



Grameen Shakti, Bangladesh

Dipal Barua

Rapidly growing solar installer provides clean cooking as well

Summary

Nearly 70% of households in Bangladesh are not connected to the electricity grid and depend on kerosene for lighting. This includes most rural areas and extends as far as the fringes of Dhaka. There are plans to extend the grid, but there is little prospect of substantial change in the foreseeable future.

Grameen Shakti is a non-profit organisation, which has established a very significant role in selling photovoltaic solar home systems (SHS) in rural Bangladesh. SHS avoid the smoke and fire risk of kerosene lamps and bring major benefits to users, including clean, bright light, radio, TV and phones. Solar-powered lights and phones were of crucial importance in cyclone Sidr, when there were widespread power cuts on the mains. The large number of SHS installations has been achieved by enabling users to purchase their systems on micro-credit with affordable terms, tailored to their specific needs, and providing local service. Funding for the micro-credit system came from the World Bank and GEF via the Infrastructure Development Company Limited (IDCOL) which provided Grameen Shakti with both subsidy and concessional loans.

Grameen Shakti won a first-prize Ashden Award in 2006, for enabling 65,000 households and small businesses to buy SHS. Since then it has both grown enormously and diversified. It is now probably the largest single provider of SHS in the world. By April 2008, Grameen Shakti had installed 150,000 SHS (6.75 MWp of photovoltaic capacity) and was adding 5,000 additional systems each month. Smaller systems have been developed, to make the benefits of PV electricity more accessible to poorer households. For example, a 20 Wp system to supply two lamps and a radio or phone charger costs about Tk 15,000 (£115). This can be paid through putting down a 15% deposit and then making 36 monthly payments of about £2 – the monthly saving on kerosene. Other options are available to customers who can afford larger payments. The default rate on loan payments is very low. Although the reduction in greenhouse gas emissions per SHS is quite modest (500 kg/year CO₂ per 50 Wp system) the programme is so large that overall savings are significant, about 68,000 tonnes/year CO₂. Grameen Shakti is intending to use carbon finance for future expansion of the programme.

Rural households lack modern cooking options as well as electricity. Many rural women have the daily burden of collecting fuelwood and cooking over open fires, at risk of

respiratory and eye disease and burns. Grameen Shakti has therefore started to sell biogas plants (which produce biogas for cooking from cattle dung) and improved cooking stoves (which halve fuelwood use and remove smoke from the kitchen). These save significant amounts of fuelwood, giving savings in money from buying wood and time from collecting it. Equally important, they make kitchens cleaner and safer. Both the stove and biogas programmes have achieved significant scale in less than two years, with 15,000 stoves and 3,000 biogas plants sold and installed. Micro-credit is also available for these systems. The Tk 750 cost of a stove can be paid back in six months from the cost of the wood which it saves. Biogas plants produce compost as well as cooking gas, and in larger plants spare gas can be sold or used to generate electricity.

Grameen Shakti has achieved this impressive expansion and diversification by growing its own infrastructure very carefully, and emphasising strongly that growth must not compromise quality. For the PV and stoves, marketing, sales, system installation and collection of loan payments are arranged through 387 local unit offices, and such is the demand that ten new offices open each month. In parallel, a network of 'Grameen Technology Centres' has been set up to train female technicians to assemble SHS accessories (lights, phone chargers, charge controllers) and to install and maintain SHS. The GTCs also train stove technicians. About 300 PV technicians now work either with the 20 GTCs which are now in operation or independently. 50 of the most able technicians have been helped to set up their own businesses. For many female technicians this is their first opportunity for earning and income.

It is clear from the continuing success of Grameen Shakti that there is significant demand for the lighting and cooking services which local, sustainable energy can provide. Families and small businesses buy the systems because they can see the benefits. Through continuing to build its infrastructure, Grameen Shakti plans to provide one million SHS, 10 million improved stoves and 500,000 biogas plants by 2015, bringing the benefits of local sustainable energy to over 15 million people.

The organisation

Grameen Shakti is a non-profit organisation, which was established by Grameen Bank in 1996, with a mission to promote, develop and supply renewable energy technologies to rural households in Bangladesh. It employs over 2,000 staff at its head office in Dhaka, other offices and technology centres. Its turnover was about £15 million in 2006.

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Context

Nearly 70% of households in Bangladesh are not connected to the electricity grid and depend on kerosene for lighting. This includes most rural areas and extends as far as the fringes of Dhaka. There are plans to extend the grid, but there is little prospect of substantial change in the foreseeable future. Many people in rural areas rely on

fuelwood for cooking, and most still use open fires or very basic stoves. Grameen Shakti initially focussed on electricity, by bringing off-grid households the opportunity of buying photovoltaic solar-home-systems (SHS) for lighting and small appliances. Through the network of offices and technology centres which it has developed throughout Bangladesh, Grameen Shakti is now able to move into other energy services, in particular providing safer and cheaper cooking options.

Statistical Information - Bangladesh	
Population (2005)	153 million
Urban population	25%
GDP per capita US\$ (2005)	423
- at purchasing power parity	2,053
Population living on less than US\$1 a day (1990-2005)	41%
Population living on less than US\$2 a day (1990-2005)	84%
Population with access to grid electricity (2004)	32%
Annual electricity consumption per person (2004)	154 kWh
Annual CO ₂ emissions per person (2004)	0.3 tonnes
Population undernourished (2002-2004)	30%
Population with access to an improved water supply (2004)	74%
Source: <i>UNDP</i>	

Technology and use

Solar home systems

Solar-home-systems (SHS) are small, stand-alone electrical systems. They consist of a photovoltaic (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; fluorescent lamps; wiring and fixtures. Grameen Shakti uses PV modules imported from Kyocera in Japan. Initially the rated PV capacity varied from 40 to 120 Wp, with a 40 Wp system powering about four lamps for four hours per day, as well as radio, phone-charger and TV on larger systems. To make the SHS affordable to poorer households, smaller systems based on 10 to 20 Wp modules are now available as well, using low-power LED lights.

Grameen Shakti uses 18 to 130 Ah deep-cycle batteries, manufactured by four different companies in Bangladesh. It manufactures its own charge controllers, but also purchases from Phocos with whom it has opened a joint venture to manufacture charge controllers in Bangladesh. LEDs are purchased from other companies.

Biogas systems

Biogas systems take organic material such as cattle dung into an air-tight tank where bacteria break down the material and release biogas – a mixture of mainly methane and carbon dioxide. The biogas can be burned as a fuel, for cooking or other purposes, and the solid residue can be used as organic compost. The plants made by Grameen Shakti use a digester tank which is constructed from bricks and concrete in a shallow pit, and

has a fixed brick dome built over it. The structure is finished with mortar to make it gas tight.

Manure is blended with an equal volume of water in a mixing tank (in order to make it flow easily) before it is added to the digester tank. Here it decomposes, producing biogas (typically 60% methane and 40% carbon dioxide) which is tapped off via a pipe in the centre of the dome and used for cooking in specially-designed stoves. An outlet tank receives the residue that is displaced when new feedstock is added; the residue is collected and used to make compost. Grameen Shakti is carrying out research into a range of different ways of composting biogas residue.

Domestic plants are made in a range of standard sizes, from 1.2 m³ digester capacity (suitable for the manure of two cattle) up to 4.8 m³ (about 10 to 12 cattle). Larger plants (6 m³ to 20 m³) have also been constructed. Grameen Shakti has also constructed a biogas plant with plastic portable dome in Gazipur. Some of the 20 m³ plants have generators attached and use the biogas to generate electricity.

Improved stoves

The Grameen Shakti improved wood-burning stoves use pre-fabricated chimneys and grates. Chimneys are produced by local manufacturing centres run by trained technicians. Grameen Shakti provides materials, and controls the quality of production. Grates are supplied by two national suppliers.

The rest of the stove is built on-site by a trained technician, using locally available mud, mixed with water. If necessary the mud is mixed with cow dung and rice husk to make it sufficiently sticky. The stove has a single combustion chamber with one, two or three holes for pots. The chimney takes smoke out of the kitchen. Larger commercial stoves are made to a similar design, but using concrete rather than mud so that they are more durable. Grameen Shakti has started a tree-planting programme to complement its work with fuelwood-saving stoves.

How users pay

130 Bangladeshi Taka (Tk) = UK£1 = US\$2 [May 2008]

The PV programme is supported through the Rural Electrification and Renewable Energy Development Project (REREDP) financed by the World Bank and Global Environment Facility (GEF), and managed locally by the Infrastructure Development Company Limited (IDCOL). Initially the project provided Grameen Shakti with both low-interest loans (from which to provide microfinance for end-users) and end-user subsidies. The subsidy level was gradually reduced, and subsidies have now been phased out completely.

The cost of a 50 Wp PV system is about Tk 27,900 (£215), which is equivalent to about half the average annual income of a rural household. A small 20 Wp system costs only Tk 15,000 (£115). Customers can choose from three payment options. Those with limited cash income can pay a 15% deposit (£17 for a 20 Wp system) and receive a loan for the remaining 85% of the price. This loan, with the addition of a 6% service charge, is paid back in monthly instalments (£2/month for a 20 Wp system) over three years. A more rapid payment method is to pay a 25% deposit and pay back the loan, charged at 4%, over two years. Alternatively, a 4% discount is offered for cash purchases.

Contracts are signed with either men or women. Grameen Shakti tries to sign with women where possible, since they are in the home more than men and use the SHS more. The monthly payments are collected by field staff from the local Grameen Shakti unit office, who also check that the system is working properly. The repayment rate on loans is an impressive 98% (although this figure excludes families who have run into financial difficulties because of natural disasters like cyclone damage or bird flu). Overall, 38% of the total loan disbursement has been repaid.

The price of domestic biogas plants varies from Tk 15,000 (£115) for a 1.2 m³ plant to Tk 35,000 (£270) for a 4.8 m³ plant. A subsidy and loan programme, supported through IDCOL, has been designed to assist customers with purchasing plants. Tk 7,000 is provided as a direct subsidy. Out of the remainder, customers pay 15% as a down-payment; Grameen Shakti pays 17%; and 68% (up to a maximum of 147 Euros) is a loan from IDCOL.

The biogas plants need cattle dung, so poor families without cattle are unable to benefit from them, even with affordable finance. Grameen Shakti has therefore started an innovative financing scheme for poor families, through which they buy cattle at the same time as the biogas plant, and have the option of paying back through compost or cattle.

Improved stoves cost between Tk 700 and 780 (£5 and £6). This can be paid as a single cash payment, or through a 15% (£0.85) deposit followed by six monthly instalments, charged at 4%.

Training, support and quality control

From the start of its work, Grameen Shakti has actively involved the local community in the planning, installation and maintenance of SHS. One of the reasons that the programme has been able to scale up so rapidly is the effective way in which Grameen Shakti has provided sales, components and servicing at a community level, by local people who are familiar with community needs.

There are two distinct ways in which Grameen Shakti has kept its operations local. Firstly, SHS marketing, sales, installation, and collection of payments, have always been undertaken through a network of local 'unit offices', now 387 in number. Secondly, Grameen Shakti has started a network of 'Grameen technology centres' (GTCs), managed mainly by women engineers. The GTCs train other women as solar technicians, through an initial 15-day course in which they learn to assemble charge controllers, mobile phone chargers, lamp shades, and electronic inverters for fluorescent lamps, and how to install and maintain SHS. With further training, they are also able to repair systems. There are now 20 GTCs in operation, and these have trained 1,037 technicians. At least 300 of these technicians are working for the GTCs or independently. The GTCs also train users to take care of their systems and undertake minor repairs.

Recently Grameen Shakti has helped about 50 of its best technicians to set up as independent entrepreneurs, and pays them to assemble solar accessories in their own homes and to install systems. The GTC provides marketing, management and business support to the entrepreneurs, as well as providing them with business. The aim is that eventually the entrepreneurs will generate much of their own business.

Grameen Shakti is committed to training women in order to build their confidence and give them employment opportunities – usually their first paid employment. It also recognises that women are the main social force in communities. However, there is also a practical benefit to having female technicians, since they are allowed to visit homes during the daytime if the men of the household are away.

The GTCs also train technicians to build improved stoves, with a five-day programme. Although the initial intention was that stove technicians would also be female, there were some cultural problems over this, so most of the 700 stove technicians trained to date are male. Biogas technicians are all male, and are trained on the job by specialist biogas engineers. They then build biogas plants under the supervision of a biogas engineer.

Having local technology centres enables service to be provided by local people and provides local jobs, as well as saving the cost of centralised management over a large geographical area.

It is essential that the systems sold by Grameen Shakti are of high quality and reliable, otherwise customers will not want to buy them. For SHS, the main components are covered by warranties: PV modules for 20 years, batteries for five years, and charge controllers for three years. Once components are out of warranty, Grameen Shakti offers SHS owners a service contract for Tk 500 (£4) per year. Including a quick check of the system with the monthly visit to collect payment is a very effective way of sorting minor problems, and preventing major ones.

Benefits

As of April 2008, Grameen Shakti had installed 150,000 SHS, with 6.75 MWp total capacity (45 Wp average per system). Over 50,000 of these installations were carried out by GTC-trained staff. Although the cooking technologies have been promoted only for the past two years, already 3,000 biogas plants and 15,000 improved cook stoves have been installed. Together the technologies installed by Grameen Shakti provide services to more than one million people.

Direct benefits to users

The Grameen Shakti programme could not have achieved such impressive numbers unless users really appreciated the benefits, because users make the choice to buy systems.

Solar-home-systems replace kerosene lamps for lighting, and in doing so provide several benefits. The immediate benefit to users is avoiding the fumes and fire-risk of kerosene lamps. Mosquito nets, crucial for malaria control, are particularly easy to set alight if a lamp is knocked over. Women, who usually spend more time in the home, benefit most from the elimination of kerosene smoke and the risk of burns.

The use of SHS brings significant social benefits. Families can listen to music and, with larger SHS, watch television. Domestic chores and studying can be carried out more easily, for longer, and more safely in the evenings with PV lighting. Many clinics use SHS to provide lighting during check-ups or operations. The availability of PV power for phone chargers has made it possible for people in rural areas to use mobile phones. This increases business opportunities, and also allows people to maintain contact with family members throughout Bangladesh and abroad. In areas which were struck by

cyclone Sidr in 2007, PV was a lifeline. After the cyclone hit, the only homes with light were those with PV. Through PV-charged mobile phones, people learned about the approach of the cyclone and were also able to call for help. Most PV systems survived the impact of the cyclone, and demand for PV has increased substantially in the area which was hit.

Biogas users can usually replace all the wood or LPG that they previously used for cooking, which can bring a significant financial saving. Cooking conditions are greatly improved: women no longer have to breathe wood smoke, which is known to contribute to respiratory and eye diseases, and the kitchen is also much cooler and cleaner. Cooking is much quicker, and more time is saved if wood had previously been collected.

The improved stoves reduce wood use by about 50%, saving time (if wood was previously gathered) or money. Nearly all smoke is removed from the kitchen, and cooking is much cooler and cleaner.

There are significant financial savings. Owners of a 20 Wp SHS who previously used about 7.5 litres/month of kerosene save Tk 335 per month, at the current subsidised price of Tk 45 per litre. This is the same as the repayment cost on a 36-month loan. So for the price of kerosene come brighter, safer light and all the other benefits of solar electricity. Users of improved stoves reduce their monthly wood consumption from about 40 kg/month to 20 kg/month, which saves over Tk 100/month, if wood is purchased. Thus the cost of the stove is repaid within about six months. The payback is even faster for commercial stoves. Biogas users save all the cost of wood (over Tk 200/month) and may also be able to sell part of the compost they produce. With larger, farm-based biogas systems, it may be possible to sell gas or electricity too. For instance, the owners of a 2,000 bird poultry farm bought a 9 m³ biogas plant costing Tk 39,000 through a Tk 10,000 deposit and monthly payments of Tk 1,300 for two years. The biogas supplies the owner with cooking fuel, and also an electric generator for three hours per day. In addition, biogas is sold to ten neighbouring families giving an income of Tk 3,900 per month, or three times the monthly payments. The owners of this farm also estimated that their improved vegetable production from the composted biogas residue increased their income by Tk 7,000 per month, with reduced fertiliser costs too.

Environmental benefits

There is a significant reduction in greenhouse gas emissions from the use of such large numbers of SHS. An early survey carried out by the Finance Ministry found that households using an SHS save about 12 litres/month of kerosene, which is equivalent to about 375 kg/year CO₂. A more recent figure from the CDM carbon-finance assessment is 500 kg/year CO₂ per 50 Wp system. On this basis, the 6.75 MWp of PV installed to date by Grameen Shakti saves an impressive 68,000 tonnes/year CO₂.

Biogas systems and stoves also reduce the consumption of unsustainable fuelwood, thus preserving wood supplies and reducing greenhouse gas emissions. Overall wood savings, assuming 20 kg/month saved per stove and 40 kg/month per biogas plant, are about 5,000 tonnes/year. If wood production is completely unsustainable, this represents a greenhouse gas saving of about 8,000 tonnes/year CO₂. This is currently much less than the saving from kerosene replacement, because far fewer biogas plants and stoves have been installed than SHS. However, the rapid expansion of the cooking programmes will mean that they could soon be the major source of greenhouse gas savings.

Economic and employment benefits

Owning an SHS increases opportunities for income generation. Many women have used the increased working time provided by an SHS to start small-scale businesses such as poultry-rearing and handicrafts. Businesses can also remain open for longer, including tailoring shops, restaurants and grocery shops. New business opportunities and jobs have been created, such as running community TV stations and renting mobile phone time.

Grameen Shakti set up a micro-utility scheme to help shopkeepers get access to PV lights and extend their business hours, even if they could not afford a whole system. Under this scheme a shopkeeper installs a PV system with spare capacity. This capacity may be used to operate lights in neighbouring shops, for a fee, or else to charge portable lanterns which can be rented to other shopkeepers. There are now more than 30,000 of these micro-utility lights operating in rural market places. To encourage shopkeepers to invest in micro-utility systems, Grameen Shakti allows them to pay a deposit of only 10% on their SHS, and repay the loan over a longer period.

Biogas plants also give income-generation opportunities. As well as income from sales of biogas and vegetables (discussed earlier) there is also the possibility of selling compost. In future Grameen Shakti is considering the feasibility of bottling biogas, which would extend the opportunities for sale beyond the immediate neighbours of a biogas plant.

Grameen Shakti itself employs over 2,000 people and, with the growing numbers of unit offices and GTCs, an increasing proportion of its employees are based in the rural areas. Stove technicians receive Tk 200 per stove installed, and an experienced technician can install 40 stoves per month, thus earning Tk 8,000/month (£62/month) – over twice the Government minimum wage. The solar entrepreneurs have only just started working independently, but already they are earning Tk 4,000 to 5,000/month.

Potential for growth and replication

The SHS programme has expanded enormously since Grameen Shakti first won an Ashden Award in June 2006. At that time, it had sold about 65,000 SHS, and biogas installations had just started. As of April 2008, there are 150,000 SHS installations, with nearly 5,000 more installed per month. If the target of 75,000 SHS during 2008 is reached, then the total will exceed 200,000 by the beginning of 2009. The biogas and improved stove programmes have both achieved significant scale in less than two years, with over 3,000 biogas plants and 15,000 stoves installed. All programmes are popular, and marketing is largely by word-of-mouth.

Grameen Shakti has achieved this extraordinary growth through very careful development of its own infrastructure; by rigorous targeting and auditing (see next section); and through an emphasis on quality control and after-sales-service at all levels of operation. It has targets of one million SHS, 500,000 biogas plants and 10 million stoves by 2015. To reach these targets, it aims to have 1,000 unit offices and 500 GTCs, and in addition 100,000 independent entrepreneurs. The GTCs will act as knowledge centres as well as technology centres, providing internet access to local people.

The main limiting factor for achieving this rapid growth is to train sufficient technicians, masons and engineers to carry out installations, but the expanding GTC network is set up to do this. Working capital is crucial for the SHS programme, although some is currently available through the REREDP. Grameen Shakti has recently signed a memorandum of understanding with the World Bank for carbon finance under the CDM, and this should help provide capital in future.

There is significant potential to roll-out large scale programmes of local sustainable energy in other countries, using the Grameen Shakti approach. Grameen Shakti staff have promoted the approach at seminars in India, Thailand, Sweden, USA and Germany. Presentations have also been made at leading international universities. Many donors consult Grameen Shakti when planning programmes to provide local, sustainable energy technologies. Many organisations, especially in Africa have shown interest in collaborating with Grameen Shakti to replicate its approach.

Management, finance and partnerships

Dipal Barua, Managing Director of Grameen Shakti, is in overall charge of all the programmes. Grameen Shakti employs over 2,000 staff in its Head Office, 387 other offices and 20 GTCs.

The office organisation is in a pyramid structure. The Head Office is responsible for orders and storage of equipment, finance, monitoring and auditing, and also has a production facility. It has overall responsibility and direct oversight of seven divisional offices, which oversee 60 regional offices, which in turn oversee and monitor the 387 unit offices. Each office has monthly targets to meet, which increase each month: these targets are monitored very closely, with explanations needed when targets are not met and rewards when they are exceeded. Unit offices are intended to work as close as possible to customers. When more than four or five staff are needed to manage the volume of work, then the unit office is divided into two. At the moment about ten new unit offices are opened each month.

In parallel, the GTCs train technicians and carry out installation, maintenance and assembly work. Although at present there are only 20 GTCs, the aim is to localise as much as possible of the practical work into GTCs, and to have one GTC for every two unit offices by 2015.

The initial funds to establish Grameen Shakti came from the Grameen Trust and Grameen Fund. Later on, it received both subsidy and low-interest loan finance from IDCOL under the REREDP. Some loan finance is still available, but Grameen Shakti is increasingly funded through revenue from sales and loan repayments. Direct donor support for specific programmes comes from the UNDP, USAID, GTZ and KFW.

Grameen Shakti runs joint training programmes on renewable energy with the Bangladesh University of Science and Technology (BUET). It has given placements to over 100 interns from Europe, USA and Canada.

A joint venture has been set up with Phocos to produce charge controllers, and in future this will also produce LED and CFL lights.

Use of the 2006 Ashden Award

Grameen Shakti used its 2006 Ashden Award to set up ten of the new Grameen Technology Centres and to run technician training programmes through them.

This report is based on information from the application submitted to the Ashden Awards by Grameen Shakti, findings from a visit by one of the judges to see their work in Bangladesh, discussions between Dipal Barua and the Ashden Awards judges at interview, and presentations by Dipal Barua at Ashden Awards seminars in London in 2006. Further information was obtained from a visit and discussions in 2008.

Dr Anne Wheldon, Technical Director of the Ashden Awards
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