainability of the project, overseeing operations and maintenance and increasing awareness through BOP marketing of sustainable energy products and services, using local advocacy.

Project Financing and Costs

The project total cost is around 10,000,000 EUR. 58% of the costs are financed by the 10th European Development Fund from the European Commission; the remaining percentage will be funded by the partner companies. The long-term financial sustainability will be assured by the revenues generated from the sales of services and products through the kiosk. The expected break-even point is four years.

Project Outcome

The short-term outcome is greater access to a sustainable energy supply and renewable energy products to enable and empower communities. Services and products provided through the *POWER KIOSK* will benefit 44,800 households, improving the living conditions and replacing hazardous kerosene lamps with solar lighting solutions. An estimated 101,000 people will be better informed and have access to modern communication through solar energy powered mobile phones, internet, radios and TVs. The long-term effect will be felt through the scalability of the project – the technical solution and the commercial model in communities across Africa.

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20. SOLARLAND

- **Organisation:** Solarland (Wuxi) Electronic Power Technology Ltd.
- **Title:** Solar street lights projects in West Africa
- **Location:** Cotonou, Benin/Ouagadougou, Burkina Faso
- **Year of completion:** 2014–2016



The Company

Solarland is dedicated to bringing solar light and power solutions to over 1.6 billion people with no access to an effective power/light source. Working with global corporations and cooperating with various humanitarian organisations, Solarland has developed innovative, effective products and solutions meeting different needs in specific parts of the world. Solarland lighting and power solutions have been successfully implemented all around the world.

The Challenge

Cotonou is a city by the sea, so an increase in the zinc coating thickness had to be considered. The weather in Burkina Faso is very hot, so focus was put on heat insulation in the system design, which is why the high temperature resistant battery was used to ensure the system life. How to best consider all the local conditions was thus a challenge.

Opportunities for Renewables

Solar Street Light is an important energy saving product, not only because of its capacity for solar energy conversion, but also because it is equipped with a LED light source, which increases environmental benefits.

Project Outcome

In Cotonou and Ouagadougou, 80% of roads don't have street lights. Since the installation of solar street lights, the dark roads are lit up and the roads are crowded with people and cars in the evening. Vendors gathered under the street lights to do business, the road turned into a commercial street.

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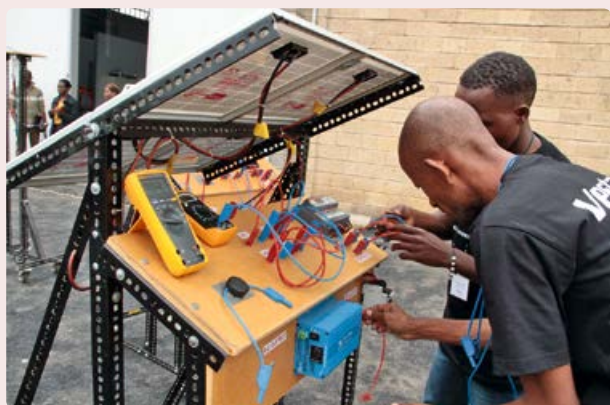
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21. SERC

- **Organisation:** Strathmore Energy Research Centre (SERC)
- **Title:** Renewable Energy and Energy Efficiency Competence Centre
- **Organisation:** Strathmore University
- **Location:** Nairobi, Kenya
- **Year of completion:** 2016



The Organisation

Strathmore Energy Research Centre (SERC) is an institution that was established in July 2012, with the aim of carrying out high quality research and technical training as well as consultancy services in the energy sector in Kenya. The institution effectively offers its services to the government, private sector and the general public.

The Challenge

The capacity to implement renewable energy and energy efficiency in East Africa is lacking. A number of constraints exist which inhibit successful utilisation of renewable energy (RE) resources and adoption of energy efficiency and conservation (EE&C) measures: inadequate policy and regulatory frameworks, capacity gaps in the field of RE and EE&C in terms of project design, development and maintenance, shortage of energy auditors or insufficient awareness by the public and private sectors.

Opportunities for Renewables

East Africa is endowed with abundant renewable energy resources, in particular solar energy. In Kenya for example, solar insolation averages more than 5 kWh/m² per day. There is also a large potential to save energy through energy efficiency and conservation (EE&C) measures.

Project Financing and Costs

The RE & EE competence centre co-funded by the GIZ-Development Partnerships with the Private Sector (DPP) and Strathmore at a cost of 400,000 EUR. This includes the cost of the components. The project was funded by GIZ-DPP, through the Project Development Programme.

Project Outcome

Support to the Energy Regulatory Commission (ERC) and to develop and approve a PV and Energy Auditing training curriculum. Around 1,000 professionals have been trained and certified in the level T1/T2 Solar Photovoltaic training.

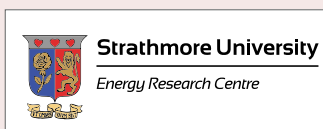
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22. SERC

- **Organisation:** Strathmore Energy Research Centre (SERC)
- **Title:** Capacity Building for Technical Training Institutes
- **Location:** Kenya
- **Year of Completion:** 2016



The Organisation

Strathmore Energy Research Centre (SERC) is an institution that was established in July 2012, with the aim of carrying out high quality research and technical training as well as consultancy services in the energy sector in Kenya. The institution effectively offers its services to the government, private sector and the general public.

The Challenge

This project tries to address the findings from the survey funded by JICA in 2012 in which 41 higher education institutions participated and it was identified that only 50% offered courses in Solar PV technology. Of the 368 teaching staff interviewed, only 16% had received prior training in solar PV technology. 52% of the institutes did not have access to adequate training materials while 60% of the respondents felt that they did not have appropriate hands-on training equipment. 20% did not have any hands-on training equipment.

Opportunities for Renewables

The project aims to build technical capacity on solar systems in rural areas through decentralised training of solar technicians in local Technical Training Institutions (TTIs) who will in turn provide technical support for solar products. Through this partnership, the project partners have provided training equipment to the TTIs while SERC provides the Training of Trainers courses (ToT) and support to the TTI to establish and sustain their training programmes. So far, 25 TTIs have been equipped and have started offering training programmes.

Project Financing and Costs

SERC was funded by the United States Agency for International Development (USAID) under the PEER project (Partnership for Enhanced Engagement in Research) science grant in partnership with the Energizing Development Kenya Country Programme and the SNV Netherlands Development Organisation. The 119,000 USD project commenced in July 2014.

Project Outcome

Through the project at least 50 trainers have been certified and through them 1,000 technicians have also been trained and certified at level T2. Thus, there is a sufficiently qualified pool of solar PV professionals conversant with proper design, installation and commissioning of solar PV systems in the rural areas.

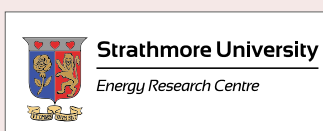
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23. SUNNA DESIGN

- **Organisation:** Sunna Design
- **Title:** Sunnami – Nanogrid Sunna
- **Location:** Niomoune, Casamance, south of Senegal
- **Year of completion:** 2016



The Company

In France, *Sunna* designs and manufactures innovative solar off-grid solutions for developing countries, withstanding desert and tropical environments (up to 70°C). Thanks to an ambitious R&D programme, Sunna holds 10 patents protecting a unique technology that has already become the reference on the solar street light market. Sunna just released the “Nanogrid”, its most innovative solution ever for off-grid populations: a solar street light that brings energy also inside homes.

The Challenge

Most of the rural population in Casamance, Senegal, lives off-grid. People use kerosene, torch lamps and candles (which are expensive and damage their health) to light their homes. Some companies tried to bring electricity but failed at maintaining the systems. People are still waiting for a trustworthy and affordable energy access.

Opportunities for Renewables

Thanks to a high level of sunlight in the region, solar energy brings enough light and electricity to homes and public spaces.

Renewable Solution

Sunna designed the Nanogrid, generating enough energy to power a small DC grid connecting up to four homes. Each household benefits from four LED lights, one portable LED light, one USB for mobile charging, and public lighting. The Nanogrid is an innovative way of delivering energy access, allowing a 100% electrification rate. Sunna offers a 10-year lifespan maintenance free product. With Bluetooth, GSM

and GPS based connectivity, Sunna monitors the systems remotely and ensures correct functioning.

In a joint venture with a local partner the locally based and staffed organisation Sunna Solar System (SSS), ensures the sustainability of the project. The technical team installs and maintains the Nanogrid while the commercial team keeps in touch with and educates the customers and resellers, and collects the money from the villagers’ resellers.

Project Financing and Costs

The business model is based on Pay-As-You-Go. Sunna pre-finances the CAPEX and OPEX, connects and operates the Nanogrid. Customers then pay their daily energy fee and repay the equipment in a couple of years. PAYG maximises the repayment rate: failure to repay will result in a cut in energy access. The first phase of the project was co-financed by crowd lending: 500,000 EUR were collected from 500 different funders. Now Sunna is looking at completing the 10,000,000 EUR million overall project cost with private, multilateral and donor funding.

Project Outcome

- Around 1,000 people benefit from the solution with a very impressive penetration rate of 97% in the village. Children in Niomoune can now study after sunset and have better access to education, while the Nanogrid has replaced the kerosene lamps, their smoke and fire hazard. Customers indicated they save average 192 EUR per year.
- An important lesson learnt was that local presence, training and after sales service is very important for user acceptance.

The Senegalese Agency for Rural Electrification (ASER) has already granted Sunna Design a 5,000 nano-grids programme in off-grid areas of Casamance with an objective to connect 20,000 households by the end of 2018.

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More information: www.lendosphere.com/les-projets/un-nano-reseau-solaire-innovant-pour-l-electrification

www.france24.com/en/20160514-down-earth-senegal-solar-energy-sunna-design-africa-electricity



24. WISIONS OF SUSTAINABILITY

- **Organisation:** WISIONS of Sustainability, Humana Fundación Pueblo para Pueblo, ADPP Mozambique
- **Title:** Introduction of innovative solar tunnels for food processing for 300 farmers in Mozambique
- **Location:** Cabo Delgado Province, Mozambique
- **Completed:** 2013



The Organisations

The project was funded by *WISIONS of Sustainability*, an initiative by the *Wuppertal Institute*, and was implemented by *Humana Fundación Pueblo para Pueblo* in cooperation with the local NGO *ADPP Mozambique*. Humana is an NGO that has carried out cooperative projects in various countries in sub-Saharan Africa since 1987, while ADPP is a local NGO that currently implements over 60 projects across all provinces of Mozambique aiming for the holistic development of local communities.

The Challenge

In northern Mozambique many farmers face challenging living conditions. Given the seasonality of the vegetable and fruit harvests and the difficulty of adequately preserving and storing their products, many farmers suffer from food shortages and malnutrition.

Opportunities for Renewables

Renewable energy technologies can provide an alternative solution for farmers to preserve their harvest and reduce post-harvest losses, as well as offering the opportunity to generate additional income by selling the surplus production. Compared to traditional drying methods, the application of solar power results in a better quality and more hygienic product.

Renewable Solution

The project built six innovative solar tunnel dryers for food processing and preservation in cooperation with existing local farmers' associations. The tunnels are 3.5 metres wide,

5 metres long and 2 metres high. They were constructed of bamboo and plastic and the ground was lined with stones, sand, bricks and cement. Bamboo is locally available, while the UV plastic had to be imported from Tanzania.

The solar dryers are owned by the associations, who are also responsible for their maintenance and servicing. The cost of smaller repairs has to be borne by the association, which collects fees from the tunnel users. In addition to technical capacity-building, 18 female entrepreneurs received training in nutrition, food processing, drying, storage and micro/small business development. These women are now responsible for managing the solar tunnels and have established schedules enabling 50 families to dry their products. Furthermore, 300 members of farmers' associations were trained in small business management during their weekly meetings.

Project Financing and Costs

The total project budget amounted to 32,654 EUR, of which 22,000 EUR was financed under the Sustainable Energy Project Support (SEPS) scheme of the WISIONS initiative. The remaining amount was financed by funds from Humana and Ajuda de Desenvolvimento de Povo para Povo (ADPP) Mozambique.

Project Outcome

300 farmers have benefited from the introduction of the six solar dryers. Harvest losses have been significantly reduced and local food security has been increased. Furthermore, the farmers no longer need to sell their vegetables and fruits at low prices immediately after harvesting, but can achieve better prices for their dried products. The innovative and simple technology of the solar tunnel dryers, together with the local availability of materials and sufficient sunshine, makes this project easily replicable elsewhere in Mozambique.

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