Small Scale Carbon Sequestration using Solar Powered LED Lanterns in Uganda

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Abstract

The quest for reducing GHG emissions has got a great deal of opportunities in Africa. From the energy forests, short rotation coppice, to reducing paraffin use for lighting purposes we find a wide field of initiatives with the power to greatly impact climate change and global warming. The present study is one of the said initiatives.

In Uganda 7 out of 10 people use paraffin for lighting. It is not surprising in a country where less than 10% of the population has access to electricity and more than 85% of the population still cooks with firewood and charcoal.

A sample of 100 households in an area with no electricity was chosen to purchase at subsidized price the solar lanterns and a logbook system were put into place to check how much paraffin were spared. A monitoring, verification and evaluation system was followed to assess also other issues apart from carbon sequestration such as change of behavioural patterns, use of saved money, product improvement, etc.

Another 100 households with no LED lanterns were used as control sample.

The study was done in cooperation with Uganda Carbon Bureau. This institution provides support to such initiatives. Lessons learned and best practices are included.

Key words: Carbon sequestration, LED lamps, Solar Energy, Paraffin Use

Background

This promotion and use of Light Emitting Diode (LED) solar powered lamps to replace kerosene lamps in households in rural areas of Uganda is in line with the global trend of reducing green house gases. Today, close to two billion people still use paraffin for lighting. It is estimated that about 40 billion dollars is spent per year in paraffin lighting only. Paraffin consumption for lighting is 1.7 million barrels of oil per day, greater than the oil production of Libya.

In Uganda, the business of paraffin for lighting is a 300 million dollar per year business. This is so because 4.5 million households in this country are not yet connected to the main electricity grid.

The World Bank issued a report on Solar Lanterns in August 2005 where it is stated that about 1.6 million children die every year due to indoor pollution related diseases. These cases are mostly in Africa, India and South Asia.

Ultra bright white LEDs have improved greatly over the last 5 years. Their production cost has also decreased quite a bit making it a natural solution for lighting in future replacing the Compact Fluorescent Lamps in practically all small applications.

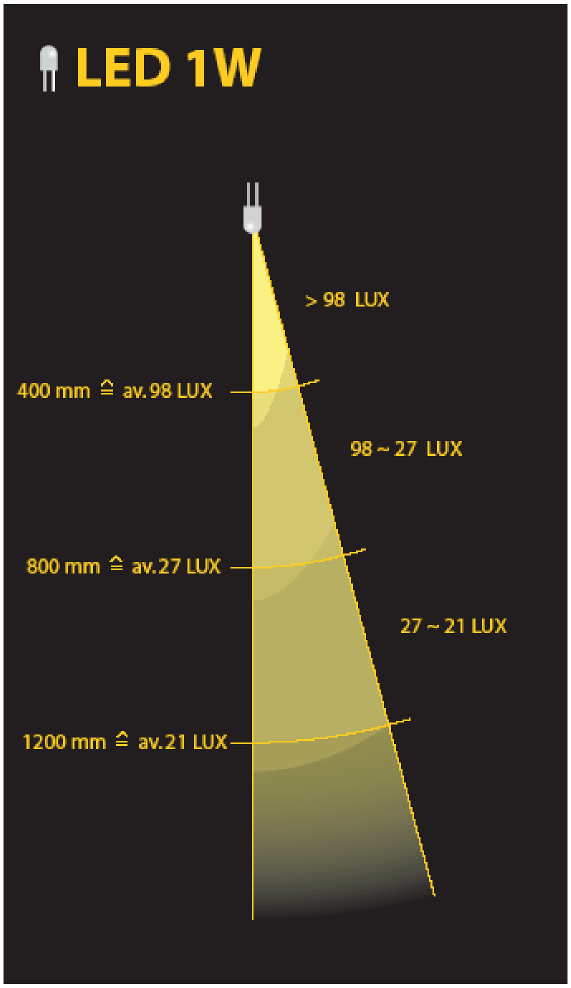

Figure 1: Ultra bright white LED lumen output

Since the type of lamps being promoted is powered using solar energy, it has been referred to locally as "TALA-MUSANA" meaning "light from the sun lantern". The importance of such initiative can be gauged by the following quotation:

"The single greatest way to reduce the greenhouse gas emissions associated with lighting energy use is to replace kerosene lamps with white LED lighting systems in developing countries; this can be accomplished even while dramatically increasing currently deficient lighting service levels."

Global Lighting Energy Savings Potential
Evan Mills, Ph.D.
Lawrence Berkeley National Laboratory, Berkeley CA
Light & Engineering, 2002, Vol 10, No 4

The specific lantern this study used is called "Firefly" and is manufactured by Barefootpower, a company from Australia which centres its effort in designing and disseminating energy solution for the poor. The company has placed a unit in China to do R&D and QC of their products. They have made East Africa, South Asia and India their focal areas for dissemination.

The replacement of paraffin for lighting with solar powered LED can qualify for small scale carbon sequestration schemes. This study has been done in coordination with the Uganda Carbon Bureau (UCB).

UCB was registered in April 2006, and is the only full-service carbon finance company in Uganda. The Bureau provides professional support to project developers, carbon credit buyers, development agencies, financiers and the public to ensure that biodiversity and social impacts are carefully assessed and innovatively treated in projects developed in the voluntary and compliance carbon markets.

The Bureau is building a carbon offset portfolio, based on credits from Ugandan projects, for use by Ugandan companies, organisations, individuals and event managers. The Bureau provides information about climate change and the carbon markets to a wide audience in Uganda. The Bureau's founder has worked in Uganda for 10 years and has had a continuous involvement with the development of Uganda's participation in the growing carbon markets.

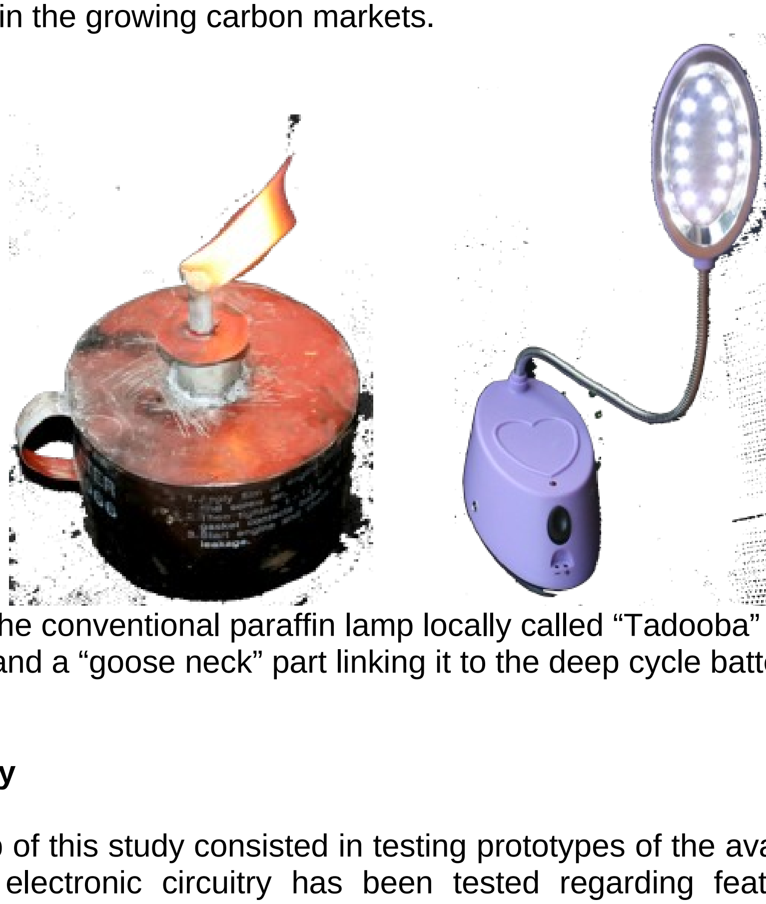

Figure 2 – The conventional paraffin lamp locally called "Tadooba" and the "Firefly" with its 12 LEDs and a "goose neck" part linking it to the deep cycle battery and control.

Methodology

The first step of this study consisted in testing prototypes of the available solar powered lamps. The electronic circuitry has been tested regarding features such as over-charging and over-discharging battery protection; quality of components; switching, etc. The LED has been tested on its lumen output specifically compared with the paraffin lamps. The solar panel was tested in terms of current and voltage output in different insolation levels. As a whole the lantern was tested to find out how long it takes to charge fully the battery and also how many lighting hours are there available once fully charged. It was found that the product (Firefly) was a reliable one and that it would qualify to be disseminated.

Figure 3 – Comparison between one LED solar powered lamp and three paraffin lamps

The first attempt of dissemination was done in a village near Lake Albert on the west side of Uganda called Buliisa. The project did not go well because one of the aims was to find out how much paraffin was sequestrated and as the community uses paraffin also for cooking the impact of the use of the LED lamps was not felt. It nonetheless worked well on customer acceptance of the solar lamps. More than 300 units were sold and a business person in the community became a kind of "representative" of Base Technology in that area.

A second area was chosen. This time the village did not have any regular income such as the people of the Buliisa fishing village. A team of undergraduate students of Electrical Engineering under the supervision of a PhD student took a three day field trip to have a person in each household of the village filling a questionnaire with questions on lighting, fuel consumption, home patterns and income flow. This information was intended to provide a baseline for the study.

The group also carried with them a good number of LED lanterns to sell to the villagers. Because the residents of that village did not have regular income, the USD 15 which is the cost of a LED solar lamp proved to be above their affordability limit. In a bid to overcome this hurdle to the study it was decided to give the lamps at a subsidized price of USD 5 only.

Once the 100 households were furnished with a LED lantern, an 8 week process of Monitoring, Verification and Evaluation started, analysing logbooks on paraffin savings, change of pattern in the home, student's performance improvement due to the 5 extended hours of lighting and any other offshoot consequences of the adoption of this new technology.

Data Collection and analysis

Each member of the research team was provided with more than 10 questionnaires to collect the information regarding paraffin use and other relevant data such as: numbers of members in the household, income levels and pattern, household fuel usage for lighting , activities carried out after dusk and their duration before bed time, , number of children in school, etc. While collecting data members were also expected to explain and demonstrate to households how the LED lantern works bringing out clearly its advantage in comparison with the Kerosene lamps.

As light is used mostly for reading (poor people in the rural areas of Uganda eat while there is still natural light and go to bed early to avoid spending money on paraffin) the acceptance of the LED lantern occurred more in those houses where there were children in school who needed to read at night. Those are the majority as more than half of the population of Uganda is aged below fifteen. It was found that on average, the time spent for reading at night in the household was 3 to 4 hours. Since the LED lamp can provide light for 4 to 6 hours when fully charged, it proved sufficient to cater for the need to provide lighting for extended reading.

Income levels were such that about 46% of the households earned less than a dollar a day. This puts them below poverty line and unfortunately they were not able to purchase the LED lantern. The next 40% of the people interviewed have income between 1 and 2 dollar per day. This bracket became the target group for the lantern as they were able to purchase it at the discounted price. . The majority of the households have their income from agriculture. This is small scale, almost subsistence level income and it is seasonal.

Paraffin consumption is shown to be between 1 and 1.5 litres on average per week per household. This represents a monthly expenditure of about 4 to 6 dollars. This means that even for the lower consumption households the payback period for a LED lamp would be less than 4 months. As the lamp is meant to last at least one year, each lamp represents a saving of 32 to 48 dollar per year which is sizable saving on their budget. This averted expenditure can be used to purchase books, medicine, better food or making small improvement in the household.

In addition to the fuel cost savings from the use of the LED lamps, the households indicated that they enjoyed much better quality of light as shown in the comparison in figure 3. Furthermore, the hazards of smoke-related illnesses experienced with kerosene lamps as well as the fire risks involved were considerably reduced.

Conclusions

In order to provide for the sustainability of this small scheme carbon sequestration, the main issue is to identify a reliable product which is at the same time affordable to the target market of rural Uganda. This was successfully done with the Firefly from Barefootpower. Acceptance of the product was the second hung on the latter of changing paradigm in fuel for lighting in rural areas. This was also carried out quite well in the pilot village used in this study. Nonetheless it does not solve the bigger problem as there are about 5 million households in Uganda in need of the LED light. To create awareness at such high number is not possible with simple visits of trained researchers. Strong marketing personnel should be engaged to perform this task. Government support is required to launch a nationwide campaign.

Another important aspect of this study is to develop a reliable way of documenting the effective amount of carbon sequestrated by the shifting from fossil fuel to solar power. Other issues such as training technicians to do small repair to the LED lamps all over the geography of Uganda, getting small level entrepreneurs to trade on LED lamps, improving the product by, for example, providing slightly bigger panels able to charge cell phones as well are things which can ensure nationwide success.

Uganda Carbon Bureau (www.ugandacarbon.org) is working on ways of systematizing procedures to avail rebates to this product. This extra fund could be used to create further awareness, develop recycling procedure for battery disposal, create a call centre to link trained technicians to users with damaged lanterns, ensure regular flow of product into the country for retail commercial people, etc.

As a final conclusion we expect that in a few years time we could see Uganda becoming like any other country in the West where not a single drop of paraffin is used for lighting purposes.

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