Developing the Next Generation of Glowstar Solar Lantern
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Abstract
In the late 1990s the World Bank identified the need for solar lighting in African homes. In Kenya, for example, grid electricity does not reach 90% of homes. As a result of this, Practical Action Consulting developed a solar lantern which was intended to target African families in rural areas who had no access to electricity. The lantern, however, has not been as successful as was hoped. This research aims to investigate the reasons behind the low uptake of the lantern and to develop an improved design which better meets the needs of the intended users.

The study is ongoing but research so far suggests that the overriding reason for low utilisation is because of the price of the lantern which, at 10,500 Ksh, is double what the Glowstar market research indicated would be a practical price for the lantern. By reducing the cost of the Glowstar; incorporating into the new design advances in technology since it was originally designed; and developing a suitable distribution method to make the product accessible to the people for whom it was originally intended, it is hoped that the lantern will reach a larger number of users.

Introduction
In Kenya the electricity grid does not reach 90 per cent of homes (1) and, as a result of this, families are forced to use kerosene lamps, battery operated torches and candles for light after dark. The quality of light provided by these sources is poor and valuable cash, which could otherwise be used for education or health, is wasted buying fuel and dry cell batteries. In 1997 after studies by the World Bank identified the need for solar powered lighting in African homes Practical Action Consulting, formerly Intermediate Technology Consultants, began to develop the Glowstar lantern with funding from the Department for International Development.

Practical Action Consulting (PAC) considers itself to be a leader in the field of technology for development (2) who follow E. F. Schumacher's philosophy of “Small is Beautiful”. With this in mind they develop appropriate, sustainable technology solutions to improve livelihoods in developing countries. In 2001 Practical Action Consulting formed a partnership with Sollatek Ltd, a UK based manufacturer of power protection equipment and solar power products, to produce and distribute the Glowstar lanterns.

The Glowstar lantern, Figure 1, is a lead-acid battery powered lantern which can be recharged in a number of ways, including using a Photo-Voltaic Panel, and can then provide up to 8 hours of high quality light after a day's charge (3). It is claimed that the lantern eliminates running costs as there is no need to replace batteries or pay for fuel and maintenance is unnecessary.

The purpose of the lantern is to provide an affordable, reliable solution for people in African countries to give them an opportunity to get onto the first step of the energy ladder. It is recognised that this is not a long term solution to Africa's energy needs but it is certainly a good short term answer. With light, families are able to make use of cooler evening and night times to study, make goods for selling, tend to animals and socialise. Being able to do these things improves the family's income and allows them to move up to a more sophisticated or long term lighting and energy system.

During the development stage of the lantern, research was carried out by producing a small batch of prototypes which were used for field trials in rural Kenya. The prototypes were used by local families for two months and questionnaires and focus groups were then used to return feedback on the lanterns (4). From there the lantern was improved and went into manufacture.

Despite initial enthusiasm for the lantern it has not been as successful as it was hoped it would be. It is still produced and sold worldwide but the technology has not spread as far as is needed. The aim of this project, therefore, is to investigate the Glowstar solar lantern from first principles, including market, design, manufacture, distribution and sustainability. The final objective will be to design a new lantern, bearing in mind the most up to date technology. A new distribution method will also be developed to make this expensive product accessible to people who otherwise would not be able to afford it.

Figure 1 Glowstar lantern (7)
As mentioned earlier, PAC develops appropriate technology solutions for developing countries. Their definition of appropriate is that the technology should (5):

- Meet the needs of both men and women
- Enable people to generate income
- Be able to be designed, improved, managed and controlled by local people
- Be affordable
- Use local skills and materials as much as possible
- Have limited impact on the environment

Methods and Results

The project is being undertaken in two parts by two undergraduate engineering students. One student is completing a single year project which it is hoped will provide a usable analysis of the reasons for the market performance of Glowstar in Kenya, an assessment of the potential for new technology options to be included into a new generation of solar lantern and potential methods to implement this technology effectively. The other is undertaking a two year project which will be a more detailed approach and will expand upon the findings of the single year project. The aim of this project will be to design a new lantern and distribution mechanism which will better meet the needs of the people at whom it is aimed.

Consumer Research

As this is an existing product which has not been as successful as was hoped the initial step in the research was to recognise customer views and perspectives of the lantern. This was because it is important to realise why, from a consumer perspective, it is not as widely utilised as it could be. It was also useful to identify customers’ perspectives of similar lanterns and other lighting sources.

This research was carried out in two parts. One student went to Kenya to get a good overall impression of the situation through discussions with professionals in the industry, interviews with owners of Glowstar lanterns and surveys of other lighting sources available. Feedback from professionals and users alike indicate that the Glowstar is a very good product that is robustly manufactured and performs well however the overriding message from all players in the industry is that the Glowstar is too expensive for the target market, with the price putting it well out of the reach of the majority of the rural population. This pricing level restricts Glowstar sales almost exclusively to NGOs who are working in remote areas for example northern Kenya and South Sudan who value the portability and reliability of the Glowstar but most importantly have the funding available to afford the lantern.

The current list price for the Glowstar basic with a solar module is 10,500Ksh (Kenyan Shillings) (around $150 US) which is double what the Glowstar market research indicated would be a practical price for the lantern. It appears that the situation has changed little as prices suggested as sensible and affordable for the Glowstar all sat in the range of 3,000 to 5,000Ksh. There is a considerable market for solar in Kenya that is currently dominated by small solar home systems in the price range of 12,000 to 20,000Ksh which offer two or three lighting points and mobile phone charging. For Solar lanterns to have their own market segment they must avoid competing on price with other systems which the majority of people would consider as preferable.

The auxiliary output of the Glowstar plus is a valued accessory to solar lanterns as it allows mobile phones to be charged. Mobile phones are very widespread in Kenya and growing at a rapid pace however there are significant difficulties charging them in rural locations. Mobile phone charging stations are now common across the country where a phone will be charged for a fee of around 20Ksh. This adds to the perceived value of a product and would be a beneficial feature to include in future designs, as well as aiding the development objectives of improving communication access.

The other method used was to distribute questionnaires to people in Kenya who live in off-grid areas and who have used either the Glowstar lantern or a similar product. The questionnaires are being distributed by students at university in Nairobi. It is hoped the results from these questionnaires will provide quantitative data to back up the qualitative information gained from the trip to Kenya. This research is ongoing and the data has not yet been returned from Kenya.

Competitor analysis

Another stage of the research was to identify similar products which are available. This was done to identify what the minimum expectations are for a lantern and also to learn from the good and bad features each had. Once they had been identified background information, success and features of the products were analysed and compared with one another and with the Glowstar. It was found that there are many solar lanterns available throughout the world but that many are either too expensive for the market at which this one is aimed or are poorly manufactured. Most of these were not considered competitors.
The products were also rated against a set of criteria which was developed from PAC’s original field trials. The criteria were considered to be features which customers found important. Most of the products which had been identified as successful met this criteria well, as would be expected. A number of ‘successful’ products, however, did not meet the criteria. These products were deemed to have an excellent delivery mechanism and it was, therefore, deduced that the delivery mechanism is just as important as the lantern design.

Delivery mechanisms

The delivery mechanism is the method of bringing the lantern to market. It involves determining where the product is manufactured and by whom, who distributes and sells, who it is maintained by, who owns the final product and how it is purchased by end users (e.g. financial assistance). It is at this stage that PAC’s definition of appropriate technology needs to be reconsidered.

Research into distribution mechanisms revealed many different models which are currently used throughout the world. They could generally be grouped into 4 groups:

- The finance route
- Fee for service
- The social route
- The open market

The finance route is widely used. It includes receiving loans from banks, micro-financing schemes and co-ops. This is a good option as it provides a means for people to purchase products which are worth more than they are able to afford in one instalment. This would mean making repayments in instalments over a number of months or years. It generally means repaying more than was originally borrowed but that may be a small price to pay. This encourages local employment as local people are generally employed as repayment collectors. It is highly likely that the model chosen for the lantern will be in this group.

The fee-for-service is also an option with high potential. This route encourages local people to set up enterprises by buying a number of lanterns and solar panels and then charging people to use them. This allows people to only pay for what they use rather than paying too much for a solar panel and lantern which may not be needed every day. This category of models is generally used for solar home systems which are installed in a house and wired to a central solar station controlled by a local organisation but it can be adapted for lanterns. This would save the high costs of single users purchasing a solar panel.

The social route is when governments offer subsidies or free services, or international aid organisations give lanterns purchased using donations from their contributors. This route may be successful for a number of products and may be an option as a side mechanism but I don’t think it should be the main distribution mechanism used. The main reason for this is that it does not fit in with PAC’s definition of ‘appropriate technology’, it doesn’t encourage local enterprises and, as the saying goes, give a man a fish and feed him for a day, teach him to fish and feed him for life. It may be a good way for the organisation to generate additional income to keep the costs lower for the other route chosen but it should not be the main distribution mechanism.

The open market relies on being able to offer a product at a price that is affordable without third party support through standard or novel distribution channels to the end user and was the target distribution model for Glowstar. As a sustainable solution to off grid lighting this approach has many benefits as it is only dependent on those involved in the distribution chain and is controlled by market forces rather than third party organisations. The main challenges in this approach lie in the tight cost constraints imposed by the available cash of the target market which is where Glowstar has hit problems and is where the alternative methods can be helpful; however as a long term goal a self sustaining market must be a good thing.

Manufacture

The components used in the lantern and the manufacture are important to consider at this point. How and where the lantern is manufactured and/or assembled will have an impact on the distribution mechanism. Ideally the lantern should be manufactured in the country at which it is being aimed, using components which do not have to be imported. This is not always possible, however. A method used by many organisations targeting developing countries is that the parts are imported and then assembled locally. The people who assemble the products are then also stockists of spare parts and are able to carry out repairs if necessary. In the past this has been used fairly widely but organisations are increasingly moving towards other methods of manufacture. It meets PAC’s definition of appropriate technology as closely as is possible and also calms people’s worries about not being able to have the lantern repaired should something go wrong, but consideration must be given as to why organisations are moving away from it.

In the context of solar lighting it seems to be becoming increasingly common for organisations to mass produce products overseas, for example in China and import them to Kenya for distribution. This is the most cost effective way to produce and distribute products and keeps the final price as low as possible. There are significant problems with manufacture or assembly in Kenya including skills availability, operating costs and industrial capability which has resulted in production taking place overseas. This is the experience that Glowstar went through during its development that led to its production in China and still presents significant challenges to overcome.
The social and developmental benefits to in country manufacture are evident, but they must be balances against the goal of providing effective and high quality lighting to the maximum number of people.

Manufacture and distribution is an issue for the current Glowstar design which is manufactured in China and is delivered via ‘the social route’, as discussed above.

**Technology**

The current lantern uses a compact fluorescent lamp (CFL) of either 5W or 7W as the light source. The emergence in recent years of white LEDs and in particular power LEDs presents new options for the light source in portable lanterns which offer a number of advantages over CFLs and present significant challenges in the integration into products. LEDs are compact, mechanically robust and offer rapidly improving efficacy that now outperforms CFLs leading to smaller, lighter and more rugged products that require smaller batteries and solar modules. In addition LEDs have very long lifetimes (50,000 to 100,000 hours) that in effect mean they should never need replacing during the lifetime of the product and they contain no mercury that can cause environmental problems at disposal. The major challenge to their incorporation into a lantern design is the directionality of the light that they produce. LEDs produce light in only one direction which makes them very well suited to focused task lighting but makes it very difficult to spread the light in a Glowstar type room light design. With cost as a major constraint on the product both technologies should be considered in the development of a new design however one project will focus in more depth on the application of LEDs into a Glowstar type lantern design.

The current design is powered by a valve regulated sealed lead acid gel battery that has been optimised for regular charging cycles from a solar module. It is a high performance battery but it is expensive, large and heavy. Advances in battery technology offer new possibilities including Nickel Metal Hydride (NiMH) batteries and lithium Ion (Li-ion). NiMH batteries are offered in standard sizes e.g. AA, D etc which makes them commonly available on the general market and therefore easy to source replacements when required. This also allows for users to replace the batteries themselves if they wish, which could lead to lower quality batteries being installed and degrading the lanterns performance or non-rechargeable batteries could be installed which could cause significant problems. Further research and consideration needs to be undertaken into batteries to identify the most suitable for the application.

Only one of the competitors identified combined solar and wind-up as a power source. It is thought that this has a lot of potential and as a result it is intended that an assessment will be conducted to determine if it is a viable option. The addition of wind up or kinetic energy generation will improve the length of time light can be provided for at night and would ensure that, for example in the event of an emergency, light would be available.

**Conclusion**

The Glowstar lantern has a strong reputation as a high quality product but has limited penetration of the rural market for which it was intended. The overriding reason for this is the high cost of the product that puts it out of the reach of its intended users. The Glowstar program pioneered the rural lighting sector and provides some very important points to consider in future developments. Technology advances and new approaches to distribution combined with the experience of Glowstar presents great new opportunities to make progress in this sector.
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References


