

Providing PV training and reliable PV services in Ghana

Summary

Although about 57% of the population of Ghana has access to grid electricity, the grid supply is unreliable and deteriorating, due to lack of water for the Lake Volta hydroelectric scheme, the high price of oil limiting thermal generation, and the large power demand of the growing economy. There is frequent load-shedding and unscheduled power cuts, even in central Accra. There are also many rural areas where grid connection is not available. Even where connection is possible, many people on low incomes are wary of committing to a monthly electricity bill. The use of solar photovoltaics (PV) to provide a reliable electricity supply, is of growing interest in Ghana.

Deng, an established engineering business in Accra, supplies solar PV systems directly and through a dealer network. It uses high quality components to minimise the risk of faults, and ensures that all technicians and dealers are fully trained in installation and maintenance. Deng sells standalone PV systems in rural areas for providing lighting and appliances in homes and also in schools, and healthcare centres. Use of local dealers expands the market. Systems are bought by people without grid access, but also by people who could use the grid but prefer the reliability of PV. Around Accra, Deng sells and installs PV-powered grid backup systems, so that during a power cut essential lights and appliances can be run from PV. About 1,000 fixed systems and 6,000 solar lanterns have been supplied and installed during the past nine years.

Deng has recently set up a PV training centre, and developed a range of training materials on the design, installation and maintenance of PV systems. 120 people have been trained, including health service technicians, university graduates, and the local staff who now run the training courses. By making its training centre available to other users, Deng is contributing to the wider growth of solar PV in Ghana and West Africa.

The organisation

Deng Ltd is a general engineering business in Accra, the capital of Ghana, working in areas ranging from power supply and forklift trucks to lab equipment and water-pumping. It currently employs about 35 people. Deng was founded in 1988 by Frede Bosteen, the current Chairman of the company. It started working with solar PV in 1998, as a natural progression from its core business of generators and water pumps.

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Context

Statistical information	
Population (2004)	21.7 million
Urban population (2004)	47.1%
GDP per capita US\$ (2004)	\$ 409
- at purchasing power parity	\$ 2,240
Population living on less than \$1 a day (2004)	44.8%
Population living on less than \$2 a day (2004)	78.5%
Population with access to grid electricity (2000)	45%
Annual electricity consumption per person (2003)	285 kWh
Annual CO ₂ emissions per person (2003)	0.4 tonnes
Population undernourished (2001-03)	12%
Population with access to an improved water supply (2004)	75%

Sources: UNDP, World Resources Institute

Although 57% of households in Ghana have access to mains electricity, the generation capacity is inadequate, resulting in scheduled load shedding (often for 12 hours at a time) and many unplanned power cuts. The economy of Ghana is thriving, and lack of electric power is a growing concern. Electricity shortages are discussed daily in the newspapers. The problems have arisen largely due to lack of water in Lake Volta for the main hydroelectric power station, and the high price of oil limiting thermal generation, coupled with increasing demand. The average annual electricity consumption per capita is 285 kWh, compared to a global average of 2,490 kWh, and has fallen from 450kWh per capita in 1980.

Of the 43% of the population without electricity, most live in the rural areas, several days' travel from the capital Accra. Here the main income is from seasonal agriculture, and many people are cautious about connecting to the mains if the grid arrives, for fear that they will run up a bill that they cannot afford to pay,

Ghana is ideally placed to make use of solar PV, especially in rural areas, but there is a need to rapidly increase the number of people trained in installation and maintenance, and to develop the business opportunities that are present.

Technology and use

Photovoltaic (PV) modules generate electricity from sunlight. Used with re-chargeable batteries to store electricity, they can provide an independent d.c. electricity supply system that can be used both day and night. A PV system incorporates a charge controller, which prevents the battery from being over-charged or deep-discharged, and may also include an inverter to convert dc power to ac, thus allowing the use of ac appliances.

Deng sells and installs several different types of PV system. A main part of their PV business is the supply of standalone systems. The smallest solar-home-system uses a 14 Wp module, 40 Ah battery and 6 A charge controller, but larger systems of up to 100 Wp and 100 Ah are also popular. Systems up to 500 Wp in size are used for clinics and other community buildings. The systems

sold by Deng use either amorphous or crystalline solar PV modules. Modules and charge controllers are imported from Europe, while batteries, wiring and support structures are all available locally. Customers can choose between deep-cycle solar batteries or car batteries; because a charge controller is always used, the car batteries last for a reasonable time – about two years. Some customers start with a car battery to minimise the initial system cost, and upgrade to a more durable deep-cycle solar battery when the first car battery needs replacement.

Amorphous silicon PV modules are used, because for small power demand they are cheaper than crystalline modules. Amorphous silicon has a poor reputation in some parts of the world, because in the past modules degraded rapidly in use, usually because poor sealing of the edges led to water absorption into the thin layer of silicon. Deng will buy amorphous modules only from reputable manufacturers who offer a warranty on their products, and currently imports from Europe. The solar PV modules are expected to last over 25 years, while the charge controllers will operate for over 10 years.

Two of the Deng dealers run PV-powered battery charging stations, where local people can bring lead-acid batteries to be recharged as needed. This is a popular service, because it provides people with the benefits of PV electricity without the cost of buying the PV module.

Deng also provides PV systems to supply emergency backup power during frequent mains failures. These systems are sold mainly in and around Accra, to businesses, public bodies, NGOs and private homes. The PV, with batteries and inverter, will maintain power supply for the chosen priority uses of the customer. In some cases the PV also contributes to the building supply when the grid is working. These systems are generally larger than the standalone systems. The largest installed to date is a 9.2 kWp grid backup at the central courts in Accra, where the use of PV maintains lighting and thus enables court business to keep going during power cuts. Some customers buy a system with just batteries and inverter, in which the mains is used to charge the batteries. These systems are cheaper than the ones with PV, but can only maintain the emergency supply for the length of one battery charge. Most of the components of the grid backup systems are imported.

The smallest systems sold are solar lanterns, which are assembled locally using components from the Netherlands, and have an expected lifetime of three years, after which the battery and sometimes the light bulb need replacing.

Over the past nine years, Deng and its dealers have sold about 6,000 solar lanterns, and sold and installed over 1,000 other PV systems. Most have been sold and installed directly by Deng, but a priority for the future is to expand the dealer network throughout Ghana, so that high quality PV is available in the areas with lowest access to grid electricity.

How users pay

£1 = 17,000 Cedi [April 2007]

The solar home systems range in price from 4.5 million Cedi (£265) for a 14 Wp system to 12.5 million Cedi (£735) for a 100 Wp system. Most customers pay cash on installation.

Deng provides three months credit on components to its network of rural dealers. Some of them may permit reliable customers to pay two thirds up front and the remaining third within 3 months – the credit term they have from Deng. Commercial solar PV systems are paid for at installation.

For comparison, grid electricity is charged at a flat rate of 19,080 Cedi (£1.12) for use of up to 50 kWh in a month, then about 600 Cedi (£0.034) per kWh for the next 250, and over 1,000 Cedi (£0.06) per kWh after that.

Training, support and quality control

Deng recognised that a major reason for the low success of PV in Ghana was lack of trained people for system design, installation and maintenance. It therefore set up a training centre in Accra, with the Kwame Nkrumah University of Science and Technology (KNUST) as a partner. The training centre has worked with Global Sustainable Energy Solutions, an Australian consultancy specialising in solar PV training, to develop the training materials and run the initial courses. Some of the local trainees on these courses have specifically been trained as trainers, and now run the courses. Eight courses have run so far, training about 120 people – men and women – in the use of solar PV. A full course takes 12 days, and covers design, assembly, installation and fault analysis, concluding with performing an actual installation. The importance of understanding what the customer needs and providing good information to customers is emphasised throughout the training programme – this is particularly important since many customers may live at a distance from installers. There is also a 6-day course covering installation and maintenance only, with the possibility of a business management extension in future. Future courses that are planned include solar PV maintenance for village technicians and a training course in solar water pumping. All the training courses are accredited by the Institute of Sustainable Power to ensure consistent quality.

All the Deng technicians and dealers go through the solar PV training course, and all new dealers must also complete a business training course. Other customers for the training centre include staff and students from the technical university, polytechnics, health service technicians and members of government institutions.

Deng installations include a year's warranty, and commercial systems usually include a service contract. The Deng dealers do not necessarily offer a warranty, and this is one of the reasons for using good-quality PV modules and charge controllers. However, as a dealer's reputation is important for maintaining their business, they will usually carry out repairs for customers if their travel expenses are paid. Both Deng and the dealers keep records of systems sold.

Benefits

Households use solar-home-systems for lighting and mobile phone charging, and larger systems are sometimes used for television as well. Using PV instead of kerosene for lighting gives better light and a cleaner environment, and saves typically 20,000 Cedi/month for replacing two kerosene lamps. Customers in areas where the grid is available have several reasons for preferring PV. The immediate reason is to have a reliable supply without power cuts, but people are also concerned about the variability in grid voltage, which can lead to lights dimming and some appliances not operating properly. A further reason for people using solar PV in preference to the grid is the dislike of monthly electricity bills; some people have a grid connection and solar PV, and try to use the solar power as much as possible to minimise their electricity bill. In a recent survey, 76% of respondents felt that solar PV could supply their current and future energy needs, and 93% said they would remain interested in using solar PV even if the electricity supply situation improved. Several users commented to the visiting Ashden judges that what they liked most was knowing where they were with PV – they knew what to expect from the system, and if they used it correctly it always gave good service. The large grid-backup systems offer this same security to urban users.

Education has benefited from the use of solar PV lighting in Ghana, for both children and adults. The children are benefiting from having good-quality dependable light at home so they can study in the evening, while both adults and children are making use of 600 schools that have been equipped with 80 Wp PV systems so that they can remain open in the evening for classes and homework sessions.

Healthcare is also a beneficiary of solar PV, through the provision of lanterns to traditional birth attendants, and also through systems in hospitals and clinics. These are used for lighting, but also for refrigeration of vaccines and insulin, and for providing a reliable water supply. Improving the lighting and facilities in rural clinics is making healthcare more accessible for people, as they no longer have to travel into town for treatment. PV systems in health centres are no use if they break

down, and Deng has supported the installation programme by running courses for health service technicians at the training centre. As part of a wider commitment to public health, all Deng training courses (not just those for health service personnel) include a session about HIV/AIDS and malaria from a trained nurse.

The PV work of Deng has directly provided employment to about eleven people, including technicians at Deng head office and the Deng dealers. The dealers supply PV systems and two of them run battery charging stations as well. A 200 W system costing about 20 million Cedi can charge 4 batteries per day and bring in a daily income of about 20,000 Cedi (equivalent to the national minimum wage), repaying the capital cost in about three years – so this forms a good basis on which to grow a PV installation business. The use of PV for lighting has extended working hours for shops and other small businesses.

In the commercial arena, businesses using solar PV for grid-backup now have the ability to continue operation during grid outages. Although more expensive, PV is preferred to diesel generators for back-up power because it is silent

Potential for growth and replication

43% of the population of Ghana do not have access to grid electricity, and even where the grid is available the supply is increasingly unreliable because there is insufficient generation capacity to meet demand.

In many places (including Ghana in the past) people became unenthusiastic about stand-alone PV systems when they received, or expected to receive, grid electricity, because of the much larger power demands which could be supplied from the grid. However, the unreliability of grid supply in Ghana means that people now want PV systems even when they have grid access. The lack of adequate grid capacity will probably result in sustained demand for solar PV equipment from households, businesses and public bodies, and the whole of Ghana has a suitable climate for the use of the technology. This should lead to continued potential for Deng and any other well-run solar PV installer, provided that sufficient equipment can be imported.

To date, the market for PV from Deng has been limited to those who can afford to pay up front. The World Bank is setting up a major PV financing programme in Ghana, through which loans for standalone PV systems will be available from a rural banking network for a target of 4,000 solar-home-systems and 6,000 solar lanterns.

The people who would benefit most from PV services are in the more remote parts of Ghana, and a major barrier is access to systems and service, given the distances involved. Deng was the first PV business in Ghana to set up dealers outside Accra, and has started to expand to other areas using small a network of trained dealers. Deng is aiming to expand this network by recruiting existing businesses, ideally already selling electrical items, that would like to start selling solar PV equipment in areas that are currently not covered. The training centre provides the ideal opportunity for these prospective dealers to be trained in the installation and maintenance of solar PV, so ensuring that quality is maintained.

The training centre itself is a significant driver for growth in the Ghanaian solar PV market, as it is providing training to people from other businesses, government and educational institutions. The longer-term aim of the centre is to provide solar training throughout West Africa, both bringing trainees to the centre, and using Deng trainers to run courses elsewhere. One such course is already being developed for the Faurah Bay College, Freetown, Sierra Leone. Solar PV awareness workshops are also run in rural areas to make people aware of the benefits they could get from the technology, so helping prepare the ground for new dealers and businesses entering the market.

Management, finance and partnerships

Deng employs 35 people to run the main business and the training centre. The business runs on a commercial basis, although some grant-funding was useful in the early stages to enable Deng to

collaborate with European PV businesses and set up supply chains for PV modules and other components.

The development of the training centre and training materials was 50% grant-funded by the German development agency DEG. Now that the centre is established, it must work on a self-sustaining basis, although it is not required to make a profit. However, to facilitate offering scholarships to educational institutions, donor support will still be needed.

Deng widens the outlet for its products by using a dealer network; there are currently three dealers in different rural areas, and a plan to add more in the near future. Deng prefers to use existing electrical businesses as its dealers, as they are well-placed to push the products into the marketplace and form part of the supply chain, once they have been fully trained.

Two key partners were important in setting up the training centre: The Department of mechanical Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, and Global Sustainable Energy Solutions, Australia, a consultancy specialising in solar PV training.

Deng was a founder member of the Association of Ghana Solar Energy Industries (AGSEI) which negotiates with government on behalf of the industries, and is supporting the development of the World Bank finance programme for solar PV in Ghana.

This report is based on information provided to the Ashden Awards judges by Deng, and findings from a visit by one of the judges to see their work.

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