SUSTAINABLE IMPLEMENTATION OF SOLAR HOME SYSTEMS IN RURAL AREAS IN THE NORTH EAST OF BRAZIL

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Abstract

Solar Home Systems (SHS) are widely used in rural areas to cover the basic needs of the population in terms of lighting, and little electricity for radio and perhaps a black and white TV-set. Those SHS find their way into the houses by several different channels, which may or may not guarantee their sustainability. If somebody simply buys such a system at a local reseller, it is up to him to pay for the follow-up services like repair, spare parts and take care about appropriate operation. In case of a donation, which is still a way used frequently by some national and international donor organizations, such follow-up services are mostly not available or the initially happy customer does not have the necessary funds to pay for it. The systems may work for a certain time, but when it comes to the substitution of the battery; the SHS abandoned due to the financial incapacity of the user. A substantial part of the SHS may have failed and rejected already earlier, caused by the mal-function of components and unreliable installation.

The mostly extreme low income of the population in question, asks therefore for an adequate financing system, which has to go along with appropriate technical advise, all together coordinated and administrated on a local basis.

In order to avoid the well known financial, technical and operational problems regarding the implementation of SHS, IDER has developed and implemented in several rural communities a revolving fund financing scheme, which provides a sustainable operation and maintenance of the SHS. Local people are trained up-front to provide the necessary administrative and technical services. The associated members are asked to pay into a common bank account a pre-established monthly fee which covers the expenses of administration, frequent visits of a trained technician, spare parts and battery replacement.

Since such community-based matters are not practiced by the people living in the north eastern region of Brazil, specific efforts have been undertaken to convince the local population in adopting such a system. Already known procedures used by local shops providing credits when people buy bicycles or other goods have been implemented in the revolving fund scheme.

Already 12 communities with in total some 500 families have adopted the revolving fund scheme developed by IDER and a very high grade of satisfaction, expressed by nearly 100% installments paid every month, show the efficiency and acceptance of the scheme.

1. INTRODUCTION

IDER (Instituto de Desenvolvimento Sustentável e Energias Renováveis), Institute of Sustainable Development and Renewable Energy was created in 1995 in Fortaleza, capital of the State of Ceará, Brazil. The Institute is a non governmental, non profit organization, based on the concept of the sustainable development, in which the preoccupation with the environment, the local culture and the strengthening of the local participation in the decision making process, is looking to foster an efficient and rational growth through actions that would supply the present and future needs for everybody.

Beside taking care of the perfect adaptation of renewable energy technologies to the needs of the population, **IDER** is looking to the communities as a whole, introducing also complementary aids like health care, vegetable plantation, community organization, hygienic education, just to name some. All actions have in mind to enhance the local life conditions.

However, **IDER** does not believe in pure donation, therefore the planning is governed by front up economical and financial calculations in order to assure the sustainability of the projects and implementing a "revolving fund" system in each community.

Under these given rules **IDER** has accomplished in the last four years a number of projects involving some 12 communities in five northeastern states of Brazil, and has installed more then 500 solar home systems and over 60 solar water pumping systems, beside implementing approximately 12 solar electrified health stations, also in the Amazon region at Indian tribes.

2. ENERGY SUPPLY SITUATION OF BRAZIL

The use of Renewable Energy in Brazil has a long history. If one considers the production of electricity by hydro-electric power plants as pollution free, Brazil is one of the most remarkable countries in the World. Ninety six percent of its electricity is produced by hydro-power. Extreme pollution caused from thermo-electric power plants commonly in use is up to now not the case of Brasil, but the hydro resources relatively nearby populated areas are already exhausted.

Industries especially in the north eastern region of Brazil are concerned about a lack of electricity in the first decade of the year 2000. Additional hydro-electric power plants can be installed only in the Amazons region. Some 50.000 MW can be drawn from there, however, this would mean heavy impacts on the environment by inundation of hundreds of square kilometers of rain forest and extremely high transmission costs. Wind power resources are also planned to be introduced in the energy matrix. Several wind farms with approximately 1.800 MW total capacity are due to operate in-between the next five years along the coast of the North East of Brazil. Thermal electric power plants fueled by natural gas are an other option. Brazil is planning 49 power plants with some 20.000 MW in total.

Although, these new power plants may help decrease the effects of the energy crises, only a very small portion of this new sources of electricity production will reach the poor population in the rural areas. Still today and for sure in the next decade does exist in these regions a lack of mostly any kind of comfort, communication and ease of production processes which electric power can provide.

Brazil faces actually a bottleneck in the supply of electricity for industrial use and urban areas, and on the other hand appears a growing demand in the rural area which can not be covered by the grid.

Just for comparison, some figures of the State of Ceará, where IDER is working in rural energy electrification by solar energy :

Table 1. Demographical and energy data from the State of Ceará, Brazil

	Units	State ofCeará
Area	1000*km2	148
Population	1000*	6,520
Urban	%	62.3
Rural	%	37.7
Electricity		
Production	GWh/Y	negligible
Consumption	GWh/Y	5,000
Urban / Industries	%	82
Rural	%	6
Losses	%	12
Income profile		
lower three minimum salaries	%	92.8
higher ten minimum salaries	%	2.9
Medium Income		
Total	SM	1.86
Urban	SM	2.41
Rural	SM	0.73

Minimum Salary (SM) = R$ 180,00 ≈ 80 USD in December 2001

Besides being a state with large rural areas, the population is concentrated in the urban region in the neighborhood of the view big cities. The energy consumption does not reflect the populations' distribution. In the extreme case of the state of Ceará the urban population including industries consumes 13 times the electricity than the rural population, but represents less than 60% of the population.

The income situation is even worse. Over 90 % of all families (urban and rural) have to make their living with less then USD 250 per month, while only 3 % can be considered to be the "upper class" with a monthly income above US$ 800.

The following table gives an overview of the rural electrification in the State of Ceará

Table 2 Situation of Rural Electrification in State of Ceará

Total households in rural areas	495,000
Total electrified households in rural areas	190,000
Farms	70,000
Domestic customers	120,000
Total rural communities	9,750
Total electrified rural communities (~ 96 houses)	1,250
Total not electrified rural communities (~ 24 houses)	8,500
Total not electrified households in rural areas	305,000
Estimated annual growth of grid connection	~ 10,000

The picture shows clearly that there does exist a need and a opportunity for Solar Home System applications over the next decades.

3. ENERGY SUPPLY OF RURAL FAMILIES

Beside the grid connected rural villages and isolated grid systems with diesel generators, many rural families depend on their own, independent energy supply. It ranges from kerosene lamps, gas lamps, dry cell batteries for radios and automotive batteries to power a black and white TV set to small stand alone gasoline or diesel generators. These generators do not provide 24 hours/day service, but just for 4 to 5 hours at night time.

Energy costs for those energy supply systems are relatively high. Own research during many years revealed the following numbers :

- A rural family spends between R$ 5 to 25 R$ (2 to 10 USD) a month for kerosene, liquid gas and dry cell batteries.
- Battery charging costs are in the range of 3 to 6 R$ per charge and is necessary two to three times per month.
- Owners of stand alone diesel generators providing electricity for small communities ask to be paid in fuel and not in money. The connected users have to provide a pre-established amount of fuel on-side. Since those places are mostly located far away from cities with difficult access, the fuel prices are extremely high on delivery. A household has to provide approx. 20 liters of fuel per month which costs 1,50 R$/l including transport to the village (price at the gas station is actually 1,00 R$/l).

4. COMMERCIALIZATION OF RENEWABLE ENERGY SYSTEMS

Renewable energy systems have proven commercially viable for certain applications in the past decade, and make a significant and growing contribution to the energy supply of some counties. Led by biomass cogeneration, wind farms, small hydroelectric plants, off-grid photovoltaic systems, and geothermal power generation, renewable systems have proved to be reliable and profitable sources of energy. In spite of this success, many countries in the World have seen almost no development of commercial Renewable Energy systems.

Several factors impede commercialization development of Renewable Energy technologies in Brazil[1]:

- electric utility preferences for large central power systems;
- funding patterns of international financial institutions (lending to governments only in large amounts and preferably for single site energy installations);
- lack of risk capital for local entrepreneurs and high cost of business development for foreign technology developers;
- structure of financial and equity markets;
- policy and regulatory obstacles;
- large architecture and engineering firms that normally develop energy projects have not been interested in “small” projects;
- owners of resources often do not understand the energy business;
- small-scale, Renewable Energy Systems (as opposed to components) resist mass production because of the need to match local resources with applications,
- lack of education and training in renewable energy research and application at professional schools and universities.

Governments have tried to overcome these barriers but are limited in what they can do. The experience in Brazil shows the manifestations of these limitations. Governmental applications are mainly directed to community services like school lighting and water pumping, thus forgetting the

[1] *These assumptions are also true for other counties.*

needs of electric energy supply of the rural families at their homes. Despite substantial and growing government emphasis and support, the Brazilian renewable energy industry faces many challenges, largely because government policies lack clearly formulated regulations, and governmental subsidies have tended to steer industry toward non-commercial markets.

5. SUSTAINABLE APPROACH

Since centuries the development of the Brazilian rural area is governed by policies which provide great opportunities to the big landowners. Not always, but in many cases, the land belongs to the politicians themselves or they are strongly influenced by the farmers. The military governments left their traces with the still today so called "Coronelismo". Small farmers and rural workers suffer when it comes to defend their rights and their land. Due to the European influence the small farmers in the southern region of Brazil have already developed functioning rural communities and associations, while the Northeastern small farmers are still being suppressed by their own inability to act, the result of long lasting, nearly slavery treatment in the past. Forced by international workers laws the picture is slowly getting better. Some NGO's and World Bank Programs only issue loans to governmental rural programs when is taken care of the formation of associations. However, such pre-requisites have also lead to associations which do only exist on paper, where the local mayor, his wife and some close friends signed the necessary documents, sometimes backed up by the state governmental bank loan administrators.

Despite the said obstacles and clearly visible difficulties, IDER is convinced that solar energy applications are a key factor for the development of the rural area in the North East of Brazil. It is under the given circumstances unimportant who provides the Solar Home Systems and who pays for it. However, highly important is that before starting any project to implement Solar Home Systems (SHS), that there is a clear consensus how to approach sustainability. Some of those issues are:

- Diagnostic the energy demand and the communities resources;
- Verify the users possibility to pay with his products such as crops, beans, animals etc.;
- Foresee the implementation of a transparent financing mechanisms, e.g. revolving fund, that assures its growth and fits the communities characteristics and the project goals;
- Create a community based project administration;
- Inform the users of purchase possibilities of SHS and spare parts on the local market;
- Visualize the factors that influence the failure or the success of the project and demonstrate its advantages and disadvantages.

IDERS' aim is to implement Solar Energy Cooperatives in rural areas, independent of any political power. This is under the described circumstances not an easy job.

6.1 Specific Objectives

In particular, IDER is trying to realize the following specific tasks :

- Disseminate renewable energy, decentralized and sustainable in the rural area;
- Stimulate the creation of renewable energy cooperatives through revolving funds or other systems of credits that facilitate the acquisition and the maintenance of the systems for the population;
- Foment projects with productive use of energy, objectifying to increase the income of the rural families;
- Qualify the local human resources in management techniques and technical issues.

6.2 Methodological Aspects

In order to reach the set goals, IDER is applying the following methodology :

- Guarantee the participation of the population in all planning phases, execution and evaluation;
- Train local technicians in installation and maintenance of the systems; as well as in the administration of the revolving funds;
- Implement the community based fund management, becoming one of the warranties for the success of the project;
- Observe constantly the willingness to pay and the payment capacity of the user during the whole period of the project (in minimum two years of accompaniment);
- Accomplish costs calculations of the previously used energy sources;
- Respect the community's decisions, values and habits;
- Guarantee the integrated action and the commitment shared between the community and project executors.

6.3 Accompaniment and Evaluation

A project to implement SHS has to be constantly monitored during a certain time period in order to be sure of the set goals and to detect failures in the early beginning. IDER adopted the following scheme :

- Monthly visits at the community;
- Technical and social-economic reports;
- Financial reports;
- Meetings among the involved partners;
- Control of the bank account movements;
- Verification of the administration of the project, respecting the own initiatives and correcting if necessary.

6.4 Revolving Fund

Basically, there are two means of a revolving fund to be implemented, one which covers the investment costs and the maintenance or just the maintenance. Depending on the situation and the aspiration of the community, both methods have been implemented with success. Given today's prices and maintenance costs for SHS, a family has to come up with monthly installments of approximately R$ 20,00 (USD 8,00) over a period of six years and will own the SHS after this period or pay R$ 8,00 (USD 3,50) forever. The revolving fund is solely meant to cover costs related to the operation, maintenance and administration of the SHS. This includes spare parts as well as visits of the local technician in case of troubles.

This monthly fee lays well in the limits of R$ 5,00 to R$ 25,00, which the families already had to come up with to cover their former energy needs. Moreover, the SHS provides clean and save energy. The installments are collected and administrated by the association. No external institution or governmental organization is involved in the process. A contract signed by all involved parties regulates the rights and obligations. For example, in case of failure to pay during a three moth period, the association has the right to take away the SHS from the respective family.

6.5 Analysis of the users behavior

After nowadays having implemented the revolving fund system in 12 communities all over the North East of Brazil, IDER can confirm that all of the communities, beside having their specific characteristics, showed enormous easiness for the conduction of the project management, and surprised very often for their organization intensity and initiative.

After the initial difficulties to organize an association and get the project on track, the problems were few, as technically as in relationship to the insolvency, and made clear that the association behaved like expected and adopted the sustainable approach.

We can affirm, that today many communities serve as " model " for SHS implementation for the neighbor villages, demonstrating total energy autonomy, besides having learned to maintain and administrate the equipment. The associative spirit has strengthened the populations power to obtain additional agricultural projects for their community. The Solar Energy Cooperative was the seed for other local improvements.

Seeing the peoples satisfaction, ever since the systems entered into operation, without any negative impacts, but the opposite, it was in many cases responsible to motivate the people to improve and amplify their houses.

An other fundamental factor is related to the people's health level. Several times was witnessed the improvement of breathing problems, as asthma, bronchitis, fatigue, etc, caused by the use of diesel oil and kerosene as fuel for the lamps.

7. CONCLUSION

The experience of IDER has shown that SHS can be sustainable implemented in the rural area of the North East of Brazil. The SHS satisfy the needs of the local population and the self-administration has strengthened the associative and cooperative spirit in the communities. The revolving fund solely managed by the community gives absolute independency and guarantees sustainability.