

## **2009 Ashden Awards case study**

### **The Solar Energy Foundation**

- Finalist's work:** Bringing affordable lighting to communities in Ethiopia using solar-home-systems
- Organisation:** Charitable foundation based in Germany, established 2006. Annual turnover US\$1.5m, 35 staff in Ethiopia (2008)
- Location:** Ethiopia

#### **Summary**

In Ethiopia, the main sources of light in rural homes and small businesses are dim kerosene lamps and candles, which emit fumes which can lead to health problems. The Solar Energy Foundation (Stiftung Solarenergie) has developed a small solar-home-system (SHS), powered using a photovoltaic module, to supply electricity for lighting and small appliances and replace kerosene lamps. The villagers of Rema chose to have SHS rather than a diesel generator, because of concern about the running costs of the generator.

- Basic SHS includes 10 Wp PV module, 18 Ah battery, charge controller and up to four LED lights. Most components are imported, and assembled in Ethiopia.
- Charge-controller can be disabled remotely if fees are not paid.
- International Solar School set up to train solar technicians with installation, maintenance and business skills. 30 have graduated from the six-month programme.
- 2,100 SHS have been installed in Rema and nearby areas: maintenance is provided by the locally trained technicians.
- In Rema, households pay a charge of about US\$1 per month, which covers maintenance and replacement of components. Management of income is controlled by a village committee, and nine villagers are paid as fee collectors.
- Solar lighting avoids eye irritation from kerosene smoke, and the risk of burns and house fires.
- Better light allows shops and craft-workers to work later and improve income.
- Students are now able to work at home in the evenings, and evening classes have been set up to improve adult literacy.
- Reduction in greenhouse gas emissions is about 650 tonnes/year CO<sub>2</sub> to date.
- A well and PV-powered water pump were provided in Rema, to supply drinking water for a small charge. Previously there was a two hour walk to collect drinking water.
- Four more Solar Centres have been set up in other parts of Ethiopia: technicians will run these as franchises from the Solar Energy Foundation.
- In future installations, households will pay for the capital cost as well, with loan repayments from US\$7 to 13 per month over one to three years – similar to the current cost of kerosene and dry cell batteries.
- Plans for 8,500 more SHS to be installed by the Solar Centres by December 2009.

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## Context

In Ethiopia, like many parts of the developing world, reliable electricity supplies are unavailable to many rural and semi-urban dwellers. The main sources of light in homes and small businesses are kerosene lamps and candles. These emit fumes which can lead to eye and health problems for the users, and the low levels of light cause eye strain.

A solar-home-system (SHS) provides a small supply of electricity, powered by solar photovoltaic (PV) modules, to individual homes and work places. The supply is sufficient for lighting, and often small items of home entertainment equipment such as a radio or tape player. Unfortunately the capital cost of such systems is usually beyond the resources of the people who need them, so an alternative method of financing and distribution is necessary if such systems are to achieve widespread uptake.

The Solar Energy Foundation (Stiftung Solarenergie in German) has developed high-quality solar-home-systems and solar lanterns. In 2005, a small trial of 30 systems was started in the Ethiopian village of Kechemober, 240 km north of Addis Ababa. Representatives from the village of Rema, about one hour drive away, came to see the systems. Rema had been offered a diesel generator by another NGO, but villagers were reluctant to accept the offer because of their concern about the running costs, particularly the cost of diesel fuel. The visitors were very impressed with the solar systems and requested similar systems for Rema. The Solar Energy Foundation developed a programme for Rema which provided not just the solar technology, but also the maintenance and financial structure, so that each household could have a solar-home-system.

| <b>Statistical information, Ethiopia</b>               |            |
|--|------------|
| Population (2005) million                              | 79.0       |
| Urban Population % of total                            | 16%        |
| GDP per capita US\$ (2005)                             | US\$157    |
| GDP at purchasing power parity                         | US\$1055   |
| Population living on less than \$1 a day (2005)        | 23%        |
| Population living on less than \$2 a day (2005)        | 78%        |
| Population with access to grid electricity (2005)      | 23%        |
| Annual electricity consumption per person (2004)       | 36 kWh     |
| Annual CO <sub>2</sub> emissions per person (2004)     | 0.1 tonnes |
| Population % undernourished (2002 -2004)               | 46%        |
| Population with access to improved water supply (2004) | 22%        |

*Source: UNDP Human Development Report 2007/2008*

## Technology and use

An SHS consists of a PV module, which generates electricity from sunlight; a rechargeable battery, which stores electricity so that it can be used during both day and night; a charge controller, which prevents the battery from being over-charged or deep-discharged; lights; wiring and fixtures. The basic 'SunTransfer 10' system developed by the Solar Energy Foundation uses a 10 Wp SunTransfer PV module, and an 18 Ah maintenance-free gel type lead-acid battery. This combination is designed to provide light for a minimum of four hours per day, with the possibility of connecting a radio or music system for short periods as well. The battery is expected to last for five years if used carefully. The PV module and charge controller are expected to last more than 10 years.

The current system has up to four light-emitting-diode (LED) lamps, although some earlier units used compact fluorescent lamps. A much brighter LED (80 lumens rather than 25) has recently become available, and this will be used in future systems.

The innovative charge controller was designed to allow the systems to be disabled remotely by a local technician, as a last resort if the user does not pay the rental costs. The battery and charge controller are housed in a sealed box, which needs a special tool to open it. The Foundation has also developed a very small solar lantern with phone-charging facilities, and larger PV systems which can run a TV or music system, or even a refrigerator

The Foundation has also installed a solar powered water pump in Rema, to provide fresh drinking water to the village. Previously the only supply was from a source about two hours walk away. There are two sets of taps in the village where people can collect water twice a day, for a small charge.

### How users pay

£1 = 16 ETB (Ethiopian Birr), 1US\$= 11 ETB (April 2009)

Each SHS costs about US\$260 (3000 ETB), including manufacturing and installation, divided approximately:

|  |     |
|--|-----|
| 10Wp PV module   | 15% |
| 18 Ah gel-type lead-acid battery                                   | 20% |
| Charge controller with payment function and data logger            | 25% |
| Lamps  | 15% |
| Cable, box, plugs, user book, fixings, manufacturing, installation | 25% |

The capital cost of the systems installed in Rema and its neighbouring village of Rema ena Dire were financed by donor funds. However, households must pay a monthly fee of between 10 and 14 ETB (US\$0.9 and 1.2) depending on the number of lamps in their system. The charge is divided into two parts: a basic fee which is used to pay the local technicians for regular maintenance work, and a further fee to pay for replacement parts such as the battery and LEDs. An outline agreement on charges and conditions was set up between the Rema village administration and the Solar Energy Foundation, before installations started. Each household also has its own contract with the Foundation, which gives details of the agreed individual fees and other conditions.

In future villages, owners will also pay for the capital cost of the system, either directly or through a loan over one to three years. A revolving capital fund is being set up to cover the purchase of further SHS units and allow the programme to become self supporting. Loan repayments will be set at about 80 to 150 ETB (US\$7 to 13) per month. This charge is similar to the energy costs which are avoided by having an SHS. Surveys by the Foundation suggest that families in rural areas of Ethiopia spend about 60 to 90 ETB on kerosene, and 20 to 80 ETB on dry cell batteries, each month.

Payment is managed by a village committee. In Rema there are nine fee collectors, located in different parts of the village. Households have a period of three days in which to pay their monthly fee to their collector. If they do not pay within this time, then the system will be shut down remotely by the maintenance engineer. In practice this happens rarely, and usually when the user has been away from the village. The system is re-activated when the amount

owing is paid off. The contract states that if fees are not paid for three months then the system will be removed but to date this has not been necessary.

The fee collectors are responsible for recording the fees received, stamping receipt the householder's receipt book, and passing the money to one of the village administrators for banking. Fee collectors are paid 30 ETB per month.

### **Training, support and quality control**

Individual SHS components are imported and then assembled in Ethiopia, where quality checks are carried out. Each system has a reference number, which is recorded both on the box and over the door of the house where it is installed. The only parts at present manufactured locally are the solar box, which contains the battery and the charge controller, and the mounting brackets for the solar modules. There have been only minor problems with the units installed to date, and these have been easily rectified by the technicians. All installed units are still functioning.

In order to supply well-trained solar technicians, an 'International Solar School' was set up in Rema by the Solar Energy Foundation. The curriculum consists of six weeks of theory on solar technology, six weeks of business management, and three months of practical training. The assembly and installation of the solar home systems in Rema ena Dire was used for the practical training of the two groups of 15 technicians who have completed the course so far. Some of these engineers have now moved to four new solar centres which have been set up in other areas of Ethiopia. Future trainees will get their work experience as new systems are installed.

Householders are shown how to use their systems when they are installed and, as part of the contract, they have to confirm that they understand the instructions and the rules for use. Instructions are also painted on the battery box both in written and picture form. At the end of the installation work, each family receives their own user manual and record book in which details of the equipment are noted, and all repairs and payments are recorded. The solar technicians in the village (easily identified by bright yellow T-shirts) can rectify small problems.

### **Benefits**

#### **Numbers**

By the end of 2008 about 2,130 SHS installations had been completed by the Solar Energy Foundation. 30 were in the original demonstration, 1,100 in the village of Rema, and a further 1,000 in Rema ena Dire. With an average of five people in each family it is estimated that over 10,000 people are benefitting.

#### **Environmental benefits**

Replacement of kerosene lamps for lighting saves about 70 litres/year of kerosene per lamp, equivalent to about 0.19 tonnes/year CO<sub>2</sub>. A survey in Rema suggested that households were using about 1.6 kerosene lamps on average. Thus for the 2,130 SHS installed to date, the total saving of greenhouse gases is about over 650 tonnes/year CO<sub>2</sub>.

Previously dry cell batteries were used to power radios and music players. The disposal of the spent batteries is a problem, since they are often simply thrown into the streets. Radios and, to a limited extent, other equipment can now be powered by the SHS, which reduces the problem of disposal.

## **Social benefits**

There is a real sense of pride in the Rema communities that they rejected the option of a diesel generator, and gone for the more modern approach of solar lighting.

Health benefits arise from eliminating kerosene. Smoke and fumes from the kerosene lamps previously caused eye and other problems. These are even claims that this has led to blindness. In addition the low level of light from the lamps made close work difficult and was a cause of eye-strain. There is no risk of burns from touching kerosene lanterns (a particular problem for children) or from house fires when lanterns or candles are knocked over. Easy access to clean drinking water, without a long walk to collect it, is also a great benefit to health.

Having adequate lighting in the homes allows children to study and complete their homework in the evenings. The village teacher thinks that grades in the primary school have improved by 75% as a result of the PV lighting. A night school has been set up to tutor adults who received little or no schooling, thus improving literacy. This programme has been set up by the Women's Association in Rema and shows the significance of the solar initiative in bringing opportunities to women.

## **Economic and employment benefits**

The programme has provided a range of employment for both men and women. Thirty technicians, including five women, have now been trained in the Solar School and are employed by the Foundation. There are nine fee collectors in Rema, including one woman. Their monthly payment is similar to the daily wage for a labourer, so a useful addition to earnings from other work, like running a shop. Three administrators handle the money. In addition, many people in the village benefit from increased working hours, including shopkeepers, tailors and craft-workers.

## **Potential for growth and replication**

The Solar Energy Foundation estimates that out of the approximately 13 million households without electricity in Ethiopia, about 10 million have sufficient income to pay back a loan on a solar home system. Many of them live in the closely-knit communities where the approach used in Rema would be applicable. The 2,100 installations in Rema and its surroundings are seen as the start of a country-wide programme.

Four new Solar Centres have now been set up in different parts of Ethiopia, and it is intended that these will have installed a further 8,500 systems by September 2009. More Solar Centres are planned. The Solar Centres are run by technicians from the Solar School, who will have both technical and business management expertise. Each centre will operate as an independent franchised business. The initial capital to set up a revolving fund for purchasing equipment will be provided by the Solar Energy Foundation, but the Centres will then be self-financing, the cost of the installations being met from the monthly user repayments. The aim is to recoup the cost over a period of three years

The components for the initial installations were imported and just assembled in Ethiopia. The intention for the future is to expand the amount of work carried out locally, with a plan for two factories to be set up, one for assembling solar modules and the other for charge controllers and lamps. Both of these will increase employment opportunities for the local population. These factories will be set up as joint ventures with European companies

The potential for using such systems in other countries is also significant. A request has already been received for 100,000 smaller systems, for use in Kenya and Uganda.

## **Management, finance and partnerships**

The Solar Energy Foundation was set up and is managed by Dr Harald Schützeichel, with an advisory board of seven people and a foundation board of three. The country representative in Ethiopia is Samson Tsegaye. He manages the local operations. Workeneh Gashie is the director of the International Solar Energy School.

Harald Schützeichel has considerable experience in the field of solar energy, having co-founded the company Solarstrom AG in 1998 and run it for six years, eventually floating it on the stock exchange. At the moment he is raising finance to set up the revolving funds needed for the next stage of the work. An associated company, SunTransfer, sells solar products on a commercial basis in places such as the Philippines, Kenya, Uganda and the profits from this help to fund the work in Ethiopia. The NGO Menschen für Menschen provides assistance, particularly with logistics in the region and Good Energies Foundation, Hilti Foundation, Conrad Electronic and other large donors have provided grant funding. In Ethiopia the Solar Energy Foundation works closely with local government bodies and also the Disaster Preparedness Agency Ethiopia. The International Solar Energy School, with its headquarters in Rema, is supported by the solar cell manufacturer Q-cells.

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This report is based on information provided to the Ashden Awards judges by the Solar Energy Foundation, and findings from a visit by one of the judging team to see their work in Ethiopia.

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