Light for Education

The First 2000
**Table of Contents**

Introduction: Light for Education (LFE)
- Statement of need and Background
- Model: Technical and financial details
- Intended benefits

Impact assessment study
- Aims of the study
- Methodology
- Limitations
- Results
- Intended benefits compared with real benefits

Discussion

Conclusion
**Introduction:**

SELCO’s years of experience on the field have exposed us to the existence of several villages in Karnataka and other parts of south India that have extremely unreliable access to the grid or worse, completely lack any access. Under these circumstances, students who use the hours after sunset to complete school work are forced to use kerosene lamps or candles. These sources provide dim light unsuitable for studying. Kerosene lamps also give out harmful smoke and heat making it difficult for students to concentrate for more than 30 minutes, and cause irritation and pain in the eyes. These lamps also increase the risk of fire accidents. To add to these issues, the education system is fraught with problems of low school attendance rates and poor quality of work completed by students at home. Teachers affirm that the most common excuse given by students for not completing their home work is the lack of proper lighting. It was with this background that the 'Light for Education' program was envisaged to provide a safe, cost-effective and reliable solution to these problems.

Rolled out with the aim of capitalizing on the linkages between energy access and education, the magnitude of the programme today belies its modest beginnings. What started off as a small experiment involving 30 students in a school in Sulliya, Dakshina Kannada district, has evolved into a programme with substantial funding, reaching out to over 2000 students across 20 districts of Karnataka. Improving the academic performance of school children was the underlying aim of this experiment, which sought to achieve this by providing an affordable, reliable light source for students residing in rural areas. By doing so, issues of academic performance and interest in education were to be addressed, while simultaneously resolving the lack of energy access.
**Timeline of Important developments in the LFE programme**

<table>
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<tr>
<th>Time period</th>
<th>LFE-related development</th>
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<tr>
<td>November 2009</td>
<td>Concept note about LFE circulated internally at SELCO.</td>
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<td>January – February 2010</td>
<td>Pilot phase of 30 students in a school in South Karnataka.</td>
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<tr>
<td>June - December 2010</td>
<td>Testing extended to 100 other students from 4 more schools in the same area; Students given commercially available small LED study lamps.</td>
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<td>February - March, 2011</td>
<td>Light for Education programme in its current form kicked off with the first installation in a tribal school in Mysore district. Technology Alumni Association (TAA), the alumni association of the Indian Institute of Technology (IIT), Kharagpur, along with Menda Charitable Trust, became crucial to the expansion of the programme beyond the initial phase.</td>
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<tr>
<td>June 2011 – March 2012</td>
<td>Large scale expansion of the programme to reach out to over 2000 students across Karnataka</td>
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<tr>
<td>January - February 2012</td>
<td>First Impact assessment study of LFE conducted</td>
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All of these developments were integral to the scale-up of the LFE model from a pilot project to a full-fledged programme that has catered to more than 2000 students in the state over the course of the academic year 2011-2012. Appropriate changes were introduced in the model during this scale up including the design of products being used in the model, suppliers of technology and the distribution of financial burdens on the various stakeholders.
An impact assessment study of this programme was conducted in the months of January and February through the SELCO Labs, with the help of students from SDM Institute of technology, Ujire, Dakshina Kannada district. The study was carried out to document the achievements and failures of the programme at the end of one year of its operation. The larger aim was to understand the challenges in future implementation and to streamline processes that could lead to more effective implementation and long term sustainability of the programme. Till date, 42 LFE projects have been implemented across 20 districts in Karnataka, with more than 2000 student beneficiaries.

The Model:

The Light for Education programme essentially consists of the following three parts-

- A centralized charging station at the school
- The study light, kept in the student’s house, and
- A pocket size battery pack which is charged in the school and powers the light

LFE seeks to provide a reliable, clean and safe lighting source for the benefit of students and their education. In this programme, students are given an LED powered study light from the school, which
includes a small detachable battery that can be recharged at the school's solar recharge center. Therefore, school attendance becomes crucial to access lighting at home, adding an incentive for parents to ensure their child attends school. It is believed that by providing a clean and bright light source, children will also be able to complete their work in relative comfort and fare better in academics.

Once schooling has been completed, every student beneficiary is expected to return the study lamp and battery back to the school, which can then be redistributed to the next batch of students. This creates a sustainable model for lighting the homes of students. The replacement of kerosene would bring added health benefits to households in the long run. SELCO Foundation hopes that this program can be part of the solution to the growing problem of indoor air pollution, which claims 1.5 million lives every year.

**Technical specifications of the model:** A typical LFE technical setup will comprise of 2 sub systems – Study Lights and the Charging Station.

The study lights provided to the students come with the following technical specifications:

- Light - Two hi-power LED’s of approx 0.5W total power consumption
- Detachable Battery pack - 2700 mAh NiMH batteries. This can give a backup of 8-9 hrs, and can be charged on alternate days.

The centralized solar charging stations at the school consist of the following components:

- Polycrystalline silicon solar PV module: 30W
- Lead acid tubular battery: 30 Ah
- Charge regulator: 5 A
- Charging points: 12
- Wiring and casing
The programme was designed after extensive study in Karnataka. The study lamp is placed at home for students to use after sunset, while the pocket-sized, detachable battery (which is smaller than the size of a pencil box) can be carried to school in the morning on a daily basis.

At the school, batteries are charged by the centralized solar charging system. In the evening, after school hours, students carry the charged battery back home. When it is time to study, students fix the battery to the LED lamp with the help of a connecting plug. A completely charged battery will provide light for 3 hours a day with 2 days autonomy.

**Financial specifications of the model:** The base cost per student in this model works out to Rs. 1500 (all inclusive). This could increase up to Rs. 2000 depending on the location of the school and its remoteness. In this pilot phase, the model does not expect any payment from the school itself. However, it does require that a certain contribution be made by student beneficiaries. This user fee works out to Rs. 200 for the first year and Rs. 150 for every subsequent year and will be used for the maintenance of the system. The model allows for this contribution to be made in installments for the benefit of students who may not be able to pay a lump sum amount. The remaining cost is borne through donor-based funding.

**Intended benefits:**

- Establishment of an independent solar charging system which does not require grid electricity
- Cost effective model because a centralized charging system is used to charge all the battery packs which reduces the high expense and the inefficiencies of providing individual solar panels for each student. (Technically, the performance of the central charging system would also be much better than individual solar panels, especially during rainy season.)
- Improvements in studies and school attendance rates as parents see an added advantage in sending their child to school.
- Provision of clean, safe, bright and reliable light source for all students in the school to study at home. The harmful smoke and heat emitted by kerosene lamps are also avoided improving the health of students and their families.
Impact assessment study

Aims of the study

- To determine the impact of the programme on student beneficiaries, their households and the hosting schools
- To understand and document the real benefits of the programme and compare these against the intended benefits
- To use the results of the study to understand the challenges within the model, both technical and financial, and determine how these challenges can be overcome

Methodology of the study

This impact assessment study was conducted by SELCO Labs, a program of the SELCO Foundation. The Labs was able to complete the study with the help of engineering students (in their 1st year) from SDM Institute of Technology, Ujire, Dakshina Kannada district. These students (from here on referred
to as volunteers) volunteered to conduct surveys of the student beneficiaries and teachers. A three hour training session was conducted for volunteers to cover details of the program, the aims of this study and the specific schools they would be surveying. Instructions were also given on visual documentation of the projects in various schools.

This study was conducted over a period of four weeks. During the last week of January, 38 volunteers surveyed 19 schools across Karnataka, equivalent to nearly 50% of the total number of schools covered by the LFE programme. The schools were chosen through random sampling and each school visited by 2-3 volunteers. The details of the schools and the number of students interviewed in each school are provided in Appendix 1.

The questionnaire used for survey was designed by senior members of the SELCO Labs who have been closely involved with implementation of LFE program and is attached in Appendix 2. The questionnaire consisted of three parts:

- **Part 1**- addressed to School Principal: Elicits general information on the school, the number of students attending the school, its address and the electrification status of the village.
- **Part 2**- designed for teacher respondents: Information on the functioning of the LFE project in the school and changes noticed in student behavior. Although some questions in the survey tend to cover changes in the behavior of all school students (quality of homework, attendance rate etc.), volunteers took special care to elicit responses on the specific changes in the behavior of student beneficiaries in particular.
- **Part 3**- for Student beneficiaries: Responses on the impact of the project, its advantages and problems.

The interviews were primarily structured interviews, with some leeway to understand the reasons for certain ‘yes’ or ‘no’ responses. Through this study, the responses of a total of 803 student beneficiaries and 49 school teachers were documented.

**Limitations of the study**

- The structured nature of the interviews may have reduced the possibilities of asking follow-up questions to supplement certain responses and/or prevented students and teachers from freely expressing their opinions on the programme.
• This format may also have created a bias towards certain kinds of responses based on the way the questionnaires are designed. However, owing to time and resource constraints, more elaborate interviews did not seem feasible.

• The sample of schools surveyed in this study was randomly selected and by default most of these schools are located in the southern parts of Karnataka. Since this does not constitute a representative sample, caution has been taken to avoid generalizations that would be area specific.

• The information provided by the beneficiaries and teachers were taken at face value and in a majority of cases it was not practically feasible to verify this information with realities in the household or school.

**Results of the study**

Volunteers state that Part 1 of the questionnaire was completed with information from school principals and in their absence with inputs from senior teachers or others in charge at the school.

The main results of the study are categorized based on certain broad indicators

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<tr>
<th>Indicators</th>
<th>Findings and Results</th>
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| **Site-specific indicators**                    | **Household electrification status:** Nearly 80% of the student users reside in households that are electrified, but owing to unreliable power supply, students are benefitting from the study lamp. The remaining 20% are from un-electrified homes.  
**Reliability of supply:** A large majority of the villages have more than 5 hours of power cut every day. |
| **Socio-economic indicators and usage**         | **Kerosene usage:** 90% of student respondents claim that with this study lamp, they have been able to completely eliminate their usage of kerosene or candles for studying.  
**Savings:** Owing to this elimination, these students are able to save anywhere between Rs. 50 and Rs. 150 per month. While some gave a monetary value, others mentioned their savings were from the reduced expenditure on health services, indicating health benefits from reduced use of kerosene.  
**Usage of lamp:** The lamp has primarily been used for studying purposes of the beneficiary and his/her sibling(s), and this should ideally have a positive impact on the education of the children in the household. |
Around 40% of households use the lamps for purposes beyond studies. A number of households, particularly un-electrified ones use the light during cooking and as torch lights during the night.

Nearly 65% of the respondents use the light on weekdays for 4 hours or less on a daily basis.

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<tr>
<th>School-related indicators of improvements</th>
<th>Awareness: This programme appears to have been largely successful in creating awareness amongst students about renewable energy and its practical applications.</th>
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<td><strong>School attendance</strong> has increased, with 90% of teachers agreeing the programme has shown marked improvements in school attendance rate of student beneficiaries</td>
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<td></td>
<td><strong>Academic improvements:</strong> Nearly all teacher respondents attribute an increase in the completion of school homework and an improvement in the quality of homework to the LFE programme.</td>
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<td>A large majority of schools suggested that students could continue using the study lamps during the vacation period since the school administrative office would remain open.</td>
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<tr>
<th>Technical indicators</th>
<th><strong>Brightness:</strong> Nearly 85% of the student respondents agree that the brightness from the light is adequate and are happy with brightness levels.</th>
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<td></td>
<td><strong>Battery and connector defects:</strong> Around 20% of the students are facing problems with the batteries and connectors, and this is coherent with the responses of the 10% of teachers who suggested that their school students were facing technical problems with the lamps. Nearly 50% of teachers claim that the students charge their batteries thrice a week.</td>
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<td>Both students and teachers (in separate questionnaires) assert that a maximum number of issues lie with insufficient charge, battery failures as well as troubles with the connector (where the connector splits on account of students pulling the wire instead of the connector while disconnecting the portable battery from the larger battery bank).</td>
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<td><strong>Other complaints:</strong> A couple of primary school students mentioned that their batteries had been stolen. These responses came from the same school where the teacher complained about the charging station being too far away (since it is located in the high school). It appears that keeping the charging stations in one school and expecting students from other schools to use this space for</td>
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charging their batteries has led to the theft of batteries.

**Monitoring:** Most schools claim that someone on their staff monitors the charging of batteries and reports problems when charging does not take place.

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**Intended benefits compared with Real Impact**

It is worth assessing in a nut shell, the extent to which the real impact corresponds to initial aims or intended benefits of the programme.

- Establishment of an independent solar charging system which does not require grid electricity

  *Real Impact: This has been achieved.*

- Cost effective model because a centralized charging system is used to charge all the battery packs which reduces the high expense and the inefficiencies of providing individual solar panels for each student. (Technically, the performance of the central charging system would also be much better than individual solar panels, especially during rainy season.)

  *Real Impact: The system has been cost effective compared to providing individual panels at students’ homes (Rs. 1500 versus Rs. 2000). Charging has been consistent even during the rains (owing to the buffer batteries in the charging station). Maintenance has been easier to manage since the school becomes the single point of contact for all maintenance visits.*

On the flip side, the frequent attach-detach of the NiMH battery and lamp has created higher than normal maintenance issues. These include non-functional battery pack (connector open circuit), over heated battery pack (connector short circuit), flickering light (lamp side connector loose contact), etc. The issues, though fairly easy to fix, have affected more than 20% of the lamps/batteries. A major learning has been that the connectors are the weakest link in the technology and are subject to very rough handling by students, therefore needing special attention in design. A new connector design has been introduced recently, but there are already 2200 lamps in the field with the old connector. These technical failures have created pockets of unhappy users in some areas.

*Additionally, the current repair model of sending lamps requiring the most minor of repairs to the Head Office has added unacceptable delays to the repair cycle and needs to be modified.*
• Improvements in studies and school attendance rates as parents see an added advantage in sending their child to school.

Real Impact: Teachers claim that attendance has improved in schools as has the quality of homework. They attribute the changes to the Light for Education programme.

• Provision of clean, safe, bright and reliable light source for all students in the school to study at home. The harmful smoke and heat emitted by kerosene lamps are also avoided improving the health of students and their families.

Real Impact: The lamp has provided brighter light and increased savings. It has also reduced the consumption of kerosene among students.

Almost 80% of the LFE users surveyed have grid power in their homes and use kerosene lamps only during power failures. However the failures were frequent enough to merit daily usage of the study lamps (especially in summer).

Discussion

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<th>Main Issues</th>
<th>Addressing the issues</th>
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<td>Identification of schools and rigorous need assessment</td>
<td>A more rigorous, targeted need assessment and school identification exercise to be undertaken for LFE next year. A potential plan to allow Headmasters to pick students and distribute lamps to the most deserving candidates (coming from underserved households)</td>
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<td>Technical problems with the lamps and batteries</td>
<td>Short term: New connectors being introduced into existing design. Long term: Study lamp with new design will be manufactured</td>
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<td>Branch inability to repair and maintain lamps</td>
<td>Regional customer support personnel being trained through a workshop on repairing study light components; this knowledge will be transferred in time to local technical support to overcome delays in servicing and repairs</td>
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<td>High operational and maintenance overheads</td>
<td>Regional customer support training and subsequent branch level training would ensure repairs are localized; replacements of batteries to be made locally available to reduce downtime on systems. This would ideally be solved with reduced battery failures and more localized, immediate repairs.</td>
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<td>Overload on after-sales</td>
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<td><strong>support</strong></td>
<td><strong>School vacation period</strong>&lt;br&gt;<strong>Process for collection and redistribution</strong>&lt;br&gt;Process has been put in place for Regional customer support staff to coordinate with schools and branches in their respective jurisdictions.&lt;br&gt;Lamps are being serviced and left in the safe keeping of the school, while portable batteries are being brought back to branches for storage during vacation period.&lt;br&gt;Batteries will be returned to schools when they reopen and lamps redistributed to students upon payment of annual user fee.</td>
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<td><strong>Financial model: primarily dependent on donor funding</strong></td>
<td>Although the programme will continue to be dependent on donor funding, the mandatory student contribution helps cover the operational and maintenance costs of the system. This ensures, at the very least, operational sustainability.&lt;br&gt;This donor funding should ideally be viewed as an investment in education, where the returns are not immediate or fully quantifiable.&lt;br&gt;In addition, the sale of carbon credits derived from this program could offset some of the operational costs of the model</td>
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**Conclusion**

Having completed one year of its operation, the Light for Education programme was evaluated for its impact and challenges. Student beneficiaries and their households appear to have benefited from the access to this programme and the solar-powered lamp. Schools have also realized the value add of the LFE, attributing improvements in school attendance and academic performance to the programme. Undeniably, the programme has succeeded in effectively and efficiently scaling up from 30 students on an experimental basis to benefiting over 2000 students through a full-fledged model. The learnings from this programme are as important to take note of as the benefits themselves.

LFE has forced individuals to think more seriously about issue-linkages and capitalize on the links between energy and other socio-economic indicators of betterment. It has also emphasized the importance of experimentation and user feedback in the effective functioning of any model. All the issues addressed above – technical, operational and financial- have added to the learning from the programme. A long-term study of the comparative benefits of the programme is being planned that documents the impact that this programme may have had on the education, livelihood and future
decisions of a small group of beneficiaries over the period of 5-10 years. This would help understand
the long-term impact of renewable energy based lighting used in the promotion of education, adding
to the understanding on linking related socio-economic infrastructure facilities.

The larger goal is to incorporate other aspects and projects that add value in the realm of education,
particularly in rural areas. This will extend the Light for Education programme beyond mere lighting
to aspects of increasing the impact of education in rural areas.