



Fundación Energía sin Fronteras

FOCUS ON SUSTAINABILITY

Case studies in Benin, Peru and Rwanda



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Typical problems and solutions: Case studies

All the projects below were implemented with the support of the Foundation Energía sin Fronteras.

CASE STUDY 1. Participatory techniques in Rwanda

Location

The Rwandan community targeted by the project is Karambit Umu Dugudu (village), this community is located in the Northern Province in the Gicumbi District, Mutete and Cell Sector of Musenyi.



Context

Rwanda has achieved to increase access to electricity from 6% to 17% by 2013, with a clear focus on electrifying schools and other social institutions. For the past 20 years, Rwanda has achieved outstanding success in economic growth (GDP growth over 8%), food security, public health (over 24% of public expenditure) and education. Still, about 63% of the rapidly growing population lives below the extreme poverty line. The Second Economic Development and Poverty Reduction Strategy (May 2013, EDPRS2) includes a parallel plan for electrification, the Energy Access Rollout Program (EARP). Rwanda aims to increase access to 70% of households, 45% by grid extension and 25% by off-grid solutions. According to the Permanent Secretary of Education, the typical un-electrified rural schools in Rwanda are basic facilities that offer both primary and secondary education and support about 40-50 teachers, all without the benefit of electric power. As a result, students can only attend classes or other educational activities during the daylight hours. Moreover, these schools tend to be located in villages with about 1,200 people, all of whom also lack access to affordable, reliable electricity because they are too remote to be easily connected to the grid distribution.

Currently, Rwanda's Ministry of Education is supporting rural electrification program that hopes to bring solar-powered generation to these schools

Project description

The MIT (Massachusetts Institute of Technology), in collaboration with the Energía sin Fronteras (Esf) Foundation (Energy Without Borders), the Institute for Research in Technology (IIT, University of Comillas, Spain), with funding from Iberdrola, has promoted the development of a pilot project for the electrification of a village in Rwanda, where the local school will be used as the anchor load. Ad-hoc studies comprise the early involvement of the community in the co-design process, the characterization of sustainable business models and

the proposal of a suitable regulatory and enabling environment. Based on the experience gained with the pilot project, this Project also includes a study to extend the concept to a large number of rural schools in Rwanda.

In the first phase of the pilot project, the Foundation Energy Without Frontiers collaborated in the application of participatory techniques to define the electricity supply in Karambi Umudugudu to schools, and 200 homes, community centers and other small businesses and shops. Being the resulting technology, a mini-grid in combination with solar systems domiciliary.

Previous considerations: Participatory techniques

Considering the causes that have led to some of the rural electrification projects in isolated areas not being sustainable over the years, it can be concluded that for this type of actions:

- An essential requirement is that the initiative to participate in an electrification project arises from the community itself and is considered by them as a need to be met. These communities often lack a series of infrastructures and services, but also other basic needs (food, health ...), so that the use of their limited resources should be dedicated to the needs that they consider to be priorities.
- The application of traditional top-down electrification schemes is not valid. These types of projects should be designed together with the local population and not from the high buildings of the big cities.
- In order to achieve long-term sustainability, in addition to the usual technical and economic aspects, social, institutional, environmental and political aspects of the participating communities should be considered in the design and operation of projects.
- It is necessary the participation of the future users actively and not only as subjects that transmit information so that later it is analyzed by external experts (in many projects the participation of the population is reduced to the realization of some questionnaires, group meetings or other extractive techniques of information, but without real participation of the population in decision making). Particular attention should be paid to the participation of women in the design of projects, gender issues should be one of the cross-cutting factors considered in the development of projects.

There are several tools that can be used to achieve an active participation of the population in the processes of design and decision making in projects that can be included within the so-called "Participatory Techniques". These tools facilitate a more active participation of the population, contributing to the formation and empowerment of the communities in which the project will be developed, so that they are participants in their own development, directing it and focusing it according to their preferences, which will effectively contribute to the long-term sustainability of the project.

Participatory techniques emerged as a complement to the so-called Rapid Rural Appraisal, which was developed in the 1970s and proposed the use of simple methods to extract information, but without the active participation of the population in the design of projects. When the deficiencies were detected, the most extractive information techniques of the Rapid Rural Appraisal were developed in the late 1980s and early 1990s another set of methods under the name of Participatory Rural Appraisal and in which a role More active participants, reflecting together on their own reality and proposing the population their own change initiatives.

Participatory techniques are instruments that are used to acquire knowledge jointly among the participants through the development of different dynamics and workshops, allowing to work based on the experiences of people, their feelings, as well as the problems and difficulties of their environment. The application of these techniques can be carried out in all the phases of a project from the design, the execution and until the evaluation of the project. Within the broad set of participatory techniques can be differentiated 4 categories within which there is a wide variety of techniques. Here are some examples:

Interviews Oral information	Visualization techniques	Group dynamics	Observation techniques
<ul style="list-style-type: none"> •Open questionnaires •Group meetings 	<ul style="list-style-type: none"> •Diagrams •Maps •Flow-charts •Time usage lines 	<ul style="list-style-type: none"> •Brain sotmings •Analysis of advantages and disadvantages Decision arrays 	<ul style="list-style-type: none"> •Participatory tour Scheduled Visits Habits and customs

A detailed description of the different participatory techniques can be found in Geilfus (2002 and 2009). In addition, different techniques are analyzed in Anyaegbunam (2004) and World Bank (1996).

It should be noted that participatory techniques have been used for years in the development of projects in rural areas in agriculture, sanitation or irrigation. The development of these tools and the dissemination of their use for the success of the achievement, is being promoted by a wide variety of entities, from NGOs to government institutions at the country level and by different international organizations such as the World Bank and FAO . As a counterpoint it should be emphasized that the use of participatory techniques in the development of rural electrification projects has not been widely developed.

Technical sustainability

The decision process on electricity supply technology to be implemented in rural electrification programs is a complex problem and involves working on a wide variety of aspects. In order to carry out the decision on the most appropriate technology for a project, the term "technology" should be considered in its broadest sense and not only as the part related to the equipment and the different technical alternatives.

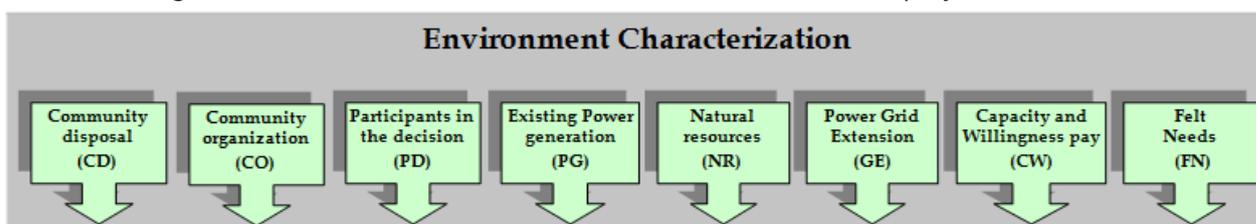
Among the most relevant aspects that must be defined in the process of selecting the appropriate technology, three main factors must be highlighted: (i) the technical alternative; (ii) the management and maintenance system; and (iii) the economic-financial mechanisms related to the implementation of the technological system.

The decision process on the most appropriate technical alternative was divided into two phases.

- *The first phase was the characterization of the parameters of the environment and viable technologies.* In this phase, we worked with the local population as a whole to identify and analyze various parameters and characteristics of the community, necessary for i) establish the set of community representatives (decision-makers) who participated in the process of selecting alternatives; ii) define the set of initially viable electrification alternatives for the project.
- *The second phase was the selection of the appropriate alternative.* In this phase we worked with the group of decision makers. Viable alternatives were ordered based on

the interests and preferences of the population. The set of decision makers analyzed (accepting or rejecting) the proposed alternatives to finally agree the most appropriate technology for the community. A set of well structured parameters were considered (Figure 1). The characterization of these parameters was done jointly with the local population. Positive spaces were created that encouraged their participation in the process depending on the techniques that were used to characterize each of the parameters. Various techniques were used, such as general meetings, semi-structured interviews, questionnaires, analysis of habits and customs, joint reconnaissance of the terrain and direct observation (Table 1).

Figure 1. Parameters to characterize the overall context of the project



The final part of the process of selecting the most appropriate alternative is to obtain the ordering of the alternatives accepted according to the priorities and preferences of the population. Within the set of participatory techniques are included so-called analytical games, which are based on voting and obtaining the agreement based on different types of majority. However, some authors consider that decision making by majorities may be inconsistent and give results that do not consider the basic points of social choice theory. Taking into account these considerations, the Rwanda project considered multicriteria decision technique.

Table 1. Techniques, participants and results in the project in Rwanda

	Techniques	Participants	Results
Characterisation process			
Community disposition	Participatory Mapping	Local authorities Community representatives	Community Plan Houses with electricity Housing grouping / dispersion
Community organization and participants decisión	Institutional analysis Focused groups	Local authorities Community representatives Population	Community social structure Harmed identification People participating in the decision
Existing electrical generation	Meetings focused groups	Population Decision makers Local authorities	Existing technologies Technological maturity, existence of installers and maintainers Availability of engines
Estimation of natural resources	Guide to estimation of available energy resources	Population Local authorities	Possible locations Resource variability Resources available
Grid extension	External consultations (electricity distributors and legislation)	Electricity supply companies Local authorities Community representatives	Cost of electricity (network + community) Fixed monthly cost per connection Variable cost energy consumption
Ability and willingness to pay	Individual questionnaires	Population (income / expenditure)	Income level Current energy

		Participants decision (willingness to pay)	expenditure to be replaced % Lighting / revenue expenses Willingness to pay
Setting of needs	Individual questionnaires Focused Groups	Population Responsible consumption points	Minimum and maximum electric demand Annual consumption profile Future years growth
Selection process			
Description of alternatives	Group meetings	Population Decision makers Local authorities	Definition of alternative characteristics Definition of distribution systems Clarification of doubts
Preselection of alternatives	Group meetings	Participants decision	Listing of available alternatives Listing accepted distribution systems

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<http://energiasinfronteras.org/proyectos/nuestros-proyectos/en-ejecucion/93-estudio-de-viabilidad-de-electrificaci%C3%B3n-de-escuelas-en-ruanda-mediante-microrredes>
- Website (in Spanish) - focus on participatory approaches:
<http://energiasinfronteras.org/proyectos/conferencias-y-seminarios/126-presentaci%C3%B3n-proyecto-microrredes-ruanda>
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Work in focus groups (Credit: Esf)

CASE STUDY 2. Implication of the municipality in Matanza, Peru

Location

The district of Matanza is one out of ten that form the province of Morropón, located in the Department of Piura, under the administration of the regional government of Piura, in the north of Peru.



Context

In the zone of influence of the projects there is no conventional electrical connection, petrol and gasoline engines are used. Currently the Peruvian government is installing solar panels in houses under the administration of a private supply company; however, coverage is still 60%. The intervention area has been prioritized by the municipal authorities. Its criterion is based on the lack of basic services and on morbidity rates, which are based on the lack and poor quality of the water consumed. Water is extracted manually from very early hours, usually by women. Subsequently it is carried to the dwellings in long stretches of travel in bunk beds, given the dispersion of the dwellings, and the conditions of the tracks, it takes an hour to cover 15 km. The low quality of the water generates in the population the presence of gastrointestinal diseases.

This area is located in the ecoregion called "Equatorial dry forest", with fertile soil for the development of natural, vegetable and animal life. Hence, its population is mostly devoted to dry land and livestock farming, its main source of income being the latter. In these projects, MIRHAS Peru has been a local partner. The MIRHAS Peru Association (Movement for the realization of social habitat) has signed an agreement of interinstitutional cooperation with the Municipal District of La Matanza, allowing a joint work to diagnose the main problems of the district and supporting both the formulation and the search of support from international cooperation institutions for the financing of project proposals that have been taken into account in the Annual Municipal Participatory Budgets.

The collaboration between this NGO and the Energia sin Fronteras (Esf) Foundation goes back to 2007, when the electrification project of 9 posts of the Morropón Chulacanas health network began in the region of Piura. The experience of this project generated confidence in this local partner to carry out more projects in the Matanza region.

Project description

The objective of this project is:

- Facilitate access to drinking water for people and animals.
- Promote sustainable water management through local community support and organization.
- Provide better health and hygiene conditions for the population.

Initial population benefitting from the project

Nombre de pozo	Caseríos	Coordenadas UTM		Número de habitantes	Número de familias	Hombres	Mujeres
		N	E				
Colpas	Colpas	9408651	608265	139	35	73	66
	Cur Cur	9403910	612837	67	13	39	28
	Hualtaco	9396168	611743	120	28	72	48
Hispción	Km66	9432235	597258	165	40	95	70
	Hispción	9417308	597258	48	13	29	19
Ternique	Ternique	9407256	604523	240	45	144	96
	Barrios Altos	9410304	603935	110	23	62	48
Km 83	Km83	9403786	0605243	100	20	62	38
	Potrerillo	9392178	0603055	53	11	29	24
TOTAL				1042	228	605	437

Initially (2011 - 2012) the project installed four wells: Hispción, Ternique, Colpas and Km 83, with funding from the Community of Madrid, Esf, Endesa Solidarios and Ficaid, as well as Proinso donation. With the recovery of its IGV (tax equivalent to Spanish VAT), the scope of the project was expanded with a fifth well in the San Jacinto farmhouse. The positive results of this first phase led other nearby communities to request a similar solution. In response to these requests, the municipality of La Matanza approved the necessary budget, in collaboration with the financing provided by Esf and the City Council of Alcobendas, to equip a well in the village of Monte Azul by photovoltaic electrification. The total number of beneficiaries increased by 303 people, 130 children and 173 adults.

The technical characteristics of the project are:

a) 6 Solar pumping system equipment:

Well	Peak Power (Wp)
Colpas	1.225
Hispción	1.225
Km 83	1.225
Ternique	1.470
San Jacinto	1.225
Monte azul	1.925

It includes, additionally, multistage submersible water pump, power adapter (DC to AC), lightning rod system, etc.

b) 6 accumulation tanks of 25m³, except in Km83 and San Jacinto which are 10m³, complemented with its chlorination deposits.

c) 11 distribution points (water intakes for human consumption, consisting of pool and hose)

d) 6 livestock watering troughs

In addition, awareness-raising and training activities were defined:

- Creation of a Water Service Management Board (WSMB), in each of the hamlets, to ensure the technical and administrative sustainability of the water supply system.
- Training program in good sanitary practices for the beneficiary population.

- Coordination with the health sector to complement actions to raise awareness among families benefiting from the project.

Technical Sustainability

SINELEC has been the supplier and installer of the equipment, which provides the technical training courses for the O & M of the facilities, as well as performing maintenance rounds during the first two years of preventive maintenance (at 3, 15 and 24 months) and its corresponding corrective maintenance. From the moment in which the facilities are ceded to the Municipality, represented by the ABSS in each well, these will give permanent maintenance to the facilities. During the first two years the ABSS facilities will operate in collaboration with the installer (SINELEC) and the local partner (MIRHAS Peru).

Economic Sustainability

It is based on the economic contribution by the beneficiaries through family and extraordinary quotas that are approved by the ABSS. In addition, the Municipality is committed to supporting the ABSS in establishing an organizational and economic system that can assume the expenses derived from the cost of gas oil, inputs for chlorination of water and maintenance of project equipment.

Social and Organisational Sustainability

S1. The project team has sufficient knowledge of the community, the area and the institutional environment in which the project is to be carried out.

Working with a strong local partner who knows the community and the environment in which the project is going to be developed is fundamental. MIRHAS Peru has been the local partner of Esf. MIRHAS Peru has been a local partner. The outstanding activities that MIRHAS Peru has carried out during the development and implementation of the projects are the following:

- Coordination with the Municipality and with the Installer for the contribution of labor to support the installer in tasks such as opening trenches, excavations and cleaning.
- Promote the constitution of Administrative Board of Sanitation Services (ABSS). And support them for the formulation of the Convention on the Management and Exploitation of facilities, which ensure the sustainability of the facilities by attracting funds from the beneficiaries.
- Supervision of project implementation, follow up of the O&M courses executed by the Installer, verification of the results of preventive maintenance tests at 3, 15 and 24 months after provisional acceptance by the Installer.
- Once the project is put into service, and during the next two years, conducting semiannual evaluations of the operation of the project and the evaluation of the service provided by the holding company.
- Support to the Municipality and ABSS in the management of the project during the 3 years following the assignment of the facilities.

Of all these activities, MIRHAS Peru has made reports transmitting all the information to Esf.

S2. The project responds to a priority need of the community.

The needs have been demanded by the community itself with the constant support of the Municipality. MIRHAS Peru has conducted "focus groups" with the families of the villages to analyze their problems, having as one of their main problems the supply of water and energy at the family level. On the other hand, being able to meet these needs is a priority objective of the municipality of la Matanza.

S3. All project stakeholders have been identified and their responsibilities defined and committed.

The final owner of the facilities is the Municipality of Matanza district according to the jurisdiction of each well, for which an act of transfer of the goods between Esf and the Municipality was signed at the end of the execution. The document establishes clauses of loss of ownership in case of misuse of the system or for purposes other than those that were delivered, the system being moved to another area, and whose relocation costs would be assumed by the new beneficiary. Subsequently, the Municipality cedes the management and administration of the assets to each Administrative Board of Sanitation Services (ABSS) through a municipal resolution. These ABSS are intended to ensure the maintenance of wells. For the project to be sustainable, each ABSS has an account where funds are provided to ensure the maintenance of the equipment. In this account, each beneficiary will pay the corresponding Family Fee and Extraordinary Fees approved by the General Assembly.

The constitution of the ABSS of each well has been carried out in a democratic way. According to the new regulations of community organizations, a gender quota must be taken. The ABSS must consist of 7 members, at least 2 of their positions must be assumed by women.

The Municipality issues a Municipal Resolution to each ABSS that has a validity of two years in which it is authorized and transfers the administration of the systems according to the statutes and regulations, previously approved in ABSS assembly. These statutes and regulations aim to define the following points:

- Rights and obligations of partners for effective administration, operation and maintenance of water services.
- Sanctions applied for the misuse of water services.
- Importance of payment for the service - payment culture.
- Functions of the assembly and Steering Committee.

The members of the Board of Directors hold the position for 2 years. However, at the end of this period, the General Assembly (all associates enrolled in the Standard Book of Associates: beneficiaries of each village who are current in the payments corresponding to the quotas) must elect at least 2 of the members of the Council Director, with the aim of giving continuity to management. On the other hand, the ABSS have published the regulation of operation and maintenance of the wells through assemblies with all families benefiting from each well.

S4. The community has adequately appropriate the project. Knows its benefits and accepts his responsibilities.

It is important to highlight the degree of organization in these localities, as it is a key factor in generating the ABSS and carrying out the different activities by the beneficiaries. Since the beginning of the project the community has been present in a permanent way in each stage of it, participating in the construction of troughs, in addition to providing raw materials for construction, as well as unskilled labor; establishing rotating weekly working wards, distributing activities between women and men, according to the physical effort of each gender; organizing night shifts to monitor facilities by family.

Institutional sustainability

All the activities have their origin in needs demanded by the beneficiary population and it is the Municipality itself that establishes as a priority the power to meet those needs. Through the interinstitutional cooperation agreement signed with MIRHAS Peru, the local partner, both the Municipality and the local partner have promoted, formalized and trained the members of the Administrative Board of Sanitation Services (ABSS) to develop management, operation and

maintenance of the water supply system. The responsibilities of the Municipality have been well delimited and have been well defined and assumed.

In addition, the project is being further promoted by the Regional Government through the Deputy Director of Economic Development. The project formulation area is supporting a well drilling program throughout the Piura Region to supply water to rural populations that have dispersed housing and are not considered in public investment projects for the cost involved because of the reduced number of users and the dispersion of dwellings. The implementation of the wells will depend on the municipalities so in the case of areas where there is no electric power will take the design validated in la Matanza.

References

- Website (in Spanish) - overview of the project:
<http://www.energiasinfronteras.org/noticias/noticias-proyectos/183-noticias-per%C3%BA-sexto-pozo-en-la-matanza-per%C3%BA-sexto-pozo-en-la-matanza>



Access to fresh water in Peru (Credit: Esf)

CASE STUDY 3. Local empowerment in Benin

Location

Benin is a tropical and sub-Saharan nation, largely dependent on agriculture, whose population lives mostly in the south of the country, in the Gulf of Benin.

Fô-Bouré is a small town in the commune of Sinendé in the province (department) of Borgou, located in the center-north of Benin. It is head of district, with a population estimated in more than 3,000 inhabitants.



Context

The municipality of Sinendé, as head of the local administration, is very active in providing services to the communities.

For more than twenty-five years there has been an inter-diocesan Catholic mission from the dioceses of Calahorra-La Calzada and Barbastro-Monzón. The mission covers thirty-four communities in the eight communes of the department of Borgou and has been established in Fô-Bouré since 1986. The mission has extensive experience in community development, develops projects for education, health, strengthening of women, water and energy. In addition, it maintains a good relationship with the different actors in the area, such as the municipality of Sinandé, the different representatives of other religious denominations and development NGOs.

Energia sin Fronteras (Esf) has collaborated with the Mission since its creation in 2003. Installed 144 photovoltaic street lamps in nine communities of Sinendé, in service from the years 2006 to 2010. The lighting works from sunset thanks to the energy stored in the battery housed in the base of each lamp. In each of the communities an Energy Committee was set up, which appoints one responsible for the care and maintenance of each street lamp. In 2006 it was electrified the dispensary and nutritional center of the Oblates religious of Fô Bouré; Three years later, in 2009 a system of water supply by photovoltaic pumping was installed for this particular town, until the creation in 2014 of the Solar Field.

Project description

Before the implementation of the solar field, the population of Fô-Bouré had electricity for about 12 hours a day thanks to diesel generators owned by the Catholic mission. There are

about 110 houses, including mosques, the district office, the health and maternity center, four bars-restaurants, two sewing workshops, two hairdressers, four shops, a carpentry workshop, a welding workshop, a women's cooperative for the transformation of shea nut into oil and another women's cooperative that peels rice and grinds the cereal.

With the prospect of contributing to the improvement of people's lives, and in view of the prospects of not having a good electric service in the coming years or decades, the Mission, with the support of the entire population, requested to Energía sin Fronteras (Esf) the realization of a small solar field that supplies electricity to all its inhabitants. With this background, Esf has carried out the project of the solar field of Fô-Bouré, with the Mission like local partner.

Opened in 2014, the Fô-Bouré solar field project is currently serving all inhabitants. Prior to calculations to define the required power, real consumption data were collected by a network recorder installed in Fô-Bouré (Nov / Dec 2012) and supplied for measurement by a Spanish company. In the recolection of data also participated another Spanish electrician, friend of the Mission.

The solar field of 40 KW of power was built in lands assigned by the Mission to the community, with dimensions approximately of 45x20 meters. It consists of 200 panels of 200 W each, divided in three areas each connected to a 'Sunny Tripower' equipment, and these in turn connected to a set of three inverters with 'Sunny Island' batteries. The battery park consists of 24 2-volt lead-acid glasses with liquid electrolyte and a capacity of 3950 Ah. In turn the whole is connected to a diesel support group for emergencies. The solar field covers 4.5 hours more demand than previously offered by the diesel groups.

In addition to the solar field, water wells were electrified with solar pump. In the subsoil of Fô-Bouré there are water tables that can be exploited by wells. There are a number of traditional wells (open, with manual water extraction, bucket and pulley) and in existing sites. The new generation and well exploitation promoted by Esf has the common characteristics of having a deep well (drilling by machine), with extraction by solar pump (photovoltaic panels) and the establishment of a distribution network that allows access to water by Of 12 sources distributed throughout the population.

Local Partner Capacity

The Fô-Bouré Catholic Mission has recognition and leadership among the population and institutions of the Sinandé region. In its thirty years of existence, the Mission has promoted projects involving and energizing the population, creating management committees in all of them, supporting their development, training technicians for operation and maintenance, and, in short, ensuring the sustainability of the projects and the benefits derived from them. He has accumulated experience in electrification through photovoltaic systems, and groundwater abstraction. For lighting and electrification, the Mission has mainly counted on the support of Esf; for the construction of wells, the Mission has also had the support of Manos Unidas.

Community strengthening

The successive projects carried out by Esf in the area have led to a real increase in local capacities, including the nearby training and maintenance center at the Don Bosco Center in Parakou, which ensures the maintenance of photovoltaic systems, one of the main problems in isolated rural areas, and extend this training to other areas of Benin.

The social development that has been achieved in Fô-Bouré has led to the establishment of new neighbors (rural teachers among others) who, in addition to enjoying access to electric

energy that they did not have in their place of origin, can facilitate the increase of local capacities.

Community participation in the project

The Mission, with the support of the entire population, requested Energías sin Fronteras the execution of the solar field. The Mission assigned the lands to the community for the installation of the panels. The Economic Council consists of representatives of users, large and small consumers, with the assistance of representatives of the Mission. The Municipality of Sinandé and the institutions of other religious denominations in the area are permanently informed.

Technical sustainability

In 2009, Esf promoted the training in Spain of two technicians in photovoltaic energy. This has allowed the creation in Parakou (capital of the Borgou department) of a Solar Aula in the Don Bosco vocational school, supported by Esf. The solar field is operated by two local technicians trained in the Parakou Solar Aula, supported by a senior technician, professor of the Institute and resident in Parakou. All three actively participated in the project.

Economic and financial sustainability

Financial management of the solar field is done by the Economic Council, which establishes the tariff policies for beneficiaries, set according to the type of user and to the income statement and the forecast of expenses.

The Economic Council consists of representatives of users, large and small consumers, with the assistance of representatives of the Mission of Fô-Bouré. In the case of large consumption, counters are installed that serve as the basis for billing. In the case of small consumers the tariff is fixed, depending on connected devices (light bulbs, telephones, simple domestic appliance). There is also a subsidized rate for productive consumption by women's milling cooperatives, as this type of social benefit initiative is considered for the community.

The Economic Council carries out the management of the bank account where the revenues are made, with control of joint signatures to proceed with the expenses. There is a person hired to read the accountants and raise money. The management of defaults is done as follows, when there is a delay of 15 days in payment, a third of the payment is overcharged, if it is a month, the charge is half of the payment, in addition the supply of light at the time of default is canceled and once they return the debt, they are left for two months without supply until they can reapply. This rigorous collection and revenue policy allows us to have the necessary funds to meet the current maintenance costs, as well as the necessary replacement of batteries at the end of their useful life, estimated between six and eight years, and which is the greatest expense commitment of the facilities.

As an important economic factor, it is important to highlight the large fuel savings represented by the electric generation produced by the solar field with respect to the previous generation by a generator group. The fuel expense before the solar field was 12000 euros per year. During the first two years of operation, the collection of electric bills dedicated to the sustainability of the installations represents more than 65% of the annual savings, which allows to ensure with a wide margin its economic sustainability.

Environmental sustainability

The fact that photovoltaic energy is used, makes the project environmentally more sustainable, as it prevents, in addition to CO2 pollution, engine, oil and breakdown problems.

Sustainability of the water supply service

Operation and maintenance of the service: Access to the source is controlled by the person in charge of giving the service receiving in return a salary for his work. The first level maintenance is done by local plumbing technicians, supported by photovoltaic technicians, where and when it is needed.

Economic and financial management of the service: The management of the whole is carried out by the Water Committee. In order to be able to attend the maintenance of the installations, a price per liter of water is fixed. Part of the collection goes to the maintenance of the facilities. Another part is set as a contribution to the Municipality, as a common good that is water. The Municipality of Sinendé, as head of the local administration, is very active in providing services to the communities, among others in the construction of schools, and benefits from a jointly agreed rate on the collection of water carried out by the municipality. Mission. With the remainings, a fund is set up, managed by the Water Committee, with supervision of the Mission, and which is in accordance with the needs and priorities established. The collection is managed by the Mission.

Community participation in the project: The community manages and maintains the service through the Water Committee formed by the beneficiaries themselves, supported by the Mission.

References

- Website (in Spanish) - overview of the creation of the local capacity training program: <https://www.energiasinfronteras.org/proyectos/nuestros-proyectos/en-servicio/78-ben%C3%ADn-campo-solar-para-el-desarrollo-de-cooperativas>
- Article in “El País”, 08/08/2016 (in Spanish) http://elpais.com/elpais/2016/08/01/planeta_futuro/1470062546_232015.html



Solar Field in Benin (Credit: Esf)