Design, Development and Marketing of Solar Lanterns

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Background

In many parts of Africa people who live in rural areas have no access to electricity. Despite ambitious government plans, the constraints imposed by a scarcity of financial resources and the sheer practical difficulties of transmitting and distributing grid electricity over huge areas means that most people face the prospect of going without a connection for many years to come. As a result, most families are forced to rely on candles or Kerosene lamps to provide basic lighting in their homes. In Kenya 96% of householders use kerosene for lighting, while 70% also spend significant amounts of hard earned cash on dry-cell batteries for torches.

Successive studies have highlighted the potential for decentralised supplies of power for lighting at both community and household level, and advances in Photo-voltaic technology has resulted in the steady growth of sales in Solar Home systems over the last few years. Unfortunately the cost of installing even a moderate Solar Home System puts it out of reach of the majority of rural families in developing countries.

A recent World Bank survey carried out in Kenya pointed to the potential for solar rechargeable lanterns as a low cost and flexible lighting option for large sections of the rural community. The project identified seven existing lantern designs considered to be appropriate to the African environment and used between thirty and sixty of each (all imported to Kenya) to test customer demand for the products and to collect feedback on the technical performance of the samples. While the study demonstrated that there was a real demand for Solar Lanterns, customers highlighted a number of technical shortcomings with all of the products tested. Most of these shortcomings related to the poor construction of the lanterns, the quality of light and the relatively sharp drop off in performance after a period of months of use.

Why has an effective Lantern not been developed by the Private Sector in developing countries?

For manufacturing companies in developing countries, new product development for local markets is expensive and risky. This is particularly true when the product is targeted at rural mass markets where effective marketing and distribution techniques are still unproven.

Not only may the company have poor access to technical know-how, but the long term capital investment required for mass production tooling makes it an unattractive option compared to products for smaller but more accessible markets amongst higher income groups.

On a global scale however, the potential for solar lantern products is huge (2 billion people currently without access to electricity) and the potential for a commercially viable product would seem to be great.

As a result of this analysis, Intermediate Technology Consultants were able to securefunding for a project to develop an improved lantern for use in rural households in developing countries. The main activities of the project were outlined as follows;

- using customer information as a starting point and working together with local manufacturers, provide technical “know how” to develop an improved lantern which meets all of the criteria demanded by customers,
- employ appropriate manufacturing and assembly techniques that would allow the product to be manufactured and assembled easily in developing countries,
- incorporate within the project a facility to overcome the constraint associated with capital outlay for mass production tooling,
- provide assistance with local marketing of the product using rural mass marketing techniques currently being developed in countries such as India through organisations such as International development Enterprises (IDE)

As a result the IT Solar Lantern has been designed as a low-cost alternative to a Solar Home System and is intended to allow rural African families to climb the first step on the “energy ladder”.

Structure of the project

The project has been broken down into a number of stages, of which one to three are now complete;

1. Customer Research and product specification
2. Design and Development
3. Prototype production and household testing
4. Selection of manufacturing licensees
5. Tooling and setting up for production
6. Marketing

Progress so far

Customer Research

Market research which is carried out in countries of the south must take careful account of peoples lifestyles and cultural backgrounds. This is particularly important when dealing with communities in rural areas where conventional research techniques can easily fall short and yield inaccurate results.
Bearing this in mind, a number of studies have been carried out in Kenya by project partners Energy Alternatives Africa. These have attempted to identify which aspects of existing Solar Lantern designs are favourable to potential customers.
During the Lantern survey, focus groups were used to measure reactions to particular design details. They were also used to stimulate more general discussions where participants could air their viewpoints and develop their responses. Detailed results from question and answer sessions were recorded on paper while more general feedback from discussion groups (which often contained interesting and unexpected information) was recorded on tape for analysis later.
As well as gathering important design data, a number of interesting lessons have been learnt which may serve as important pointers in future surveys of this type.
The team discovered that survey groups which were well balanced, helped to engender an atmosphere where everyone felt comfortable about having their say. These groups tended to yield more accurate results than those where the discussion was dominated by a few knowledgeable individuals.
The location and time of day for group surveys was also important. Holding a survey after dark might at first seem to be the best way of demonstrating lanterns and their important characteristics to customers. In practice the team found that in rural areas with no street lighting, finding participants (women in particular) who were willing to travel from home at that time was more difficult.
The team also discovered that although participants drawn from slightly higher income groups are easier to access and interview, their spending patterns can differ from those of customers from lower income households at which the new products might be targeted.

Product Specification

As a result of the initial focus group study the project team were able to come up with a concise description of the “ideal lantern”.
The most important features were identified were as follows;
Service characteristics;

- The maximum price of the lantern should be no more than $75 if possible
- The lantern should provide light for up to 4 hours each evening.
- Customers should have access to affordable and readily available spares
- Customers expect an overall lifetime of the lantern of 6 years
- Customers expect a 12 months warranty for the product

Design characteristics;

- The lantern should give a 360 degree spread of light,
- The bulb enclosure should allow maximum transmission of light with minimum dispersion effects.
- The carry handle should be sturdy and comfortable.
- The preferred choice of bulb was (5w CFL type)
- The lamp should be portable and weigh no more than 2.5 kg.
- The lantern should be stable with a good base.

Some of the extra features that potential customers expressed a need for were;

- An indicator to show that lamp is charging,
- A warning light to show that the lamp is about to switch off when the battery is low,
- A power socket to allow a small radio to be connected to the unit.

The findings of this initial survey were used to form a design brief and as a result, the team produced a new design for a lantern which incorporates all of these features.

Manufacturing Options

There are a range of options in terms of manufacturing techniques that are available to the designer today, and the choice of the most appropriate comes down to considerations of scale of production and cost. As a general rule, individual component part costs come down as production levels increase. This is usually accompanied however by a higher level of capital investment in tooling.
Injection moulding is a well established and cost effective technology for the mass production of household items in the North, it is becoming increasingly available as an option for manufacturing in developing countries where it is used in the mass production of basic goods such as buckets, basins, tableware and packaging.
High Density Polyetylenes and filed Poly Propylenes are relatively inexpensive and robust materials which can be recyled using simple equipment.
Considering the technical requirements for the Solar Lantern and the projected production quantities, injection moulding was selected as an ideal technology for producing low cost, high quality components with the level of detail required for this product.

Battery technology

A crucial component for any rechargeable device is the battery. The project activities have included research into available battery technologies to identify a battery which;

- has the capacity to store charge sufficient for the required period of lighting
- is suitably robust to withstand the heavy duty cycle required for daily charge and discharge
- requires no customer maintenance (also spill and leak proof)
- has minimum impact to the environment if disposed of at the end of its life cycle
- could be manufactured locally in the medium term in developing countries
- provides a cost effective solution

As a result a Valve Regulated Lead Acid (VRLA) battery with a gel electrolyte has been selected as the battery technology with which to prototype the lantern. Although this is available only through import at present, the project has established that with suitable investment the battery could be produced locally by manufacturers of traditional wet lead acid batteries.

Design and development - Rapid prototyping

It is vital during the development of any new product to show customers a sample and to listen to their ideas about it. This is especially important if fully-fledged production involves substantial investment in terms of tooling and machinery.
Until a few years ago designers could only produce “block models” of new injection moulded products. These were constructed by hand from wood and plastic and although they had the appearance of the final product they could not normally demonstrate any of the working characteristics. Today, computer aided design (CAD) software combined with rapid prototyping techniques and “soft-tooling” allow the designer to realise his new design in a matter of hours. A computer generated “electronic model” which contains all of the physical information about the size and shape of the new product is fed into a Rapid Prototype machine. The machine uses a filament of plastic and a moving nozzle to lay down successive layers of material (rather like icing on a cake) which are built up to produce a plastic replica of the design. A soft silicon rubber mould, which is created by pouring liquid rubber around the original and allowing it to set, can then be used in turn to produce a small batch of products.
This technique allows the design team to assess the design very quickly and more importantly allows manufactures to obtain feedback from potential customers, all before any significant tooling costs have been incurred. This technique which is not normally available to manufacturers in developing countries has been brought to bear in the project through facilities at Coventry University and has been used to produce a small batch of sample lanterns for use in field trials in rural households in Kenya.

Prototype production and household testing

At the time of writing, thirty fully working prototype lanterns have been distributed to sample households where they have been used for a period of two months. Facilitators will shortly visit households and use a questionnaires to measure customers reactions to the new design. In addition, selected members from each household will be gathered together to form focus groups where information will be collected through more informal discussion about the lanterns.

Remaining work

Selection of manufacturing licensees - Investors prospectus

During the course of the project it has become apparent that the scope and potential for the Solar Lantern stretches far beyond Kenya. As a result the project geographical focus has been modified to encompass a number of other countries. The objective of this phase of the project will be to identify a number of regional centres where manufacturers are strategically placed to serve a number of high potential countries. Regions that have been identified so far are, Southern Africa, Western Africa, Asia and South America.
The Project team are currently working on developing an Investors Prospectus which will allow any potential manufacturer/distributor to assess the product in terms of the investment needed to commence local assembly and the likely returns in terms of sales to local markets.
Markets for new products in developing countries build up slowly and as a result manufacturers are naturally more cautious when it comes to investing in large production runs. It is likely that the project will facilitate the supply of component parts for lanterns to a number of manufacturers in regional centres. Injection moulding tooling held centrally in Europe or the Far East and funded by the project, will be used initially to supply mouldings in batches to licensed manufacturers who are interested in local assembly. As local markets are developed, tooling will be leased and transferred for local production of component parts.
For local manufacturer this removes some of the risk associated with setting up for large scale production and for the project it allows the capital cost associated with tooling to be amortised using royalty payments from licensees in a number of countries.

Quality control

Quality control is an important issue that needs to be addressed if a new product is to gain a foothold in the market and build reliable reputation. This is no less true in developing countries where the Solar PV sector has suffered as a result of the introduction to the market of poor quality amorphous panels. A product that is produced, assembled and distributed locally in more than one country presents even more of a challenge. By licensing manufacturers to produce and assemble lanterns locally using components and mouldings supplied initially from a central facility, the product holders will have an important tool with which to ensure that all lanterns meet minimum quality standards.

Lessons learnt so far

The project has broken new ground for ITDG in a number of areas and as a result has already produced a number of valuable lessons in development agency/commercial sector partnerships.

Commercial ownership and intellectual property

To ensure the success of the project, it has been essential at an early stage to involve potential manufacturers in the design and development process. This has thrown up interesting questions concerning commercial ownership and intellectual property rights. Ownership of a commercial product which has had design and development input from a number of different parties is potentially difficult to ascertain and agree upon. In addition, whereas development agencies are keen to disseminate and maximise the impact of their research, private companies have commercial interests which are focussed on maximising profit and protecting their share of the market. This can lead to problems when it comes the time for the technology to be disseminated.

With the Solar Lantern project, this potential hurdle was avoided by ensuring that all detailed technical input which had the potential to lead to an intellectual property asset, was carried out at arms length from the initial project manufacturing partners. These manufacturers although technically having no ownership of the resulting design, will be given first option to manufacture under license when the design process is complete. This ensures recognition of their input during the early stages of the project but provides the project team with the necessary flexibility and autonomy in selecting suitable licensees in other countries.

Development versus commercial interests

In the development sector the primary concern of agencies is to successfully deliver benefits to target groups (large numbers of poor people). In the commercial sector the bottom line is profit and continued growth of the business. In many instances these forces can work successfully hand in hand, and have real potential for mobilising change on a large scale. In projects which involve private sector/development agency collaboration, it is important however that these two goals are recognised and that there is a clear understanding of where they may cause project activities to diverge.

For products where there is a demonstrated demand across a variety of income level groups (eg. Solar powered lighting) the manufacturer has a choice in terms of pricing. A medium to high priced product will have a small market but will generate a relatively high margin and quick return on investment. These markets are generally easily accessible and are based around large centres of population. The same product, priced at a lower level will result in a lower margin but will give access to a much larger market with greater potential for overall profit. These markets are generally widely dispersed in rural areas and carry a larger risk in terms of return on investment for new products.

Whereas the latter generally contain the bulk of the beneficiaries targeted by development agencies, it is the former, lower risk group that manufacturing businesses are more comfortable in dealing with.

The marketing mechanisms needed to reach these customers are still being developed within countries of the South and the project has identified the need for a component which builds the capacity of local manufacturers to reach large rural mass markets through networks of rural marketing agents.

Conclusions

Work on the development of the Solar Lantern has generated a considerable amount of interest amongst potential customers and manufacturers alike. It is clear from the experience so far, that the unique position of development agencies such as ITDG can serve to bring together the necessary ingredients and partners for the development of new products for mass production within the commercial sector.

There are still many lessons to be learnt however surrounding issues of ownership and control of such products and the best models for working relationships between the development and commercial sector.

How does it work?

The Solar lantern kit consists of a Photo-Voltaic Panel, and a lantern containing a high efficiency lamp, a rechargeable battery and a charge control circuit. The concept is a simple one – during daytime, sunlight falling onto the Photo-Voltaic Panel generates a small electrical voltage. This is used to charge the Lanterns battery so that the lamp can provide light during darkness.

The charge control circuit housed within the lantern is the “brain” of the unit. Not only does it ensure that the battery is charged and discharged correctly so that it gives a lifetime of maintenance free service, but it can also “decide” to give the battery an extra top-up charge if the panel has gone without its full quota of sunlight for a few days. It’s on-board microprocessor will even store information (which can be downloaded later after “interrogation”) on how the lantern has been used over a period of time. This information is extremely useful and will help the designers build a picture of how customers use their lanterns. This information will be used to design better lanterns in future.