Solar Home Systems for Rural Electrification in Developing Countries

An Industry Analysis and Social Venture Plan

Steve Dahlke

ENTR 311 Social Entrepreneurship, Terri Barreiro
College of St. Benedict and St. John's University

Venture Overview

Lack of access to electricity is one of the biggest issues facing the world's poor, with over 1.6 billion left in the dark globally. The vast majority of these people live in rural areas of developing countries because they are too poor and may be in too remote a location to be reached by the national grid. For their lighting needs they rely on candles, kerosene lanterns, and firewood. This results in a daily expense that is expensive in the long run. Furthermore, this type of indoor lighting causes indoor pollution and chronic lung problems. Long-term, solar energy is the most practical and economical way of bringing power to poor and remote communities.

Small-scale, distributed solar home systems provide an effective and affordable way to bring light to people without electricity. A basic system consists of a small solar panel, a battery, a charge controller, LED lights, and a universal outlet for charging cell-phones or other small appliances. A basic system will cost roughly $350, and can be made affordable through microfinance options. Partnering with local banks and/or microfinance organizations to create payment plans can help overcome the large initial investment associated with purchasing a system. Energy savings result from not having to buy candles or kerosene fuel, and can make the monthly payments affordable.

When proposing this technology to a new area, it is important to target a community that has expressed a need and desire for solar electricity. Identifying and allying oneself with a respected community leader who is receptive and supportive is a good idea. Also, word of mouth and seeing their other systems successfully installed are the most effective advertising strategies and drivers for technology adoption. Therefore, it

may be a good idea to initially donate a solar generation system to be used at a highly visible building, like a community center or school.

The proposed organizational structure will be very community-centered. The system components, including the solar panels, will be sourced locally to the greatest extent possible. The system will be assembled and installed in conjunction with the purchaser of the system. This will minimize costs, build local capacity, and provide opportunity to train the owners to properly operate and maintain their system. Early owners who become knowledgeable may then serve as advocates and technical support for future customers in their community. This approach differs from the many for-profit organizations, who use conventional business strategies, simply importing their technology and sell the product with financing to those who can afford it. My community-centered capacity building strategy differs from current industry players in that it allows for increased local capacity and empowerment. It is the key social innovation in this social venture plan.

Value Proposition and Opportunity

There are over 1.6 billion people worldwide who lack access to electricity. The vast majority of these people live in rural areas of developing countries, where scarce of government investment and difficult geography keep the national electric grid from extending to their villages. Investment in transmission lines is expensive, especially when a village is far away from a large city or in the mountains. Poor villages without electricity face greater difficulties in meeting needs such as food, shelter, and entertainment. They must do so with forms of energy other than electricity. Candles and kerosene lamps that emit toxic fumes damaging to the lungs are commonly used for lighting. Firewood is commonly used for cooking, which can further contribute to indoor pollution, and refrigeration is not an option. Studying after dark to dim, flickering candle lights and kerosene lamps is difficult for children, and businesses usually cannot continue operating after dark.

Small-scale distributed solar home generation systems offer a solution to these energy issues. A solar home system (SHS) can be installed and function almost anywhere there is sunlight. They can provide electricity for services such as lighting, television, cell phones, fans, cooking, refrigeration, and more. Furthermore, storing the electricity in a battery will allow electricity to be used for hours into the night. While there are companies already doing this in rural areas, the need is vast and all over the world. The problem is being addressed in small pockets all across the globe, but this is only a small dent compared to the total amount of people without electricity. For the problem to be

addressed, many more social enterprises distributing SHS's will need to be set up in countries all across the world.

There are a variety of benefits to adopting a solar home system. Besides households, solar home systems could provide power for schools, clinics, or small businesses. Having this bright source of light during the night can also deter wild animals that are dangerous or eat their crops and livestock. They replace kerosene lamps and candles traditionally used for lighting. Having to purchase fuel and/or candles is a daily expense that can be eliminated with a SHS. Typically, a rural family will spend between $5-$10 per month on energy and lighting expenses. Furthermore, fumes produced from traditional lighting methods are toxic and lead to chronic lung problems, especially when children are exposed. Generally, a family will use about 3 liters of kerosene per month. Using these dimmer sources of light for studying or handicraft production can strain the eyes and cause long-term vision problems. Having a solar system will allow children to study and small businesses to continue production later into the night. This increases the population's ability to be self-sufficient, raises their incomes, and allows them to begin to lift themselves out of poverty.

This study looks at the potential of small-scale solar energy generation for electrifying rural communities in developing countries. It includes an industry analysis, profiling innovative companies around the world that work in this area. From that, barriers to rural electrification and industry best practices are concluded. Finally, a preliminary venture plan is created and next steps are identified.

Target Market

The target market for this particular application of solar home systems (SHS) includes individuals living in rural villages of developing countries who are not connected to the grid and without a sustainable or reliable source of electricity. The solar solution will need to be customized depending on the village, available materials, need, and income of the potential customer. However, in its most basic form it consists of a small solar photovoltaic panel, a charge controller to regulate the current and voltage, a storage battery (usually a lead-acid battery in distributed applications), and the load, which consists of everything in the house demanding electricity. This includes lights, television, a cell phone charger, etc. (see Figure 1). It is not rocket science; rather it is a simple, basic technology that is being applied in a new small-scale way to address a need.

When distributing these systems it is important to keep the needs of the customer in mind. Not all energy needs are the same, even in a community without electricity, so being open to customizing the product is a good idea. Some families will not be able to afford as large a system as others, some may have larger homes with greater lighting needs, or some may prefer to trade off less lighting for more appliances, like a television. The point is that a one-size-fits-all approach is not ideal. Before attempting to sell any systems, it is a good

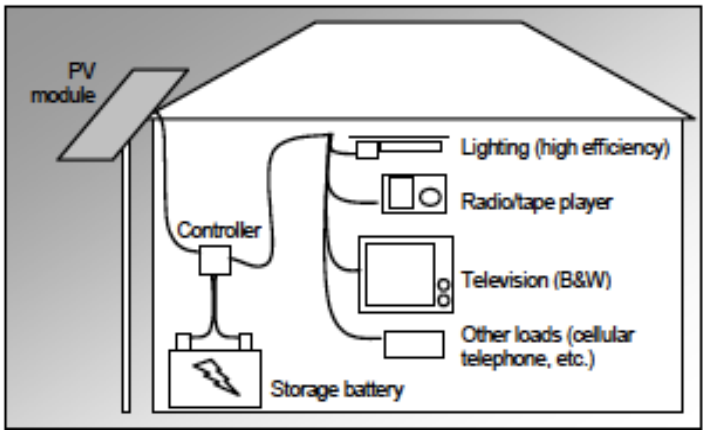

Figure 1: Components of a solar home system[1]

idea to spend a few months in the target area doing field studies, identifying community leaders, and figuring out what the local needs are.

Adoption of a solar home system will proceed in a set of stages, just like the adoption of any technology. When planning outreach strategies it is helpful to have in mind Rogers' classic five-stage model of diffusion of innovations. First is the *knowledge* stage, where a consumer first learns about the technology and gains an understanding of how it functions. He then forms a favorable or unfavorable attitude towards it in the *persuasion* stage, chooses whether to adopt it or not in the *decision* stage, and puts it into use in the *implementation* stage. During the *confirmation* stage, he seeks reinforcement of a decision already made, and may reverse the previous decision in response to new information. Furthermore, decision makers can be divided into five groups based on when they adopt the technology. *Innovators* are the first adopters. They are venturesome and less risk-averse than other groups, and are relatively wealthy and well-educated. The *early adopters* come next, who are well-respected people and often play the role of opinion leaders. Typically, others look to them as role models and imitate their adoption decisions. The next two groups of people to adopt are the *early majority* and *late majority*. The *laggards* are last, and tend to have traditional, conservative values and low incomes.[2] Dividing the target market into these segments is a helpful way of understanding the customers.

Having success in distributing SHS to bring electricity to the poor depends on a variety of factors. Awareness is most effectively spread through word of mouth and observation of existing systems. So, when entering a new area it may be in the venture's

best interest to donate a system to a highly visible building, like a community center or school. Rebane et al studied adoption rates of solar home systems in rural Nicaragua, and came up with a list of factors to consider that affect an individual's likelihood of purchasing/adopting a system, in no particular order:

- **Familiarity of Technology:** An individual is more likely to adopt a system if they have already learned about it from a friend or neighbor, or by directly observing it in operation.
- **Number of children:** Entertainment and illumination for studying are two top reasons customers point to for adoption of an SHS. So, the more children they have, the likelier they are to purchase a system.
- **Per-capita income:** While aimed to target the poor, SHS systems still present a significant up-front investment. Innovative financing structures have been developed to address this issue, discussed later in this paper.
- **Level of education:** The higher level of education a person has, the greater likelihood they have of purchasing an SHS.
- **Proximity to dealers:** The closer someone lives to an SHS dealer or non-profit organization that promotes the technology, the greater likelihood they have of buying a system.[3]

Financing

Financing is a crucial component for any enterprise wishing to sell solar home systems. Systems can cost many times what the consumer makes in a single month, and to a rural family is a purchase comparable to a new car in a developed country. Local banks and microfinance institutions offer the potential to overcome the financial barrier standing in the way of a household and a solar home system. However, the presence of banks alone does not guarantee success. Many banks perceive the poor as high risk and are unwilling to make loans to them, even if this may not be the case. The emerging field of microfinance has proven financing the poor can be low-risk, with default rates being the same or lower than conventional loans. However, because of the perceived risk, banks will usually offer loans with high interest rates. Furthermore, when providing financing for a solar home system they will usually require a high down payment, often between 15%-25%. This is still too high for many poor families.

This first cost issue is probably the biggest barrier to widespread adoption of solar home systems. Other impediments to lending include the fact that banks are hesitant to take on the risk of lending without collateral, and many families do not have the means or resources to provide the proper collateral. Also, poor customers can lack legal standing, not have an official land title, or not have any credit history. Most successful microfinance institutions conduct business in urban areas, where high customer densities make profit-generation easier. Asia is an exception to this, where they have a strong financial infrastructure in place serving rural areas. However, in the case in Latin America rural customers account for only about 10% of microloans (see Figure 2). Unfortunately, the

large majority of people in the world without electricity who need off-grid generation systems are in rural areas. These financial obstacles may seem daunting; however there have been innovations that make rural financing feasible. Here is a list of strategies that will reduce the financial barriers to SHS adoption:

1. Recruit a banking institution to provide loans.

An important goal for convincing institutions to lend to the poor is to mitigate the financier's risk or perceived risk. SELCO Solar in India has been a pioneer in developing financial mechanisms for making possible the purchase of solar systems. They have partnered with a wide variety of rural banks to make this happen (SELCO is detailed later in this report). Mitigating the financier's risk can be done in a variety of ways. For households that don't have the resources to put up the necessary collateral, the system itself could be used as collateral. Furthermore, a third-party institution or non-profit could cover the loan risk. Even a partial loan guarantee could be enough to persuade banks to lend, as SELCO's experience has shown. Or, a third-party could cover the down payment. It is also possible to account for external system benefits when

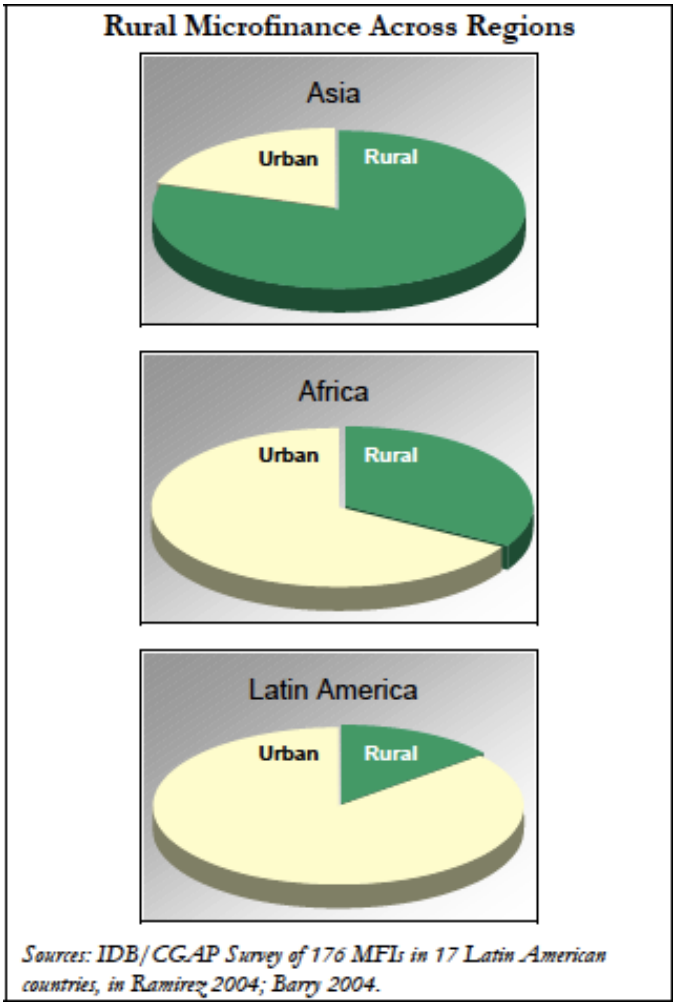

Figure 2: Ratio of rural to urban customers for microfinance[4]

assessing risk. For example, with a small business, having a solar system can allow the business to operate later hours and generate extra income.

2. Overcome the "free-rider" problem.

SELCO's pioneering efforts with microfinance in rural India is a large reason why they have become a world leader in the field. However, their case also brings to light another issue relating to "free riders." Innovative companies willing to be first in the game can be put at a competitive disadvantage when they spend resources on innovation and capacity building. This is due to other companies taking advantage of their earlier efforts, getting a "free-ride." For example, after SELCO spent many years and dollars on developing India's rural financial infrastructure, other companies benefited from it. There were even some banks that, after giving out successful loans for SELCO systems, started selling their own systems for personal social development programs. Broadly speaking this isn't a bad thing, as it results in greater adoption of the technology and increased electrification for the poor. However, it does result in a decreased incentive for individual companies to innovate if their competitors are accruing benefits from their investment.

To overcome the free-rider problem, governments and non-profit development institutions should provide funding and incentives for enterprises to innovate. This could be in the form of technical and financial support for businesses entering an unserved geographical area. Furthermore, a government or non-profit could provide financing for early-stage systems, which would allow local banks in the private sector to see the technology successfully implemented before they decide to take on the risk of making SHS loans.

Successfully financing a solar home system can have external benefits in addition to the direct benefits of electrification. Many poor rural individuals have never been inside of a bank before. Simply the process of applying for and receiving a loan, as well as successfully repaying the loan, instills financial confidence. This leads to greater financial literacy and can result in them opening savings accounts. From the bank's perspective, success can lead to the establishment of a relationship with a community previously thought of as being unlendable. After experiencing on-time repayments this can result in future loans, further lifting the community out of poverty.

3. Raising Capital Funds

Financial return in this business can be slow due to multiple factors. High transaction costs occur from small-scale sales, transportation, and maintenance across a large geographically dispersed market. As a result, raising funds from conventional investors that don't take into account social returns is difficult. The World Bank has historically been a big financier for these types of projects. The social enterprises Grameen Shakti and Tecnosol (profiled later in this report) currently have the majority of their operations working within World Bank-backed government frameworks for consumer finance and subsidies. For a more detailed account of World Bank and other international developmental organization-sponsored rural electrification investments, see "The Welfare Impact of Rural Electrification" (IEG).[5]

National governments can also sponsor projects and provide subsidies, making systems more affordable. However, caution should be exhibited with government-sponsored approaches, as subsidies can manipulate the markets and change customers'

expectations of system costs for the worse. Give-away programs or subsidies raise the risk of long-term industry failure when funds run out and the program ends. Non-coordinated government programs will take away opportunities for private enterprises to grow and be self-sufficient. Customers will not purchase systems that their neighbors had previously received for free or purchased for much cheaper. Also, without coordination, government programs run the risk of targeting areas that have already been sold systems by a local enterprise. This happened in the Dominican Republic, when a government give-away program targeted an area that already had systems installed by the SHS company Soluz.[6]

The most common energy solution offered by government is investment to expand the electric grid. This is important, as it allows a country to electrify lots of homes at once. However, there will always be a segment of the population that is too remote to receive grid access or too poor to pay connection fees. When announcing planned grid investments, governments should be transparent with where they plan to build. Non-transparent or unpredictable government investment in electricity development or grid expansion has the potential to disrupt business operations of SHS enterprises. Households will not want to purchase systems if the electric grid will be coming their way shortly, and the social businesses cannot plan their operations accordingly. Even the mere possibility of planned investment (sometimes empty promises by politicians to gain votes) has shown to disrupt business. This was also Soluz's experience in Honduras and the Dominican Republic in the late 1990's and early 2000's.[7]

Instead, governments would be better suited to channel their funds to market innovation and building the right environment for social enterprises to flourish. In addition

to government investments, private investors or development institutions will sometimes invest in these projects by providing grants or equity. For example, the non-profit organization E+Co has provided seed funding for many private enterprises related to energy and development. It has invested in SHS providers in Nicaragua, Tanzania, Ghana, India, and Nepal, including Tecnosol and SELCO India, detailed in this report.[8] As shown, there are many financial issues that must be confronted by any social enterprise in this field. An existing financial infrastructure is important to have for any business to be self-sufficient, and as such should be a precursor when deciding where to establish an operation.

Barriers

There are significant challenges that make implementation of SHS difficult. Drawing from the experiences of the organizations analyzed in this report, a number of common barriers have been identified:

- **High initial cost of SHS.** Spending $400 or so on a electricity system for a home in a poor rural village is proportionally similar to buying a car. It is a large investment, and without financing will not be affordable to the majority of the target market. Even the down payment on a loan for an SHS may be too expensive for many families. So, offering financing that can minimize the initial down payment if necessary is necessary.
- **Lack of financial infrastructure.** In many rural areas of developing countries, especially in Latin America, there aren't many banks or institutions that provide

microfinance. Partnering with banks to expand their service to rural areas is one option. Otherwise, renting systems is another way to overcome the high cost of SHS without presence of microfinance. However, a business plan based on renting requires high capital investment. Another option in the absence of microfinance is to set up a revolving loan fund. Enersol, a predecessor of Soluz in the Dominican Republic, spent $10,000 to set up a revolving loan fund to make loans for solar home systems.

- **Lack of knowledge or suspicion among rural populations.** It is likely that the customer doesn't have previous experience with solar, and possible they haven't heard of SHS at all. It is also possible that a village has had visits by politicians or government officials who have made empty promises to bring electricity to their village. To overcome this it is important to invest enough resources in outreach, demonstrations, and training.
- **Lack of capital funding.** Because of the many small sales spread out over a large geographic distance, high transaction costs characterize this business model. As a result, the slower return on investment associated with this type of social venture make raising capital funds more difficult.

While the barriers listed here are significant, there are a number of successful organizations that have made it work. Collectively they have managed to distribute hundreds of thousands of solar home systems to the rural poor. There is ample opportunity to learn from the experiences of pioneer companies.

Industry Overview

The following is a series of mini case-studies, profiling of social businesses who are currently doing work in this field. The intention is to give the reader some examples of how people have been successful and give them references for further contact if they would like to learn more.

SELCO India

SELCO is a for-profit social enterprise that provides sustainable energy solutions and services to under-served households and businesses in southern India. They aim to empower their customers by providing a complete package of product, service, and consumer financing. Founded in 1995, SELCO has become one of the world leaders among energy development social enterprises in terms of volume of units sold and company innovation. It is based in Karnataka, and operates in the surrounding rural areas (Figure 3). SELCO employs about 170 employees spread out geographically. Since 1995 it has sold, serviced, and financed over 115,000 solar home lighting systems. They are now a profitable, multi-million dollar enterprise. SELCO has 25 regional services spread out across the Indian states of Karnataka and Gujarat. Their product line consists of standard

Figure 3: SELCO India coverage, headquarters and approximate retail area[9]

home lighting solutions ranging from 1-10 lights and fans. They also will customize their systems depending on the energy requirement of the client. A typical SELCO SHS will cost a little over 400 U.S. dollars, and the majority of their products are sourced locally. The customized system will depend on local factors like lighting needs, available financial institutions, and other community dynamics.

Furthermore, SELCO has pioneered rural micro-credit in India. Since their inception they have forged partnerships with nine regional rural banks, as well as commercial banks, NGOs, and rural farmer cooperatives. Interest rates on their loans depend on the credit source and range from 5%-14%. Customers typically put between 10%-25% down, paying the balance over three to five years. SELCO employees do sales, installations, user education, and maintenance. Before closing a sale, a local installation technician visits to install the system and teach the customer on proper use and care. They will also periodically visit after the installation to check on performance. They service systems for free during the first year, including planned quarterly visits. SELCO's success with customized product and financial solutions show the power of "door-step service."

Website: http://www.selco-india.com/

Tecnosol

Tecnosol is a for-profit enterprise based in Nicaragua, with small operations in El Salvador and Panama (Figure 4). Founded in 1998, they have installed more than 40,000 systems in Central America and have executed over 300 energy projects of various types. Tecnsol has 17 offices throughout Nicaragua, and one each in El Salvador and Panama. Similarly to SELCO, various micro financiers have integrated Tecnosol's systems in their loan options. Their most basic product is called a pico lamp, imported from Germany, and costs $80 per lamp. Each lamp includes a battery and universal charger, but does not include a solar panel. They also offer a variety of LED lamps, batteries, solar panels, and more. The majority of their technology is imported from abroad, with solar panels imported from the U.S., China, and Germany. The battery for a pico lamp lasts from 2-5 years, and replacement costs $8. In terms of providing credit, they partner with micro-credit organizations and various foundations. They also have their own pot of money that they use.

Figure 4: Tecnosol offices[10]

Website: http://www.tecnosolsa.com.ni/

Soluz

Soluz is one of the oldest enterprises working with solar home systems. It was founded in the mid-1990's by Richard Hansen, an engineer who has been working in the Dominican Republic since the 1980's installing solar home systems. They have established operations in the Dominican Republic and Honduras (see Figure 5). Since inception they have served over 10,000 households and small businesses in off-grid areas. There are negligible micro-finance options available in these regions, and government policies are largely unfavorable for social enterprise development. As a result, Soluz has pioneered a different financial approach, with a business model based on unsubsidized micro-rentals. They have been able to offer household PV systems starting at $5 a month. Renting systems is a good idea if microfinance is not available, or if there is potential of national grid extension in the near future. Renting allows the customer to avoid the expensive up-front payment. It is also a good idea for customers who

Figure 5: Soluz coverage in the Dominican Republic (top) and Honduras (bottom)[11]

face a risky and unstable financial future (like farmers who depend on an unpredictable growing season), since there is not a long-term commitment. The downside to renting is that it requires significant capital investment from the enterprise to make the business viable. Soluz is one of the world leaders in innovation, and has pioneered their model of rentals to become the world leader in rural PV rental systems.

Website: http://www.soluzusa.com/

Quetsol

Quetsol is a for-profit company that provides solar home lighting systems for customers in rural Guatemala. In Guatemala there are around 500,000 homes without light, about 20% of the population. They provide a simple, easy to use "plug n' play" kit that consists of up to 3 LED light bulbs and a universal cell-phone charger (Figure 6). Their solar panels will last about 20 years, LED light bulbs about 7-8 years, and the batteries about a year and a half. The biggest maintenance challenge is replacing the batteries, which needs to occur every couple of years and costs about $20-$30. Therefore, when they sell kits, customer training consists of informing them how to operate the system to optimize battery life and to make them understand the costs of replacement. Furthermore, they plan specific maintenance days

Figure 6: Quetsol solar home lighting kit[12]

where they invite all consumers in a certain area to bring in their systems to change the batteries. A large indigenous population lives in rural areas of Guatemala, and there are 22 indigenous languages spoken among them. This presents a cultural barrier, and to overcome it they use local sales people. 90% of their systems are sold through micro-credit. They have partnered with banks, including one of the biggest banks in Guatemala, Banrural, as well as one of the largest micro-finance institutions in Central America, Genesis Empresarial. Quetsol also partners with local NGO's to better connect themselves to the community, and have received funding from a variety of foundations. They have recently constituted the Quetsol foundation, a non-profit arm designed to bring lighting solutions to people unable to afford systems through commercial operations.

Website: http://www.quetsol.com/

Grameen Shakti

Grameen Shakti ('shakti' means 'energy' in Bengali) was created in 1996 as a non-profit organization designed to deliver climate-friendly and reliable energy to the poor in Bangladesh. It is a subsidiary of Grameen Bank, the well-known pioneer organization of micro-finance started by Muhammad Yunus. They utilize their expertise in micro-finance to make renewable energy applications affordable to rural people. As of October 2011, they have opened 1,348 total offices, employed 10,800 people, and installed 718,146 solar systems. See Figure 7 for a year-by-year breakdown of growth in installations of solar home systems. They have calculated that one of their solar home systems replaces about

374 kg CO_2 from entering the atmosphere annually, and saves between $6.00–$7.50 per month on kerosene fuel costs.

In terms of financing, the organization has developed four different credit schemes to make solar home systems affordable. Customers pay different proportions of down-payments and monthly installments based on their financial circumstance. These are supported by low-interest loans made possible by foundations and the World Bank. Grameen Shakti has also received grants from USAID to cover overhead costs. Grameen Shakti has tried to involve the local community by starting a network of technology centers. These are managed mainly by women engineers, who then train other women as solar technicians. They serve to service and repair systems in their areas, and manufacture solar home system accessories. They have also received the European Solar Award in 2003 and the Ashden Award for Sustainable Energy in the UK in 2006.

Website: http://www.gshakti.org/

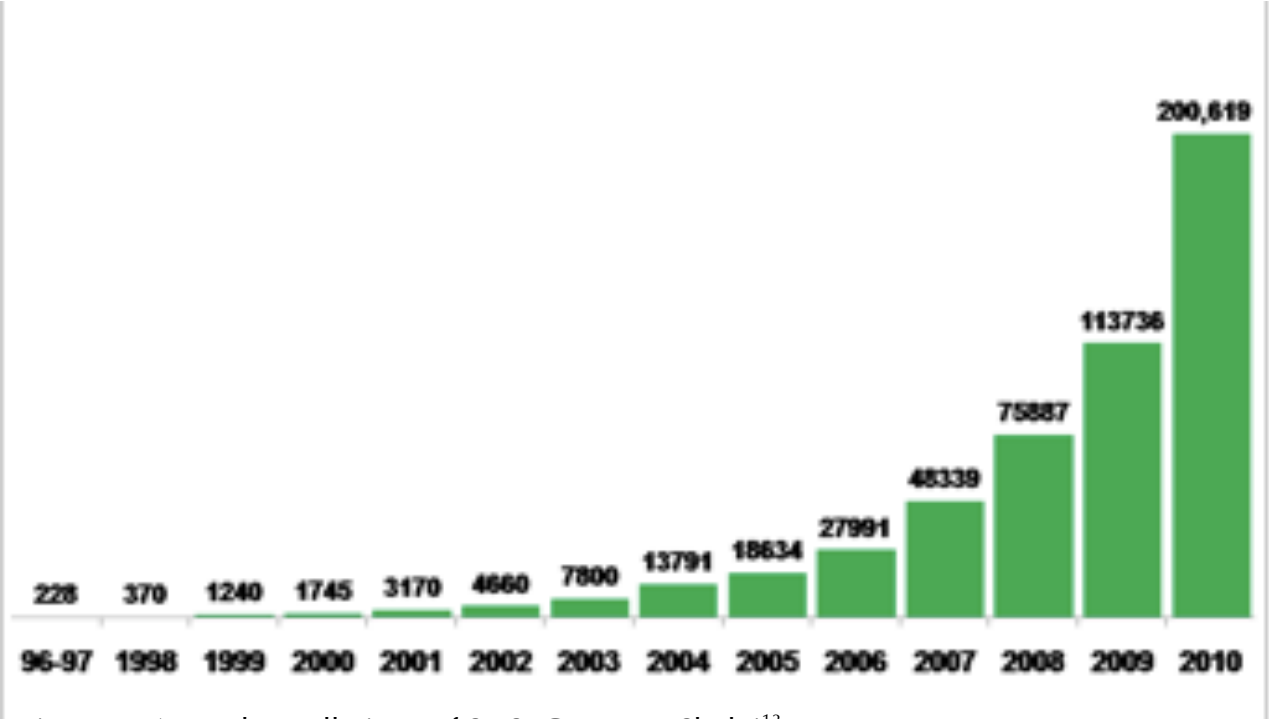

Figure 7: Annual Installations of SHS, Grameen Shakti[13]

Casa Solar

Casa Solar is a renewable energy organization located in Quetzaltenango, Guatemala that works on a variety of sustainable development projects, including installations of solar home systems. The kit they have used consists of a 50W solar panel, 4 compact fluorescent lamps, a 5-amp charge controller, 105-amp battery, and a cell phone charger. They import their panels from Germany, China, or Spain. While Casa Solar is a for-profit enterprise, they incorporate social development aspects in their projects. For example, on a recent project they partnered with a foundation to deliver 58 solar home systems to a community. They then used the profits to purchase a communal refrigerator so the residents can sell ice cream, cold drinks, and more to generate additional income for the community. They are also looking to partner with local banks to provide credit. Casa Solar is smaller than some of the other companies profiled here, yet is innovative and promising.

Website: http://casasolar.com.gt/

Barefoot College

Barefoot College in India has been working with solar electrification in non-electrified villages since 1989. The "Barefoot" method involves working with rural villages that express a need. They will then take a few local community members and train them for six months in India to become solar engineers, who will then return to their communities to install, maintain, and repair solar lighting units. Barefoot college encourages communities to send middle-aged and poor women to be trained as solar

engineers, even if they have no previous qualifications. They don't even need to be literate. Part of this is because they want people with strong roots in the community who will return to the village and work for its development instead of finding a job in the city after they are trained. In addition to India, Barefoot College has brought in and trained engineers in 25 total countries spanning Asia, Africa, and Latin America, and speaking English or Hindi is not required. The College has partnered with India's Foreign Ministry, which covers the travel costs of bringing in women from other countries to train in India.

The entire community must be involved in the electrification process; every individual who expresses an interest in acquiring a unit must pay a proportional and affordable monthly contribution, irrespective of how poor they are. This payment is proportional to how much the household spends on kerosene, candles, wood, and other lighting materials each month. In addition, the community must donate a building for building and storage of solar systems, and identity individuals who will be responsible for punctually collecting the monthly fees for the solar systems. A percentage of the financial contributions go to the barefoot solar engineers, and the rest covers the system costs. The Barefoot model for implementation of community-owned and managed solar systems has resulted in solar-electrification benefiting nearly 190,000 people in over 750 communities in 16 states in India and is being replicated in 24 other countries in Africa, Latin America and South Asia.. The scale they have achieved with their unconventional approach shows its success. The thousands women engineers they have trained, including grandmothers and illiterate widows, has resulted in many inspiring stories.

Website: http://www.barefootcollege.org/default.asp

Organizational Structure

The organizational structure for this venture will be very community-focused, especially at the beginning. When entering a new village, one of the first goals is to find and establish a relationship with a local champion. This will ideally be a respected village leader who wants to bring solar electricity to the village. Furthermore, it will be important to begin building local capacity right away. Therefore, early adopters will need to be identified who have a desire to acquire a system, as well as the ability and time to be technically trained regarding its operations. The early adopters need to be able to afford a system, be committed to their community, and be willing to put in the time to build and understand the system before adoption. The system will be built using locally sourced materials to the greatest extent possible, including components of the solar panel. This will keep prices low, benefit the local economy, and provide an opportunity for the owner to become knowledgeable about the system.

One of the requirements for the early adopters will be that they need to participate in the building of their systems. This is part of the training they will go through that will teach them how to operate an SHS and perform maintenance and necessary repairs. For example, the battery lasts a few years before needing to be replaced, so this will need to be a part of training. Once more systems are purchased in the community, these early adopters can provide the installation and maintenance services to others who are interested in owning a system but may not have the time or technical knowledge to build it themselves. Once the business model is in place, these early adopters may become employees of the venture and perform their services for a fee. A potential community

worth exploring for this venture is in Yambiro, Ecuador. The College of St. Benedict and St. John's University already have an established relationship with the residents, and they have been open to working with students and faculty on developmentally-related projects, including the building of a greenhouse.

Budget

This is meant to be a rough and preliminary budget. The travel and living expenses are approximate. Furthermore, the components of the solar home system were found using Google Shopping. For these products, much more due diligence will need to be done in order to figure out what specific types of components work best with each other to obtain the maximum performance at least cost. The panels used in this budget will be imported. However, a conclusion from this report is that additional cost savings may be achieved by building the individual solar panels instead of importing. Most likely the individual silicon solar cells will need to be imported but it is probable that the rest of the necessary materials can be found at hardware or electronic stores in a nearby city.

Travel and Living Expenses, 1 month	
Flight to Quito, Ecuador	$1,000
Food/Rent/Entertainment ($30/day x 30 days)	$900
In-country travel	$200
Total	**$2,100**
Solar Home System (x5)	
Solartech 20W solar panel	$115
Enersys 12V sealed lead-acid battery	$75
Xantrex C35 Charge Controller	$100
5W LED Lights ($20x2)	$40
Misc (wiring, tools, etc	$15
Total for SHS	$345
x5 systems	**$1725**
Total Expenses	**$3825**

Conclusions

As demonstrated in the previous case studies, this technology is viable and ready to be distributed to the world's poor. Solar home systems are simple, easy to install (can be made for "plug-and-play"), and the most effective option in distributing power to the world's poor and remote. They provide better quality of light, are cleaner, more environmentally friendly, and save money in the long run compared to non-electric sources of light like candles and kerosene lamps. The main barriers to SHS adoption include lack of rural infrastructure (relating both to setting up the supply chain and financing), suspicion and lack of knowledge among rural people, lack of skilled labor for installation and maintenance, and most significantly the high upfront cost. It is essential to invest time to understand the needs and characteristics of the target communities. Furthermore, microfinance must be available to make affordable the upfront investment of a solar home system. This could be through loans from a local bank; or, a community revolving-loan-fund could be established to provide loans. After doing an industry analysis and studying a variety of companies operating in the field, the following "best practices" have been concluded:

- **Door-step service and customized solutions.** While it may be tempting to standardize the product for convenience and easy production, not all rural individuals will have the same energy needs, and the amount each family can afford will differ. Upon greater understanding of a community's energy needs will come the realization that more is needed than just lighting solutions. That is why

many companies eventually branch out and provide other technologies, including solar water heaters, stoves, and wells. A one-size-fits-all approach will not work.

- **Community-committed 'solar champions.'** For technology adoption to be successful in any community, it will need committed local residents. Ideally members of the community can serve as salespeople and technicians if they receive proper training. Local champions will understand the community and relate to the customers better than any outsider.
- **Local supplies and manufacturers.** Using locally sourced supplies can save money and contribute to the local economy. Furthermore, importing solar panels from China, the US, or Germany, as most SHS companies do, is expensive. The entire solar home system can be simply built using most if not all materials purchased in country. Training engineers who are community members to build the panels further builds local capacity. Money that would otherwise end up as profit for an international corporation stays in the local community where the need is greater. Not many of the companies studied here employ this strategy, with the exception of Barefoot College and to some extent SELCO Solar.
- **Microfinance.** As discussed in depth earlier, affordable financing is essential for making the investment in an SHS affordable. Purchasing a solar home system for a rural villager is roughly the equivalent for an average American purchasing a new car. Most companies have partnered with local banks and/or microfinance organizations to provide the necessary financing. Generally, a finance plan will require a 15%-25% down payment with the rest paid in monthly installments over

a period of 2-3 years. A strategy not employed by the larger companies, but one that is more community-centric, involves establishing a locally managed revolving loan fund.

The research put into this report is sufficient as an exploratory and initial feasibility study. Much more work would be necessary for a social venture of this nature to be successful. First of all, a target community will need to be decided on as the first location to sell SHS. This will need to be a community in which the residents have expressed a need and desire to acquire solar home systems. As mentioned before, the community in Yambiro, Ecuador would be a good community to look at first because of already established relationships and because they have been open to collaborating on projects in the past. An important factor to consider is if there is a local champion and an early adopter(s) willing to put in the time to learn about the technology and promote it to his/her neighbors. Another consideration is availability of local materials within an accessible distance to the village. Finally and most importantly an assessment of current electricity and lighting usage will need to be done to determine if there is an adequate need for electricity in the village. After all this is taken into consideration, seed funding will need to be acquired from social investors, another significant hurdle.

Solar home system technology offers the epitome of sustainable development. If implemented correctly, it will begin to lift rural communities out of poverty in an environmentally friendly way. Furthermore, if technical training is accompanied with sales, community members are left with greater knowledge than before, which can lead to future

jobs and greater income. This benefits local economies and creates a positive feedback cycle that can work to light up the darkness for millions of the world's poor.

Footnotes

1. *Soluz, Inc,* Web. <http://soluzusa.com>.

2. Rogers, Everett M. *Diffusion of Innovations*. New York, NY: Simon & Schuster, 2003, 161.

3. Rebane et al, *Knowledge and Adoption of Solar Home Systems in Rural Nicaragua,* Energy Policy, 2011.

4. John Rogers, *Innovation in Rural Energy Delivery: Accelerating Rural Energy Access Through SMEs,* Navigant Consulting & Soluz, Inc., 36.

5. The welfare impact of rural electrification a reassessment of the costs and benefits ; an IEG impact evaluation, Washington DC, World

6. John Rogers, *Innovation in Rural Energy Delivery: Accelerating Rural Energy Access Through SMEs,* 69.

7. Ibid, 17.

8. *E+Co, Energy Through Enterprise,* Web. <http://eandco.net>

9. John Rogers, *Innovation in Rural Energy Delivery: Accelerating Rural Energy Access Through SMEs,* 51.

10. *Tecnosol, Energía en Sus Manos,* Web. <http://www.tecnosolsa.com.ni>

11. John Rogers, *Innovation in Rural Energy Delivery: Accelerating Rural Energy Access Through SMEs,* 61.

12. *Basic Energy, Quetsol Solar Energy Kit,* Web. <http://www.quetsol.com/index.php?option=com_content&view=article&id=87%3Acontent-energia-basica&catid=37&Itemid=90&lang=en>

13. *Grameen Shakti Growing as a Social Business to Meet the Energy Needs of Rural People,* Web. <http://www.gshakti.org/index.php?option=com_content&view=article&id=57&Itemid=77>

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