Alliance for Rural Electrification

Shining a Light for Progress

The Productive Use of Renewable Energy in Africa

Africa-EU Energy Partnership

Imprint

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Africa-EU
Energy Partnership

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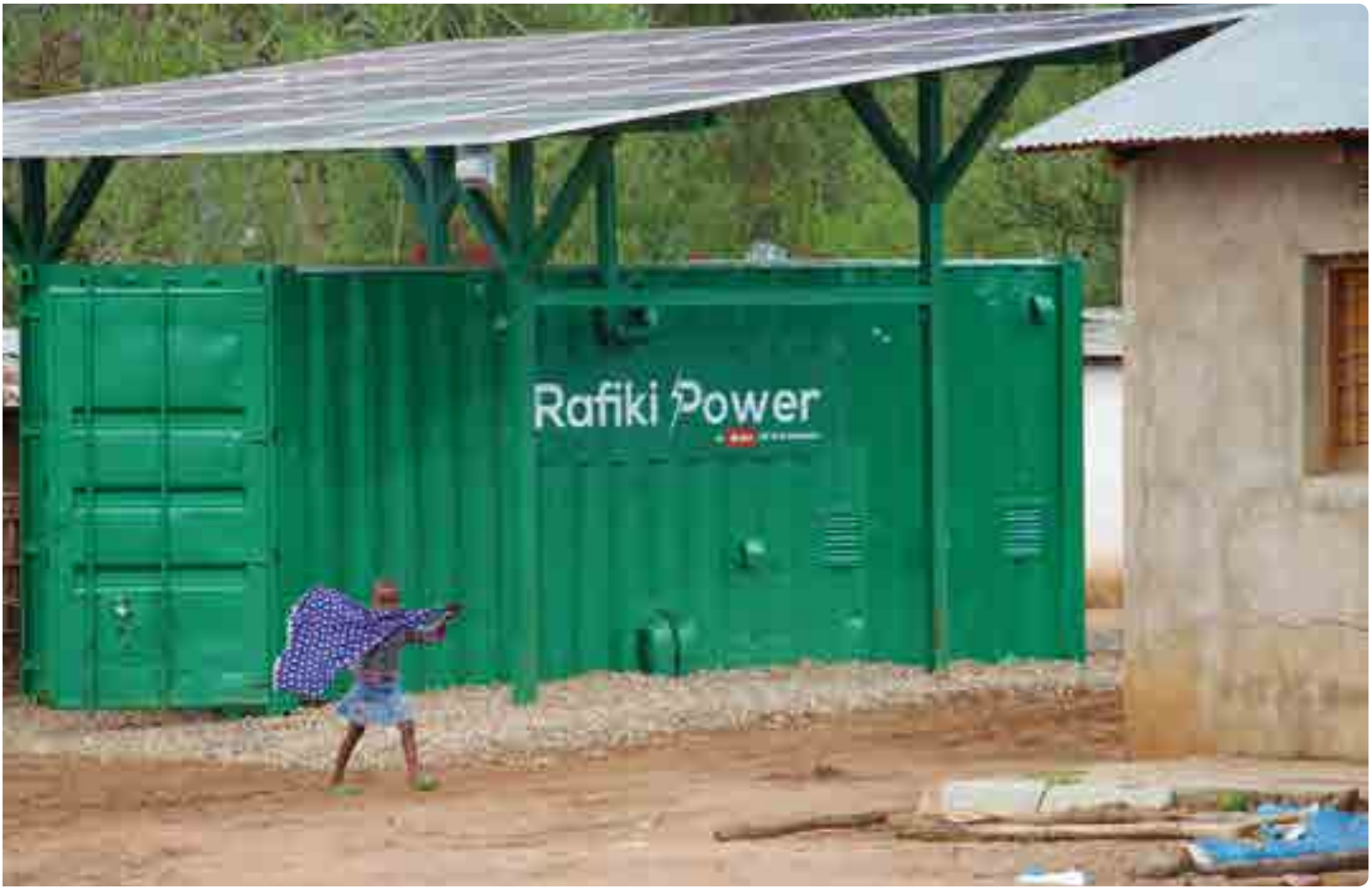
1. EXECUTIVE SUMMARY

In a time when the world is working towards universal access to clean energy and sustainable development, as exemplified by the SE4All initiative and the UN SDG on energy, it is crucial for the Africa-EU Energy Partnership (AEEP) and the Alliance for Rural Electrification (ARE) to underline the key role Productive Use of Renewable Energy ("PURE") can and should play for the future growth path of Africa.

This paper addresses the need for reliable energy access for businesses to enable the productive use of clean energies. Energy security from private sector perspective means that present and future access to energy is guaranteed at affordable prices. It focuses on the benefits of PURE, highlights lessons learnt and challenges, and formulates recommendations to stimulate its spread and better realise its potential.

In addition, the paper presents case studies from nine African countries to show promising ways to successfully engage in rural developing areas for entrepreneurs, NGOs, investors and policymakers[1]. ARE believes that these examples can also be used as showcase examples in other parts of the developing world.

1 Please refer to the publication "Best Practices for Clean Energy Access in Africa" by the AEEP and ARE for additional case studies from Africa. It is available on http://ruralelec.org/38.0.html



2. KEY RECOMMENDATIONS

In full recognition of public sector efforts to help build a more sustainable rural electrification sector, there is scope to better make use of past experience to work effectively towards the realization of the SE4All objectives and SDGs.

In order to create an enabling environment for PURE in sub-Saharan Africa, ARE recommends that energy-sector decision makers, such as ministries of energy, power regulators, rural electrification/energy or renewable energy agencies and public utilities, consider the following recommendations:

- **Raise awareness for PURE, which is the least cost option over its life cycle**, through communication campaigns, with a particular focus on the return on investment generated by renewable energy installations based on sustainable business models;
- **Facilitate access to finance for small and medium-scale PURE project**s – which could be replicated and scaled up – by increasing the overall budgets available for this and in particular for upfront investments, allowing small ticket sizes and stimulating the bundling of projects where appropriate, also taking the gender bias into account;
- Stimulate clean rural electrification through PURE projects in particular with a **clear, efficient and supportive policy and regulatory framework**; behavioral change requires at least a level playing field for RETs and is further facilitated if incentives are more attractive;
- **Facilitate private sector investment** in small and medium-scale PURE projects, by helping to reduce the (perceived) risks on the regulatory, technological, political and market development level, as well as by taking part in financing e.g. through grants and soft loans;
- Support local **capacity building** and training, especially to start and run a business, as well as to work with the renewable energy installation;
- Highlight the importance of **sharing experience and best practices** both on the political-institutional and the industry level, and work with established sector partners and stakeholders;
- **Engage with the local community** and NGOs when developing programmes targeting the spread of PURE to better understand and support local needs and increase local acceptance, whilst integrating the feedback into a holistic approach to stimulate local economic development;
- Consider a more systematic and **market-near approach** by facilitating the understanding of the local energy market and its outlook for potential market participants, and avoiding the distribution of energy systems without any reciprocal commitment in order to focus on quality and cost-effective renewable energy solutions[2].

2 For more information, see the ARE publication "Renewable Energy Based Rural Electrification – Industry Lessons Learnt To Make Public Supporting Schemes A Success", available on http://ruralelec.org/38.0.html

3. INTRODUCTION AND DEFINITION

Rural electrification is key for the socio-economic development of non-urban regions in developing and emerging countries. While energy is used for various consumption purposes such as lighting, access to information, comfort and entertainment, it is not sufficient by itself to trigger development in rural areas. Since there is a high **correlation between energy access and economic growth**, the usage of energy should also be aligned in such a way that it will trigger economic development through enhancement of the income generation of the local population. This economic development would further mutually improve the social well-being.

Hence, the **"Productive Use of Renewable Energy (PURE)" could be defined as agricultural, commercial and industrial activities, powered by renewable energy sources, which generate income**[3]. The PURE can be employed at various levels such as by powering machines for pumps, drip irrigation, milk machines, mechanical workshops, refrigeration of food, mobile charging, IT supply for businesses, processing and storage industries, and so on. Some of the productive applications are enlisted in the Table 1.

The residential use of electricity improves the quality of life of the rural community while PURE in rural areas leads to increased rural productivity, higher economic growth, and a rise in rural employment.

3 While there does not seem to be a universal definition of productive use of (renewable) energy, most definitions seem to integrate these elements. See e.g. GIZ and EUEI PDF, Productive Use of Energy – PRODUSE: A Manual for Electrification Practitioners: "[...] productive uses of electricity are defined as agricultural, commercial and industrial activities involving electricity services as a direct input to the production of goods or provision of services"; SE4All Energy Access Committee Report of 27 May 2014: "[...] productive energy such as mechanical power which supports value adding activities and/or income generation"; EUEI PDF et.al., Workshop Productive Use of Energy in Ghana 12 Dec 2013 – Summary Report: "[...] utilisation of energy, both electric and nonelectric energy in the forms of heat or mechanical energy, for activities that enhance income and welfare [...]"; UNDP 2015, EnergyPlus Guidelines: Planning for Improved Energy Access and Productive Uses of Energy; etc.

4. BENEFITS OF PRODUCTIVE USE OF RENEWABLE ENERGY

The Productive Use of Renewable Energy has many benefits, a selection of which is outlined below.

Triple Bottom Line Sustainable Business

Having access to clean and reliable electricity means that local businesses in developing areas, both existing and upcoming, can reap the benefits of extended operating hours, mechanisation, product preservation, higher productivity, improved working conditions, communication and education – in a socially and environmentally sustainable way. **As such, PURE benefits the local business' profit, the local people and the planet.**

As an illustration of the impact on profitability, electric-powered farm equipment has tremendous benefits for rural farm incomes. Farm machinery such as water pumps, fodder choppers, threshers, grinders, and dryers, increases average yields per acre, improves cropping intensities, is more dependable, increases cost efficiency and productivity, decreases labor time consumed, increases areas for cultivation, and results in higher crop growth.

Stronger local economy

PURE enables the diversification of the economic base by making it possible for the local community to both deepen and move beyond traditional economic activities. Entrepreneurial activity varies but often include agro-processing, electronics charging stations, general shops, restaurants, repair shops, salon/barber shops, Internet service providers, telecom tower stations, ...

Table 1. Examples of various energy services and their income generating value

Energy Services	Income Generating Value	Renewable Energy Services
Irrigation	Better yields, higher value crops, greater reliability, growing during periods when the market prices are higher	Wind, PV solar, biomass, micro-hydro
Illumination	Reading, extending operating hours	Wind, PV solar, biomass, micro-hydro, geothermal
Grinding, milling, husking	Create value-added product from raw agricultural commodity	Wind, PV solar, biomass, micro-hydro
Drying, Smoking (Preserving with process heat)	Create value-added product, preserve product to enable selling in higher-value markets	Biomass, solar heat geothermal
Expelling	Produce refined oil from seeds	Biomass, solar heat
Transport	Reaching markets	Biomass (biodiesel)
TV, radio, computer, internet , telephone	Entertainment businesses, education, access to market news, coordination with suppliers and distributors.	Wind, PV solar, biomass, micro-hydro, geothermal
Battery charging	Wide range of services for end-users (phone charging business)	Wind, PV solar, biomass, micro-hydro, geothermal
Refrigeration	Selling cooled products, increasing the durability of the products	Wind, PV solar, biomass, micro-hydro

Local impact: Jobs & increased purchase power

PURE means that local jobs on different levels of qualification are created directly, as the renewable energy equipment needs to be installed, operated and maintained, as well as indirectly, as the access to electricity favours business creation and expansion.

The jobs and businesses thus created or maintained generate income, leading to an increased purchase power of the local community. A useful knock-on effect is that the increased income enhances the consumer's capacity to pay for the energy services and invest in high-quality, reliable products. In addition, in the long term this may have a positive effect on government budgets.

Easy implementation: Renewable energy technology neutral

Generally speaking, the agricultural, commercial or industrial activity can be powered by any type of renewable energy source. However, depending on the specific application, some renewable energy technologies may be better suited or more commonly used than others[4].

Enhanced gender equality: Leading to broader engagement

The productive use of (renewable) energy, when aligned towards involving women in the rural communities to engage in small businesses, helps in empowering women. Through small scale cooperative businesses, not only have employees doubled their household incomes, but previously unemployed rural women can now earn a regular income and, in many cases, have become the principal wage earners.

Improved health and sanitation: Stronger socio-economic development

Rural social and economic development depends significantly on the state of health of the population. Modern energy services improve health service delivery, increase access to safe drinking water, enable clean cooking, and can make available various communication tools (e.g., radio, television, and the internet), which can be utilised effectively against diseases.

Contribution to SE4All and SDGs: Environment and climate change

The energy used for the productive applications originates from local renewable energy sources. Hence, there is no need for transporting and burning fossil fuels (except in a limited way in projects with diesel back-up), and thus no local pollution or CO_2 emissions. In addition, when e.g. agricultural residue is used as bioenergy for electricity purposes, the local waste is valorised.

4 See abovementioned table. See also ARE publications on "Risk Management for Mini-Grids"; "Relevance and Implementation Possibilities for Bioenergy Technologies in Rural Electrification Markets"; "The Potential of Small Hydro for Rural Electrification – Focus: Latin America"; "Using Batteries to Ensure Clean, Reliable and Affordable Universal Electricity Access" and "The Potential of Small and Medium Wind Energy in Developing Countries. A Guide for Energy Sector Decision-Makers".

5. LESSONS LEARNT & CHALLENGES FOR THE PRODUCTIVE USE OF RENEWABLE ENERGY

Despite the availability of advanced renewable energy technologies to tap the energy potential in developing countries, the widespread adoption of renewable energy for productive use has not been achieved due to a variety of reasons. ARE considers the following obstacles as key ones to overcome a selection of which is outlined below.

Access to finance

A key barrier to overcome the business-as-usual situation is the poverty trap, which does not enable low-income, often indigenous, people to invest capital upfront, and the mixed results of government assistance in adaptive policy and regulatory frameworks to incorporate new communities into a market economy through PURE.

In addition, it remains difficult to obtain financing for small and medium-scale renewable energy projects in Africa, which makes the higher upfront investment costs (in comparison with diesel gensets) of many renewable energy installations challenging to bear and thereby not always sufficiently competitive

Moreover, there seems to be a considerable gender bias regarding access to credit, which in many rural areas severely limits women's access to capital and thus restricts the number of people involved in productive use.

Policy and regulatory framework

In full acknowledgement of the many efforts undertaken so far, it must be noted that many policy and regulatory frameworks in developing countries are still inadequate to support renewable energy technologies in general and PURE in particular[5].

Amongst others, it is crucial that there is at the very least a level-playing field for renewable energy (i.e. no subsidisation of fossil fuels) and preferably an incentivising scheme such as feed-in tariffs, clear and efficient procedures to become an independent power producer and to acquire the necessary equipment and permits, official templates for power purchase agreements, etc.[6] Such de-risking measures will allow market participants to engage on a higher level.

Capacity building

The development of skills remains a crucial challenge in local communities, particularly for women and the young, on two levels. First, a number of locals usually need to be trained to operate and maintain the renewable energy installation. Second, to start and run a business, it is highly valuable for budding entrepreneurs to have some business and management training. The companies installing the renewable energy systems, NGOs, academia and local associations can play a crucial role in this regard.

Sharing experience and best practices

Building on the need for capacity building, it is highly relevant to share experiences made and best practices. This exchange needs to take place on several levels. On the political and institutional level, it is very positive to note the increasing intercontinental cooperation through programmes such as the AEEP and the Africa-EU Renewable Energy Cooperation Programme (RECP), strongly supported by the European Commission and the African Union Commission.

On the industry level, it is clear that well-established associations such as ARE with their achieved high level of competence and networks have a key role both to share experience and best practices as well as to serve as a platform for 'connecting the dots'. In addition, it is important to note that a partnership approach between small(er) and big(ger) companies can have a beneficial impact and result in new business opportunities.

5 See the abovementioned ARE publications on various renewable energy technologies on which elements should be considered.

6 Specifically for mini-grids, please see RECP, EUEI PDF, ARE, REN21 (2014): "Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-grid Roll-outs", available on http://ruralelec.org/fileadmin/DATA/Documents/06_Publications/INENSUS-Toolkit-EN-21x21-web-OK.pdf

Participation of the local community in PURE planning

To increase the likelihood that a programme enhancing PURE will be successful, it is evident that there needs to be a consultation process with the target group of such a programme. Indeed, not only does this enable planners to better understand the local needs, but it will also increase the prorgamme's social acceptability at the local level.

In this context, it can be remarked that the local promotion of PURE should focus on the return on investment of the energy installation, rather than its level of kWh.

At the same time, such a consultation process provides an opportunity to understand what the local community considers necessary to enhance its own economic development. Their input should be considered in parallel with the PURE planning, so that a holistic approach towards local economic development can be realised.

A more market-near approach

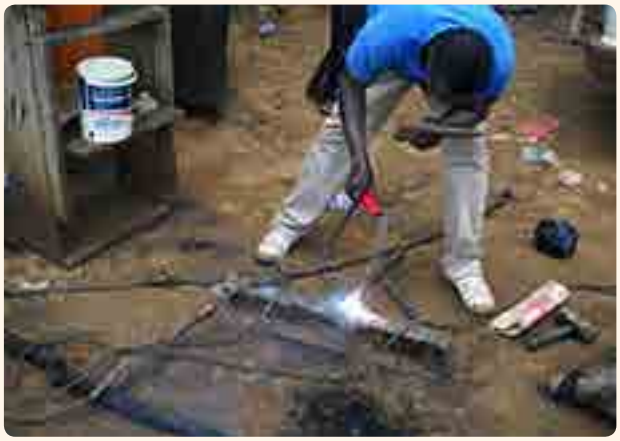
Before installing renewable energy systems, it is key to understand the local market so that market participants can develop their business case. Key elements to be considered are the level of expected and future demand, the capacity and willingness to pay, seasonal revenue variations of the local entrepreneurs,...

In addition, experience shows that installation of renewable energy systems without any reciprocal commitment such as payment for electricity consumption, handling the basic maintenance, etc., should be avoided so as to strengthen the community 'ownership' of the system and stimulate private sector involvement. This should also stimulate the longevity of the installation.

6. CASE STUDIES OF PRODUCTIVE USE OF ENERGY

6.1 EnDev, Ghana

- **Energising Development (EnDev)**
- **Energy for Productive Uses in Ghana**
- **Ghana, 7 regions: Brong Ahafo, Ashanti, Central, Eastern, Western, Volta and Northern**



The organization
EnDev is a multi-donor programme managed by GIZ and the Dutch agency RVO with energy access interventions in 24 countries. Its aim is to provide and enhance energy access in developing countries. EnDev is embedded in the GIZ structure, a German development organisation, assisting the German Government in achieving its objectives in the field of international cooperation.

The challenge
While the electrification rate for households in Ghana is relatively high compared to its neighbours (80 %), there is a significant gap in electrification policy that has left many Micro, Small, and Medium Enterprises (MSMEs) which account for more than 60 % of employment in Ghana, without access to modern forms of electricity. As a consequence, Ghana's recent economic growth has been restricted to the capital and big cities in the South.

Opportunities for productive use
Due to the expansive grid infrastructure in the country, there are significant opportunities to connect many MSMEs to existing grid infrastructure; however, affordability remains a barrier for many to access the grid. Moreover, decentralized, small scale energy production in both grid connected and off-grid regions can catalyze local development and economic growth and reduce energy expenditures for MSMEs in the long run. Through market incentives and capacity development for solar companies, the access and use of solar PV pumps for irrigation for small-scale farmers can be significantly supported.

Project description
Operational since 2009, the project's main objective is to provide access to modern energy services for Productive Uses in agriculture and small scale manufacturing through four components: grid electricity for irrigation, solar PV pumps for irrigation, improved cookstoves (ICS), and follow-up and monitoring of electrified industrial zones. In order to foster access to energy for MSMEs, the project focuses on removing barriers to access to energy through supportive subsidies for small-scale farmers, to connect to the grid or finance the purchase of a decentralized generation source such as a solar irrigation system. In addition, a market-based incentive scheme is being implemented that supports 300 small scale agri-processors to access and use improved institutional cookstoves. The result is a more efficient energy usage, reduced energy spending, as well as improved working conditions of cookstove operators, 80 % of which are expected to be women. Moreover, EnDev works with local business associations and authorities to provide business development services, technical advice and training to farmers using electricity from the grid for irrigation, as well as providers and users of solar irrigation systems.

Project financing and costs
The current phase is financed by EnDev with allocation Euro 1,500,000 which ended in May 2015.

Policy and regulatory frame work
The energy policy of Ghana is extensive and ambitious. Ghana plans to become a net electricity exporter in 2015, while simultaneously promoting the establishment of RE, as reflected in the Ghanaian government's SE4All Country Action Plan.

Project outcome
So far, the project was very successful: 1000 MSMEs have been founded/relocated and 3000 employment opportunities were created. 417 MSMEs with 700 employees and an overall of 1,600 people have new access to electricity. In most towns, dialogue platforms for local Governments and Business Associations were established and the electrical hardware to 18 industrial zones was procured and delivered.

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6.2 Energie Douce

- **Energie Douce and EnR Congo**
- **Solar power for rural communities in the region of Kouilou**
- **Republic of Congo**

The company
Energie Douce is a conceiver and distributor of solar powered systems used to supply power to off-grid sites around the world, with a focus on French-speaking countries in Central and West Africa. Energie Douce provides turnkey projects including solar and electronic products, engineering services, logistics, installation, maintenance and training for local installers or communities.

EnR Congo is a non-profit organisation that promotes sustainable development in African countries through the use of renewable energy. They help civil society, governments and private firms in implementing renewable energy powered projects that will have a significant impact on the welfare of the population and can foster further social and economic development.

The challenge
In many African countries, agricultural products are the main source of income for populations living in rural areas. Yet, these products have first to be processed in order to provide food for the population and generate revenues through commercial activities. Due to the lack of materials and reliable energy, it has not been possible to industrialise the processing of agricultural products. In rural areas, women still use traditional ways of pounding grains that are both exhaustive for the body and time consuming.

Opportunities for productive use
When using fuel to power the mill, people face many obstacles including the lack of paved road and high delivery costs (the roads turn into mud trails in the rainy season). This makes the supply unstable and uncertain. Powering mills with renewable energy offer a self-powered system whereby economic and social development can be assured. Solar panels will be used to power electric mills in areas with high agricultural potential and increase the productivity of this process.

Project description
The project aims to implement solar-powered mills that will ease the processing of cassava and grain. It will also include the installation of a solar-powered pumping system. Finally, solar street lights will be installed in the communities to give life to a local night market allowing the products from the solar-powered mill to be sold after sunset. Training for local users will also be provided so that they can carry out the maintenance work of the installation.

Project financing and costs
Up to this point, the total investment to acquire all necessary materials is roughly estimated at 12–19.000 EUR per site depending on the installed capacity of the solar system as well as the battery bank sizing. This project is designed to be developed in many rural communities, starting in Congo and subsequently in communities in Gabon and Cameroon and could represent about 20 sites in the next years.

Project outcome
If successful, Energie Douce and EnR Congo plan to replicate this project in other regions in the Republic of Congo.

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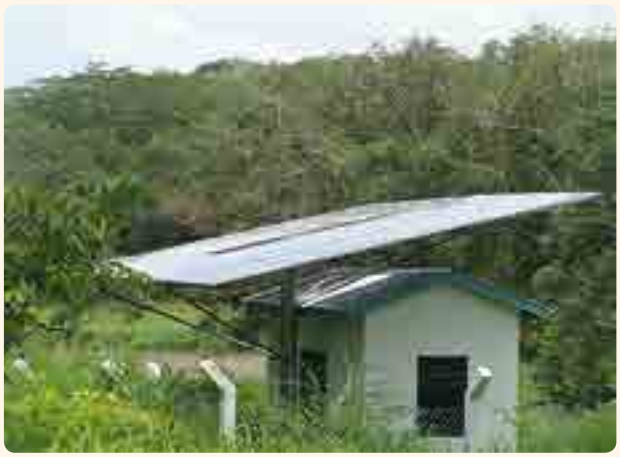
6.3 Ensol Tanzania

- **Ensol Tanzania Ltd**
- **Supply and Installation of Solar Operated Water Pumps in Mtwara Rural**
- **Tanzania**



A 6.12 kW Solar Water Pumping System at Misufini Village, Mtwara (R)

The company
Ensol Tanzania Ltd was established in 2001 with the purpose of supplying, installing and maintaining photovoltaic products and systems in Tanzania. It is now one of the renowned solar suppliers and Class I contractors of solar energy systems in Tanzania. Ensol has also twice been named one of the top 100 mid-sized companies in Tanzania, in 2011/12 and 2012/13. Ensol employs 17 permanent staff and over 30 technicians on a contractual basis.

The challenge
Tanzania has one of the lowest access to electrification rate in the world with only 24 % of the entire 45 million population accessing electricity. About 70 % of Tanzanians live in rural areas where electricity access is a mere 7 %.

Mtwara Rural is a location in Tanzania where access to clean water and electricity is poor and poverty in the area is extreme. Energy access in the area could improve standard of living, the provision of health and educational services and more importantly catalyse economic activities in the area.

Opportunities for productive use
Due to high cost of installing grid lines, the best alternative to electrify rural Tanzania is through renewable energy technologies, particularly solar energy. Although lighting small businesses like shops and restaurants has traditionally been the main application of such renewable energy technologies, the solar energy is also used in phone charging centers, video shows, small machines (carpentry and milling machines), hair cutting kiosks and water pumps for irrigation and community usage.

Project description
The project was implemented in 2012 – 13. All 11 villages in Mtwara Rural, a region in South of Tanzania, were supplied with a solar water pumping system capable of supplying a maximum of 50,000 litres of tap water per day. The minimum water pumping head was 100 m and in some villages, where water was transported from the source to the village over a distance of 1.9 km. A water committee in each village is responsible for collecting a small contribution from residents to sustain the project.

Project financing and costs
The 340.000 USD project was financed by the European Union and administered by African Medical and Research Foundation (AMREF). Procurement was conducted through open competitive tendering.

Policy and regulatory framework
Since 2005, most of renewable energy equipment can be imported into Tanzania tax-free. This decision has impacted the spread, usage and application of renewable energy technologies in Tanzania.

Project outcome
Residents of the eight villages are still enjoying tap water three years after the completion of the project.

As a result of the success of the project, the government has notified all district councils in Tanzania to put in place plans to ensure that all diesel water pumps in Tanzania are replaced with solar pumps.

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6.4 ISC Konstanz

- **ISC Konstanz**
- **Electrification of a dispensary and a village in rural Littoral**
- **Cameroon**

The company
The International Solar Energy Research Center Konstanz e.V. (ISC Konstanz) researches and develops crystalline silicon solar cells with the objective of making solar cells more efficient and reduce their production costs. Furthermore, ISC Konstanz also develops new technologies for industrial solar cell production and test innovative solar cell concepts. These goals are reflected in their motto: Research for a sunny future!

The challenge
The village is located at 100 km away from the city Edea. The village has 200 inhabitants living in 50 households and a small dispensary. Since the village is neither connected to the national grid nor electrified, the only way to get power for the dispensary was the use of a diesel generator. The price of diesel is often higher in rural areas due to the long distances to reach a petrol station.

The main economic activities of the village are agriculture, farming, hunting, and small commerce. The average monthly wage is 25 EUR. Due to the lack of electricity, it was difficult to store the agricultural products and to transform them. Moreover without electricity, activities were reduced due to shorter days (sunrise at 6:00 am and sunset at 6:00 pm throughout the year). Furthermore, since the dispensary did not have electricity, it was not possible to store medicines and drugs.

Opportunities for productive use
The installation of solar panels and solar home systems (SHS) reduced some problems in the village. The days became longer offering the possibility for the inhabitants to work after sunset, and by this mean increase their income. Since students could now study in the evening, their school performance improved significantly. Moreover solar energy is cheaper and healthier than diesel. Before, each household was spending 6 EUR on diesel. With solar energy, each household pays 3 EUR for maintenance. This will also allow for the construction of a drinking water supply point.

Project description
Expectations and sustainability of the project were:
- Direct involvement of the beneficiary population throughout all the phases of the project
- Training of three young including a young girl from the village on how to maintain the solar infrastructures
- For each medical consultations at the dispensary, each patient paid 0,50 EUR

Technical information on the infrastructures
Installation of solar kits in all 50 houses of the village as well as the dispensary. Each house had an independent solar kit with the following characteristics: 1 solar panel 160 Wp; 6–10 LED bulbs 10 W/12 V; 1 solar accumulator/ Battery; 1 charge controller; 1 protection kit again power surge; 1 scaffolding and other required material for electric installation. The dispensary includes 1 solar panel 1,000 Wp; 40 LED bulbs 10 W/12 V; Solar accumulators; Inverter; Solar fridge; 1 charge controller; DTO.

Project financing and costs
The total investment cost of the project was 35.000 EUR. The project was financed through donations, legacies of private persons, private enterprises working on solar and German NGOs including Solarcomplex from Singen, Sunways from Konstanz, Centrosolar Sunny, Solarworld, Centrotherm, GP Solar and Deutsche Umwelthilfe.

Policy and regulatory frame work
There was no policy who supported the project, the project also does not receive any support from the Cameroonian government. To bring the solar kit components to the village, ISC Konstanz had to pay a high cost for taxes and clearances.

Project outcome
- Education: as children could now study in the evening, a significant improvement in their scores was recorded – from E to C.
- Health: health improvement amongst the inhabitants thanks to a lower reliance on diesel, better care of the patients at the dispensary and the possibility to conserve medicines and drugs.
- **Economics:** each household saved at least 35 % from their previous expenditure on energy and enjoy a better service with clean energy.
- **Social:** the village has become more attractive, a result that led to less rural exodus. It has even become the most attractive village in the Littoral region.

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6.5 Mobisol GmbH

- **Mobisol GmbH**
- **Mobisol – Solar-Empowered Entrepreneurs**
- **Tanzania and Rwanda**

The company
The Berlin-based social business Mobisol develops, delivers and services high-quality solar home and business systems for low-income customers in Tanzania and Rwanda.

The challenge
Energy poverty in Tanzania and Rwanda is widespread with electrification rates of less than 10 % and even lower rates in rural areas. As access to reliable energy constitutes a precondition for thorough economic growth, the demand for energy is continuously rising.

The major obstacle to inclusion in the national grid is that it is simply not economically viable. Strong solar radiation ratings and scattered settlement patterns predesign the region for decentralised solar solutions. However, the base of the economic pyramid lacks financial resources to purchase larger off-grid solar systems.

Opportunities for productive use
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 energy-based enterprises such as phone and lantern charging stations, solar powered barber shops or village cinemas. Customers can therefore actually make money and simultaneously pay off their personal energy source.

It is in this way that Mobisol overcomes several challenges at once: The provision of electricity for rural households and businesses, the stimulation of economic growth by empowering entrepreneurs and the protection of the environment by ensuring sustainable and CO_2 neutral energy consumption patterns.

Project description
Mobisol provides high quality solar systems powerful enough to run small businesses in rural or semi-urban households without prior access to reliable energy. Additionally, a range of business kits was developed to empower rural entrepreneurs. The systems are made affordable by a micro-financed installment plan that is paid off in monthly rates via mobile banking. Mobisol solar systems come complete with an extended warranty, remote monitoring of each system and a full service package including a free customer care hotline and three years free maintenance and repair within 48 hours. In order to effectively and sustainably service customers, the Mobisol Akademie was established in 2014 and now trains all staff and local entrepreneurs working as Mobisol technicians and sales personnel.

Project financing and costs
Mobisol's total budget consists of a mix of angel investors and institutional equity, institutional grants and loans from international development banks. Mobisol has raised total capital around USD 30 m and USD 6.7 m in grants and reached breakeven in early 2015.

Policy and regulatory frame work
Market expansion was furthered by political commitment such as from the Government of Rwanda. Mobisol also recently received substantial financial and operational backing from the DEG, the EU and the GSMA in order to support the build-up of infrastructure and a sustainable scale-up.

Project outcome
Mobisol has electrified over 23,000 households in East Africa. 40 % of their customers earn an incremental income with the Mobisol system (each approx. USD 300 per year) by, for instance, charging mobile phones and solar lanterns – thus achieving a substantial impact on the rural economy. Additionally, Mobisol contributes to capacity building through the Mobisol Akademie and has already directly created over 300 green jobs in East Africa. Mobisol's electrification model currently offsets approximately 5,250 tonnes of CO_2 per year by substituting fossil fuels. The company is growing at a yearly rate of over 250 % and will expand to other East African countries in late 2015.

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6.6 Neu-Ulm University of Applied Sciences

- **Neu-Ulm University of Applied Sciences (HNU)**
- **Applied Entrepreneurship Education Programme (AEEP)**
- **Ethiopia**

The company
The Neu-Ulm University of Applied Sciences (HNU) is an international connected business school. It prepares bachelor and master students orientated towards future management tasks and runs different kinds of interdisciplinary projects in several African countries.

The challenge
In the Applied Entrepreneurship Education Programme project, HNU focused on two different kinds of location areas within their productive use of energy stream: an electrified city and at an unelectrified rural area. In both cases, the income level of people is very low and their price sensitivity is very high. In rural areas, in particular, a further problem is the low population density which further decreases the market potential.

Opportunities for productive use
Productive use of energy is needed to increase the quality of life and reduce the need for inhabitants to walk into the city to obtain electricity services. In cities, it offers the possibility to offer mobile moveable solutions that provide local services customers and thereby, enables entrepreneurs to achieve a much higher income than they would achieve if they had just a stationary solution.

For rural areas moveable solutions are needed to increase the draw area and thus the income possibilities for such businesses. However, infrastructure conditions are often a major bottleneck. Hence, when considering moveable solutions, the area conditions have to be selected carefully. Moveable vehicles such as compact solutions are generally preferable for cities and flat ground in rural areas. Meanwhile, “plug and play” solutions should be targeted for hilly areas.

Project description
The project was conducted together with the Arba Minch University in Ethiopia to develop, test and implement the project at Arba Minch and run for 3 years. The solar company Phaesun GmbH, XCOM Africa GmbH, Sahay Solar Initiative e.V. and the Chamber of Crafts Ulm supported the project as industry partners.

The project focuses on entrepreneurial education with the objective to create job opportunities. Micro entrepreneurs were trained to build and maintain prototypes for diverse kind of businesses such as for productive use of energy businesses. Within the two education runs of the study courses, eight Business Opportunities with Solar Systems (BOSS) models were developed and constructed in Arba Minch with the assistance of Phaesun. In the first run of the project, a solar-powered 1) barber shop, 2) cafeteria, 3) charging station and 4) ice cream shop were developed and implemented. In the second run, a solar-powered 5) mobile city photography shop, 6) ICT training center for rural areas and 7) rural mobile photograph were developed and constructed and will be implemented within the next month in Arba Minch and rural surroundings.

Project financing and costs
The project funds come from the German Federal Ministry of Cooperation and Development and are received from DAAD under the umbrella program “Industry partnerships 2013”. The program has a financial revolving mechanism. Micro entrepreneurs get materials for building the prototypes and are obligated to pay back all costs including a small extra fee within 2 years to the Arba Minch University, so the university can refinance the program with the repayments.

Project outcome
The major impact of the program was the creation of jobs with sustainable income for people who were previously jobless. Rural businesses have also improved the quality of life of the villagers. And finally, the long-term training program has enabled the Arba Minch University to deliver outstanding community services.

Potentially single micro businesses will be scaled up in the form of a production facility and a similar or adapted project version will be implemented in a further University in Ethiopia and potentially South Africa.

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6.7 Phaesun GmbH

- **Phaesun GmbH and Horn Renewables**
- **Business Opportunities with Solar Systems in Somaliland**
- **Somalia**

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 is fishing. Due to the lack of cooling opportunities, fishermen were unable to preserve their catch.

Opportunities for productive use
Off-grid solar power systems can be an important factor to support rural development in areas that are not connected to the electricity grid. The Phaesun Business Opportunities with Solar Systems (BOSS) solutions target specifically the commercial sector in unelectrified areas. The Phaesun technical team develops innovative solutions together with component manufacturers and partners in the target countries. Together with Phaesun, the local solar company Horn Renewables has been implementing BOSS solutions since 2012.

Project description
Since 2012 the project partners have been developing and implementing entire BOSS solutions for the business needs of the users.

- Solar charging stations were developed and set-up in different locations in Somaliland. Besides the charging of mobile phones, LED lamps with integrated battery (Ulitium 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 financing and costs
There was no external financing institution involved.

Policy and regulatory frame work
The project was a private-sector initiative without any institutional framework.

Project outcome
Since the first introduction of BOSS solutions in Somaliland in 2012, the number of interested entrepreneurs has grown steadily. Until mid of 2015, more than 30 solar charging stations for cell phones and lamps have been opened. Furthermore, 30 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.

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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6.8 RVE.SOL

- **RVE.SOL – Rural Energy & Water Solutions**
- **KUDURA, power to change in Sidonge Village**
- **Kenya**

The company
RVE.SOL is a triple bottom line social entrepreneurship using renewable technology to eradicate poverty, create jobs and empower businesses in rural Africa. The KUDURA technology is a sustainable integrated solution encompassing potable water production and renewable energy generation, distribution, monitoring, mobile prepayment and smart metering, safe biogas and organic fertiliser, all within a single integrated system.

The challenge
Sidonge lies in western Kenya in an off-grid area and was chosen to implement a pilot project using KUDURA technology. The nearest power grid from the Municipal's Busia County has frequent losses. Chief activities in the area are subsistence farming of cassava, sand harvesting for building at the river and some cattle-raising.

The goal was to demonstrate, not only how renewable energy mini-grid could be reliable, cost-effective and increase the local living standard, but also that new services could be generated and provided to the community (e.g. a mobile phone charging station, a hairdresser's and video hall). The challenge was turning the model based on the concept of financing microgrids through positive cash flow, while maintaining a beneficial social and environmental impact.

Opportunities for productive use
Solar PV can play a significant baseline role in terms of enabling stand-alone productive use of energy, ranging from small-scale SME (e.g. cooking services, refrigeration and bottling associated with potable water) to industrial mobile BTS towers. It facilitates expansion of energy generation, distribution and prepaid metering for deploying a community-wide mini-grid. Biomass gasification, leveraging local waste, integrates well with the mechanical energy required for agricultural post-processing. And biogas digesters are excellent sources of renewable heat for cooking in restaurants or baking ovens assuming consistent availability of organic waste.

Project description
The KUDURA microgrid has been providing renewable electricity and potable water to 12 families in Sidonge since 2011. RVE.SOL is currently in the transition from pilot to market validation and commercialisation scale-up. The business model centers around defining sustainable financial models tailored to the local environment in which they will function. These are normally based around an Anchor-Business-Consumer model with the unique addition of ancillary resource production in the form of potable water in order to strengthen project cash flows.

Project financing and costs
RVE.SOL financed the pilot project with a focus to test the technology and validate community management – the cost of which amounted to USD 87,000. A local community-based organisation provided the on-the-ground know-how and community management. The fees for provision of water, biogas and electricity services fund the day-to-day operation. The project is expected to break even after a 12-year period of operation.

Policy and regulatory framework
Through the Rural Electrification Authority (REA) and the Energy Regulatory Commission (ERC), RVE.SOL applied and were awarded a small-scale energy generation and distribution permit. In addition, RVE.SOL completed the due diligence required to conduct an Environmental Impact Assessment, file the necessary reports and obtained the needed NEMA authorisation to go ahead with the project. Potable water was tested and certified by the National Water Authority.

Project outcome
After four years of pilot project, RVE.SOL funded a third party survey which concluded, not only that KUDURA technology is reliable and cost-effective (compared to kerosene), but that consumers were willing to pay for clean energy & water services and were organising themselves to gain extra income for that purpose. The research indicated high-level social impact with regards to health, education and wealth, while reducing environmental impact.

There was a mobile charging kiosk during a first phase, which could bring an entrepreneur USD 4 – 5.50/day or up to USD 165/month. However, it was interrupted due to frequent changes in the individuals and was ultimately destroyed by inclement weather. Community management and financial governance continue to be key challenges. In any case, the use and payment for electricity, with new households signing for the expansion phase, will open the perspective for new PEU.

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6.9 Smart Hydro Power

- **Smart Hydro Power GmbH**
- **Irrigation for rice plantation powered by kinetic hydropower and PV**
- **Colombia**[7]

The company
The company: Smart Hydro Power designs, fabricates and installs hydro-kinetic turbines in the range of 1 to 50 kW. It is a unique and proprietary plant which is built up in modules and which is integrated together with PV into a complete hybrid system for rural electrification.

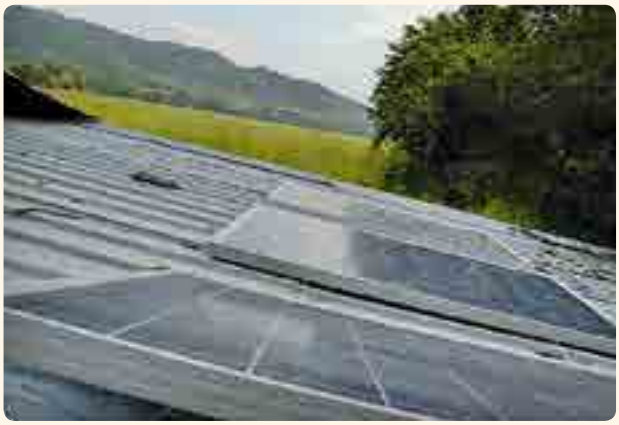
The challenge
Rice requires constant irrigation. In the case of the rice farm in Neiva, it was not connected to the grid. As a result, irrigation pumps were powered by 110 kW diesel generators – a solution which was both expensive (USD 1.2/l) and environmentally unhealthy.

Opportunities for productive use
There were opportunities to partially replace the rice farm's dependence on diesel.

Project description
Installation of an irrigation pump was directly powered by a hydro-kinetic turbine. The turbine generates an average of 1.1 kW with 36 m^3 water pumped over 3.5 m height per hour. The diesel replacement was measured and monitored by SENA, a Colombian training institute. First results show costs savings per 1,000 m^3 pumped water of 65 % of the USD 1.2/l costs for diesel and an average water velocity of 1.5 m/s.

Project financing and costs
Because the project was employed as a trial and reference case using different technology types (incl. PV), total project costs exceeded EUR 80,000. This was co-financed by Smart hydro Power co-financed by the German Energy Agency (DENA). The installation of the final equipment (incl. turbine, direct interface and pump) generated EUR 17,000 in additional costs, which would be repaid through diesel savings.

Policy and regulatory framework
The current Colombian policies do not apply.



Project outcome
The project was successful. Part of the irrigation is now powered by green energy. Smart Hydro Power will integrate the kinetic pump in a standardised version in its product portfolio starting January 2016.

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7 The business case could also be applied in the context of Africa

7. References

Under consideration of the feedback received from ARE members and partners active in rural electrification, this paper also reflects views, statements, findings, facts and figures from the following sources:

Anil Cabraal R., Barnes D.F., Agarwal S.G., World Bank, Productive uses of energy for rural development.

Annemarije L. Kooijman-van Dijk, The role of energy in poverty reduction through small scale enterprises in the Indian Himalayas.

ARE (2011), Rural Electrification with Renewable Energy: Technologies, Quality Standards and Business Models.

ARE (2013), Renewable Energy Based Rural Electrification – Industry Lessons Learnt to Make Public Supporting Schemes a Success

ARE, AEEP (2014), Best Practices for Clean Energy Access in Africa

Barnes D. (1988), Electric Power for Rural Growth: How Electricity Affects Rural Life in Developing Countries. Westview Press: Boulder.

Bensch G., Peters J., Schmidt C.M., (GIZ), (AEI), Impact Evaluation of Productive Use – An Implementation Guideline for Electrification Projects Productive Use of Electricity (PRODUSE).

Best S., Growing Power: Exploring energy needs in smallholder agriculture, IIED.

Bose S. (1993), Money, Energy and Welfare: The State and the Household in India's Rural Electrification Policy. Oxford University Press: New Delhi.

Campen B., Guidi D., Best G. (2000), Solar Photovoltaics for Sustainable Agriculture and Rural Development. Rome: Food and Agriculture Organization.

Economic Commission for Africa (ECA) Southern Africa Office (2006), Sustainable energy – a framework for new renewable energy in the southern Africa.

Etcheverry J., Department of Geography and Institute for Environmental Studies, University of Toronto, Renewable Energy for Productive Uses: Strategies to Enhance Environmental Protection and the Quality of Rural Life

EUEI PDF et.al., Workshop Productive Use of Energy in Ghana 12 Dec 2013 – Summary Report

GIZ, Productive Use of Energy (PRODUSE) – Measuring Impacts of Electrification on Small and Micro Enterprises in Sub-Saharan Africa.

GIZ and EUEI PDF, Productive Use of Energy (PRODUSE) – A Manual for Electrification Practitioners

Kapadia, K. (2004), Productive Uses of Renewable Energy: A Review of Four Bank-GEF Projects. January 2004 draft version. Washington, D.C.

RECP, EUEI PDF, ARE, REN21 (2014), Mini-grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-grid Roll-outs

SE4All Energy Access Committee Report of 27 May 2014

The Economist (2009), Triple bottom line

UNDP, Project document: Productive Uses of Renewable Energy in Guatemala (PURE)

UNDP 2015, EnergyPlus Guidelines: Planning for Improved Energy Access and Productive Uses of Energy

Weingart, J.M. and Lee, R.F. (2000). Widespread Implementation of Renewable Energy Projects in APEC Member Economies: Road Maps for Success. Silver Spring, USA: Alternative Energy Development Inc.

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About the Alliance for Rural Electrification
The Alliance for the Rural Electrification (ARE) is an international business association representing the decentralised energy sector working towards the integration of renewables into rural electrification markets in developing and emerging countries. ARE is the custodian to the Africa EU Energy Partnership's work stream on energy access.

About the Africa-EU Energy Partnership
Established in 2007 as one of the partnerships under the Joint Africa-EU Strategy, the Africa-EU Energy Partnership (AEEP) is a long-term framework for strategic dialogue between Africa and the EU aimed at sharing knowledge, setting political priorities and developing joint programmes on key energy issues and challenges of the 21st century. The African Union Commission, Germany, Italy and the European Commission are the Steering Group members providing political guidance to the Partnership.

http://www.euei-pdf.org/downloads/africa-eu-energy-partnership-aeep

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