Examining Consumer Preferences for Solar Portable Lights (SPL) in Tamil Nadu: A Product Comparison Report

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Contents

Abstract

India is a rapidly emerging economy with the world's second largest population that is facing a growing energy demand. The rural Base of the Pyramid (BoP) in India is comprised of 114 million households that comprise approximately 60% of the country's total population. These households are a significant untapped consumer market for energy services and products including solar lights. While there is a large market for lighting and clean energy, often times the decision to purchase a solar portable light (SPL) product does not actually lie with the product's end user. Organizations implementing programs or selling products have many choices to make about the type of product they will distribute or sell, and subsequently influence the variety of choices available to the end-users and purchasers. These organizations can benefit from understanding the different types of products available, and how the end users feel about the features and attributes of different products. This report, which was developed through a literature review and analysis of surveys conducted within the Essmart network in Tamil Nadu, shares preferences of end users regarding SPL qualities, as well as existing perceptions on different products and designs. The following is explored in the report: (1) the main reasons people use SPLs; (2) who uses SPLs primarily in a household vs. work setting; (3) preferences among SPL product qualities; and (4) an overview of several SPL models and their consumer feedback evaluation results including a ranking of preferred products. Ultimately this report can inform manufacturers and distributors in order to better serve consumers and more effectively tap into SPL markets in the BoP.

Acknowledgements

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Introduction

India is a rapidly emerging economy with the world's second largest population that is facing a growing energy demand. The rural Base of the Pyramid (BoP) in India is comprised of 114 million households that comprise approximately 60% of the country's total population. These households are a significant consumer market for energy services and products.

While there is a large market for lighting and clean energy, often times the decision to purchase a solar portable light (SPL)[1] product does not actually lie with the product's end user. Organizations implementing programs or selling products have many choices to make about the type of product they will distribute or sell, and subsequently influence the variety of choices available to the end-users and purchasers. These organizations can benefit from understanding the different types of products available, and how the end users feel about the features and attributes of different products. Therefore, this report shares results from end user, retailer, and sales associate surveys within the Essmart Global (Essmart) network in Tamil Nadu. Essmart has been selling SPL products since 2012 through local *'kirana'* stores (local, family-owned retail stores).

This report analyzes the results from surveys in the form of a product comparison report, comparing basic SPL products and their qualities, specific to the Tamil Nadu region. The ultimate goal of the report is to inform Essmart, other SPL distributors, and SPL manufacturers of preferences of end users regarding SPL qualities, as well as existing perceptions on different products and designs. This report presents an overview of several SPL models and their consumer feedback evaluation results as an example of a comparative product rating. This report also sheds light on the main reasons that people use SPLs, which people use SPLs primarily in a household vs. work setting, and the preferences among product qualities.

There are several key findings in the report. First, SPL products in Tamil Nadu are most commonly used for power outages and housework, with 61.6% of respondents saying they use or would use a solar lantern product for power outages, and 53.4% of respondents saying they use or would use a solar lantern product for housework (not being mutually exclusive). Of the eight specific qualities of SPLs that respondents ranked, battery was ranked as the most important quality in the solar lantern product, with brightness following close behind. The least important qualities in the solar lantern product are the automatic dimming and charge time for the lantern. The report reveals that the most popular solar lantern products overall are the SunKing Pro2 and SunKing All Night products. The main reason cited for a favorite product was 'brightness', while the 'design' was also an important factor. 'Brightness' was cited as the main reason for both the lowest ranking and highest ranking products, which is aligned with the ranking of brightness being one of the most important qualities in an SPL product among interviewees. 'Price for value' was another frequently cited reason for low product rankings, including for the SunKing Eco, despite it being one of the most affordable products surveyed.

The survey feedback regarding ranking of specific SPL products is representative of Essmart's sales data. The comparative ranking of the different SPL products correlates with the sales data

[1] In this report we use the term propagated by Lighting Africa of 'solar portable light' (SPL). This term been referred to as "pico-solar" in some report, or more generally "solar lanterns" in earlier industry and development agency literature.

and popularity of the SunKing products in the Essmart network. This report's method is validated as results found are representative of actual sales and adoption. Research conducted through Essmart can enable the international development sector in better choosing products because survey findings can be compared with actual adoption and sales data.

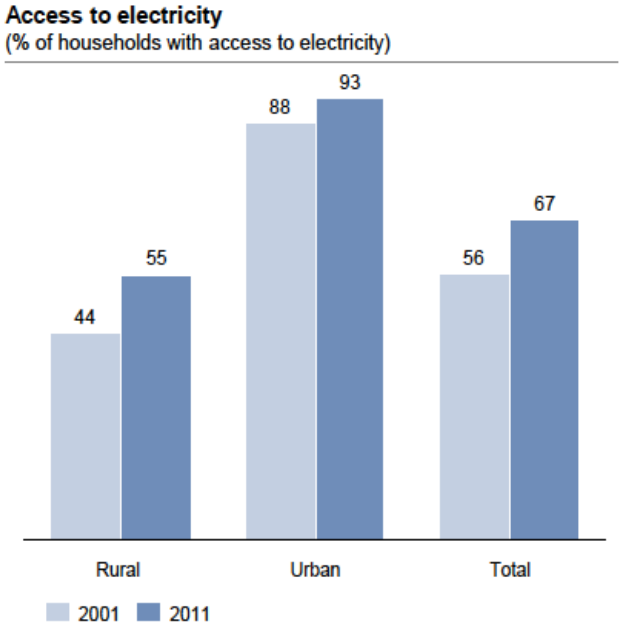
Background

In the developing world, access to reliable, safe lighting continues to be an issue. 1.5 billion people worldwide lack access to electricity[2], which severely impedes economic development.[3] Electricity is important for income generating activities, provision of health services, and educational outcomes (through allowing students to study at night). Electricity can also enhance social connectivity through shared experiences such as with television and radio, and for charging of cellular phones.[4] A large percentage of households throughout Africa, Latin America and Asia have unreliable or no access to an electricity grid, and instead employ kerosene lanterns, candles, or other forms of expensive and dangerous fuels for their lighting needs.

In India, access to energy is a challenge for many households. In rural locations 55% of populations have access to electricity, whereas that number is 93% for urban populations. Overall, 67% of the population has access to electricity. Access to electricity may also be overstated due to biases in the data and frequent power outages.[5] An estimated 27% of the country's power gets lost through theft and technical failure, while blackouts reduce the country's GDP by 15% annually. Overall, an estimated 300 million plus people are not connected to the grid in India and demand for power is anticipated to double by 2020.[6]

India continues to rely on fossil fuels as its main source of electricity, with 67% of the electricity obtained in India being from fossil fuels, exacerbating its energy deficit.[7]

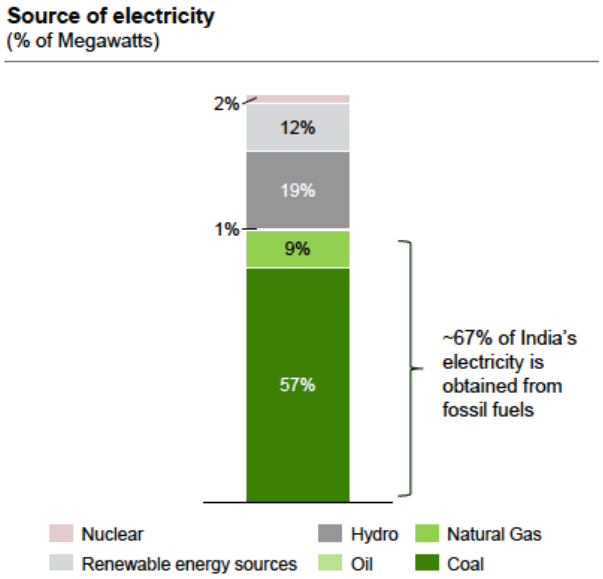
Figure 1. Access to electricity in India



[2] IEA (2009). *2009 world energy outlook.* International Energy Agency.
[3] Barnes, D. (2007). *The challenge of rural electrification: Strategies for developing countries.* Washington, DC: Resources for the Future.
[4] Jacobson, A. (2007). Connective power: Social electrification and social change in Kenya. *World Development*, 35 (1).
[5] Central Electricity Authority of India; Census of India 2011
[6] Kanellos, M. (2014). India becomes next hot market for solar an LED with new PM. *Forbes*. Retrieved from http://www.forbes.com/sites/michaelkanellos/2014/05/19/india-becomes-next-hot-market-for-solar-and-led-with-new-pms-promise/.
[7] Central Electricity Authority of India; Census of India 2011.

Fuel and lighting can also be expensive, as Indians spend approximately 7 to 10% of their total expenditure on fuel and light, which is significantly more than households in other developing countries. Interestingly, discretionary spending, including spending on aspirational products, has grown to 35% of total expenditure, thus providing a purchasing base into which the solar lighting sector can tap.[8]

Figure 2. Source of electricity in India



Tamil Nadu

Tamil Nadu is India's sixth most populous state with a population of over 72 million people and has emerged as a major hub for renewable energy over the last decade. Compared with the national average of 12%, renewable energy accounts for 44% of the power consumption in Tamil Nadu, and of this, 90% comes from wind. Tamil Nadu leads in wind power generation in the country with over 7,000 megawatts (MW) and has a wind power season from May to October.

While approximately 300 million still lack access to electricity through India, Tamil Nadu has a relatively reliable electricity supply, which attracts many industries to the state. According to GOI Census data in March of 2015, Tamil Nadu is considered to have 100% of its 15,049 villages 'electrified'.[9] Census data from 2011, says that 93.4% of households use electricity as their primary source of lighting.[10] Despite this high access to electricity, energy access remains intermittent and very unreliable.

The electricity demand-supply gap is an issue as energy demand increases. In 2014 the gap between peak demand and supply was over 8%, with an unmet peak demand of more than 1,000 MW. The Tamil Nadu Electricity Board imposes power cut demands and energy quotas for heavy power users. In 2015 the government imposed a 20% demand restriction on industrial and commercial electricity users. In peak usage hours, this restriction can be up to 90% of demand, resulting in severe shortages that contribute to this unreliable and intermittent energy access challenge.[11] In the last several years Tamil Nadu has faced severe power shortages that last from 8 to 10 hours. In rural areas, these power cuts can last 14 hours or more.[12]

[8] Dalberg. (2014). India cookstoves and fuels market assessment. *Dalberg*.
[9] A village is deemed electrified, if 10 percent of all the households of the village has electricity access and if electricity provided to public spaces such as schools, panchayat officers, health centers, community centers and dispensaries.
[10] Government of India. (2011). Census data highlights 2011. *Government of India Ministry of Home Affairs*. Retrieved from http://www.censusindia.gov.in/2011census/hlo/hlo_highlights.html.
[11] (2015). Tamil Nadu could become renewable energy powerhouse. World Research Institute (WRI). Retrieved from http://www.wri.org/blog/2015/02/india%E2%80%99s-tamil-nadu-could-become-renewable-energy-powerhouse.
[12] Leena, B. (2014). Tamil Nadu imposes power cuts again. Livemint. Retrieved from http://www.livemint.com/Politics/B3qr1TABeAeHxRoSnqbOaL/Tamil-Nadu-imposes-power-cuts-again.html.

Issues with electricity connection and power outages are not specific to Tamil Nadu in India. A survey conducted of 1919 households in 240 villages in 16 districts of 8 states of India, revealed trends of electricity connection. Of the 1919 households surveyed, 1881 households had electricity connection, with only 108 households not being connected to the electricity supply. 36% of the total households receive electricity supply for 20 to 24 hours, while 30% of the households get less than 12 hours of electricity supply and 23% of households getting less than 8 hours of supply. The remaining 11% had either no supply or were getting less than 4 hours of supply daily. The villages which had 20 to 24 hours of supply are in the state of Kerala, Gujarat and Haryana, while those getting less than 12 hours of supply are in the state of Maharashtra, Uttarakhand and Karnataka and villages which were getting less than 8 hours of supply or no supply are in the state of Odisha and Jharkhand.[13]

Solar portable lights (SPLs) in the Indian context

SPLs are an alternative source of illumination that are sustainable and safe. Solar lighting has received a large amount of attention and various designs have been developed for use in the developing world. The technology needed to manufacture solar-powered lighting options, in the form of light-emitting diodes (LEDs) and solar panels, has been available for several decades, but only recently have the component prices dropped enough to be able to market these products to the developing world in an affordable manner. Although solar lanterns can still be expensive for the developing country market, at US$10 to US$100 for personal or small-scale systems, they offer a variety of health advantages and also do not incur the additional fuel costs that traditional kerosene does.

In India, there has been growing attention towards solar energy and lighting, which is reflected in government action and initiatives. In 2010, the Ministry of New and Renewable Energy of India launched the Jawaharlal Nehru National Solar Mission (JNNSM), which sought to replace kerosene lighting in rural communities through providing 20,000 MW of grid connected solar power by 2022. The JNNSM seeks to reach this target and "reduce cost of solar power generation in the country through (a) long term policy; (b) large scale deployment goals; (c) aggressive R&D; and (d) domestic production of critical materials… [therefore making] India a global leader in solar energy."[14]

In addition to government support for solar energy, the demand for energy and affordable, reliable lighting in India is high. The off grid energy access market in India includes 114 million households who are at the Base of the Pyramid (BoP) earning less than $2 per day, according to the World Resources Institute (WRI). It is estimated that India's rural BoP consumers spent INR 224 billion (US$4.86 billion) per year on their energy needs.[15] There is thus a large market opportunity in providing BoP households with access to energy solutions, particularly including cooking and lighting needs. For solar lanterns specifically, the WRI estimates the market to be INR 855 million (US$18.58 million). Of rural households, an estimated 56% still rely on

[13] Current status of rural electrification and electricity delivery in rural areas of India. *Vasudha Foundation*. Retrieved from http://www.vasudhafoundation.org/wpcontent/uploads/2)%20Reader%20Friendly%20Paper%20for%20USO_Status%20of%20Rural%20electrification%20status%20in%20India.pdf.

[14] Ministry of New and Renewable Energy. Scheme/Documents. *Government of India Ministry of New and Renewable Energy.* Retrieved from http://www.mnre.gov.in/solar-mission/jnnsm/introduction-2/.

[15] Power to the people. WRI. Retrieved from http://www.wri.org/sites/default/files/pdf/power_to_the_people.pdf.

kerosene as their primary lighting fuel.[16] Given the potential market, a growing number of companies have targeted BoP households to purchase solar lighting solutions.

Despite this market opportunity, a variety of barriers exist in regards to adoption of SPL technology in India. First, charitable distribution schemes can distort the local market.[17] In addition and at a larger level, government subsidies for kerosene in India can dissuade consumers from purchasing solar products; however the landscape for this is now changing. Since World War II, the Government of India (GOI) has increasingly subsidized kerosene through the Public Distribution System (PDS). Yet, according to a government-sponsored study, as much as 38% of PDS kerosene was diverted and sold at higher prices to intended beneficiaries.[18] There have been four unsuccessful national efforts attempting to reform the kerosene subsidy and reduce the systematic corruption.[14] In the past several years, gradual reductions of the PDS kerosene of 5-7% annually have been occurring, according to Census data. As of December 2014, the Union Finance Minister Arun Jaitley scrapped subsidized kerosene through the PDS. Following this, states should now only provide subsidized kerosene to un-electrified households, and states that have achieved near 100% electrification will be incentivized to become kerosene free. Un-electrified households in the remaining states are to be offered the choice between cash subsidy in lieu of kerosene allocation as well as an upfront subsidy for greener solar lighting systems. PDS kerosene in the 2014 budget was INR 63,427, whereas it is estimated to come down to INR 5,852 in the 2015 budget.[19]

Challenges at the micro (consumer) level to adoption of SPL products include:

1. User doesn't know about product (awareness)
2. User cannot afford product (affordability)
3. User cannot access microfinance (affordability)
4. User cannot always find product in stores, variable inventory (availability)
5. User lacks confidence in performance, perhaps due to poor past products (acceptability)[20]

Cost is a critical barrier to adoption in Tamil Nadu that needs be addressed, as prices of SPL products remain too expensive for those living in poverty, particularly without financing options. Related to this cost barrier, an additional barrier to adoption is the widespread availability of cheaper torchlights (flashlights) from China that skew the market. These torchlights are sold for a fraction of the price of solar lantern products (approximately INR 250) and thus remain very attractive to end-users. However, according to interviewees, these torchlights often break within several months and customers thus need to return to purchase a new product up to three times per year. Ultimately, torchlights can be more costly to the end customer and are not a good long-term

[16] IFRC. (2011). Can urban user testing labs evaluate rural solar lighting solutions. IFRC. Retrieved from http://www.ifmrlead.org/wp-content/uploads/2015/OWC/Can-Urban-User-Testing-Labs-Evaluate-Rural-Solar-Lightng-Solutions.pdf.

[17] Baitiganjan, S., Cheung, R., Delio, E., Fuente, D., Lall, S., Singh, S. (2010). Power to the people. *IFMR & WRI.* http://www.wri.org/sites/default/files/pdf/power_to_the_people.pdf

[18] Shenoy, B.V. (2010, March). Lessons learned from attempts to reform India's kerosene subsidy. *Trade, Investment and Climate Change Series, Geneva: International Institute for Sustainable Development.* Retrieved from www.iisd.org.

[19] Mehra, P. (2014). No more subsidized kerosene through PDS. The Hindu. Retrieved from http://www.thehindu.com/news/national/no-more-subsidised-kerosene-through-pds/article6662420.ece.

[20] Brine, D., Frey, D., Goentzel, J., Graves, S., Green, J., Montgomery, B., Sanyal, B., & Weck, Olivier de. (2015). Experimentation in product evaluation: The case of solar lanterns, in Uganda, Africa. *Comprehensive Initiative on Technology Evaluation (CITE)*.

investment. Important to note is that retailers make high margins on these torchlight products. As retailers benefit from the accumulated high margins from repeated purchases of these low-quality products, as well as the business created by the necessitated repeat visits from the buyers of these products, retailers may be more inclined to push sales for these cheaper, lower quality torchlights. Educating consumers about the importance of quality goods and the benefits of a long-term investment in a more expensive solar lantern product is critical.

Despite these barriers, as aforementioned, there remains immense opportunity in the solar market. Companies that offer SPL products need to understand these challenges, and more, understand their BoP target consumers including their needs, wants, and preferences in regards to SPL products. In Tamil Nadu specifically, as the kerosene subsidy has been largely removed in towns that are '100% electrified', there can be greater market opportunity than there was historically for SPL products in the Tamil Nadu region for those that either use kerosene as a primary form of lighting or for those that use it as a backup.

SPL Evaluation History

There are several organizations and initiatives conducting evaluations of SPL products. Several examples include Lighting Africa, the Comprehensive Initiative of Technology Evaluation, and the Centre of Development Finance. Lighting Africa (LA), a joint initiative of the International Finance Corporation and World Bank created to foster the development of markets for off grid lighting solutions, has conducted extensive work in solar lantern evaluations. They do testing and certification processes for personal solar lanterns and conduct testing to verify specific aspects of solar lantern performance in order to create standards. LA is industry sponsored however, as the manufacturer pays them for testing and certification. Therefore, detailed testing results remain the private property of the manufacturers' and only the certification document is publicly available.

The Comprehensive Initiative on Technology Evaluation (CITE) at MIT completed the first comparative evaluation of solar lanterns in 2013 with the organization Solar Sister. This evaluation, based in Uganda, examined 11 different solar lantern models in order to identify usefulness of solar lantern devices and assist international agencies in making more informed purchasing decisions. The CITE report also seeks to analyze consumer preferences through a evaluative model that will allow manufacturers to design products directly aimed toward increased distribution to the BoP.[21]

Photo 1. D.Light Kiran S10

The Centre of Development Finance-IFMR (CDF) conducted research evaluating solar lantern products in India for rural market insight in April of 2011. The report entitled, *Can Urban User Testing Labs Evaluate Rural Solar Lighting Solutions?*, was based on an 8-week study of user experience with D.Light's Kiran S10 solar lantern and focused on evaluating the effectiveness of urban user data in representing rural consumer ideas and opinions.[15]

[21] The full CITE report can be found here: http://cite.mit.edu/reports/solar-lantern-evaluation#

The unique offering of the methodology used by this report and of conducting research through the Essmart network is that survey findings comparing SPL models are able to be compared and analyzed in light of actual sales data among the target populations for multiple types of SPLs. By comparing results to sales data, the report findings and evaluations can be legitimized.

Essmart Global (Essmart)

Essmart is a social enterprise building the last mile distribution network needed for life-improving products to reach and be adopted by their intended low-income end users. Essmart distributes a variety of essential goods through a network of local, family-owned retail shops (called '*kirana'* stores). The Essmart solution creates an "essential marketplace" to bridge the last-mile distribution gap in the global supply chain through leveraging existing rural retail networks to commercialize products that have significant potential for social impact, such as clean cookstoves, water filters, and solar lights.

Essmart connects high quality products with their intended users through these *kirana* stores in the following process: (1) Products are entered in the Essmart catalogue; (2) Local Sales Executives demonstrate the catalogue of products to retailers and end users, building relationships with the local stores in the process; (3) Store owners become distribution points for Essmart products and have the Essmart catalogue in store; (4) The Sales Executives provide ongoing marketing and distribution to fulfill any coming orders. If a product breaks, the Essmart team provides after-sales service through facilitating manufacturers' warranties.

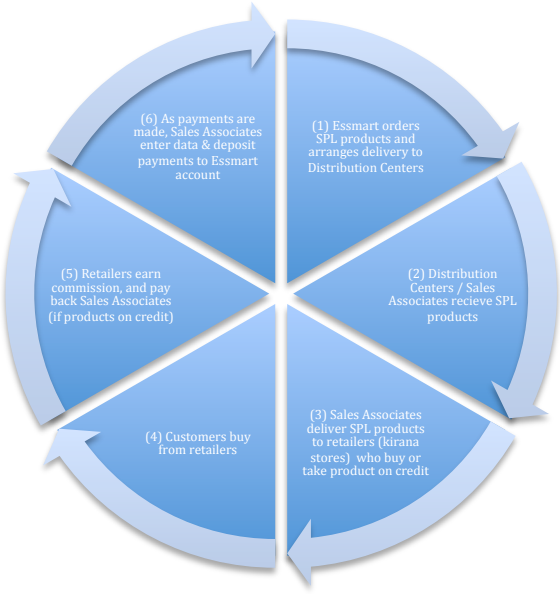


Figure 4. Sales cycle

Essmart currently has six Distribution Centers in Tamil Nadu. These Distribution Centers have built a combined network of over 1000 retail shops that have sold over 11,000 products. The goal over the next three years is to expand to 28 Distribution Centers and over 5,000 *kirana* stores that serve an estimated 2.2 million households.

Methodology

Personal-use solar lights as the product family for evaluation were selected for this research due to their widespread use in the developing world, potential impact on key development outcomes, and their initial success in the Essmart product mix. SPLs are relevant throughout the developing world, particularly in areas that have low or unreliable electrical coverage and can provide a more affordable alternative to electricity for low-income households.

The SPLs selected for the study are: (1) SunKing Eco; (2) SunKing Mobile; (3) SunKing All Night; (4) SunKing Pro 2; (5) D.Light S20; (6) Panasonic Solar LED Light; (7) SolarWay Power Lantern. The four SunKing models were selected for the study as these are the only models currently in the Essmart catalogue and Essmart's existing customers and retailers have experience with these lanterns in particular. Historically Essmart has attempted to sell other products than the SunKing models. However, SunKing models are the only models currently in the Essmart catalogue after pulling other models out due to poor customer feedback or challenges with quality or warranty fulfillment. The Panasonic Solar LED Light is a new model that Essmart is interested in considering to introduce to their catalogue. The SolarWay Power Lantern and D.Light S20 were added to the evaluation to gain further insight into consumer preferences for features and qualities.

The goal of this report was to evaluate preferences of consumers in regards to SPL products and more specifically, the suitability of the seven solar lantern products in the Tamil Nadu region. Key product qualities were defined that affect the suitability (technical and cultural) of a product as well as its long-term acceptability and sustainability in a community. Products are often designed and manufactured far from their end users in developed world laboratories, and thus may not capture well the preferences of users in the developing country contexts in which the products are distributed. The research was conducted in a way that was both feasible for Essmart to assist in conducting, and relevant to their current operations and long-term business objectives.

Tamil Nadu, India, is the selected setting for the product evaluation to reflect the market in which Essmart operates. The locations for the surveys were based around four cities in which Essmart maintains distribution centers in the Tamil Nadu region: Anthiyur, Mettupalayam, Pollachi, and Karur.

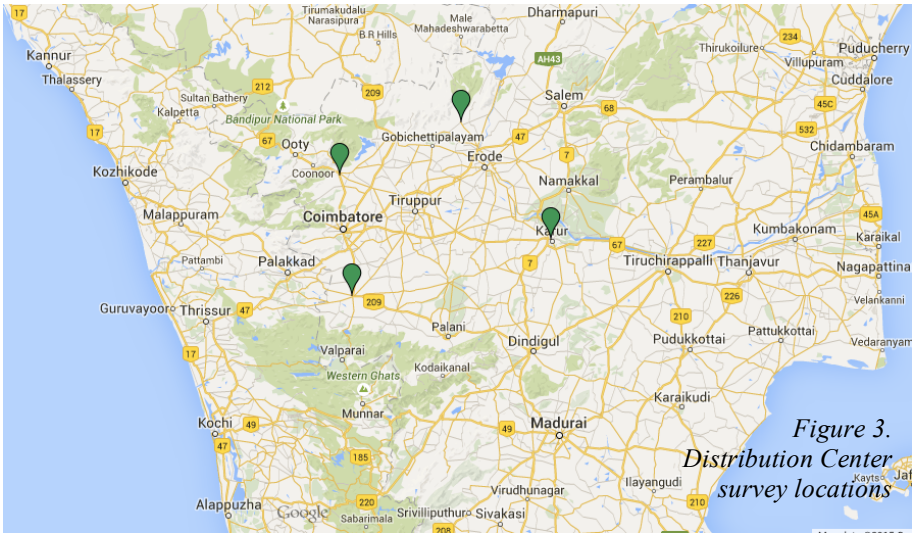


Figure 3. Distribution Center survey locations

In total, 73 surveys were conducted to gain consumer and retailer feedback on SPL features and specific SPL products. Three types of surveys were created for the following stakeholders: (1) Customers, (2) Retailers, and (3) Sales Associates in Essmart Network. The surveys comprised questions about key product qualities, product perception, and overall SPL products. The questions and prompts in the surveys were developed based on literature review, analysis of similar research studies, and in consultation with the Essmart team. The surveys were tested and iterated based on feedback with target stakeholders.

The analysis portion of the report breaks down results for each of the three types of surveys, as well as provides overall results and observations. The findings were compared and contrasted with Essmart sales data to examine correlation between survey findings and actual sales. As Essmart currently only has multiple months of sales data for four SunKing lanterns by Greenlight Planet, sales data was not available for all products.

Challenges & limitations of report

Neutrality among the different products could be a challenge. It can be difficult to obtain reliable information about how products are designed for, and used by, people in Tamil Nadu specifically. As Essmart sells only some of the products surveyed there is the possibility of the familiarity heuristic, wherein the familiar products are favored over the novel. As surveys were conducted with retailers and sales associates of Essmart, they were more familiar with SunKing products than the other products, which may have affected their judgment.

There were several limitations in regards to the interviewees. First, not all interviewees owned solar lanterns and thus needed more descriptions of solar products in order for the survey sections involving product specific review. Overall only 20 of the 73 surveys conducted were conducted with females presenting limited gender disaggregated analysis opportunities. This creates a male bias toward the analysis of the overall product preferences. Unfortunately, due to a fewer number of female customers willing to participate in surveys and the retailers and Essmart Sales Executives being prominently male, this limitation could not be significantly mitigated.

Additional limitations include interviewees not having much time to become comfortable and understand each unique product, therefore, many of the product reviews are based largely off initial observation and reactions to products given their specifications, price, features, and design. This limitation was mitigated by thorough explanations of all features of the product during the survey. Interviewees were allowed ample time to tinker with the products and view the lighting levels and structural features. Regarding product reviews, interviewees ranked specific attributes of two to three SPLs that they were allowed to select. Therefore, not all SPLs received the same number of attribute reviews.

Finally, the language barrier posed as a limitation. While the interviewer was familiar with the local language, Tamil, possible bias and misunderstanding of either questions or answers could have occurred. This was effectively mitigated by language support from accompanying sales associates, who were fluent in Tamil and moderately familiar with English.

Results & Analysis

Results have been organized according to (1) the main uses of an SPL product, (2) the qualities desired in an SPL product, and (3) the overall SPL product rankings (for each individual SPL product). Following these primary results is a review of the respondents' product perceptions and an exploration of gender disaggregated data and findings. Finally, specific product consumer notes are shared as well as a discussion on the current SunKing products in the Essmart catalogue.

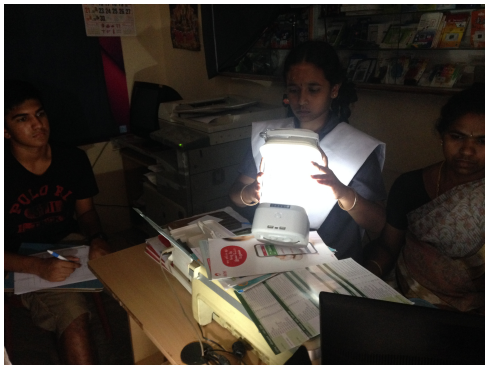


Photo 2. Surveying a female retailer during a power outage

A. Main uses of an SPL product

Overall, SPLs are used most commonly for power outages and housework. 61.6% of respondents use or would use an SPL product for power outages, and 53.4% of respondents use or would use an SPL product for housework. Typically, interviewees use an SPL product for more than one use.

While all three groups had housework and power outages as the top two ranked uses, the results varied slightly between the three groups of interviewees. The customer survey results reveal that the most commonly cited use of an SPL product is for power outages. 65.2% of households of interviewees use or would use an SPL product for power outages. 34.8% use or would use it for housework, and 34.8% use or would use it for studying. The retailer survey results reveal that the most commonly cited use of an SPL product is for power outages or housework. 70.3% of households of interviewees use or would use an SPL product for power outages. 48.15% of households of interviewees use or would use an SPL product for housework. The Sales Associates survey results reveal that the most commonly cited use of an SPL product is for housework or power outages. 78.3% of households of interviewees use or would use it for housework, and 52% of households of interviewees use or would use it for power outages.

Table 1. Uses of solar lantern products

Category	Power outages	Housework	Studying	Income generation
Customers (Sample size: 23)	65.2%	34.8%	34.8%	26.1%
Retailer (Sample size: 27)	70.3%	48.15%	37%	18.5%
Sales associate (Sample size: 23)	52%	78.3%	17.4%	21.7%
Overall (Sample size: 73)	61.6%	53.4%	30.1%	20.5%

B. Qualities desired in an SPL product

Interviewees ranked eight specific qualities that were identified based on general SPL product features and attributes. There was an option to rank 'other' qualities and several interviewees identified and ranked additional qualities that were important to them. Table 2 provides definitions of the selected qualities, while table 3 provides an examination of the rankings by interviewees. Tables 4 and 5 pull out the rankings for women and men, respectively, to explore which qualities may be important for each sex. Overall, battery was ranked as the most important quality in the solar lantern product, with brightness following close behind. The least important qualities in the solar lantern product are the automatic dimming and charge time for the SPL product. Gender-disaggregated results and insights are explored in section E.

Table 2. Definitions of qualities

Quality	Definition
1. Battery	The amount of hours of light per charge
2. Brightness	Level of brightness of the light
3. Solar panel	Whether the solar panel is integrated with or separate from the light
4. Portability	Able to move and carry around the lantern easily (dependent on handle, stand and mount)
5. Charger	Charger for cell phones or other items included in the solar lantern
6. Charge time	Time for the light to fully change
7. Automatic dimming	The light automatically dims once it has been left on for a certain period of time (allows light to last longer on lower levels)
8. Warranty	The light comes with a period of time of warranty, in which consumers can return the product free of charge
9. Others:	-
Durability	Ability to last over time, including through weather challenges and strenuous usage
Service	Small repairs or questions on product and its use provided

Tables 3 - 5. Ranking of qualities (Green is most important, to white being least)

Overall	Average Reported Importance (1 Most - 9 Least)							
Quality	**Sample**	**Customer**	**Sample**	**Retailer**	**Sample**	**Sales Associate**	**Total Sample**	**Combined Average**
1. Battery	20	2.25	27	2.52	22	2.55	**69**	**2.44**
2. Brightness	19	1.89	27	2.89	23	1.70	**69**	**2.16**
3. Solar panel	19	6.47	26	6.42	22	5.36	**67**	**6.09**
4. Portability	20	4.70	25	5.16	22	5.23	**67**	**5.03**
5. Charger	20	5.25	25	4.68	22	5.55	**67**	**5.16**
6. Charge time	20	6.55	25	6.24	22	5.82	**67**	**6.20**
7. Automatic dimming	19	7.68	24	7.63	22	7.86	**65**	**7.72**
8. Warranty	20	3.40	26	4.69	22	4.36	**68**	**4.15**
9. Others:								
Durability	4	2.75	4	2.75	0		**8**	**2.75**
Service	3	7.33	12	4.67	7	5.86	**22**	**5.95**

Females Only	Average Reported Importance (1 Most - 9 Least)							
Quality	**Sample**	**Customer**	**Sample**	**Retailer**	**Sample**	**Sales Associate**	**Total Sample**	**Combined Average**
1. Battery	7	2.57	8	2.63	4	3.75	**19**	**2.98 (2)**
2. Brightness	7	1.71	8	2.25	4	1.75	**19**	**1.90 (1)**
3. Solar panel	6	6.50	7	5.43	4	5.00	**17**	**5.64 (6)**
4. Portability	7	5.14	7	4.00	4	5.50	**18**	**4.88 (5)**
5. Charger	7	5.00	7	3.29	4	5.00	**18**	**4.43 (4)**
6. Charge time	7	7.14	7	6.86	4	6.25	**18**	**6.75 (7)**
7. Automatic dimming	6	7.67	7	8.00	4	7.75	**17**	**7.81 (8)**
8. Warranty	7	4.43	7	4.86	4	3.25	**18**	**4.18 (3)**
9. Others:								
Durability	2	3.00	1	3.00	0		**3**	**3.00**

Service	0		4	7.50	2	7.50	**6**	**7.50**

Males Only	Average Reported Importance (1 Most - 9 Least)							
Quality	**Sample**	**Customer**	**Sample**	**Retailer**	**Sample**	**Sales Associate**	**Total Sample**	**Combined Average**
1. Battery	13	2.08	19	2.47	4	2.28	**36**	**2.28 (1)**
2. Brightness	12	2.00	19	3.16	4	1.68	**35**	**2.28 (1)**
3. Solar panel	13	6.46	19	6.79	4	5.44	**36**	**6.23 (7)**
4. Portability	13	4.46	18	5.61	4	5.17	**35**	**5.08 (4)**
5. Charger	13	5.38	18	5.22	4	5.67	**35**	**5.42 (5)**
6. Charge time	13	6.23	18	6.00	4	5.72	**35**	**5.98 (6)**
7. Automatic dimming	13	7.69	17	7.47	4	7.89	**34**	**7.68 (8)**
8. Warranty	13	2.85	19	4.63	4	4.61	**36**	**4.03 (3)**
9. Others:								
Durability	2	2.50	3	2.67	0		**5**	**2.58**
Service	3	7.33	8	3.25	5	5.20	**16**	**5.26**

C. SPL product findings

Interviewees were also asked to rank the seven products overall on a scale from 1 to 5 based on a reaction to price, design, and observable features and qualities. Customer and Sales Associate groups rated the SunKing Pro2 and SunKing all Night the highest, with average overall ratings of 4.59 and 4.56, respectively. However, retailers ranked the Solar Way Pro Lantern at 4.8, slightly higher than they ranked the SunKing Pro2 and SunKing All Night. The SolarWay Pro Lantern was the favorite product of the retailers due to its design and additional features (such as having a radio). It was a popular product for the Customers as well, again due to its design and additional features. The SunKing Eco was the lowest overall ranked product at 3.57, followed by the Panasonic Solar Light at 3.77.

The main reason cited for a favorite product was the brightness, while the design was also an important factor. The lack of brightness was cited as the main reason for a low ranking. Brightness as the main reason cited for both the lowest ranking and highest ranking is aligned with the ranking of brightness as one of the most important qualities in a SPL product among interviewees. Price for value was another reason for not liking a product. This was cited as a reason for the low ranking of the SunKing Eco several times and although it was one of the cheapest products in the product basket, customers did not perceive its value to match the price.

The following chart illustrates the specifications, qualities, and overall rankings as well as specific attribute rankings of each SPL product. The sample size of the SPL product attribute ranking is low for several products as interviewees were allowed to select which two to three products they ranked. The majority of people chose to rank the three most highly rated SPL products - the SunKing Pro2, SunKing All Night, and the Solar Way Pro Lantern. For more information on sample sizes and specific numbers of SPL attribute rankings, including differentiated by gender, see Appendix 1.

Product information							Other			
Make/model	Overall score	Price (INR)	Battery (hours at high setting)	Charge time (hours)	Brightness (lumens)	Design/ portability	Warranty (years)	Solar panel integrated (Y/N)	Water resistant (Y/N)	Lifespan (years)
SunKing Pro2	4.6	2300	6	12	150	Portable; mountable stand; strap handle	1	N	Y	5
SunKing All Night	4.564	1800	7	12	110	Portable; mountable stand; strap handle	1	N	Y	5
SunKing Mobile	3.99	1500	5	12	75	Portable; mountable stand; strap handle	1	N	Y	5
SunKing Eco	3.564	650	4	12	25	Portable; mountable stand; strap handle	1	N	Y	5
SolarWay Power Lantern	4.309	2600		8	165	Handle; removable top; hook for hanging	1	N	Y	
D.Light S20	3.89	645	4	8	25	Lantern; wall mountable	2	Y	Y	
Panasonic	3.798	1499	6			Handle/stand; mountable	2	N	Y	<5

	Consumer Scores					Features
Make/model	Value	Brightness	Finish/build quality	Design (appearance /shape)	Ease of use	
SunKing Pro2	◑	◕	◕	◕	●	
SunKing All Night	◑	◕	●	●	◕	
SunKing Mobile	◔	◕	◕	◕	●	
SunKing Eco	◔	◑	●	◕	●	
SolarWay Power Lantern	◑	◑	◕	◕	◕	
D.Light S20	◔	○	◑	◑	●	
Panasonic	○	◑	◕	◕	●	

Features	
Battery level indicator:	Device notifies user of battery life
Batter charge indicator:	Device notifies user that the battery is receiving a charge
Device charges from AC:	Device not only charges from sun, but also AC power
Mobile phone charger:	Device includes the ability to charge mobile phones

Legend			
Outstanding	●	Battery level indicator	
Very good	◕	Battery charge indicator	
Average	◑	Device charge from AC	
Marginal	◔	Mobile phone charger	
Poor	○		

D. Product user perceptions

Photo 3. Surveying a female SPL consumer

The survey contained an open-ended question regarding what type of person would use each of the products. Interviewees largely responded through either noting a product as for people of low, middle or high class. The results reveal that survey respondents perceived people of low class using the SunKing Eco and D.Light. The SunKing Mobile, SunKing All Night, SunKing Pro 2, and Panasonic were perceived to be used by people of middle class mainly, as well as some of low class. Finally, the Solar Way Power Lantern was believed to be used by people of high-class largely.

The results also noted that students were perceived to be the main demographic that would use the SunKing Eco and SunKing Mobile. These smaller lights are not very bright but are considered adequate for studying. Farmers were perceived to be the main demographic that would use the Solar Way Power Lantern, Panasonic and D. Light. Each of these SPL products has a handle making them easy to carry. The radio on the Solar Way Power Lantern was attractive for potential farmer customers in particular. Several interviewees noted that this is a desired feature farmers in the field. Finally, storekeepers were perceived to be the main demographic that would use the SunKing Pro2 and SunKing All Night, followed closely by students and farmers. These products are generally considered multi-purpose by interviewees.

E. Gendered makeup of interviewees and gender-specific results

In India, men are often responsible for making household expenditure decisions such as purchasing of solar lanterns, while women play an insignificant role through the decision process. However, there are regional variations and in South India, including Tamil Nadu, women tend to have more decision making power than their counterparts in northern states.[7] The following table illustrates the number of interviewees that were male and female in the different categories.

Table 6. Gendered makeup of interviewees

Category	Women	Men
Customer (Sample size: 23)	34.8%	65.2%
Retailer (Sample size: 27)	29.6%	70.4%
Sales associate (Sample size: 23)	17.4%	82.6%
Overall (Sample size: 73)	27.4%	72.6%

Women are the main users of solar lantern products as revealed in the surveys. Overall, 65.7% of respondents cited women as using the solar lanterns. Of the customer survey respondents, 65.2% cite women as a primary or would-be primary users of a solar lantern. Of the retailer survey respondents, 48.15% cited women as the primary or would-be primary users. Of the sales associates respondents, 87% cited women as the users or would-be users of the solar lanterns.

Men and women rank product qualities similarly, as can be seen in Tables 4 and 5 of section B. The main difference is that women ranked brightness as the most important quality before battery as the second most important quality, whereas men ranked brightness and battery as equally the most important qualities. In addition, for women, having a charger for cell phones or other items was ranked as more important (4th) than the amount it takes for the solar lantern to charge (5th), where as for men, those two ranking were swapped respectively (5th for a charger, 4th for charge time).

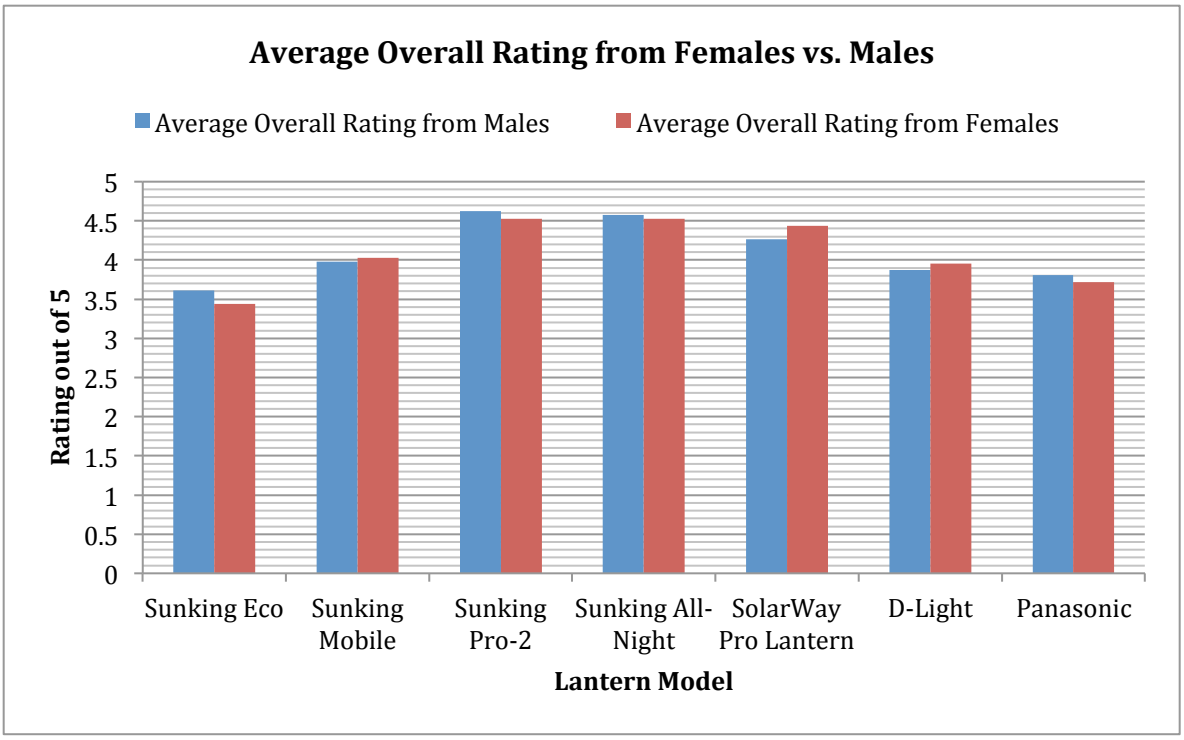
Table 7. Main users of a solar lantern product

Category	Woman/wife	Man/husband	Child
Customer (Sample size: 23)	65.2%	26.1%	34.8%
Retailer (Sample size: 27)	48.15%	29.6%	22.2%
Sales associate (Sample size: 23)	87%	17.4%	8.7%
Overall (Sample size: 73)	65.7%	20.5%	17.8%

The surveys revealed that men tend to use solar lanterns in case of power outage much more than any other activity. Only one respondent reported that men use the SPL product for housework and several other respondents said men also use it for income generating activities. This can include lighting up one's shop if one owns a local retail shop or tending to the farm, for example. Women primarily use solar lanterns for housework and in case of power outages.

As can be seen in Table 3, women and men had similar rankings for the different products, with small variances. The preferred product for women was tied at the SunKing Pro2 and SunKing All Night, while men had a very slight preference for the SunKing Pro2.

Chart 2. Average Overall Rating from Females vs. Males



F. Specific product notes and consumer desires

There were several recommendations for solar lanterns that were found from observations, surveys, and discussions with stakeholders. The following are design suggestions for the SunKing products currently in the Essmart catalogue:

1. Enhance accessibility to power switch: Various consumers who purchase the SunKing products, particularly the larger SunKing All Night and/or SunKing Pro2 models, would put the lights on their ceilings in their homes or in stores. The panel would be plugged into the solar light and on top of the house or shop. However, the switch to turn on the light is directly on the back of the solar light, which can make it challenging to turn on and off. It is recommended that products provide switches that can move, perhaps to be lower down on the cords that connect the solar panels and the light, in order for consumers to turn the products on and off at a manageable height.
2. Include Headlight strap: Torchlights and headlamps are popular items in Tamil Nadu. This is particularly true for farmers or others who walk around at night. If the SunKing products could have a removable strap that would allow them to go around the head, this would be of interest to certain consumers and allow for greater variability of the use of the product.

Consumers were also interested in the following characteristics generally in a solar lantern:

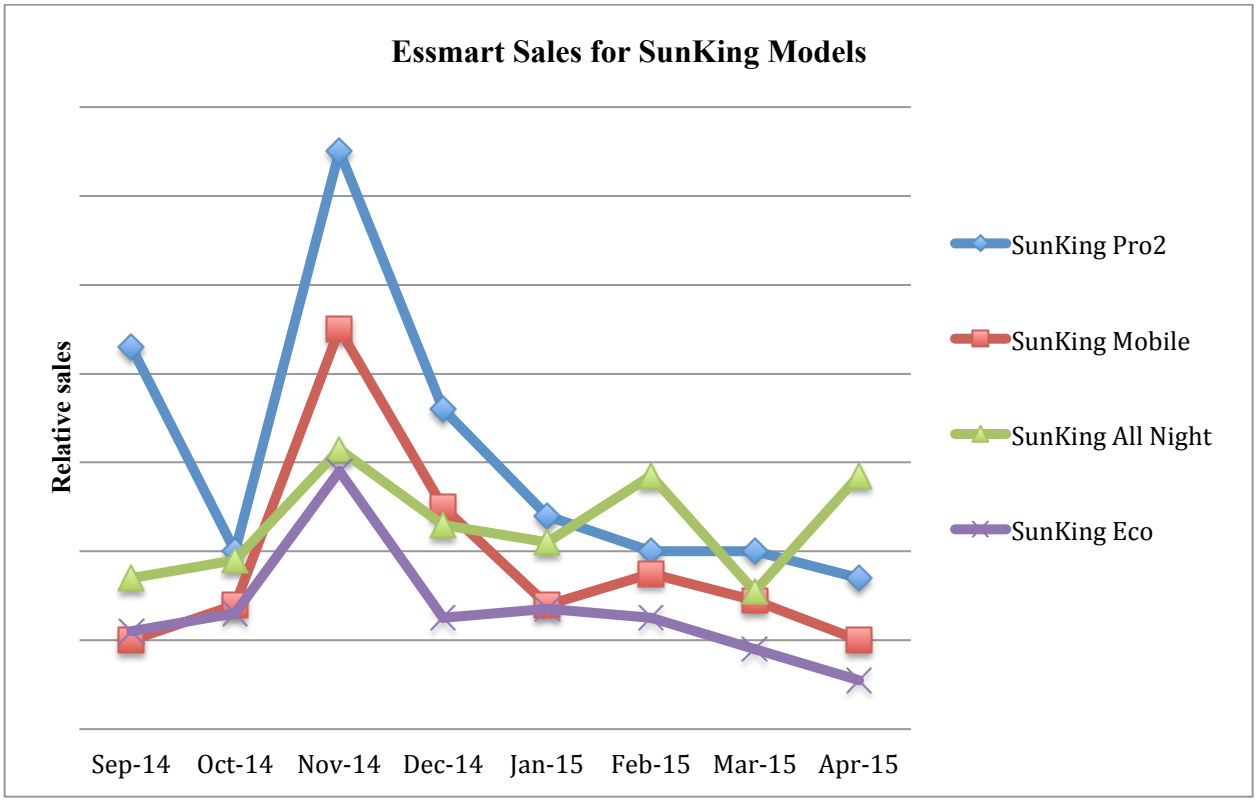
1. Whiteness of light: There is a preference for light that is whiter (perceived as having higher clarity), as opposed to the yellow-tinted light. However, important to note, is that light with a yellowish tint can help filter blue light, which research has shown to cause toxicity to cellular structures in the retina and increase potential for oxidative damage.[22]
2. Cost: Cost is the most important issue observed as a barrier for greater sale and penetration of solar lanterns. The Chinese-made torchlights, which cost approximately INR 250, are very popular, yet of very low quality and unreliable. These torchlights break every couple of months, thus consumers return to purchase another one. High cost was often discussed among consumers and retailers as being a barrier for purchase.
3. Kerosene lantern design: There was interest in the D.Light due to its similarity in appearance to a kerosene lantern. Several interviewees noted that this made the product more acceptable and had higher ease of use due to its design.

G. Discussion on SunKing products in the Essmart catalogue

As discussed previously, Essmart currently has only the four SunKing models in their catalogue. The SunKing Pro2 has the highest number of sales overall in the Essmart catalogue since entering the catalogue in 2013. Since September 2014 when the SunKing All Night joined the other three SunKing models in the catalogue, the SunKing Pro2 has had the greatest number of sales, followed by the SunKing All Night, then the SunKing Mobile, and finally the SunKing Eco as can be seen in the below chart.[23]

[22] Grimm, C. (2001). Rhodopsin-Mediated Blue-Light Dam age to the rat Retina: Effect of Photoreversal of Bleaching. *Invest Ophthalmol Vis Sci*, 42(2):497-50.

[23] Relative, as opposed to actual, sales data shared in order to maintain confidentiality.



The sales numbers correlate with the overall rankings for products. The SunKing Pro2 is the preferred product according to interviewees, followed by the All Night, then the Mobile, and finally the Eco.

Despite being the most expensive product, the SunKing Pro2 remains the most bought as well as the highest ranked (along with the SunKing All Night). Therefore, while the price of a product is an important factor and often a barrier in the purchase of SPL products, sales data shows that customers are more interested in a higher quality SPLs and willing to accept higher prices if they feel the quality of the SPL product's qualities and features match the price.

Research gaps

This report delves into initial consumer feedback through surveys of Customers, Retailers and Sales Associates. Conducting additional surveys and research on the different products in the lives of users through allowing consumer to use the products for a trial period of several weeks, for example, would be of great value and can provide for more accurate results.

The low number of surveys completed by females limits the gender disaggregated data and analysis opportunities. Further research could benefit from increasing the number of surveys completed by women. In addition, if products are to be provided to consumers for several weeks as a testing process, this research would consider interviewing women separately than men (including in separate locations), in order to avoid any bias that results from conducting surveys with women in front of their husbands or other friends or family members.

Lessons learned

The primary findings and lessons learned are as follows:

1. Brightness and battery are the key qualities that consumers prefer in an SPL product and upon initially deciding if one likes the product, a consumer will evaluate its brightness.
2. Women prefer battery before brightness, whereas men equally rank battery and brightness as the most important qualities in an SPL product. Understanding this can help retailers' market products more effectively to women and men.
3. The main uses of an SPL product are for power outages, followed by housework. 61.6% of respondents use or would use a solar lantern product for power outages, and 53.4% of respondents use or would use a solar lantern product for housework. Typically, interviewees use an SPL product for more than one use.
4. Given the energy access situation and electrification rates in Tamil Nadu, it makes sense that SPL products are used mainly for power outages. Due to power outages being common and the lack of kerosene subsidies now for electrified homes, SPL products are attractive. States throughout India face challenges with electricity connection and power outages, some more than others. Despite demographic differences in Tamil Nadu in comparison to other states in India, findings in this report are still useful in understanding consumer preferences for SPLs and SPL uses throughout India, particularly in states that suffer from similar electrification challenges.
5. The main users of an SPL product are women. Overall, 65.7% of respondents cited women as using the solar lanterns, while 20.5% cited men as using the solar lanterns, and 17.8% cited children as using the solar lanterns. For women in particular, who use the SPL products primarily for housework, battery is the most important quality. While men may often control household income, women still have a large voice in decision making for purchases. Gendered marketing strategies focused on women versus men can present greater opportunities for sales.
6. The preferred products are SunKing All Night and SunKing Pro2. The primary cited reason for liking this product most of all was its brightness.
7. The least preferred products are the SunKing Eco and D.Light S20. The primary cited reasons for this were lack of brightness, as well as price for value. This, coupled with Essmart sales data, reveals that customers are interested in and willing to pay for products that are of high quality. However, for lower quality SPL products that are priced higher than other lower quality lights in the market, consumers may be less willing to buy and perceive their prices to be too high to match their value.
8. The SunKing Eco, SunKing Mobile and D.Light were perceived to be used by people of low class. This may have contributed to their unpopularity. This is in contrast to the other products, which were perceived to be used by people of middle and high class. This confirms the hypothesis that aspirational products may be more popular and desired by customers in the BoP.
9. Women and men had the same rankings for the seven products.
10. Essmart sales data of the SunKing products correlates directly with their rankings. This supports the findings of the research.

Conclusion

India's demand for energy continues to grow, and the government is increasingly promoting clean energy solutions to meet demand. India's rural BoP population of 114 million households is a significant consumer market for energy services and products, at an estimated US$4.86 billion market per year. In Indian states where electrification rates are high, such as Tamil Nadu, access to the grid presents a potential barrier to SPL product demand. However, the frequent power outages support a market opportunity, particularly when combined with the recent lack of kerosene subsidies for electrified areas. This research revealed that power outages were the most common use of SPL products, followed by housework. Greater marketing and awareness-raising activities can support an enhanced demand for SPL products.

Consumers in the Tamil Nadu region value products of a higher quality, which is reflected in their preferences as well as in sales data for the SunKing All Night and SunKing Pro2 lanterns. The most important qualities in a SPL product are the battery life and brightness, thus these qualities should be emphasized in any marketing materials and sales pitches. Cheaper SPL products are unattractive to consumers in Tamil Nadu, particularly as they associate these products with those of the lower classes.

Initiatives seeking to distribute or sell SPL products in southern India should understand the preferences of qualities and products among consumers. Based on the findings from this report, the SunKing Pro2 and SunKing All Night should continue to be the primary solar lantern sellers. The SolarWay Power Lantern was also a popular lantern in the research and should be considered as a competitive alternative. Marketing products for their high quality, with an emphasis on battery life and brightness in particular, can have strong potential adoption results. Given the desire for these higher quality products and their prices, it is recommended that distribution companies seek to provide financial options to support consumers and/or suppliers. Results in this report can be applicable to other states in India as well. In states with similar electrification challenges, results surrounding what SPL products are used for and preferences of qualities in an SPL product in particular may be representative.

Ultimately, there appears to be a good market for SPL products in electrified regions of developing countries as primarily back up items in cases of power outages. Given the frequent power outages and outlook that this will continue in combination with the eliminated kerosene subsidy, there is great opportunity to enhance the sales and distribution of SPL products in India. Recommended next steps in supporting a stronger SPL market are enhanced marketing to increase awareness of SPL products particularly for power outages, as well as affordability options through offering supplier or consumer finance has great potential.

Appendix

Appendix 1. *Table 1. SPL Product Reviews*

	Average Reported Perception (1:Bad - 5:Great)							
Lantern	Sample	**Customer**	Sample	**Retailer**	Sample	**Sales Associate**	Total Sample	**Combined Average**
SunKing Eco:								
A. Value	5	3.20	2	3.50	6	4.67	**13**	**3.79**
B. Brightness	5	4.00	2	4.00	6	4.17	**13**	**4.06**
C. Finish/build quality	5	5.00	2	5.00	6	4.67	**13**	**4.89**
D. Design (appearance/shape)	5	4.80	2	4.50	6	4.33	**13**	**4.54**
E. Durability	2	4.00	2	5.00	6	4.33	**10**	**4.44**
F. Ease of use	4	4.75	0		3	5.00	**7**	**4.88**
SunKing Mobile:								
A. Value	4	4.00	3	3.33	4	3.75	**11**	**3.69**
B. Brightness	4	4.75	3	4.00	4	4.25	**11**	**4.33**
C. Finish/build quality	4	5.00	3	4.33	4	4.25	**11**	**4.53**
D. Design (appearance/shape)	4	4.75	3	4.33	4	4.25	**11**	**4.44**
E. Durability	0		3	4.67	4	4.25	**7**	**4.46**
F. Ease of use	4	5.00	0		1	5.00	**5**	**5.00**
SunKing Pro2:								
A. Value	8	4.13	13	4.15	17	4.15	**38**	**4.14**
B. Brightness	8	4.75	13	4.38	17	4.65	**38**	**4.59**
C. Finish/build quality	8	4.63	13	4.54	17	4.82	**38**	**4.66**
D. Design (appearance/shape)	8	4.50	13	4.15	17	4.65	**38**	**4.43**
E. Durability	5	4.80	11	4.82	17	4.59	**33**	**4.74**
F. Ease of use	5	5.00	6	4.83	7	4.57	**18**	**4.80**
Sun King All Night:								
A. Value	2	3.50	11	4.18	17	4.47	**30**	**4.05**
B. Brightness	2	5.00	11	4.14	17	4.53	**30**	**4.56**
C. Finish/build quality	2	5.00	11	5.00	17	4.71	**30**	**4.90**
D. Design (appearance/shape)	2	5.00	11	4.59	17	4.59	**30**	**4.73**
E. Durability	2	4.00	9	4.78	17	4.44	**28**	**4.41**
F. Ease of use	0		7	4.64	6	4.67	**13**	**4.65**
Solar Way Pro Lantern:								
A. Value	14	4.21	13	4.38	12	3.92	**39**	**4.17**
B. Brightness	14	4.50	13	4.50	12	3.88	**39**	**4.29**

C. Finish/build quality	14	4.71	13	4.50	12	3.92	**39**	**4.38**
D. Design (appearance/shape)	14	4.64	13	4.58	12	4.63	**39**	**4.61**
E. Durability	2	4.50	1	4.00	3	3.67	**6**	**4.06**
F. Ease of use	12	4.83	13	4.42	9	4.44	**34**	**4.57**
D. Light:								
A. Value	8	3.56	5	3.90	5	3.60	**18**	**3.69**
B. Brightness	7	3.29	5	3.80	4	3.50	**16**	**3.53**
C. Finish/build quality	7	4.43	5	4.40	4	3.75	**16**	**4.19**
D. Design (appearance/shape)	7	4.50	5	3.80	4	3.75	**16**	**4.02**
E. Durability	0		0		1	3.00	**1**	**3.00**
F. Ease of use	7	5.00	5	5.00	4	5.00	**16**	**5.00**
Panasonic:								
A. Value	5	3.10	7	3.21	9	3.61	**21**	**3.31**
B. Brightness	4	3.75	7	4.43	8	4.00	**19**	**4.06**
C. Finish/build quality	4	4.25	7	4.64	8	4.75	**19**	**4.55**
D. Design (appearance/shape)	4	4.00	7	4.64	8	4.75	**19**	**4.46**
E. Durability	1	2.00	0		4	3.75	**5**	**2.88**
F. Ease of use	3	5.00	7	4.86	4	4.75	**14**	**4.87**