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Turning on the Lights: Transcending Energy Poverty Through The Power of Women Entrepreneurs

Leslie Gray

Alaina Boyle

Victoria Yu

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Miller Center
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TURNING ON THE LIGHTS:

Transcending Energy Poverty Through the
Power of Women Entrepreneurs



Photo credit: Santa Clara University @ yvundi.

By Leslie Gray, PhD, Alaina Boyle and Victoria Yu

EXECUTIVE SUMMARY

Solar lanterns offer affordable, high-quality lighting in developing countries. A number of organizations, including social enterprises, make solar lanterns available to rural households as an alternative to candles or kerosene lamps. One of the most successful of these organizations is Solar Sister.

Solar Sister, a social enterprise operating in Tanzania, Uganda, and Nigeria, is dedicated to eradicating energy poverty through the economic empowerment of women. In addition to economically empowering its women entrepreneurs, the business model of Solar Sister also cultivates sales networks built on trust in last-mile distribution methods.

While Solar Sister has previously conducted research regarding its many entrepreneurs, it has lacked information on its end customers. In 2016 a research team from Santa Clara University's Miller Center for Social Entrepreneurship undertook survey research with Solar Sister to examine the effects of solar lantern use on users' health, education, time allocation, household savings, income generation, and increased agency. The research team conducted a 53-question survey in more than 20 villages across five regions in Tanzania, with research assistants providing English-Swahili translation.

The survey's findings demonstrate that solar lanterns' effects on end users are far more comprehensive and far-reaching than providing light. With solar lanterns, students have a reliable, bright light to use for their studies and show significant improvement in their education. Families are relieved of the damaging health effects from kerosene and no longer risk burns and home fires from kerosene lamps. Households experience financial benefits by ceasing the use of costly kerosene, growing existing businesses, and starting new businesses. Further, individuals have more time in their day due to increased lighting hours and elimination of travel time to obtain kerosene. Some solar lanterns do more than provide light: They can also charge cell phones. And all these benefits combine to create intrinsic changes in individuals' sense of agency and power.

The data and stories presented here are intended to help illuminate the potential of solar lanterns to improve livelihoods in rural Tanzania and beyond.





MEET ESIANKIKI

Esiankiki Gift is a 50-year-old Maasai woman from Eslalei, a rural Tanzanian village without electricity. She never attended school, currently lives in a mud house, and supports her family of 10 by selling milk, handmade jewelry, tea leaves, and sugar. Previously she used a kerosene lamp for lighting and had to walk three hours round trip each week to purchase fuel from the nearest provider. However, Esiankiki recently purchased a solar lantern to replace her kerosene lamp. Her new solar lantern provides brighter lighting and allows her to stop buying expensive fuel. She now enjoys an additional two hours of lighting at night that she uses for business activities and household duties. The profit from her jewelry business has doubled because better lighting quality allows her to increase the amount of time she spends working. The time she spends milking her cows has also tripled, helping her rise from a break-even weekly income stream to a weekly profit of 15,000 TZS, equivalent to about \$7 USD.

Esiankiki is not the only woman whose economic life has been transformed by solar-powered light. According to another solar lantern user from Tanga,



“Everything inside the house changes [because of solar lanterns]. If the mom wants to cook, she can. If the kids want to study, they can. If [her husband] wants to draw at night, he can.”

The simple provision of safe, affordable light can transform lives by providing an extended work day, new opportunities, and economic relief to rural households.

Introduction

More than 1.2 billion people in the world lack access to electricity, and 95% of these people live in Asia or sub-Saharan African countries.¹ In Tanzania, most citizens reside in rural locations where rugged terrain, extreme poverty, and a lack of infrastructure challenge electrification efforts.² Only 7% of rural Tanzania has access to electricity, leaving people to resort to kerosene as their primary source of lighting.³

Kerosene use, though, has many negative side effects that include poor lighting quality, health hazards, and high cost.⁴ Therefore, where electricity is not accessible, solar-powered lanterns provide an alternative to kerosene that can deliver high-quality lighting as well as financial, health, and education benefits. Small-scale solar lantern technology shows promise in sub-Saharan Africa, where prices for solar lanterns are dropping and the number of people who use solar lighting has grown 4% since 2009.⁵

In summer 2016, a research team from Santa Clara University's Miller Center for Social Entrepreneurship conducted survey research in Tanzania with Solar Sister, a social enterprise that aims to provide a reliable lighting source to rural communities and also is dedicated to the economic empowerment of women.

In the past, Solar Sister has evaluated its impact on its network of women-centered direct sales entrepreneurs (known as Solar Sister Entrepreneurs, or SSEs). The Miller Center research takes a different tack, examining Solar Sister's impact on its end customers, particularly the effects of small-scale solar lanterns on users' health, education, time allocation, income generation, and economic empowerment and agency. The research demonstrates the particular importance of studying solar lighting in the context of its impact by looking at differences between male and female respondents, and between Solar Sister Entrepreneurs and their customers.

While this project specifically investigates Solar Sister's impact on rural customers in Tanzania, the findings will be relevant to different renewable energy social enterprises in a variety of locations. Although markets vary from country to country, the research results reveal the depth and breadth of social impact achievable by solar-based social enterprises, and they suggest that the future potential of solar lighting is still largely untapped.



About the Research

In July and August of 2016, a research team from Santa Clara University's Miller Center for Social Entrepreneurship implemented a 53-question survey (see Appendix) to learn about rural household uses of solar lanterns and their impact on users' productivity, education, health, economic opportunity, and women's economic empowerment and agency.

The team surveyed 257 Solar Sister customers and entrepreneurs in more than 20 villages in the Babati, Kilimanjaro, Arusha, Karatu, and Tanga regions of Tanzania. The research team worked with Solar Sister Business Development Associates to choose the villages, then undertook a convenience sample (i.e., participants chosen for their availability) of solar lantern users. Local Solar Sister Entrepreneurs recruited solar lantern customers to participate.

The interviews generally took place in either a village public area such as a church or community building or in a private area outside an entrepreneur's home. Interviewees were informed of risks and benefits of participation (human subjects protection guidelines) and told that they could refuse to answer questions and withdraw from the survey at any point.

The Santa Clara University team worked with Tanzanian research assistants to translate the survey into Swahili. Questions were asked and answered in Swahili, and answers were translated into English. The interview teams generally consisted of a Santa Clara University researcher and a Tanzanian researcher or Solar Sister employee who acted as translator, but during the last part of the research, the Tanzanian research assistants also conducted survey interviews.

In the survey sample, 49 respondents were men and 208 were women; 27 were SSEs and 230 were solar lantern users; and 29 individuals were on-grid energy users, meaning their solar system was connected to a local utility's system, while 228 were off-grid users, not connected to a utility company. The results presented here excluded on-grid respondents because many of the central questions were not applicable to them. While the researchers recognized the significant impact of solar lanterns for on-grid participants, the focus of this research was on solar lantern usage among rural off-grid households.

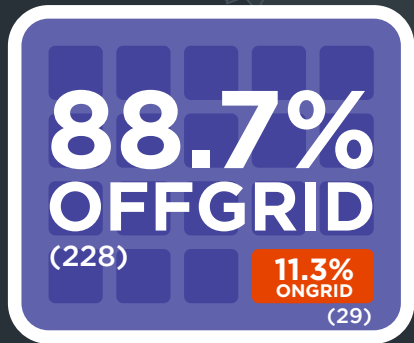
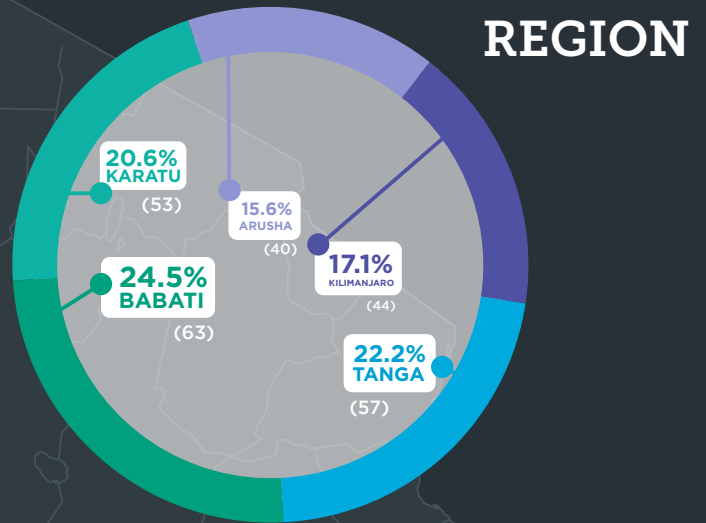
The survey research assessed the impact of solar lanterns among the survey participants in the following areas:

- Education
- Health
- Productivity
- Finances
- Women's economic and social empowerment

The researchers also asked respondents why they chose Solar Sister as their solar lantern supplier, as a way to explore the effects of Solar Sister's business model on customers' purchase decisions.



PARTICIPANT DEMOGRAPHICS



INTERVIEW TYPE



Why Did Customers Choose Solar Sister?

Solar Sister is a social enterprise with a mission to eradicate energy poverty by activating women's social networks to bring clean energy to remote communities. Solar Sister delivers a range of clean energy technologies such as solar-powered lanterns, solar lanterns that can charge mobile phones, and clean cookstoves to remote communities across sub-Saharan Africa. Its social enterprise model of women-run direct sales networks enables women to become entrepreneurs and to generate incomes.

Local management staff of Solar Sister work with **Business Development Associates** (BDAs) who

recruit and train local **Solar Sister Entrepreneurs** (SSEs) to sell solar lights and cookstoves as a way to build "trust networks" of friends, family, and neighbors. The creation and deepening of women-to-women networks and the conscious cultivation of trust networks are essential to Solar Sister's entrepreneurial strategy. Thus, Solar Sister creates social value in multiple ways: through selling distributed energy products that allow customers to address their energy poverty; by training women to become SSEs, which provides them livelihoods; and by enabling some customers to enhance or develop their own household enterprises.

Miller Center for Social Entrepreneurship's 2016 research builds on an evaluation project conducted last summer by the International Center for Research on Women (ICRW), which conducted a qualitative assessment of how being a Solar Sister Entrepreneur impacts the livelihoods of women and men in rural Tanzania.⁷ While ICRW's project focused on the qualitative impacts of clean energy technology on entrepreneurs, Miller Center's research project represents a quantitative study of the social, economic, and health benefits of solar lantern use.

An important dimension of Solar Sister's mission is the creation of trust-based social networks. Building trust between sales associates and customers, or a trust network, is essential in business, especially in last-mile distribution enterprises where an organization is trying to market a new product to rural communities.⁸

To explore how Solar Sister accomplished trust networks, the survey asked customers why they chose to purchase their lanterns from Solar Sister. The majority of participants identified personal relationships as Solar Sister's primary

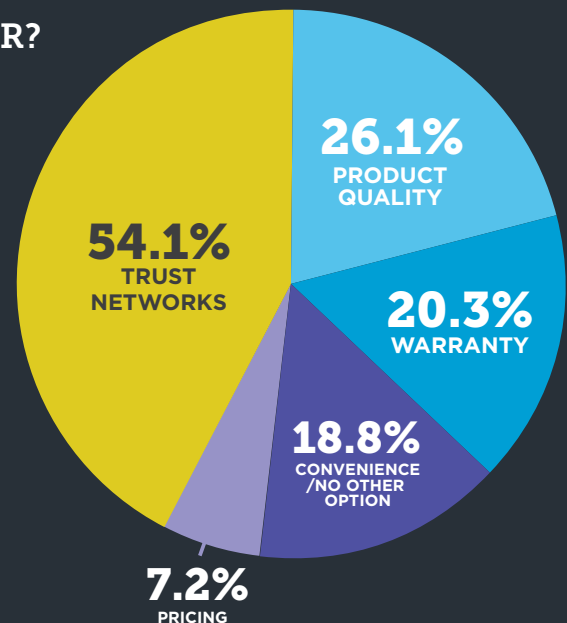
differentiating factor from other companies, including knowing someone involved with the organization, and/or receiving some form of training on solar lanterns and their benefits.

This finding implies that local sales agents prove more effective in communicating with customers and introducing new products. By understanding prospective customers' way of life, using the products themselves, and often already knowing them personally as friends or neighbors, Solar Sister Entrepreneurs report that they are able to gain the trust of community members and convince them to accept a new product.

The survey also asked participants what they liked best about their solar lanterns. Regardless of gender and interview type, respondents commented that their favorite features about the lanterns were brightness, portability, durability, and financial savings from no longer buying kerosene. When asked about what to improve, people asked for a bigger lantern or solar system, lower or credit-based prices, the capability to charge the lantern on cloudy days, and brighter, more sustained light.

WHY DID YOU PURCHASE FROM SOLAR SISTER?

-  1. TRUST NETWORKS
-  2. PRODUCT QUALITY
-  3. WARRANTY
-  4. CONVENIENCE/NO OTHER OPTION
-  5. PRICING



Solar Lantern Uses: More Than Just Lighting

Solar lanterns not only bring light into a home, they can revolutionize what is possible to do at home past dark. Beyond universal uses for daily activities such as eating dinner or changing clothes, the Miller Center survey found that men, women, and children use solar lanterns in different ways, reflecting the greater society's norms of gender- and age-related behavior.

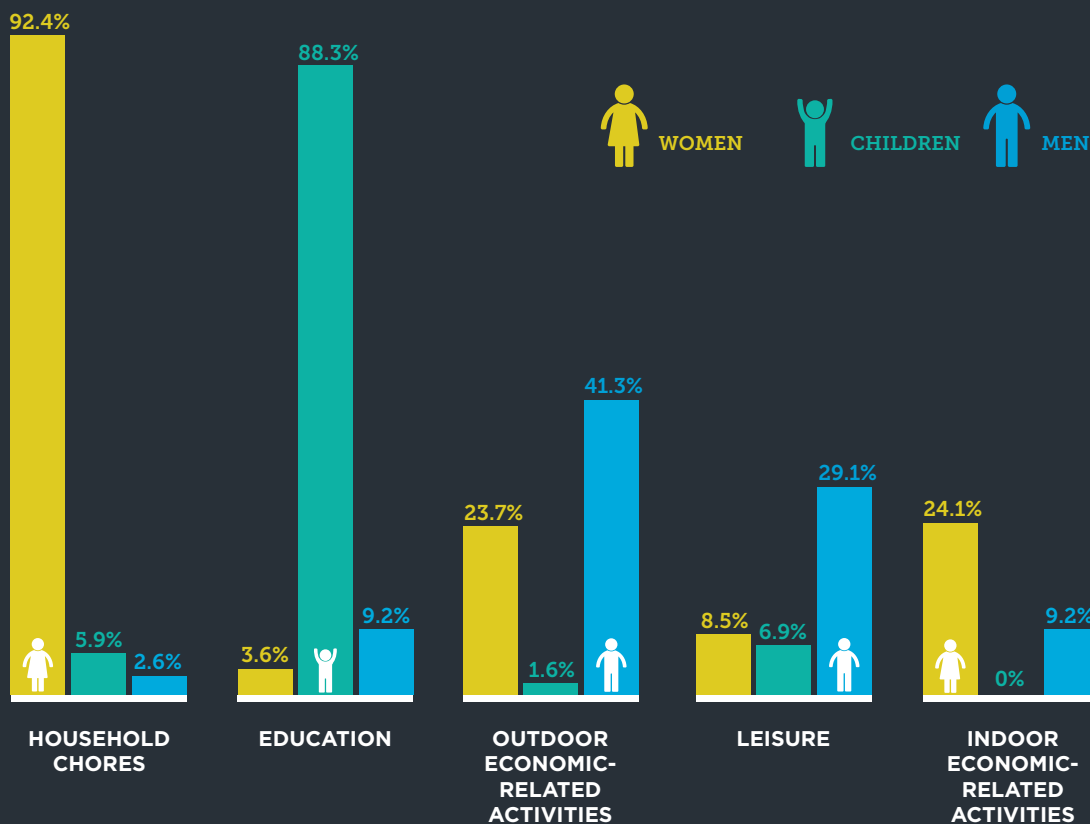
Children overwhelmingly use lanterns for reading or studying, with 88.3% of families reporting this use. Men tend to use solar lighting for leisure (e.g., chatting, reading magazines, visiting neighbors, etc.) and outdoor economic activities (e.g., milking cows, irrigating crops), while women tend to use solar lanterns for household chores (e.g., cooking, cleaning, washing dishes, doing laundry) and indoor economic activities (e.g., basket-weaving, chapati-cooking, jewelry-making).

The leisure and household chore differences are especially striking, with 3.4 times as many men as women using solar lanterns for leisure, and over 35 times as many women as men using solar lighting for household chores. An overwhelming 92.4% of women use solar lanterns for household chores compared to only 2.6% of men. Women in Tanzania spend an average of less than two hours each day engaging in leisure activities⁹, but it is unclear whether having solar lighting extends their leisure time or actually reduces it due to more potential productive hours.



Photo credit: Santa Clara University, Solar Sister

SOLAR LANTERN USAGE AMONG MEN, WOMEN, AND CHILDREN



WHAT DO YOU AND/OR SOMEONE IN YOUR HOUSEHOLD DO AT NIGHT USING A SOLAR LANTERN THAT YOU COULD NOT DO BEFORE?

- “Fetch water at night.”
- “Solar lantern lets me make more baskets, [which] puts me at a higher profit.”
- Solar lantern “helps to tell stories and spend time with family.”
- “When the power goes off, [the] kids can still read at night [and eat] at night. Solar [lighting] is brighter than electricity.”
- “Previously, it was hard to go outside with the kerosene lantern because of the wind.”
- “Charging cell phone [via the solar-powered lantern], children learning at night, calculating how many dresses I sold, hosting guests, cooking at night”
- “Weaving mats at night have been influenced by having solar [lighting]. Before I spent only 0.5 hours weaving because the lamp light would die down after that amount of time.”
- “Can move around outside at night, can go out to the farm now”; “Can’t go out with kerosene lamp or candle. Now it’s movable. You can go out at night with [solar] light. It’s movable.”



Solar Lanterns and Education: Giving Students the Opportunity to Learn

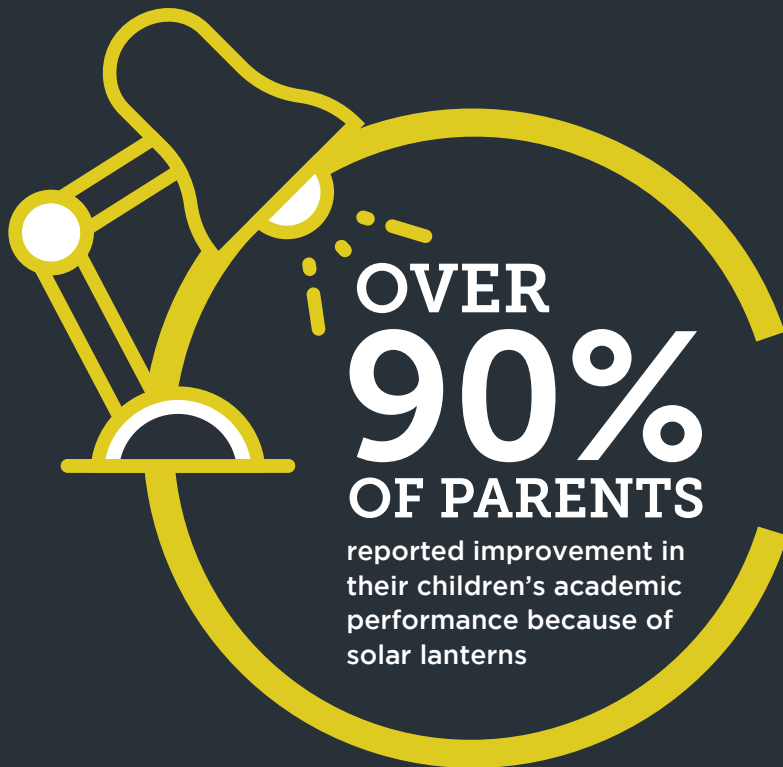
The Miller Center study demonstrates that many solar lantern users felt that solar lighting had improved their children's educational outcomes. Solar lighting allows students to study, read, and complete homework at night. Many parents explained that before obtaining solar lanterns, children could not complete schoolwork in the evenings because kerosene lamps lacked adequate brightness, caused too many health problems, or were too expensive. Therefore, they said, their children had many excuses to not complete their schoolwork.

Solar lanterns allow adequate time and resources for children to engage in educational activities. An overwhelming 90.6% of off-grid parents reported that their children's academic performance had improved since their households starting using solar lighting. Several parents reported that their children's class rankings had changed dramatically and that they were now among the

top students in their class—which they attributed to their children no longer being able to make excuses for not completing their schoolwork.

In addition, 31.3% of participants said they use their savings from kerosene for education (school fees and materials), 8.8% said they use it for farming inputs, and 7% for business investments.

Solar lighting supports education as a social, collaborative activity, as well. Parents often said that solar lanterns allow them to spend time helping their children with homework in the evenings or teaching their children to read and write. With a solar light that is larger and brighter than a kerosene lamp, more than one individual can use the light at the same time. A Solar Sister customer from Tanga disclosed that his children share the solar lanterns for "learning together" and have increased in their school rankings as a result.



HAS YOUR CHILDREN'S SCHOOL PERFORMANCE CHANGED SINCE YOUR HOUSEHOLD STARTED USING SOLAR LANTERNS?

- “One of our daughters passed secondary and is now in college; another is in Form 2 because of solar [lighting].”
- My child “in grade 7 is in [the] top 10 now because [he] can study.”
- “Now she studies about 3-4 hours whereas before she studied a lot less.”
- The children “used to have to stop studying when kerosene ran out. Now they can always study.”
- “One of my sons passed his exam and now he is in secondary school because of solar [lighting].”
- “They have no more excuses [not to study] since there is a light [after dark].”
- “One of the children got a 40 on exams [before solar lighting] and now gets a 60.”
- “Now teachers tell me that my child is the best so I’m happy.”
- His “son went from last to highest position.”



Solar Lanterns and Health: Eliminating Fumes and Increasing Safety

By reducing or halting the use of kerosene, solar lanterns improve the health and safety of rural households. Studies show that prolonged exposure to kerosene fumes, even at low levels, can cause developmental impairment in children, including severe setbacks in social, problem-solving, and memory skills.¹⁰ Cases of kerosene poisoning also pose a problem in many less-developed countries.¹¹

More than two-thirds of the Miller Center research survey participants reported negative health consequences from kerosene, with the most commonly reported issues being coughing (45.2%) and cold/flu symptoms (36.2%). As one 32-year-old customer from Babati recalls, “In the morning, [I’d] wake up and spit out saliva. It would be black from the smoke.” Unlike kerosene lanterns, solar lanterns do not produce fumes or smoke that result in discomfort and lasting lung damage.

Fatou Yona, a 39-year-old Solar Sister customer from Karatu and mother of five children, remembers when her children developed a cough from kerosene. “That time I was giving birth, [the baby] was too young and there was

bad air pollution . . . it [caused] lots of problems. Every time, [the baby had] a cough.”

Many participants also linked improvements in health from solar lighting to an increased sense of respect and safety in the household. One customer from the Babati region stated that solar lighting “is more safe [than] kerosene. [I am] not afraid that the house will burn down.”

Faraja Hoza explained that he feels more respected in his household because his family views him as a more caring person due to solar lighting. “He cares [for] them by buying solar lanterns [when] he can, to improve the household well-being by removing the hazards related to kerosene, like flu [and] coughing.” Similarly, Batuli Arcard, a farmer and small-business owner in the Karatu region, expressed that her family used to be “disturbed by coughing” from kerosene, but now with solar lighting, “They are all thanking me.”

Faraja’s and Batuli’s experiences were not uncommon among the survey respondents, which suggests that solar lighting helps promote good health, leading to more positive, respectful family relationships.



Photo credit: Santa Clara University, Solar Sister

Solar Lanterns and Productivity: Alleviating Time Poverty

Time poverty, or the inability to maintain a balanced lifestyle due to many hours of work (paid or unpaid), affects women disproportionately more than men in developing countries.¹² Solar lighting helps to alleviate time poverty by eliminating travel time previously required to purchase kerosene, by increasing available lighting time after sunset, and by providing the opportunity to shift the timing of tasks throughout the day.

Solar lanterns increase available hours by eliminating excess time spent commuting to purchase kerosene. The Miller Center survey findings indicate that before purchasing solar lanterns from Solar Sister, 97.8% of off-grid respondents used kerosene for lighting and, on average, spent 1.45 hours traveling per week to obtain it.

The dispersed, remote, and undeveloped terrain of rural locations presents considerable barriers to transportation, making it a major time-

consuming challenge for rural residents to reach the nearest shop selling kerosene. This struggle is illustrated by one customer from Babati who recalled, “[We] would suffer a lot because sometimes [we] would go all the way to the store and there wouldn’t be any kerosene.”

Although some respondents still purchase kerosene for cooking, their kerosene usage and purchasing trips significantly decreased overall as a result of solar lighting. Solar lanterns save time for the 91.6% of respondents who have stopped using kerosene for lighting. As a result, solar lanterns mitigate both financial poverty and time poverty.

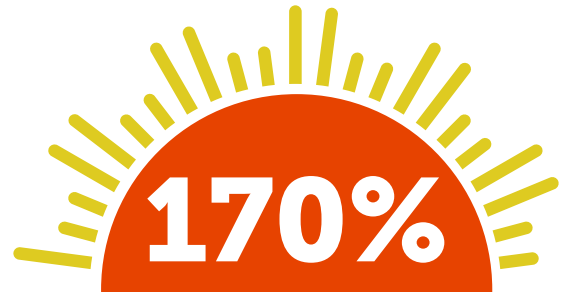
Solar lighting not only saves people time but actually extends the day, increasing the hours of light available. With solar lanterns, the average amount of time that respondents report using lighting after sunset increased 1.7 times—from 2.5 hours to 4.3 hours. By using lighting for these extra 1.8 hours daily over the course of

one year, an individual can gain approximately 657 hours, or 27 days, of increased productivity.

With more available time comes a greater ability for task shifting, which occurs when a person has sufficient flexibility built into his or her schedule to choose when to accomplish a particular task. Multiple survey respondents highlighted that solar lighting introduced greater ability to move certain duties to different times of the day.

For example, one Solar Sister customer from Babati remarked that her schedule for cleaning clothes has changed because of solar lighting. She “used to have to do it in the afternoon but it was very busy. Now I can do it at night.” Faraja Hoza, a teacher from Tanga, also shared that he “used to prepare lessons for two hours using kerosene lamps” and then “sleep at 10 p.m.” Now, using solar lanterns, he can stay up until 1 a.m. to prepare lessons. Solar lighting “changed my performance” and led him to be “promoted to

a head teacher.” Another Solar Sister customer from Babati reported that instead of rushing to complete her cooking before dark, now she can cook at night for her family of 11.



**INCREASE IN
LIGHTING
USED AFTER
SUNSET**



Photo credit: Santa Clara University, Solar Sister



Solar Lanterns and Finances: Boosting Household Incomes

In conjunction with increasing productive hours, solar lighting increases household income through both economic savings from weekly kerosene costs and the ability to improve existing businesses or create new ones. In addition to investing in education, the majority of households surveyed (53.7%) used money they would have spent on kerosene to pay for food and water. These uses support the claim that solar lighting significantly improves individuals' well-being and ability to meet their basic needs, while also enabling them to invest in the well-being of the next generation.

Additionally, solar lighting positively affects income-generating activities across diverse industries. The research team found that business ventures affected by solar lighting spanned nine broad household economic activities, including artisanal activities, retail, farming, animal husbandry, and service professions. This variety shows the versatility and practicality of solar

lighting across various sectors, in both indoor and outdoor work.

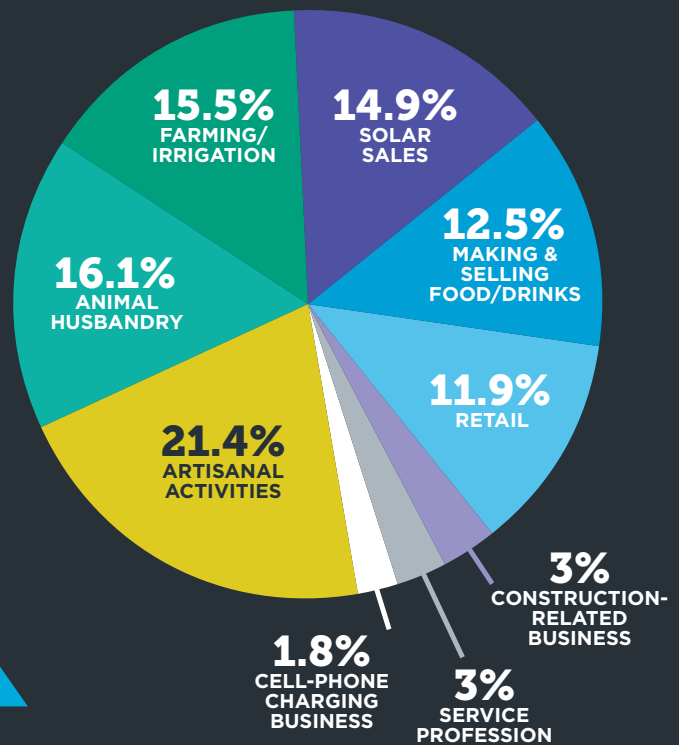
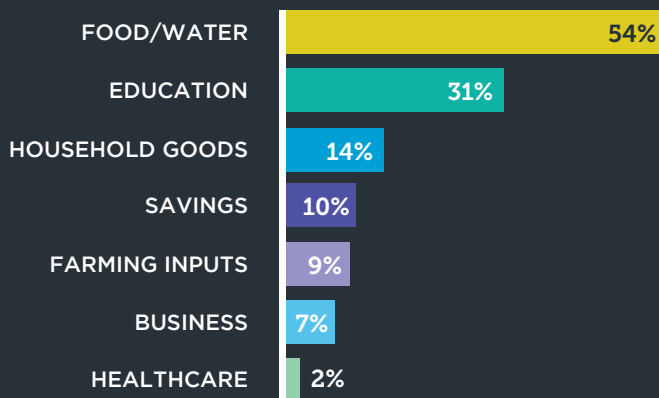
Of the 153 informal, small home businesses influenced by solar lighting usage in the research sample, 64.1% were pre-existing businesses while 35.9% started after the purchase of a solar lantern. The majority of existing businesses that incorporate solar-powered lighting are able to increase their weekly profits, and individuals often save or reinvest that profit back into their own businesses to produce even more income.

On average, individuals able to start a new business due to solar lighting enjoyed a weekly income increase of approximately 13 USD, while individuals who grew a pre-existing business experienced a weekly income increase of approximately 7 USD. Given that a significant portion of people in rural Tanzania live on between 1 USD and 2 USD a day, this income increase is substantial.

As a result of solar lighting use and kerosene savings, many respondents reported increased control over their financial decisions. Solar Sister customer Pascalina Aloyca from Kilimanjaro reported that using solar lanterns has allowed to her join “a savings group and . . . take out loans, because expenses are reduced, as solar [lanterns are] not as expensive as the [kerosene] lamp.” Another end user expressed that, “before, I couldn’t put money in the savings group but now [because of solar lanterns] I can; I’ve even taken a loan out for business.” One woman stated that “saving money” from not having to use kerosene gives her “power.”

These stories, along with many others, indicate that solar lanterns can introduce choice in how to allocate “extra” money and plan the household budget, thus fostering greater real and perceived financial control. Solar lanterns offer economic gain not only directly to SSEs, but also indirectly to end users. These simple solar-powered products can provide ongoing financial gains in which the returns far exceed the initial cost.

USAGE OF KERSENE SAVINGS



OFF-GRID VENTURES IMPACTED BY SOLAR



MEET REVINA

Solar lanterns are a powerful tool to raise the economic status of rural Tanzanian residents through increasing several of their income streams. For example, 51-year-old Revina Leopoldi from Babati was already weaving baskets and making chapati to earn income before the introduction of solar lanterns. Then she became a Solar Sister Entrepreneur and a solar lantern user. Solar-powered lighting led directly to her ability to generate income in two new ways—selling solar lanterns as an SSE and charging other people’s phones. She also used the solar-powered lighting to increase her basket-weaving and chapati-making income by doing those activities at night. Beneficiaries such as Revina showcase ingenuity through their ability to profit creatively from solar lighting beyond its basic household uses.



Photo credit: Santa Clara University, Solar Sister

Solar Lanterns and Gender: The Economic Empowerment of Women

Women's empowerment is a notoriously difficult but extremely important concept to measure. The Miller Center survey examined women's agency, evaluating how successfully Solar Sister achieves its goal of increasing women's control over decision-making and power in society.

To investigate the impact of solar lanterns on women's agency, status, and control over resources, the research team used nine questions (see Appendix, Section D), comparing Solar Sister customers with Solar Sister Entrepreneurs who also purchase and use solar lanterns. (For all questions, respondents were asked to think about changes from selling solar lanterns, buying solar lanterns, or both.)

The key difference between SSEs and customers lies in their employment through selling solar-

powered lanterns. Unlike the benefits of using a product, a job provides benefits in multiple and sustainable forms—financially, of course, and also through the support of management, career development resources, and enhanced autonomy.

Thus, the role of an SSE encourages motivated individuals to sell as many solar lanterns as possible by meeting new people, traveling, reaching out to the local community, and developing new skills in order to be successful. Engaging in a leadership role that broadens social networks and creates new positive experiences can help women cultivate greater confidence and self-esteem. The same cannot necessarily be said for customers who simply use the product.



Photo credit: Santa Clara University, Solar Sister

The Untapped Potential of Women

Globally, the economic empowerment of women presents a major untapped opportunity for human development. Research shows that women reinvest 90% of their income toward their communities and families, whereas men reinvest only 30-40% of their income.¹³ Women are also more likely than men to spend earnings on their children's health, education, and overall well-being.¹⁴

Every year, sizable GDP per capita losses occur due to the underutilization of women.¹⁵ In fact, if women fulfilled the same economic potential as men, the global GDP would experience an increase of \$12 trillion by 2025.¹⁶ Currently, 812 million women in the developing world are not contributing at full capacity.¹⁷ Although women make up 70% of the informal African economy, they remain largely excluded from more formal

participation.¹⁸ In Tanzania, 60% of women live in poverty, women's incomes are on average half that of men, and women are two times more likely to be uneducated, especially in rural areas.¹⁹ These findings are clearly reflected in this research sample, which contained 19 individuals who never attended school, only one of whom was male. The rest were women.

Solar Sister recognizes the unique skills that Tanzanian women bring to entrepreneurial jobs: Because women generally assume responsibility for domestic duties, they can draw from personal experience to communicate the benefits of solar lanterns to potential customers. Therefore, in return for supplying basic business training and support, Solar Sister employs its female SSEs as liaisons within communities to carry out its mission.

The research team divided the nine survey questions pertaining to gender into two broad categories. The first category examines solar lanterns' impact on women's perceptions of their agency (decision-making) and respect, while the second category examines behaviors that resulted in new actions or activities.

Generally, the research team found that solar lanterns affected women's perceptions of agency and respect more than their concrete behaviors, but that these differed among SSEs and end users. Almost all the entrepreneurs surveyed felt that solar lanterns increased their control over finances, children's education, and their respect in both their households and communities. Likewise, a majority of end users also observed increases in each of these measures.

Women frequently explained that their children thank them for introducing a product that helps them study at night; family members are happier in general because of solar lighting; and the women are no longer burdened by requests for kerosene money. Some women stated that society now views them as "women who dare," a label of admiration referring to female leaders and women who keep up with technology and modern civilization. Both SSEs and customers receive appreciation for contributing solar lanterns to the home, which have brought about positive changes in education, health, relationships with neighbors (e.g., hosting

them in the evenings), and income-generating activities that benefit their family members as well. The women feel more respected because they can fulfill their obligations to their loved ones and also improve their quality of life.

Participants' stories indicated that simply owning solar lanterns constitutes a status symbol. Common survey responses suggest that ownership of solar lanterns—or any new, advanced form of technology, for that matter—elevates one's social position. At times, individuals feel even more respected in their communities because their neighbors ask to borrow their solar lanterns, which makes them feel that they possess something special that distinguishes them from the rest of the community.

These women can educate strangers or friends who approach them with questions on how to acquire and use solar lanterns, making them feel as though they hold valuable and potentially unique knowledge. Other times, however, ownership of solar lanterns is precisely what makes individuals feel like they fit in. In places where most people have already adopted solar lighting, respondents reported feeling more included rather than more respected in the community after they purchased solar lanterns. In the words of one respondent who experienced no change in respect from the community, "everyone is having solar already."



Photo credit: Santa Clara University, Solar Sister

Solar Lighting as a Status Symbol

One of the many voices exemplifying the impact of solar lighting, Rodensia Elibarick states that the community views her “as [one of] the women who dare[s] to do big things” due to her use of solar lanterns. Similarly, Hawa Mshuza, a 61-year-old Solar Sister customer, expressed that she feels more respected because the community believes that she is “a woman who dares.” Despite her age and low level of education, she “knows the advantages of solar lighting.”

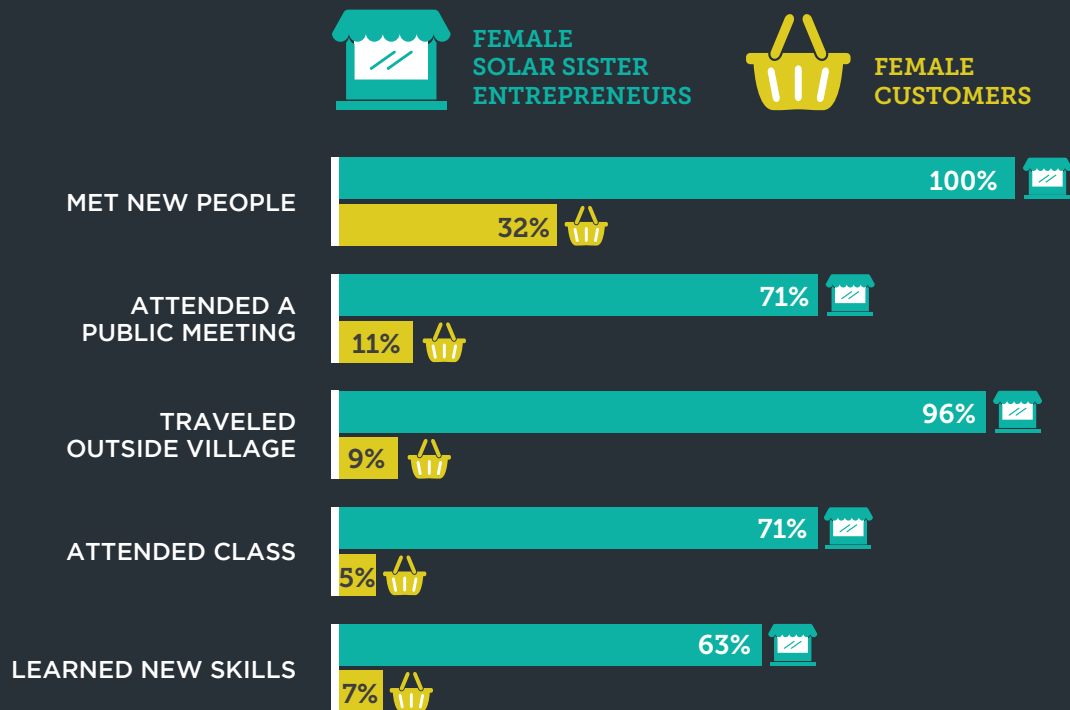
Ansila Masawe, a 23-year-old farmer and Solar Sister customer from Arusha, also explained that she feels more respected in the community “because villagers view me as a civilized person [who] can keep up with the time[s].” Similar comments were made by Selina Muzo, Efrasio Miwa, Neema Sindima, and others. “When you have solar lanterns, people think you have money so they know your financial capacity.” Another described herself as “a rich, developed woman” for buying solar lanterns.



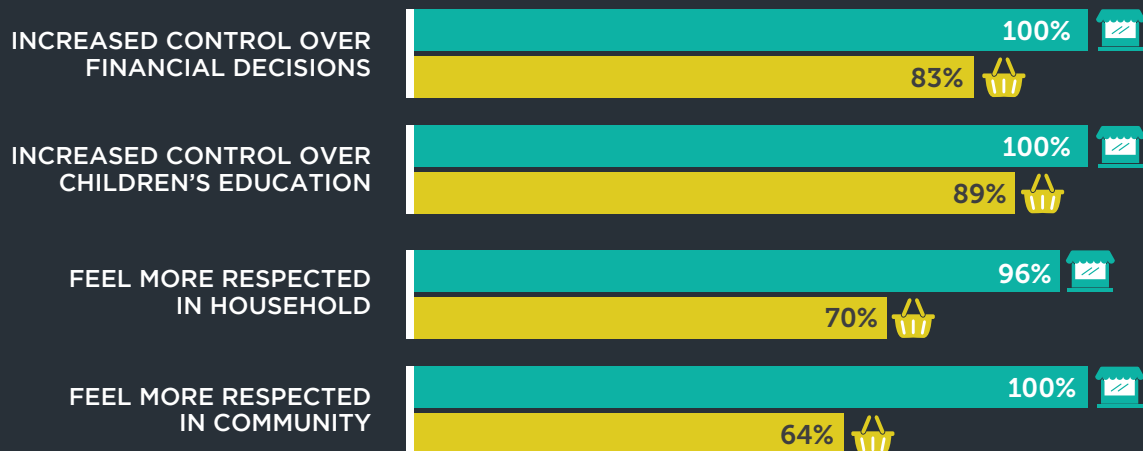
HOW SOLAR LANTERNS CHANGED WOMEN'S BEHAVIOR

To gauge how solar lanterns changed behaviors, the survey team asked participants five questions.

Among SSEs, a significant majority reported increases in meeting new people, attending a public meeting or workshop, traveling outside their village, and learning a new skill. For the end users, far fewer reported any changes in behavior. This makes sense given that the nature of the SSE job is to engage with community members and other Solar Sister employees. Overall, solar lanterns appear to impact women's perceptions of agency rather than concrete behaviors.



HOW SOLAR LANTERNS CHANGED WOMEN'S PERCEPTIONS OF DECISION-MAKING AND RESPECT





**THE SURVEY TEAM ASKED SOLAR SISTER ENTREPRENEURS
WHAT “EMPOWERMENT” MEANT TO THEM.
THIS IS WHAT SOME OF THEM SAID:**

- “Empowerment means giving money to me now, not having me buy from the company.”
- “Empowerment means that I can afford expenses so that I can develop in life.”
- “Empowerment means a woman getting profits because of business she is doing.”
- “Empowerment means I can understand and be trained by the Business Development Associate and then do it: go out and sell.”
- “I know something and maybe someone [else] doesn’t, so telling them about it is empowering.”
- “Empowerment means to receive capital for doing activities like selling solar lanterns.”
- “Empowerment means someone gives goods or money and other people (customers) benefit.”

CONCLUSION

The Miller Center survey results, illuminated by the stories of individuals whose lives have been transformed by solar lanterns, provides insight into Solar Sister's impact in rural Tanzania. Solar lanterns give families the time and opportunity to do more every day, opening doors to additional educational and business ventures. Solar lanterns create a positive cycle of economic growth that can revolutionize a family's financial well-being. At the same time, solar-powered lighting protects the health of each person in the household and spurs intrinsic changes in women's self-image and perceived agency.

Clearly, the impact of solar lanterns goes well beyond being a sustainable form of lighting. Solar-powered lighting is a technology central to the development of rural Tanzania, transforming the education, health, time, finances, and sense of power in every household it reaches. While solar technology is important, it is just one piece of Solar Sister's approach to reducing energy poverty in Tanzania. The conscious creation of trust networks and entrepreneurial solutions to poverty add value to this social enterprise through empowering women to create new economic and social opportunities.



Appendix

Here is the content of Miller Center for Social Entrepreneurship's survey researching the effects on rural Tanzanians of using Solar Sister solar lanterns:

The Effects of Off-Grid Solar Lantern Use

Interviewer/research assistant: _____

Date (month/day/year): __ __/__ __/2016

Section A: Socio-Demographic Information

Oral consent Respondent name: _____

1. Assigned household #: _____ 2. Village name: _____

3. Interview type: END USER / SSE 4. Gender: M / F

5. Birth year: _____ 6. Ethnicity: _____ 7. Education level: _____

8. Occupation(s): _____

9. How many household members are men older than 18 years of age? _____

10. How many household members are women older than 18 years of age? _____

11. How many household members are 18 years of age or younger? _____

12. Are all household members ages 6 to 18 currently in school? YES / NO / NOT APPLICABLE

If no, how many? _____

13. What is the main building material used for the walls of the main building?

A. Baked bricks

B. Poles and mud, grass, sun-dried bricks, or other

C. Stones, cement bricks, or timber

14. What is the main building material used for the roof of the main building?

A. Grass/leaves, mud and leaves, or other

B. Iron sheets, tiles, concrete, or asbestos

15. What is the main fuel used for cooking?

A. Firewood, coal, solar, gas (biogas), wood/farm residuals, or animal residuals

B. Charcoal, paraffin, gas (industrial), electricity, generator/private source, or other

16. Does your household have any televisions? YES / NO

17. Does your household have any radios, cassette/tape recorders, or hi-fi systems? YES / NO

18. Does your household have any lanterns? YES / NO

19. Does your household have any tables? YES / NO

20. Does your household own any means of transportation? 1= NONE 2= BIKE 3= MOTO 4=CAR

21. If the household cultivated any crops in the last 12 months, does it currently own any bulls, cows, steers, heifers, male calves, female calves, or oxen?

Crops: YES / NO Cattle: YES / NO

22. How many of each do you keep?

#goat(s)____ #sheep____ #cattle____ #chicken(s)____ #pig(s)____ other (#)_____

23. Marital status: _____

- | | |
|---------------------------|--------------------|
| 1. Married monogamous | 5. Separated |
| 2. Married polygamous | 6. Divorced |
| 3. Together but unmarried | 7. Widowed/widower |
| 4. Single (never married) | 8. Other _____ |

24. What is the *main* source of your household income? _____

25. What are your other sources of income? _____

Section B: Use of Solar Lanterns

1. When did you purchase your first solar lantern? _____ From Solar Sister? YES / NO

2. How many solar lanterns do you have? _____ Solar system? YES / NO

3. Why did you choose to purchase from Solar Sister instead of from another solar company?

4. Do you have a Solar Sister cookstove? YES / NO

Section C: Impact of Solar Lanterns

1. What did you use for lighting before purchasing your first solar lantern? _____

2. Did you experience any health issues from using it? YES / NO

3. How much time did it take round trip to obtain lighting before purchasing solar? _____

4. How much did you spend per week on that form of lighting? _____

5. Do you still use that form of lighting? YES / NO

6. If not, what do you do with the money that you no longer spend on that form of lighting? **

(**1=education, 2=farming, 3=business, 4=healthcare, 5=food/water, 6=transportation, 7=household goods, 8=other)

7. Who in your household uses the solar lantern(s)?

	What is solar used for?*	How many hours each day?	Comments
Men			
Women			
Children			

*1=lighting, 2=charging cellphone, 3=leisure, 4=household chores, 5=income generation, 6=education, 7=outside activities, 8=household activities (eating, toilet, etc.), 9=other

8. Do you use solar for any of your income-generating activities?

Business ventures	New or existing	Previous profit/week	Current profit/week	Use of earnings?**	Comments

**1=education, 2=farming, 3=business, 4=healthcare, 5=food/water, 6=transportation, 7=household goods, 8=savings, 9=other

9. How much time did you use lighting after sunset before you had a solar lantern? _____

10. How much time do you use lighting after sunset after purchasing a solar lantern? _____

11. What do you and/or someone in your household do at night using a solar lantern that you could not do before?

12. Have your children's school performance changed since your household started using solar?

13. Overall, what do you like about your solar lantern(s)? What could be improved?

Section D: Empowerment Information

Because you started using or selling solar.....	YES	NO	N/A
1. Do you have more control over financial decisions?			
2. Do you have more control over your children's education?			
3. Have you met new people?			
4. Have you attended a public meeting?			
5. Have you travelled outside of your village?			
6. Have you attended a workshop or class?			
7. Have you learned any new skills? (money, speaking, activity, etc.)			
8. Do you feel more respected in your household?			
9. Do you feel more respected in your community?			

10. Is there anything else that you would like to add, or do you have any questions for us?

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About the Author

Dr. Leslie Gray was the 2016 Miller Center Faculty Summer Chair. She is a professor in Santa Clara University's Department of Environmental Studies and Sciences. Besides her summer research in Tanzania, Dr. Gray has worked extensively in sub-Saharan Africa on issues of environment and development and in California on local food systems. Her research has been funded by the National Science Foundation and Fulbright.

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About Miller Center for Social Entrepreneurship

Miller Center for Social Entrepreneurship believes that social entrepreneurship—using business-based techniques to develop innovative solutions that fight poverty and address social and environmental issues—provides sustainable avenues out of poverty. Miller Center supports social entrepreneurs through its Global Social Benefit Institute (GSBI) programs, which feature top industry executives as in-depth mentors to social entrepreneurs.

Miller Center combines Jesuit values of social justice with Silicon Valley business acumen, aiming to positively impact the lives of 1 billion people through its efforts. As part of these efforts, the center's Global Social Benefit Fellowship (GSBF) annually sponsors interdisciplinary teams of undergraduate fellows from Santa Clara University to perform action research in service to social enterprises. Since 2012, the center has commissioned a total of 75 GSBF teams, three of which have worked with Solar Sister. The 2016 Solar Sister team consisted of Miller Center's inaugural Summer Chair professor and two undergraduate honors students.



Miller Center
for Social Entrepreneurship



About Solar Sister

Solar Sister, founded in 2010, is an established nonprofit organization that strives to provide light, hope, and opportunity by distributing solar lighting products and clean cookstoves to rural Nigeria, Uganda, and Tanzania. Demonstrating its dedication to increasing women's economic opportunity, Solar Sister employs women as Business Development Associates (BDAs) and as Solar Sister Entrepreneurs (SSEs), or sales agents. This business model allows women to leverage their social networks to sell products through personal, trusted relationships. In line with its mission to combat energy poverty and increase agency, particularly among women, through economic opportunity, Solar Sister has trained and created livelihoods for more than 2,500 entrepreneurs, benefiting 700,000 people.⁶