BEST PRACTISES OF THE ALLIANCE FOR RURAL ELECTRIFICATION

What renewable energies can achieve in developing and emerging markets






Alliance for Rural Electrification

Shining a Light for Progress

Table of Contents

Introduction

The new Best Practises of the Alliance for Rural Electrification (ARE) is a compilation of successful case studies implemented by ARE members and partner organisations.

Interested parties are welcome to make use of this professional worldwide network in order to replicate and to upscale proven experiences along the complete value chain for renewable energies and rural electrification.

What makes the third edition of this publication so valuable is that it shows the latest innovations and affordable rural electrification solutions for all developing regions in the world.

To provide access to sustainable electricity and services, different types of renewable energies (biomass, small hydro, small wind and solar) and technologies can be used or combined to best address local needs.

Furthermore, this publication also shows the strong involvement of a wide diversity of international stakeholders, from public sector to donors, that have recognised both, the need for and the potential of renewable energy business evolution in developing countries and emerging markets.

According to the International Energy Agency's World Energy Outlook 2012, 1.3 billion people in the world do not have access to electricity or remain un-electrified due to poor quality of the grid. Out of them, 84% live in rural areas.

Rural areas are characterised by their remoteness and low population density. While often grid extension is not a feasible option, decentralised renewable energy solutions are the better alternative to alleviate energy poverty: they are cost-effective over the system's lifetime, easy to deploy, install and maintain and their design can be tailored to demand needs. Plus, these regions offer abundant renewable energy resources.

Actually, according to the Energy Access Practitioner Network initiated by the United Nations, 60% of the additional generation capacity needed to reach universal access to electricity by 2030, will be off-grid. The undeniable conclusion is that renewable energy is part of the answer to power the needs of the world's poor, and a prerequisite for development.

As the following case studies will show, the available technologies are able to serve the market needs by offering a competitive range of products with breakeven periods of sometimes less than two years. Furthermore, this selection of projects has led to considerable reductions of CO_2 emissions.

Renewable energy solutions should become a key element of rural electrification plans in developing countries, as they can also support local business creation, improve water irrigation and sanitation systems, as well as offer new opportunities for public health, education and gender equality.

As the trends in the current international policy agendas indicate, to achieve the global challenge of universal clean, reliable and sustainable electricity services, it is vital to keep developing the still young rural electrification markets until they become mature and self-sustainable.

Since the launch of Sustainable Energy for All (SE4ALL) by the United Nations in 2011, access to energy has become one of the main priorities in the international development agenda. As a proof of its importance, the Post-2015 Development Agenda will integrate energy access as one of its primary targets. This acknowledgement comes from the fact that, in spite of not being included in the Millennium Development Goals (MDGs) agenda, energy was treated as a cross-cutting issue essential to the achievement of any other goal.

The Alliance is willing to share the experience and intelligence of its network with stakeholders from both the public and the private sector. With this brochure, the Alliance aims to contribute to the establishment of a suitable regulatory, policy and financial framework to foster better market conditions for the renewable energy industry.

Ernesto Macías, ARE President

Marcus Wiemann, ARE General Secretary

About the Alliance for Rural Electrification

The Alliance for Rural Electrification is the international business association focusing on the promotion and development of off-grid renewable energy solutions in developing countries and emerging markets.

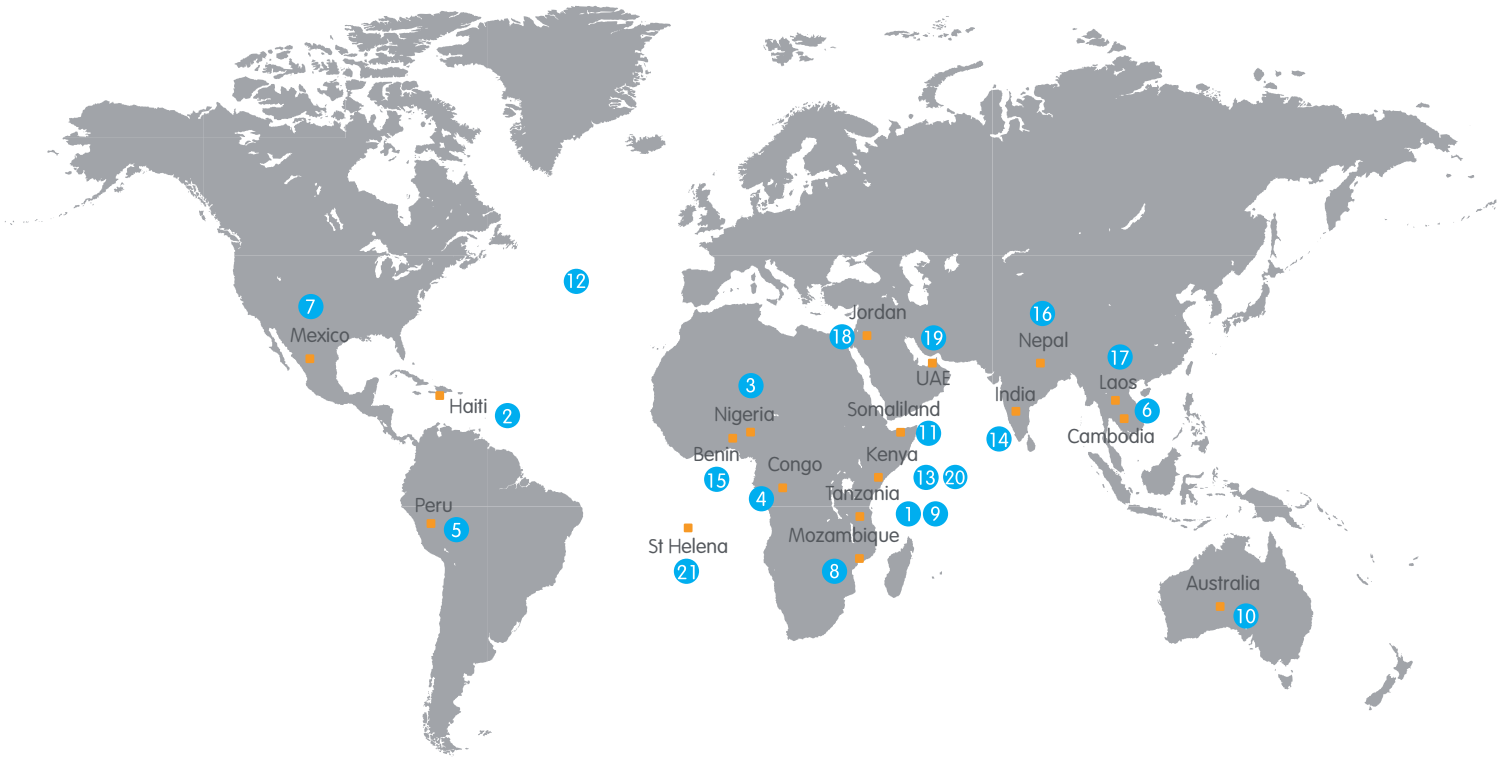
ARE serves as global business matching platform for sharing knowledge and best practises to enhance access to energy and services.

ARE has more than 70 committed members, who represent the full value chain for renewable energies, including industry, academia, not-for-profit, and public sector.

www.ruralelec.org

Alliance for Rural Electrification
Shining a Light for Progress

ARE Project locations around the World



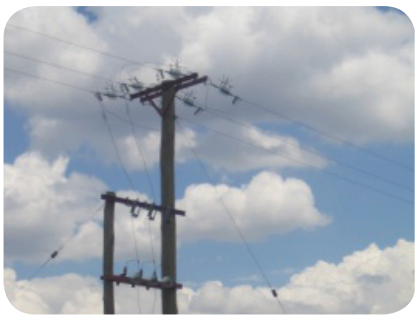
1. Acra-CCS – Tanzania
2. Centrosolar Group AG – Haiti
3. Eauxwell Nigeria Ltd – Nigeria
4. Fodazione Madre Agnese – Democratic Republic of Congo
5. Fundación ACCIONA Microenergía – Peru
6. Innovation Energie Développement (IED) / IED Invest – Cambodia
7. Ilumexico – Mexico
8. IT Power Ltd – Mozambique
9. Mobisol GmbH – Tanzania
10. Off-Grid Energy Australia – Australia
11. Phaesun – Somaliland
12. Reiner Lemoine Institut GmbH – Global
13. RVE.SOL – Kenya
14. SMA Solar Technology AG – India
15. Solar Electric Light Fund (SELF) – Benin
16. Studer Innotec – Nepal
17. Sunlabob Renewable Energy – Laos
18. Sunna Design – Jordan
19. Trojan Battery Company – United Arab Emirates
20. University of Southampton – Kenya
21. Wind Energy Solutions – Saint Helena

Case study 1

ACRA-CCS

Sustainable community-based hydropower supply in seven villages of Ludewa District

TANZANIA



Installed powerline

The organisation

ACRA-CCS, established in 1968, is an independent Italian NGO committed to the fight against poverty through sustainable, innovative and participatory solutions.

The challenge

The Ludewa District lacked access to electricity except for very few private diesel generators used for a limited number of productive activities (mainly milling) and some minor services. Natural resources management and agricultural activities in the watershed were not sustainable due to high soil losses and sedimentation in streams. Also, the diversification of productive activities was very limited. At the time of establishment of the project, it was estimated that the energy demand was of about 600,000kWh/year.

Opportunities for renewables

The installation of a 300kW hydropower scheme at the Lihata waterfall to provide 1,400 users in rural settlements with electricity.

Renewable solution

The installation of the infrastructure is complemented with activities for the constitution of a community-based association, LUMAMA, and its capacity building (good governance, management and technical). The community-based ownership of the system is complemented with awareness campaigns targeting the local population. Hydropower generation promotes the establishment of private and profitable initiatives for forestry and conservative agricultural production and facilitates improvement in environmental sustainability. It also supports business creation, and has an impact on household economy and on energy consumption. The long-term sustainability of the project will be ensured by revenues from the hydropower plant and the LUMAMA staff, who, properly trained, will be able to manage the plant.

Project financing and costs

Since the first phase of the project in 2006, the total cost of the programme amounts to about $6.76 million. The second phase (1st September 2011 - 31st August 2014) is co-funded by the European Union 10th European Development Fund, the World Bank – Energy Development and Access Project in Tanzania, the Ministry of Energy and Minerals of Tanzania and Intervita Onlus. Other partners include local NGO NDO.

Tariffs applied to end users are slightly lower than the National Utility. As capital investment was entirely granted by donors, the project will cover operation and maintenance costs including depreciation by 2015, ensuring self-sustainability.

Project outcome

20,000 people are indirectly benefiting from the project the project while those directly connected are currently about 5,000. The main lessons learned are that community ownership of the system allow social sustainability by mitigating elite grabbing and corruption (e.g.: local authorities and politicians not paying are disconnected and treated as normal customers without side effects). Community-owned hydropower generation is revealing to be a very strong incentive for natural resource conservation and watershed management. Research is being conducted in collaboration with national and international academic institutions in order to validate the model for replication. The main future challenge is that the current production will not meet the projected demand in 15 years. However, connection to the national grid will allow for increasing revenues and number of connections.

Electricity now supplies households as well as small productive enterprises (mills, oil presses, carpentries, etc.). Service is provided to all schools, health centres, one hospital and all public offices in the area. At national level, the policy framework is being revised to grant a suitable environment for sustainable business investment.

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Case study 2

Centrosolar Group AG

Solar for Haiti

HAITI

PV plant on children's hospital

The company

Centrosolar is a Germany-based group of solar companies, with their own module factory in Wismar and sales offices all over the world.

The challenge

The international NGO Nuestros Pequeños Hermanos (NPH) runs Haiti's best children hospital in Tabarre, close to the capital Port-au-Prince. Electricity has to be available 24 hours a day, 7 days a week. For that purpose, the hospital was using diesel generators. The increasing cost of diesel and the air pollution trough the generators led NPH to look for a solution for generating electricity at a much lower cost and environmental impact.

Opportunities for renewables

Some areas of Haiti suffer from extreme poverty levels and lack of electricity access. The Government has shown great interest in solar technologies and there is high solar irradiation on site, but the consumption of 2,300 – 2,500kWh per day rendered an autonomous solar solution impossible due to lack of finance. Therefore, PV plant supporting the diesel generators has been chosen.

Renewable solution

The new generation of Solar Fuel Save controllers allows a PV plant to run parallel with another diesel generator. Centrosolar designed a PV plant size capable to fill the gap between the electrical base load of the hospital and the day peak. 85kW of crystalline modules have been installed on the flat roof and have been connected to the AC line via five SMA inverters (Tripower 15000) and a transformer. The installation of all components has been realised by local workers with support and guidance of European solar engineers. The local staff has been trained on site to manage and monitor the complete system.

Project financing and costs

The cost of the projects ranged about €50,000 (approximately $67,000). Many materials were donated by the European solar industry. The German Biohaus Foundation, main partner of the project, was able to collect all modules, cables and supporting structures needed for this project for free. No public subsidies have been used.

Project outcome

Patients (10,000 per year) and hospital staff benefited from the project through improved scope of medical treatment. NPH Haiti is investing the money saved from diesel ($0.27/kWh; $100/day) in buying medicaments and in covering other needs. Breakeven is expected after two years. Based on the good experience, a follow-up project is planned: SMART SOLAR GRID TABARRE. These projects will combine all the partial electricity grids of NGH institutions in the neighbourhood and integrate as many decentralised PV plants as possible.

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Case study 3

Eauxwell Nigeria Ltd.

Mini-grids for remote and rural communities

NIGERIA

The company

Eauxwell Nigeria Limited, established in 1987, is the leading water and renewable energy-engineering firm in Nigeria. Eauxwell is committed to the growth of the alternative power sector in Nigeria through the use of innovative products and concepts. The company specialises in product sales, installation and project services in the field of solar street lighting, solar water pumping, rooftop and ground mounted off-grid systems, as well as hybrid and backup power supply systems.

The challenge

The Federal Government of Nigeria commenced a pilot scheme to provide rural areas in various geopolitical zones with access to electricity in order to increase rural electricity penetration. Decentralised systems were preferred due to difficult terrain and high costs associated with grid extension. In some cases, communities are only accessible by waterways. The major requirement of electricity by most communities is for lighting purposes.

Opportunities for renewables

Due to the decentralised and remote nature of the locations, the obvious choice was to design mini-grids powered by solar or wind energy. Solar photovoltaic was preferred due to its minimal maintenance requirement during the life cycle of the project.

Renewable solution

Installations of mini-grids using 90nos SolarWorld SW140 poly, 1x SMA Sunny Island SI5048, 48x Hoppecke OpzS solar power 1220. Upon completion, two technicians were trained on basic maintenance operations. Transmission lines were installed along 800m of the community with each of the 40 transmission poles holding a 20W LED street lamp. Each of the 120 households was provided with four to five 7W LED bulbs.

Project financing and costs

The project was fully financed by the Federal Government of Nigeria and executed within a period of four weeks in technical partnership with SolarWorld Africa. End users are not required to pay for any costs but need to provide land and security for the installations.

Project outcome

All the installations benefitted over 700 residential households. Some of the sites led to the setup of small clinics. The success has led to plans for 50kWp systems based upon similar applications. Incorporation of a billing system is being discussed for future installations.

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Case study 4

Fondazione Madre Agnese

From water sources to homes

DEMOCRATIC REPUBLIC OF CONGO

Hut with PV system and water tank

The organisation

Fondazione Madre Agnese Manzoni is an Italian non-profit organisation recognised by the Governments of Italy and Democratic Republic of Congo that develops solidarity projects in the fields of social welfare, nature, renewable energies, water collection and distribution, sewage techniques, food and water safety.

The challenge

In the hilly region of the Lower Congo, the water sources flow at the bottom of deep valleys, while the population lives on the top of the ridges. In order to draw drinkable water and to bring it to the households, a minimum of 2,000W per 100m of rise difference is required. The principal technical difficulty lies in recharging the batteries during the dry months and in conducting training programmes.

Opportunities for renewables

Three types of renewal energy have been used: solar photovoltaic, wind and hydro. Solar energy has been used to recharge the batteries and to directly feed the water pumps from a lower tank to an upper one. Wind is used at night to compensate the lack of sun.

Renewable solution

The project consists of the installation of a base system of solar panels (approx. 2 X 90Wp), electrochemical batteries (60 – 80Ah), and low consumption pumps, reduced hydraulic head (approximately 15m).

The systems are constructed in the huts that are strategically located perpendicular to the source. These huts are connected to other huts through pipelines which are placed laterally or on a slightly lower level.

Trained locals have the task of running the pipeline and the installation of solar panels. This enables to verify if the system has been well-serviced and can therefore be sustained.

Project financing and costs

The total investment depends on the implementation phase, because the project is based on a modular intervention depending on the zones where water sources are found.

Every module requires the installation of at least 10 to 15 systems in as many main huts as chief points for water storage and redistribution.

Each unit cost is approximately $540, and a total of approximately $5,800 – $9,800, depending on the difference in height.

All the costs of primary material are fully met by the Foundation, while transport and installation costs are borne by the end-users.

The project will be serviced by each user-family, which will contribute a weekly fee in return of the water received. Each family can make use of the funds coming from the sale of vegetables, which cost increases considerably in the markets found along the ridge during the dry months.

Project outcome

Each module benefits 400 to 500 people, with an initial specific cost for hardware material of about $18 per person. The project can be replicated. Furthermore, the population feels involved in the global functioning of the system.

To improve its efficiency, it would be useful to double the power of the solar panels. In the case of huts being fairly close to each other, it would even be possible to install one single solar system, which could serve all the huts.

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Case study 5

Fundación ACCIONA Microenergía

Luz en Casa (Light at Home): providing basic electricity services with solar home systems for human development

PERU

Installed PV panel

The company

Fundación ACCIONA Microenergía (FUNDAME) is a corporate foundation of the Spanish company ACCIONA, established for providing basic services to people living in isolated rural areas. FUNDAME started in 2009 ACCIONA Microenergía Peru (AMP) intending to supply electricity to isolated rural communities in the Peruvian Department of Cajamarca by means of solar home systems (SHSs). AMP is the first and only Peruvian electricity provider of SHS exclusively.

The challenge

Luz en Casa brings basic electricity services at an affordable cost to poor and isolated rural Peruvian communities. Grid extension in these areas is operationally and financially very challenging, due to the remoteness and scattering of the locations, as well as due to their low demand levels (average of 7.5kWh per month per household).

Opportunities for renewables

The deployment and use of renewable energy technologies, improved through sustainable management models, enables users to have better basic lighting and communications services than the existing ones and all this at a lower cost.

Renewable solution

AMP installs and maintains SHS comprising one photovoltaic (PV) panel (60-85Wp), one gel sealed lead-acid battery (100Ah), one regulator (10A) and three energy-efficient lamps (12VDC). The system can power low-consumption electrical appliances. A fee-for-service model is applied: it is developed within a regulatory framework based on a regulated tariff (implemented by the Peruvian regulator in 2010, and driven by FUNDAME) and a cross subsidy for exploitation to guarantee the affordability: the present tariff is about $17/month, of which the user pays less than $3.5/month. SHS can be used during 20 years. Once the installation is completed, AMP charges users the fee and uses the revenues to pay the operation and maintenance costs. The installation and maintenance tasks are carried out by local people, trained by AMP to become technician-entrepreneurs.

Project financing and costs

During the first phase of the programme FUNDAME donated 1,300 SHSs (average of $750 each) and the implementation costs of AMP. In 2012, AMP was awarded a long-term credit by FOMIN-IADB to buy additional 1,700 SHSs. With the 3,000 SHSs in use, the sustainability of AMP and the Luz en Casa programme is expected to be reached by the end of 2013.

Project outcome

Approximately 3,000 households are benefitting from an efficient illumination that extends the working day, while avoiding the negative impact of diesel lamp smokes on people's health. The SHSs also powers TV and radios, reducing their degree of isolation.

The programme has reduced the end-user's payoff for alternative electricity components by 33%, has contributed to job creation in rural areas, and has involved national, regional and local governments.

FUNDAME is currently exploring possible collaborations with micro-financing institutions and telecommunications operators (pre-paid system), as well as looking for technology innovations to improve its model.

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Case study 6

Innovation Energie Développement (IED) / IED Invest

Biomass gasification as a sustainable alternative for rural electrification

CAMBODIA

Rice husk gasification for rural electrification

The company

Founded in 1988, IED is a French independent engineering consultancy firm active in the energy sector: policy and planning, rural electrification, renewable energy and energy efficiency. Services provided cover all the stages of the project cycle in more than 40 countries across Africa, Asia and Europe. In 2011, IED established the sister company IED Invest to develop, finance and operate small renewable energy projects.

The challenge

Less than 15% of Cambodia's rural population has access to grid-based electricity. Rural Electrification Enterprises (REE) were set up to develop mini-grid systems and are playing an important role when improving energy access.

However, the REE decentralised mini-grids are mainly based on inefficient diesel gensets leading to very high production cost. Rice husk has been increasingly used over the last years to produce energy for captive uses, but there are only a few examples of biomass gasification for rural electrification worldwide.

The challenges of the Charchuck project were to meet the load fluctuations, to provide a system that enables a reliable 24 hours a day service at a cheaper end user tariff than with fuel, and to find adequate solutions to address wastewater environmental issues.

Opportunities for renewables

Cambodia has a very large number of rice mills and there is an excess of husk, which can be harnessed in several provinces. Opportunities are also offered by other biomass resources from rubber and cashew nut plantations, coconut shells or bamboo, among others.

Renewable solution

Biomass gasification is basically the conversion of solid fuels, like wood and agricultural residues, into a combustible gas. The system installed consists of a gasifier burning the fuel at more than 400°C. Afterwards, it cools the gas, which flows into a gas treatment line that feeds two engines (100% gas and dual fuel) with clean producer gas.

This is the first Cambodian gasifier that includes a water treatment plant to clean the processed water, and function in a closed circuit. A local team has been trained to operate the system and to ensure its maintenance.

Project financing and costs

IED Invest mobilised funds from its own resources and from the United Nations Industrial Development Organisation (UNIDO) and the Renewable Energy & Energy Efficiency Partnership (REEEP). IED provides technical support, and the company's local branch CCDE is in charge of site operation and maintenance. Investment costs are between $2,000 - $3,000/kW installed. The system feeds a local mini-grid, but it could also easily supply power to the national grid in case of extension.

Project outcome

Thanks to the project, service hours were extended from 16 to 24 hours a day, while decreasing the end user tariff by 25%. Increase in capacity, funding of distribution network and tariff reduction resulted in the number of households connected to the mini-grid rising from 400 to 1,100 in the year following to the installation of the biomass gasifier.

Lower cost for improved service represents positive social impacts through income generating opportunities and wider energy service affordability.

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Case study 7

Iluméxico

Rural solar lighting programme for off-grid communities from Península de Yucatán MÉXICO

Family installing 15W solar powered lighting system

ILUMÉXICO
PRENDE LA LUZ DE MÉXICO

The organisation

Iluméxico is a social project which aims at eradicating energy poverty in Mexico. Its work seeks rural community development through clean energy access with photovoltaic home systems. This is complemented through training and capacity building (T&C), as well as through maintenance programmes to promote local entrepreneurs, community empowerment and income-generating activities.

The challenge

In Mexico, 3 million people live without access to electricity. The Government's Electricity Comission target is to provide 40-50% of those who live in larger communities with electricity in 10 years. The communities involved in this project have no access to the national grid and are located in almost inaccessible rural areas with very low economic incomes.

Opportunities for renewables

Campeche and Quintana Roo have excellent wind and solar potential, and both public and private stakeholders are using renewable technology to take advantage of these abundant natural resources.

Renewable solution

The project started with the installation of 375 systems in 20 different communities, five 180W school systems and a 130W solar water pumping system to provide running water to a Mayan community. During a second phase, 112 systems were installed for a total of 487 households. Since then, six maintenance visits have been made. Iluméxico has also implemented workshops to promote community development: a two-phase workshop for better practices in community problem-identification and decision-making processes, and a financial programme.

Project financing and costs

The project was funded by the Mexican Energy Ministry (SENER) and a private initiative called iMx (Iniciativa México). These funds allowed Iluméxico to cover all operational expenses and to subsidise 30% of the cost of the equipment, leaving the remaining 70% to be covered by the end user in a one-year payment programme. Also the local NGO Amigos de Sian Ka'an donated a solar water pumping system, water filters and solar systems.
Additionally, in-kind contributions enabled the organisation of environmental awareness, financial education and health workshops.

The Mexican Social Development Ministry and the Electricity Commission provided backup and logistics in order to find the ideal communities for the project. The pricing model for end users was a one year credit plan where they paid an upfront cost of around $20 and a monthly contribution of $16-17 for 12 months, paying a total of $195. Costs of the rural branch: $10,000 upfront cost and $1,200 / month fixed costs. Each SHS is sold at $250 (15W) / $700 (60W) and maintenance for the user is $35/year.

Variable costs: An average of $75-90/person. Each household generates 25kWh/year for lighting (approximately). The cost (assuming 20 year lifetime with replacements) is $300/500kWh is 0.6$/kWh.

Project outcome

This project benefitted over 3,000 people, and contributed to reduce 0.25 TON CO_2 per system per year. Iluméxico will open a rural branch conducted by local trained technicians.

The whole project will breakeven when eight rural branches will be running. For this individual branch, if 50% of the customers purchase a service plan or Ilúmexico continues to install 20 households per month, the branch is breakeven after six months.

The goal is to continue to work in the region and to prove that a branch decentralised can create a 100% economically sustainable model to be replicated in other regions of Mexico and Latin America.

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Case study 8

IT Power Ltd

Off-grid electricity tariff model for renewable energy projects

MOZAMBIQUE

Off-grid tariff-setting has helped establish new renewable energy projects

The company

IT Power is an international renewable energy and climate change consultancy founded in 1981 that provides advisory and engineering services in sustainable energy and climate change to clients around the world. It has offices in the United Kingdom, India, China, Australia, Argentina and Kenya, working for governments and multinational agencies as well as public companies and private clients.

The challenge

Grid electricity tariffs in Mozambique are typically fixed by the Ministry of Finance. However, there was no regulation on how to set tariffs for off-grid electricity generated from renewable energy sources. This posed a problem for off-grid renewable energy projects set up by the Mozambique National Fund for Rural Electrification (FUNAE).

To ensure that sustainable off-grid renewable energy projects could be developed in Mozambique, it was vital for FUNAE to have an accurate tariff-setting tool created. This tool needed to assess financial, economic, social and environmental impacts on the cost of renewable energy electricity generated in rural off-grid locations.

Opportunities for renewables

Rural communities in Mozambique are ideally positioned to benefit from off-grid renewable energy projects. It is important to understand what tariffs can be charged to local communities and determine their capacity to pay for renewable off-grid electricity before constructing projects.

Renewable solution

IT Power developed a tariff-setting tool for FUNAE and provided capacity building and training to the organisation. The tool presents a balanced, accurate and easy to use way to calculate the tariff needed for energy services in remote locations of Mozambique. It includes data on Mozambique's most suitable renewable energy resources – namely small hydro, solar, wind and biomass technologies, and their off-grid capacities.

IT Power provided capacity building support and technical training to FUNAE staff to conduct surveys in rural locations. The surveys determined the willingness of end users to pay for renewable energy electricity in rural locations.

This tool directly improved FUNAE's regulatory capacity to develop more off-grid rural electrification projects in Mozambique and had a positive impact on the rural electrification policy throughout the Mozambican territory.

Project financing and costs

FUNAE funded the project themselves to stimulate inward investment into the Mozambican market for rural electrification.

Project outcome

The tariff-setting tool has been a worthwhile instrument for FUNAE to calculate the feasibility of developing off-grid renewable energy projects in rural locations. It has stimulated follow-up projects (including the mass roll out of 544 PV systems to schools, clinics and villages in rural communities). Additionally, the tool has been made accessible to other key stakeholders include the national utility (EDM), the Ministry of Energy and the National Regulator (CNELEC). The work carried out by IT Power has helped stimulate the rural electrification market in Mozambique and has set a precedent of best practice for other countries to follow.

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Case study 9

Mobisol GmbH

Combining solar energy, micro-financed mobile payments and comprehensive after-sales services

TANZANIA

Mobisol's Tanzanian technicians cleaning a PV panel

The company

Mobisol combines solar energy with micro-financed payment methods via mobile phone and a comprehensive customer service. The German company distributes high-quality solar home systems (SHSs) to low-income customers in developing countries.

The challenge

In the semi-urban and rural off-grid areas of Tanzania, electricity is needed mainly to illuminate homes, charge mobile phones, power household appliances and run small businesses. However, the solution of implementing off-grid energy systems entails two main problems: a lack of efficient micro-payment methods and the inability to offer long-term loans needed to purchase a quality system complete with after-sales services.

Opportunities for renewables

Tanzania's recent reform in the power sector created a more preferable climate for larger-scale employment of privately funded off-grid electrification schemes. Arusha region was identified due to already existing contacts to the local partner organisation Kakute Ltd.

Renewable solution

Using mobile banking services, payments can be made conveniently via customers' mobile phones following a 36-month instalment plan. Mobisol SHSs are available in four different sizes ranging from 20 to 200W. The smallest unit can light two rooms, run a radio and charge four mobile phones per day. The largest system powers multiple lights and consumer appliances like a laptop, a television or a DC refrigerator. Excess electricity can be used to run Mobisol's business kits such as mobile phone charging businesses or barbershops.
Mobisol SHSs come with an extended warranty and a full service package for three years including free maintenance. Through the GSM modem included in the solar controller, technical data are tracked and monitored by local technicians in a web-based interface. The remote monitoring technology allows for addressing potential maintenance problems swiftly and enables systems to be locked automatically in case of theft or overdue repayment. All technicians, sales staff and marketing agents receive regular training. Besides, capacity building is furthered by customer education courses.

Project financing and costs

The total project investment to date is $5 million. Mobisol was able to attract private investors, as well as grants and preferential loans by the Finance and investment section of the German Development Cooperation (DEG), the Energy & Environment Partnership / Southern & East Africa (EEP) and the Africa Enterprise Challenge Fund (AECF). Other partners include the mobile network operators Vodacom, Airtel and Kakute Ltd.

The fixed and upfront costs are mostly spent on pre-financing of the SHS, on wages for 50 employees in Tanzania and 20 employees in Berlin, on rent for the offices and on travels. The costs vary according to system size.

The total sales price of an installed SHS is the cumulative amount returned over the three-year period via monthly instalments. Payments are based on customers' previous traditional energy source spending behaviors. Due to expected growing cash flow, the project will reach breakeven in 2014.

Project outcome

Mobisol has installed over 1,000 SHSs in Tanzania. Customers reported that efficient, bright LED bulbs and longer light hours increased their families' productivity. One third of customers used their excess electricity to generate additional income.
Thanks to this successful pilot phase, since then, Mobisol has received numerous requests to venture different markets and is currently considering various options. They presently target the installation of over 3,000 systems in Tanzania, Kenya and Ghana for 2013.

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Off-Grid Energy Australia's full pre-assembled and tested containerised mini-grid solution suitable for all onsite power requirements

Case study 10

Off-Grid Energy Australia

Remote operations station – PV/storage/hybrid mini-grid power system AUSTRALIA

The company

Off-Grid Energy Australia (OEA) is a designer, manufacturer and installer of renewable stand-alone power solutions across Australia, Asia and the Pacific. OEA utilises the latest in PV, storage and inverter technology to deliver customised power solutions to remote locations.

The challenge

The requirement for a renewable power solution for the project location was primarily to reduce the on-going diesel fuel consumption and maintenance costs of the remote operations centre and accommodation facility. In addition, the promotion of clean and sustainable energy sources was a factor in the choice of the renewable system investment. The property has a maximum winter energy demand of 110kWh per day, with a peak power demand of 30Kw over three phases. Property loads included pumps, workshop and office equipment, cooking equipment, fridges/freezers, and lighting.

Opportunities for renewables

The remote site is located in almost desert-like conditions, with low rainfall and very high solar irradiance. The use of a reliable and robust PV array was chosen to maximise the large amount of available solar energy. The site encounters extreme heat conditions, commonly above 45°C in summer. The batteries and enabling equipment were carefully designed and housed to reduce the effects of this heat on the equipment, prolong life and improve performance.

Renewable solution

OEA first visited the site to conduct an energy review and obtain specific data required to make informed choices about the renewable power solution options to be provided. The entire mini-grid system (not including solar array) was pre-assembled and tested off-site prior to being delivered to the project location. This improved system quality control sped up the commissioning process, reduced time onsite and potential installation issues. An ongoing monitoring system was installed so that both the end user and OEA can remotely monitor system performance proactively. The time-frame from initial discussions to full system commissioning was around nine months.

Project financing and costs

The project was funded by a private investment trust as the end user is a not-for-profit organisation. The Australian Government provided solar incentives for the installation. The total project cost was $180,000 and is expected to save around $50,000 per year in diesel fuel and on-going maintenance costs. The project was solely designed, assembled and commission by OEA with technical support from SMA, Battery Energy Australia and Tindo Solar.

Project outcome

At peak occupancy, the property accommodates 40 people. Apart from the long-term financial and environmental benefits of the renewable mini-grid system, the property is now much quieter with reduced noise pollution removed, and cleaner with less fuel and oils kept on site.

This system design is scalable up to 300Kw peak demand with the appropriate storage and a PV/wind-/hybrid or combination energy sources. The designed unit is easily replicated for other applications due to its containerised housing, and full off-site assembly and testing. Further refinement of space utilisation and ventilation will be considered with future projects of this nature. The diesel fuel savings from the installation of the system will have a payback of roughly 4 years.

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Case study 11

Phaesun

BOSS – Business Opportunities with Solar Systems

SOMALILAND

Solar bar

Phaesun
stand-alone solar solutions

The company

Since 2001, Phaesun GmbH, based in Memmingen (Germany), has specialised in the sale, service and installation of off-grid photovoltaic and wind power systems. As one of the world's leading system integrators of off-grid energy systems, Phaesun offers products of all reputable manufacturers. International project management, training courses for customers and technical support complete the range of services offered. Phaesun has a daughter company in Vendargues, France, holds subsidiaries in Eritrea and Panama and can fall back on a worldwide partner and distribution network.

The challenge

The electricity grid in Somaliland is poorly developed and the roads are rough. Refrigeration of drinks and food in shops or restaurants is not common in remote areas. It is estimated that 75% of the population have mobile phones and the need for recharge is huge. In these areas the unemployment rate is huge but on the other hand it is difficult to find local technicians for maintenance.

Opportunities for renewables

Solar systems can increase the service quality of existing shops, bars and restaurants in rural communities. The opportunity to run electric light, recharge mobile phones, operate fridges and entertainment devices such as TVs or music boxes with solar power can improve service quality and service portfolio.

The Phaesun BOSS solutions specifically target the private enterprise sector in non-electrified areas. The systems are developed for the target countries, well adjusted to local requirements and with little maintenance needs. These systems bring autonomy and jobs to the people. Off-Grid solar systems are the only option for reliable energy supply in those remote areas.

Phaesun works closely with its partner Horn Renewables, based in Somaliland. Horn Renewables actively targets small businesses in rural areas and develops specific solar systems to improve their service portfolio.

Renewable solution

The Phaesun refrigeration kit is the best solution for reliable cooling and freezing needs. These kits include the solar fridge Steca PF 166, as well as the entire equipment for charging and installation material.

In 2013 the first customers of Horn Renewables bought refrigeration kits and a solar systems for mobile phone charging for their shops. The local partner gave instructions to the shop owners on how to run the solar systems. The solar systems are almost maintenance free.

Project financing and costs

These activities are not subsidised and they fully rely on private market mechanisms. The shop owners invest privately. This is a typical calculation for the pay-back period of the solar system:

Total investment made: €2,400
Daily income with the solar systems:
Sale of 45 drinks per day with an extra price of €0.12 for being cold = around €162/month.
Charging of 15 mobile phones per day at €0.12 = around €54/month.

With this additional income, the investment in the solar system is paid back within less than one year.

Project outcome

Some of the shop owners have already invested in the upgrade of their solar systems with fans or other devices - an indication that they are already making money and investing more in solar. Their customers are happy to charge their phones while enjoying cold drinks.

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Case study 12

Reiner Lemoine Institut GmbH

A GIS-based analysis of off-grid renewable energy potentials

GLOBAL

The company

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

The challenge

Rural or remote areas are either not electrified at all or the electricity production is based on diesel-fired gensets. Apart from the detrimental ecological impact, this practice of electricity generation experiences high economic pressure due to increasing world market prices for diesel. A hybridisation of gensets with renewable energies (diesel subsetting) such as solar PV or wind power with or without a battery is therefore increasingly economically viable. However, the market is very scattered and a profound locally resolved evaluation of the economic potential is hard to acquire. It strongly depends on local renewable resource abundance, diesel price, and distance to the central grid.

Opportunities for renewables

Diesel subsetting helps to alleviate both the economic pressure and the ecological jeopardy of a pure diesel-fired electricity production scheme. Furthermore, in many remote areas PV represents the most cost-effective way to provide electricity.

Renewable solution

The methodology developed at the RLI combines Geographic Information Systems (GIS)-based data analysis with a simulation model of hybrid systems to quantify the economic potential and localise the most attractive areas for diesel and rural electrification. The output include high-resolution resource data such as solar irradiation and wind speed, population data, existing electricity infrastructure, night lights, and local accessibility. By combining the datasets, off-grid electricity generation can be identified and the local economic attractiveness of a renewable hybrid system can be evaluated. It thus helps to get an overview of the inhomogeneous market of off-grid diesel offsetting. Complementing the GIS analysis, a simulation model predicts the cost-optimised configuration of a hybrid system thus quantifying the potential renewable installation capacities depending on local parameters.

Project financing and costs

The methodology has been developed at the RLI and, throughout last year, was refined in many projects with different cooperation partners. The RLI itself is co-funded by the Reiner Lemoine-Stiftung.

Project outcome

Industrial partners were provided with profound data helping them to identify the most attractive market regions for their specific technology. This includes the localization of non-electrified people, off-grid diesel-based power generation and evaluation of the local economic viability of renewable energy technologies. It constitutes valuable support for their respective business development and gives them a head start when entering new markets.

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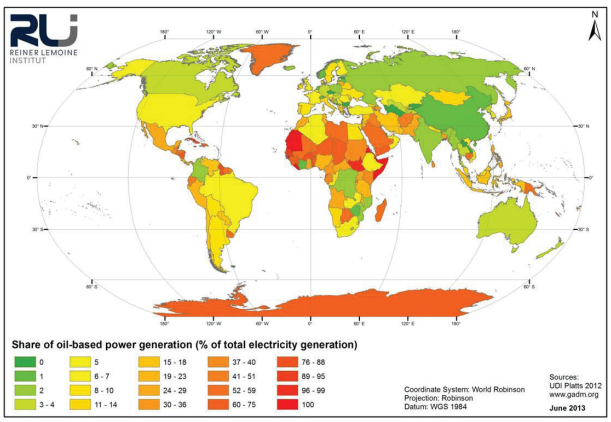

World map of oil-based electricity generation capacity share in 2012

Case study 13

RVE.SOL – Rural Energy & Water Solutions Lda.

KUDURA: Changing rural life forever in Sidonge "A" Village
KENYA

KUDURA, sustainable development in action

The company

RVE.SOL (Portugal) believes that access to sustainable energy and fresh water is key to eradicate rural poverty. Its sustainable development solution KUDURA provides communities, schools and clinics with fresh drinking water, electricity for lighting, biogas for cooking and fertiliser for crops. It contributes to the development of rural communities through increased access to education, better health and lower energy cost.

The challenge

Sidonge was chosen as the most suitable site to implement a pilot project with the objective to demonstrate how a renewable energy mini-grid could increase the living standard of the village within the context of a community-based model. According to this model, electricity is provided to 20 homes on a pre-paid, flat-rate, night-time basis for lighting, mobile phone charging, as well as powering radio and TV. In addition, an entrepreneurial kiosk is provided for charging mobile phones and hair cutting.

Opportunities for renewables

Africa is rich in natural renewable resources, making renewable energy the obvious choice for decentralised generation.

Renewable solution

KUDURA comprises a 5kWh/day hybrid solar mini-grid, a water purification system and a biogas generation system. The battery bank offers two days of autonomy, while a generator provides backup and battery maintenance capability. A remote monitoring system enables real-time visibility of the system's performance and security.

Project financing and costs

RVE.SOL financed the pilot project, which started in 2011, in the amount of $87.000. Currently, the local community-based organisation CABE Kenya provides on-the-ground know-how and is in contact with the community management committee. The fees for provision of water, biogas and electricity services fund the day-to-day operation of the project. The project is expected to break even after a 12-year period of operation.

Project outcome

- Reliability of payments for services by consumers: it is critical to contemplate an effective and "no-personal intervention" mechanism of service discontinuance after a reasonable grace period for service payment.
- Financial management of project accounting: the capacity of the project management committee to conduct transparent and accurate accounting is critical to demonstrate project breakeven.
- Financing grid extensions and increase of capacity generation: effective and transparent project management is of utmost importance to achieve long-term sustainability.
- Mini-grids can be implemented according to local standards at cost-effective prices.
- Total installed costs can be reduced by up to 20% if local import tariff and duty moratoriums are taken advantage of.
- Increase solar panel capacity by at least 25% above calculated requirements improves system performance and autonomy. Low relative cost provides great benefit in terms of ensuring the battery bank is charged quickly and effectively.

RVE.SOL plans to conduct a follow-up social impact study to show the health, education and financial improvements experienced by the families of Sidonge. The community is seeking funding to expand the grid to provide power to another 30 households.

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Case study 14

SMA Solar Technology AG

Large PV/diesel installation for a cotton mill
INDIA

Cotton mill installation

The company

SMA Solar Technology AG is a global market leader for solar inverters, a key component of all photovoltaic (PV) plants. As an energy management group, it offers innovative key technologies for future power supply structures. The product range includes both inverters for PV plants connected to the grid and inverters for off-grid systems.

The challenge

To set up a solar energy system for a cotton mill operator in India and to save fuel costs and reduce CO_2 emission considerably.

Opportunities for renewables

SMA has equipped this PV diesel hybrid system with Sunny Tripower inverters and the intelligent control unit SMA Fuel Save Controller. With a 1MWp module capacity and thanks to the SMA Fuel Save Solution, the system owner – a cotton mill operator in Palladam – is able to continue production despite daily utility grid failures with solar energy and to also reduce fuel expenses. The new PV system was designed, installed and commissioned by Chemtrols Solar Pvt Ltd, an established EPC service provider. The Fuel Save Solution is the key enabler for leveraging the full saving potential at location if main preconditions are fulfilled. The integration of a PV plant could be beneficial if there was a significant amount of 24/7 base load gensets to leverage high fuel saving potential. The load curve has to fit a daily profile of the PV power and sufficient space has to be available for the PV module installation. A high financial attractiveness is given if the diesel fuel price reaches $1 per litre for the operator.

Renewable solution

Daily power outages lasting several hours are commonplace in Palladam (India). Until now, the cotton mill operator Alpine Knits used a 1.25 MVA diesel generator to supply power during the power outages. However, the ongoing fuel consumption led to continuous increases in production costs. To reduce their energy bill, the cotton mill operator decided to install a PV system on the rooftop of their factory.

The 1MWp PV array with 44 Sunny Tripower 20000TLEE inverters can meet up to 60% of the energy demand.

Project outcome

500GW of power from diesel gensets provide industrial companies with electricity worldwide. (Source: 33th-36th Power Generation Order Survey Diesel & Gas Turbine Worldwide). Diesel gensets are essential to power supplies both in regions with and without inadequate grid infrastructure.

There is broader potential in India for hybrid systems: currently over 20GW of diesel gensets produce the energy used in industries such as raw material processing, agriculture and textiles.

The installation in Palladam is SMA's second hybrid system to use the SMA Fuel Save Solution. In December 2012, the first hybrid system in the megawatts went into operation in a chrome ore mine of Thabazimbi (South Africa). This system combines an energy supply based on diesel with PV, while the installation in Palladam is the first hybrid system in which the diesel genset is used as backup power supply, due to the weakness of the utility grid. By upgrading the conventional diesel gensets to a PV/diesel/hybrid system, the investor expected to save up to 450,000 litre diesel fuel every year.

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Case study 15

Solar Electric Light Fund (SELF)

Scaling the Solar Market Garden, BENIN

Solar drip irrigation system

Solar Electric Light Fund

The company

SELF is a United States non-profit organisation, whose mission is to create solar energy solutions to assist those living in energy poverty by supporting their economic, educational, health care and agricultural development. Since 1990, SELF has completed projects in 22 countries and pioneered applications of solar power for drip irrigation, health care (installing 328kW at 71 health centres in seven countries since 2006), and other uses.

The challenge

The goal for Scaling the Solar Market Garden™ (SMG) is to enhance food security and increase income in semi-arid regions off the grid. Energy is needed to pump enough water to irrigate fields large enough to grow crops for sale as well as consumption, particularly during the dry season.

Opportunities for renewables

Stand-alone, battery-less solar photovoltaic (PV) systems can pump enough water to meet this challenge. The passive, closed systems – requiring only cleaning the arrays and minimal maintenance – are ideal for delivering energy to locations with limited access to fuel, spare parts and technical expertise.

Renewable solution

The SMG combines PV water pumping with drip irrigation to irrigate half-hectare fields, big enough to grow crops mostly for sale. The water is pumped into a reservoir from where it is gravity distributed into the drip lines. The array size and pumping strength vary, depending on well depth and other factors. Eight SMGs were installed to validate the results from three earlier pilot SMGs, whose women farmers (~35 per SMG) consumed 21% of the produce and could sell the balance. System equipment includes: solar arrays (0.6 to 2.3Kw each); water wells (pump depths: 45 to 61m); submersible pumps; water tanks (21m^3); drip lines; and metal fencing. Consumables include seeds and fertilizer. Capacity building for the local partner has included hiring and training solar technicians, hiring agricultural technicians and an accountant, as well as providing management support.

Project financing and costs

Total expenses, including start-up costs (project design and development, capacity building, travel and management) were $896,000. Funding came from private foundations and development agencies (e.g. from Nordic Development Fund and United States Africa Development Foundation).

Direct installation expenses, including equipment, well-drilling and training, were $326,000 (~$41,000 per SMG). Annual earnings per SMG (estimated from $8,000 to $12,000 based on pilot phase results) will cover inputs, operations and maintenance, equipment replacement reserves and financing. Replication will reduce expenses through public-private partnership financing, elimination of start-up costs, economies of scale, and less reliance on imported labour.

Project outcome

264 women farmers and their families have improved nutrition and income, and 48,000 residents have year-round access to fruits and vegetables. Reportable results from these 8 SMGs will be known following the dry season ending in spring 2014. Variances from the three earlier SMG results – each women farmer earning $7.50 per week and each garden yielding ~2 tons of produce per month – will be monitored. Replication is occurring in Haiti and international agencies are investigating partnership opportunities. The need for a strong local partner is the most important lesson learned, and the biggest challenges are securing sufficient start-up financing and public sector interest to help take the model to scale.

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Case study 16

Studer Innotec SA

Hospital gains energy independence with hybrid system

NEPAL

Heart of the hybrid energy system

The company

The project was the overall responsibility of the Swiss electric company Groupe E. Bernard Magnin, appointed responsible for the technical part and installation, is a veteran in constructing sustainable power solutions with renewable energy. He has a long-time collaboration with Studer Innotec SA, a Swiss manufacturer of high-quality inverters and inverter/chargers that provides outstanding performance and flexibility.

The challenge

Nepal is one of the poorest countries in the world and providing healthcare is a major challenge for the country. The Lukla hospital, located in the Solukhumbu region at the heart of the Himalayas at 2,580m, opened in 2005. Electricity was initially supplied solely by hydropower. During the winters the hospital had to close for one or two months due to insufficient energy supply. Even at full power, the energy manager had to turn off power to parts of Lukla when the hospital needed to use heavy equipment such as the x-ray machine.

Opportunities for renewables

To create a hybrid system by adding solar power to the microhydropower plant in order to allow the hospital to obtain complete energy independence.

Renewable solution

The founders of the Lukla hospital recognised that they didn't have sufficient energy supply with their current energy solution. Marco Vuadens (Nicole Niquille's* husband) contacted Bernard Magnin to develop an adequate solution and present them with a feasibility study. The project was presented to Swiss company Groupe E which decided to finance it and provided persons to install the system. The hybrid system consists of 10kW PV, 3,000Ah battery park, a hydraulic turbine, three XTH 8000-48 used in charging mode from the hydraulic turbine, six XTH 8000-48 3ph used in inverter mode. In addition, 2 AJ inverters are used to operate the signalisation lamps. By using one part of the XTH inverter/chargers for charging the batteries from the non-stable hydro turbine and another part as inverters, the hospital always receives high-quality power supply.

The local energy manager received five days of on-site training in order to manage the production and consumption of energy. This installation is practically maintenance free.

Project financing and costs

The financing of this project is 100% covered by private funding (the Swiss company Groupe E).

The Lukla hospital is run by the Pasang Lham* Mountaineering Foundation with financial and technical support from the Foundation Nicole Niquille, a Swiss non-political, non-governmental and non-profit organisation, under the auspices of the Nepalese government.

Project outcome

Currently, the Lukla hospital provides excellent year-around healthcare for its nearby community. People come from miles around for vaccinations, medication for children, family planning, dental care, etc. The hybrid energy production system combining hydro- and solar power has enabled the Pasang Lhamu-Nicole Niquille Hospital to achieve complete energy independence.

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*Pasang Lham was the first Nepalese woman to attain the summit of Mountain Everest and Nicole Niquille is the first Swiss female mountain guide and the first woman to climb a mountain over 8,000 meters high.

Case study 17

Sunlabob Renewable Energy

Phakeo rural village grid electrification project

LAOS

A snapshot of the solar array and the neighboring houses

The company

Sunlabob Renewable Energy is a Laos-based company specialising in renewable energy and clean water access. Established in 2001, the company provides its integrated expertise of rural electrification to governments, multilateral development agencies, multinational companies, NGOs and private individuals throughout Southeast Asia, India, Africa and the Pacific.

The challenge

Ban Phakeo is a village of approximately 100 households located in the Province of Laos, isolated from the main roads without access to the national grid. Prior to the project, the village had no means of generating its own electricity. Ban Phakeo is economically challenged: many of the people in the community live on less than $2 a day.

Opportunities for renewables

As is the case of much of Laos – a country where more than 70% of the population lives in rural areas – renewable energy technologies provide the most cost-effective and robust access to electricity in off-grid areas. In the case of Ban Phakeo, solar photovoltaic is the most viable option for renewable energy generation.

Renewable solution

Sunlabob partnered with the French NGO Fondation Energies pour le Monde (Fondem) in 2009 to establish a 5kW solar PV mini-grid (with a rarely-used 5.6kW backup diesel generator) to provide Ban Phakeo with reliable and affordable electricity. High-quality technology was implemented (Tenesol PV array, Hoppecke batteries, Studer Innotec inverters and Enerstat regulator), combined with Sunlabob's community-focused microenterprise operational model to establish a technically and socially sustainable installation.

The operational model promotes self-sustaining longevity: the mini-grid is operated and maintained by the village. Two village technicians (VTs) were trained with technical and bookkeeping skills and now they manage day-to-day operations. The villagers pay a monthly tariff to the VTs. The collected tariffs are divided into three pools of money: a) approximately 25% pays the VTs monthly salary; b) approximately 25% provides a stipend to the VEC; and c) at least 50% is dedicated to a village maintenance fund, which is used to pay for replacement components and repairs throughout the future.

The role of Sunlabob's NGO partner Fondation Energies pour le Monde (Fondem) was crucial. Fondem, as part of its broader program to enable rural electrification in Laos, worked in coordination the Lao Ministry of Energy & Mines, provincial authorities and government representatives in Luang Prabang to determine the project site.

Project financing and costs

All fixed and upfront costs were covered through the donor funds of Fondem. Fondem's national electrification programme, which targeted 30 villages and 35,000 people, consisted of $3.8 million of funds.
Regarding variable costs, a fixed monthly tariff is levied on household consumers of electricity, with the tariff rate dependent on the service level of the household. There are three service levels available.

Project outcome

The facets of this project's success are multi-fold: all villagers now have the ability to access electricity; two VTs have on-going full-time employment; the solar generation has been so reliable that diesel use has essentially been eliminated. Sunlabob and Fondem also built upon the success of Ban Phakeo to establish another solar-based village grid to provide electricity access to 82 households in Ban Houaypha, a remote Lao village with narrow job opportunities and very limited education and health services.

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Case study 18

Sunna Design

Bringing off-grid PV LED street lights to the refugee camp Zaatari

JORDAN

Solar public lighting securing the Zaatari refugee camp

The company

Sunna Design is a French start-up created in India in 2010 after an experience with a local NGO dedicated to rural electrification. The company operates from France and has clear expertise in research & development (R&D), marketing and commercialisation of Solar LED street lighting products and solutions (mini-grids) adapted to tropical and cyclonic environment. Sunna Design has experience in several developing countries in Asia and Africa.

The challenge

The lack of a lighting system in the refugee camp undermined the security of its inhabitants.

Opportunities for renewables

Regular blackouts due to the weakness of the Jordanian network make it impossible for the camp managers to provide reliable public lighting.

Renewable solution

The Crisis Centre of the French Ministry of Foreign Affairs decided the project in September 2012. The implementation by the French NGO Electriciens Sans Frontières started in November 2012 and lasted for a week. Sunna Design was contacted to design an autonomous PV LED Street Lighting system that would ensure reliability while keeping the costs down. The use of energy storage was crucial as the lighting is required during the night when PV panels are not producing any more electricity. Batteries had to be placed on the top of the mast to avoid being stolen or vandalised and placed behind the PV panel protected from the heat by a patent pending passive cooling system.

Systems are maintained by the United Nations Refugee Agency (UNHCR), the refugee camp manager. Maintenance of the system is easy as no local training or specific infrastructure is required. A maintenance contract is planned for PV cleaning and Sunna Design is in regular contact with the camp supervisors. For tacking the challenges met for this project Sunna Design developed a new product: "Issl hot", standing for integrated solar street light with NiMH battery. The energy management is done by a proprietary battery and light management system which controls the charge and discharge of SAFT NiMH elements which are small and light due to their high energy/power density, tolerant to high temperatures and maintenance-free during a 10-year operation period based on the following assumptions: 90% Depth of Discharge in tropical conditions considering a complete cycle per day.

Sunna Design has developed a calculator and an algorithm for reducing the sizing of its products, using a smart management of the lighting depending on energy availability. This R&D has been done in collaboration with the French research institute CEA-INES and allows Sunna Design to guarantee a lighting service without blackouts during long periods of bad weather.

Project financing and costs

The project is divided in several phases of implementation, starting with the installation of 100 systems which was completed within one month. The first phase project budget amounted to €90,000 (about $121.500) and was funded by the French Ministry of Foreign Affairs. Sunna Design sold the equipment to Electriciens Sans Frontières, which donated and installed it in the refugee camp.

Project outcome

The camp has been growing at an average of 1,000 inhabitants per day. Thus, two new project phases have been already planned. Furthermore, another refugee camp is in construction in Jordan. As the new camp will be lit only with solar energy Sunna Design is hoping to install more than 1,000 new systems and bring long lasting light and security to thousands of refugees.

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Case study 19

Trojan Battery Company

Solar street lighting in Fujairah
UNITED ARAB EMIRATES

Solar street lighting

The company

Trojan Battery Company, based in the USA, is the world's leading manufacturer of deep-cycle batteries, offering a complete portfolio of deep-cycle flooded AGM and gel batteries that provide maximum long-lasting performance to meet the requirements of today's advanced renewable energy and backup power systems.

The challenge

Wadi Sidr is one of the most remote areas in the Fujairah province of the United Arab Emirates (UAE). Its rocky and mountainous terrain has kept high-capacity electric lines from reaching this region. Driving on these mountainous roads at night with no lights can be treacherous.

Opportunities for renewables

The installation of solar street lights improves safety conditions, visibility at night and brings lighting to homes in the area that are situated along the road.

Renewable solution

In August 2011, a solar street lighting project was installed along 11.8km in Wadi Sidr. Companies Hydroturf International LLC and Incon designed and installed 404 stand-alone photovoltaic, pole-mounted street lights. Hydroturf supplied 808 Trojan deep-cycle batteries for the project and assisted with the system design.

Each solar street light system consists of one 245W polycrystalline PV module, one 160W LED light, a charge controller and two Trojan deep-cycle 8D VRLA batteries. Trojan batteries were chosen due to their reputation for high-quality and durability.

In addition, Hydroturf's technical assistance, knowledge of renewable energy applications, and a wide range of Trojan batteries in stock also contributed to the selection of Trojan batteries for this project. Trojan's deep-cycle VRLA batteries are maintenance-free and deliver superior energy in demanding renewable energy applications.

The solar street light systems include a state-of-the art monitoring system which allows the lights to be monitored from a mobile phone. The OEC monitoring system uses software to control the brightness and timing of the lights from anywhere in the UAE.

The installation in the mountainous area of Fujairah presented several challenges. Digging through the rocks in the ground was a laborious process and ambient temperature reached more than 50°C in August. Establishing the optimal angle for the tilt of solar panels among the mountains was complex, and transporting the light poles and other heavy equipment on the interior mountain roads was very challenging.

Project financing and costs

The successful Wadi Sidr project demonstrates how solar street lighting in a remote area can be used in similar road projects where conventional grid electricity is too costly and the significant cost savings of operating solar street lights compared to the high cost of conventional electricity. While there were no government incentives for this project, the UAE Government is working on a plan to implement subsidies for renewable energy strategies, which would make applications like this one even more affordable.

Project outcome

The solar street lighting project drastically improved safety conditions on these roads in Wadi Sidr. The installation of the street lights not only improved visibility at night, but it also brought area lighting to more than 800 homes that are situated along the road.

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Case study 20

University of Southampton, Energy and Climate Change Division

Energy for Development (E4D): replication of rural decentralised off-grid electricity generation through technology and business innovation

KENYA

Kitonyoni village market solar PV project

The company

The Sustainable Energy Research Group (SERG), with the Energy and Climate Change Division at the Faculty of Engineering and the Environment, University of Southampton is the forefront in energy research, development and teaching. For this particular area of E4D, projects and network aim to enable a step-change in collaborative research and project development addressing the energy needs of rural communities in developing countries.

The challenge

To address the development and implementation of sustainable projects in rural communities in East Africa. This encompasses social, technical, economic and cultural knowledge generation as well as understanding needed to allow replication. The approach established by the E4D team is holistic, incorporating community and government participation as well as multidisciplinary researchers.

Opportunities for renewables

Renewable off-grid solutions in many cases can be constructed to provide cheaper options than grid extension when incorporated with business models which result in income generation through an energy supply company (ESCO) supported by a community cooperative.

Renewable solution

This project is based on solar photovoltaic and storage system coupled to a mini-grid. The latter connects to all buildings (business, schools, health centres, churches etc.) and provides energy services to the rest of the community through electrical charging of LED lighting, mobile phones and other appliances. This is the concept of the Kitonyoni village market solar project established in 2012 in Makueni County (Kenya). E4D's goals are to establish an economically sustainable approach, whereby the community is responsible for the operation and maintenance of the plant. Income is generated for the cooperative/ESCO through share ownership and local sales of electricity, which also finances capital cost. Together, E4D engineers, local contractors and villagers were able to assemble the 13.2kWp PV plant and the mini-grid within one week. The premise of the modular design is to make it easy to replicate.

Project financing and costs

The Kitonyoni project was financed by research grants awarded to the SERG at the University of Southampton. The project implements a business model, which can incorporate set interest rates for future investors, generating pay back durations. This model requires end users to pay a tariff for the electricity they use. The ESCO provides end users the option to purchase LED lanterns to replace their current paraffin lamps and delivers an affordable means for the majority to access sustainable electricity.

Project outcome

Up to 3,000 people can now benefit from electrical service. The school, health centre, maternity unit and 40 businesses have round-the-clock stable electricity, allowing them to provide services such as food refrigeration, lighting, phone and battery charging facilities.

Additionally, the solar canopy of the PV system was designed to act as a rain collector, enabling water storage for use by the villagers throughout the year. To bring the social, technical, economic and humanitarian benefits of this project to other villages, replication is key and the team is now working with Kenyan, Ugandan and Mozambique partners as well as financiers and donors to make this happen.

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Case study 21

Wind Energy Solutions

Hybrid WES80 turbines

SAINT HELENA

Wind turbines

The company

Wind Energy Solutions (WES) is the Dutch manufacturer of WES50, WES80, WES100 and WES250 midsize wind turbines. WES turbines are also available in a hybrid solution and connected through SCADA, a remote monitoring system. The accessible and affordable WES turbines are distributed around the world through a global network of trained and certified partners.

The challenge

WES sold six WES80 hybrid turbines at the beginning of 2013 to Saint Helena. Saint Helena is an island in the South Atlantic Ocean and one of the remotest locations on earth. The island is known from the history books due to the banishment of Napoleon Bonaparte in 1815.

Opportunities for renewables

This project of WES hybrid turbines will save diesel costs in a sustainable way.

Renewable solution

The additional six turbines will bring the existing fleet of six turbines to a total of twelve WES80 turbines. All turbines have an 18m tower and are connected through SCADA. The turbines will be delivered with the patented wind/diesel hybrid system on a turn-key project basis.

WES wind turbines have a life time expectancy of more than 20 years. A WES turbine needs minor maintenance compared to other wind turbines. WES will support the turbines on Saint Helena for the annual service and maintenance.

Project financing and costs

The total investment of the order was approximately €1.8 million (around $2.43 million). Wind Energy Solutions will integrate the turbine controls with the diesel generators to provide a total of 40% of the energy needs on the island due to the good wind conditions.

Project outcome

The yearly production of each turbine is around 240,000kWh. The fleet of twelve WES80 will produce a total of 2.88 GWh per year. This saves 4,800 barrels (960,000 litres) of diesel oil compared to the previous situation. All inhabitants of Saint Helena will benefit from this renewable energy project.

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List of Abbreviations

A	Ampere
Ah	Ampere Hour
AC	Alternating Current
AECF	Africa Enterprise Challenge Fund
AG	Aktiengeselschaft
AMP	Acciona Microenergía Perú
ARE	Alliance for Rural Electrification
BOSS	Business Opportunities with Solar Systems
C	Celsius
CO_2	Carbon Dioxide
DC	Direct Current
DEG	Deutsche Investitions- und Entwicklungsgesellschaft Mbh
DoD	Depth of Discharge
E4D	Energy For Development
EEP	Energy and Environment Partnership/ Southern and East Africa
FUNAE	Mozambique National Fund for Rural Electrification
FUNDAME	Fundación Acciona Microenergía
GIS	Geographic Information System
GSM	Global System for Mobile Communications
GWh	Giga Watt Hour
IMx	Iniciativa México
km	Kilometer
kWh	Kilo Watt Hour
kWp	Kilo Watt Peak
LED	Light-Emitting Diode
Ltd	Limited
m	Meters
NGO	Non-Governmental Organisation
NPH	Nuestros Pequeños Hermanos
PV	Photovoltaic
R&D	Research & Development
REE	Rural Electrification Enterprises
REEEP	Renewable Energy and Energy Efficiency Partnership
RLI	Reiner Lemoine Institut
SA	Société Anonyme
SE4ALL	Sustainable Energy For ALL
SELF	Solar Electric Light Fund
SENER	Mexican Energy Ministry
SERG	Sustainable Energy Research Group
SHS	Solar Home System
SMG	Solar Market Garden
SW	SolarWorld
T&C	Training & Capacity Building
TV	Television
UAE	United Arab Emirates
UN	United Nations
UNHCR	United Nations Refugee Agency
UNIDO	United Nations Industrial Development Organization
VDC	Voltage Direct Current
VEC	Village Energy Committee
VT	Village Technician
W	Watt
WES	Wind Energy Solutions
Wp	Watt Peak

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About the Alliance for Rural Electrification
The Alliance for Rural Electrification is the international business association focusing on the promotion and development of off-grid renewable energy solutions in developing countries and emerging markets.

Alliance for Rural Electrification
Shining a Light for Progress

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