WASH
FACILITY:SIERRALEONE

Solawata:

A social enterprise approach to disseminating improve water access in northern Sierra Leone

Monitoring and Evaluation report - August 2013

UKaid
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ENERGY FOR OPPORTUNITY

This report is a part a broader project which is focused on providing improved water access at the community level across three Sierra Leonean districts. The overall project is being financed by the Department of International Development (DFID), United Kingdom.

The contents of this report are the sole responsibility of ENFO and can in no way be taken to reflect the views DFID.

This report provides an analysis of the research conducted in the Kambia, Bombali, and Koinadugu Districts during June and July 2013

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1. Introduction

This report presents an analysis of Energy for Opportunity's (ENFO) "Solar Powered Water Purification" project, known locally as SolaWata. As part of Sierra Leone's broader Water Sanitation and Hygiene (WASH) program, the SolaWata initiative focuses on the improvement of water quality and access in the Bombali, Kambia, and Koinadugu Districts of Sierra Leone. Throughout the past year, ENFO has installed solar powered water filtration and purification systems in nine communities across the three districts to produce purified drinking water on a commercial basis for household consumers. The systems were installed in Kamabai, Kamakwie, Kassirie, Mambolo, Rokupr, Tawuya, Bafodia, Bendugu, and Sinkunia. Table 1 contains general information about each site and Figure 1 shows each location on a map of Sierra Leone. This report details the successes and limitations of SolaWata throughout its four to six months of production, focusing on community uptake and health effects in each of the target communities, and concludes with a series of recommendations for broadening the impacts of SolaWata.

Community Name	District	Population (approximate)	Households (approximate)	Installation Date
Kamabai	Bombali	4,000	336	March 2013
Kamakwie	Bombali	17,500	1,750	January 2013
Kassirie	Kambia	5,500	430	January 2013
Mambolo	Kambia	5,500	423	December 2012
Rokupr	Kambia	11,000	786	January 2013
Tawuya	Kambia	3,500	184	December 2012
Bafodia	Koinadugu	5,800	417	February 2013
Bendugu	Koinadugu	3,500	313	December 2012
Sinkunia	Koinadugu	2,700	218	January 2013

Table 1: The district, population, number of households, and SolaWata installation date for each of the target communities. Data derived from Sesay et al (2006), Statistics Sierra Leone (2006), Munro and Kebbay (2012) and general observations at each site.

Figure 1: The target communities in the Northern Province of Sierra Leone.

Each SolaWata system was installed in a Community Charging Station (CCS), pictured in Figure 2. CCSs, established as a part of previous ENFO projects, utilise solar power to recharge mobile phones and LED lanterns in order to disseminate affordable and healthy electricity throughout the target communities (Willans et al., 2011). Market rates are charged for the recharging of these items and all profits are channeled into a community fund used for development projects such as solar installations on schools and health clinics. The addition of SolaWata complements this existing model by adding sales of purified water to the CCS's services; the community gains access to pure drinking water and the sales profits augment the communal revenue stream already established by the CCS. The use of low-cost solar energy and the for-profit design of the CCS and SolaWata ensure both long-term sustainability and the capacity for future system expansions independent of donor funding.

Figure 2: The Kassirie CCS, used for the production and sale of SolaWata and mobile phone charging

SolaWata can be purchased from the CCS in one or five gallon containers. The basic pricing structure for the product functions on a deposit system to order to ensure the containers do not get lost, stolen, or damaged. Customers are required to pay a deposit of Le 15,000 for the five gallon container or a deposit of Le 5,000 for the one gallon container. Customers can then use the container at home and bring it back to the CCS any time they want to refill the water, at a cost of Le 3,000 for the five gallon container and Le 1,000 for the one gallon container. If at any time customers wish to stop purchasing SolaWata, they can return the container to the CCS and reclaim their deposit. This basic structure is implemented at all nine sites, with various adjustments at some of the sites. At all four of the sites in the Kambia District, customers can pay their deposit in three increments of Le 5,000 instead of paying the entire fee at once. In Sinkunia, the price for a refill of the five gallon container has been lowered to Le 1,000. In Bendugu, customers are allowed to bring their own containers to be filled with SolaWata instead of paying the deposit for the SolaWata container; the CCS is responsible for washing the customer's container before filling it with SolaWata for the regular cost of a refill. These adjustments were made in April and May 2013 in response to community feedback gathered during regular monitoring of the project. These changes were designed to address specific concerns within each

community, increase the accessibility of SolaWata to the general public, and to test the viability of new methods for selling SolaWata.

2. Methodology

In Sierra Leone, as in much of West Africa, a key challenge for monitoring and evaluation is the poor quality and extremely limited availability of secondary data such as health statistics or census results with which to contextualise data analysis. As a result, health-focused projects require innovative approaches to the measurement and analysis of their impacts (Hyder et al., 2007) and implementing organisations must typically generate their own primary data. As such, prior to the implementation of this project in July 2012, ENFO performed a baseline survey of the target communities to provide a pre-project snapshot of community water and health issues in eighteen villages (Munro and Kebbay, 2012). By conducting interviews of health clinic staff, water supply engineers, and other officials while also conducting general household surveys, the baseline study collected information about water-borne diseases and water supply concerns for each village. This preliminary survey allowed ENFO to select the nine initial sites for the SolaWata project. It also provided a baseline focused on metrics regarding quantity of water consumed for drinking, stomach sicknesses in the average household, and the management of the CCS. An interim monitoring and evaluation exercise was conducted in April/May 2013; this provided some initial insights into the project's progress, as well as informed the design of the project's final evaluation. This report compares the statistics and information from the project evaluations to the metrics to from the preliminary baseline, as well as analysing the current quantity of SolaWata produced and sold.

In June 2013 the main monitoring and evaluation survey of SolaWata was conducted in all nine of the project's target communities. In each community fifty-five to eighty households were interviewed over the course of several days, including at least one SolaWata user, one health clinic staff member, and one CCS operator. For the community members, the interview focused on CCS usage and perceptions and understanding of SolaWata, while for the health clinic staff the interview focused on any changes in the rates of water borne illnesses and SolaWata use in the facilities. In contrast, interviews with the SolaWata consumers focused on the reasons behind

their personal decisions to buy SolaWata, their experiences with the system, and any recommendations they might have for its improvement. This survey and its results serve as the basis for this report, are designed to gauge SolaWata's success based on baseline metrics, and were used to develop various business models for the project in the future.

There are several sources of uncertainty that should be considered before analysing the results of the most recent survey. First, the residents of rural Sierra Leone typically to not delineate time in terms of calendar years, months, or specific days, meaning that getting respondents to provide quantitative information of the frequency of waterborne disease illness and hospital visits, among other activities, is fraught with challenges. Similar issues appear when asking for age, the amount of time required to collect water daily, the time required to walk to the CCS, and weekly expenditure for batteries or kerosene. This is not to say that the data collected from the surveys is inaccurate, but rather that the quantitative values should be taken as approximate rather than precise. Second, at several of the sites, the respondents only spoke their local language and were unable to communicate in English or Krio, the official language and lingua franca of Sierra Leone, respectively. Thus, ENFO was forced to repeatedly switch translators throughout the survey process, almost all of whom had no experience translating or interviewing, since the ENFO interviewers did not speak these local languages. This introduced a moderate response bias into the survey results. Particularly, at the Bombali and Koinadugu sites, the respondents were informed of the current prices of the product before being asked their willingness to pay, thus influencing their responses. Furthermore, for several questions the respondents seemed to not understand what was being asked of them. While the translator attempted as best as possible to explain these questions, in some interviews the respondent still struggled to provide an informed answer. Lastly, special care should be taken when comparing the results of this survey with those of the baseline study because the time between the two is relatively short. Indeed, care should be taken when drawing any causal relationship between large-scale community change and four to six months of SolaWata operations. Even taking into account these uncertainties, the quantitative and qualitative components of this research project provide a reliable basis for analysing the strengths, weaknesses, and progress of ENFO's SolaWata project to date.

3. Results

The results of the surveys in each of the nine communities revealed key components of SolaWata's progress, successes, and limitations in its first several months of production. While all of the sites appreciated the CCS's work in their community, SolaWata has experienced only limited sales thus far. The interviews showed significant trends in the current acceptance of SolaWata and its health impacts on both the individual and community level. The respondents themselves indicated several barriers to their purchase of SolaWata, most notably the request for SolaWata to be sold in plastic packets and issues with the current container and pricing system.

3.1 SolaWata Operations

Each CCS is managed by members of the community, with only limited monthly supervision from ENFO staff. This is a crucial component in making the CCS and its services a community driven project and in guaranteeing its independent sustainability. The community members who work at the CCS are responsible for running its day to day services, performing basic tests and maintenance of the solar electricity and SolaWata systems, and managing revenue and expenses in a community bank account. ENFO regularly monitors each of the nine communities to ensure the CCSs are being operated correctly. At the time of the survey, all nine sites had opened a bank account with the CCS chairperson as the primary account holder; the revenue from the CCS is deposited into this account to be used to pay salaries for its workers, pay ENFO for any maintenance or new parts for the systems, and potentially fund additional community projects. There were enough funds for the basic operations and maintenance of the CCSs in each of the nine community bank accounts, showing the success of the CCS as a sustainable business. In addition, ENFO completed the training of the CCS operators on the proper management, both technical and financial, of the various services of the CCS. All nine communities' operators demonstrated the understanding and ability necessary to properly use and care for their system, including how to operate the SolaWata pumping system and how to maintain the filters for purifying the water. There were, however, some substantial discrepancies, between statements by SolaWata users about how often they purchase Solawata, and the sales records kept at each of the CCSs (sales records showed a consistently lower figure). The discrepancy, to an extent, can be a result of what is known as "warm glow" (Hogarth 2012) – in which the research participants answer in a manner to please the researcher – thus some

exaggeration from respondents is expected. Nevertheless, in a few of the villages (i.e., Sinkunia, Bafodia, Rokupr, and Mambolo), the discrepancy is large enough to raise some concerns of poor bookkeeping. Ultimately, ensuring proper financial records is a perennial challenge with CCSs, due to low numeracy and business skills at the village level, and as such ongoing efforts is being made at each of sites to ensure financial records are conducted in a rigorous manner. Despite these challenges, all of the CCSs have still proven to be success entities and as such have been established as sustainable operations.

The CCSs and SolaWata services are appreciated and accepted by all nine communities. Figure 3 displays respondents' level of agreement, ranging from strongly disagree to strongly agree, to the following statement: "The presence of the CCS has had a positive impact on the community." It is encouraging to see that the vast majority of all interviewees agreed, either mildly or strongly, that the CCS and all its services are a positive project in their community. Many interviewees, especially throughout the Kambia District, indicated that they agreed with the statement because they were proud to have the CCS and its SolaWata production in their community and because SolaWata elevated their status in the surrounding area, even if they did not use the product themselves. While the positive reception of the CCS in all the communities is encouraging and demonstrates the success of the facility's operations, it reveals that the source of any limited success in the SolaWata project is most likely in relation to the product itself and not in a lack of acceptance of the CCS.

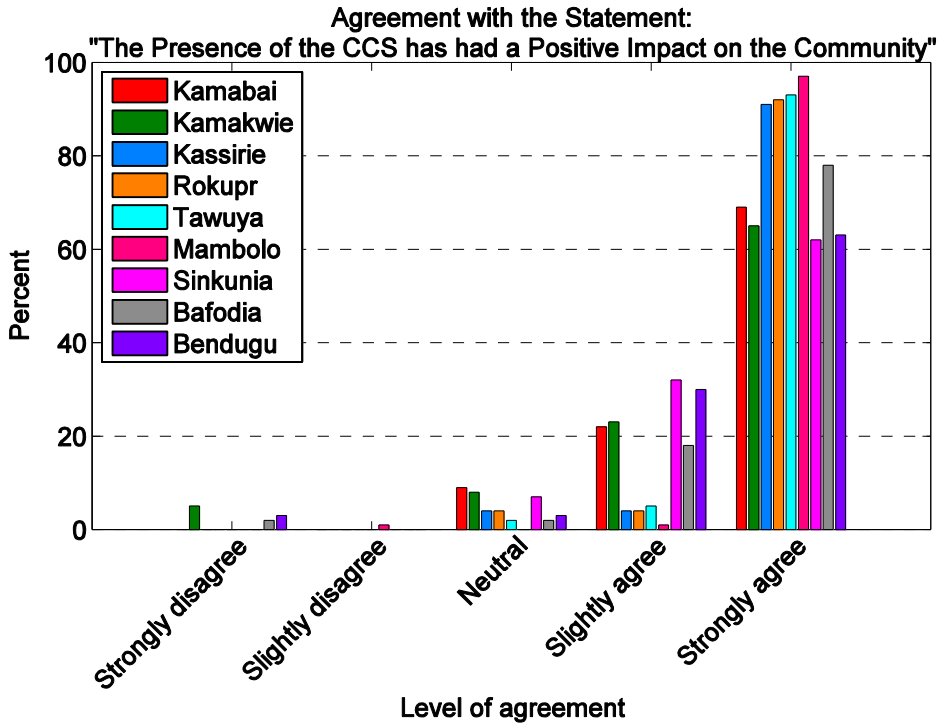

Figure 3: The respondents' level of agreement with the statement "The presence of the CCS has had a positive impact on the community" across all nine sites. Seventy-nine percent of all respondents strongly agreed with the statement, while fifteen percent slightly agreed, four percent were neutral, and only two percent disagreed. The vast majority of agreement shows a strong positive relationship between the CCS and community members.

All nine communities have an established customer base for SolaWata, with consumers regularly buying SolaWata on a weekly basis. Figure 4 displays the quantity of litres of SolaWata produced and sold per week at each of the nine sites, estimated using the amount of SolaWata all regular customers reported purchasing in a week and the sales records kept by the CCS. While it is clear that each site has regular sales, the amount of SolaWata sold does not cover a significant portion of the drinking water used in any of the communities. During the baseline survey, it was calculated that an individual was consuming an average of two litres of water per day; the community water consumption for drinking per week was over thirty-five thousand litres at every site (Munro and Kebbay, 2012). The quantity of SolaWata sold weekly is a very limited portion of the drinking water consumed by the entire communities. In addition, the households in the communities who are purchasing SolaWata regularly only buy enough for each

member of their household to drink less a litre per day.[1] Thus, as demonstrated when compared to the baseline study, SolaWata has yet to become a major source for drinking water in any of the communities. However, each site is regularly selling notable quantities of SolaWata on a weekly basis.

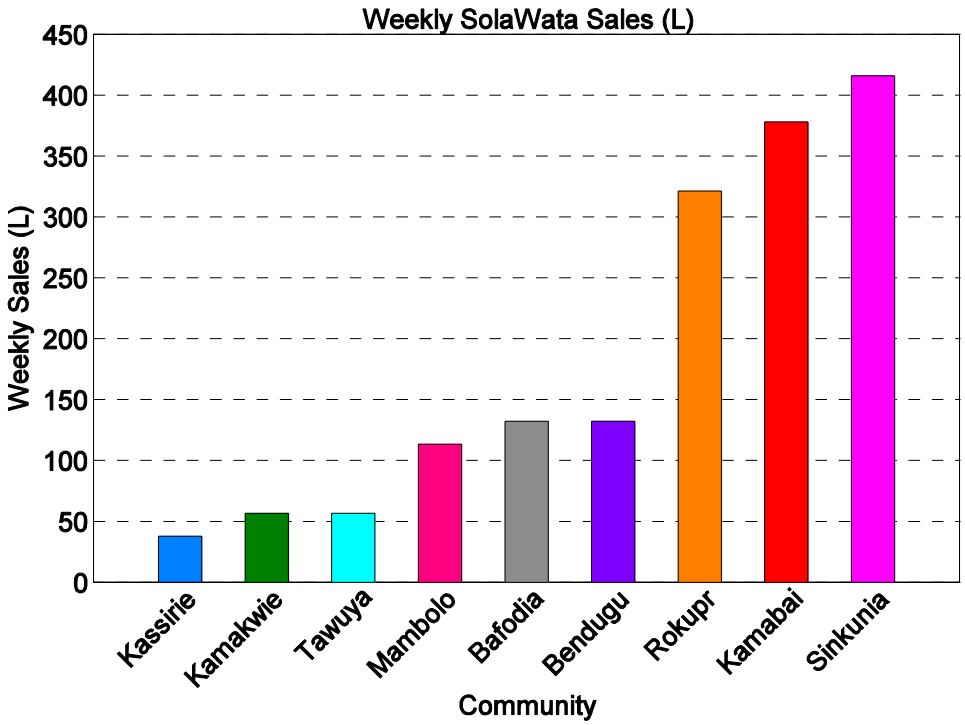

Figure 4: The quantity of SolaWata sold in litres at each of the nine communities, calculated based on surveys conducted with regular SolaWata users. While these sales do not constitute a significant portion of the total drinking water consumed by the entire community, this data shows that all nine sites have established regular SolaWata sales.

Each community's customer base for SolaWata can be broken down into those who regularly purchase the water and those who have merely registered for the container. Figure 5 displays the number of households who have purchased Solawata in each community, given by the sales records kept by the CCS operators. Figure 6 displays an approximate value for the percent of all households that these SolaWata users constitute, calculated using an estimated

[1] This number was calculated based on surveys with regular SolaWata users. They reported the number of people in their household and the amount of SolaWata they bought on average per week. Using this data the litres per person per day of SolaWata consumed by regular customers was calculated for each community. For all communities, this value for how much SolaWata a person drinks per day was less than a litre, with the highest in Sinkunia at 0.7 litres per day and the lowest in Tawuya at 0.2 litres per day.

number for the total households in each community. The regular users are those who purchase the water on a weekly basis and list SolaWata as their household's main source of drinking water while those noted as only registering have either never returned for a refill or only purchase a refill occasionally. While the households who have registered for SolaWata make up a small percentage of each community, these households are all now using safer storage methods for their water. SolaWata five gallon containers are transparent and have a tap for dispensing water; the transparency allows people to see when the water or the container itself has become dirty and needs to be cleaned, while the tap eliminates the need for frequently opening the container and thus decreases the chance of the water becoming contaminated. The typical storage methods for water in these communities are open buckets or yellow five gallon containers, neither of which have the benefits of the SolaWata container. Thus, all of the households who have registered for a SolaWata container, even if they do not regularly refill it with SolaWata, now have access to an improved method for storing clean drinking water.

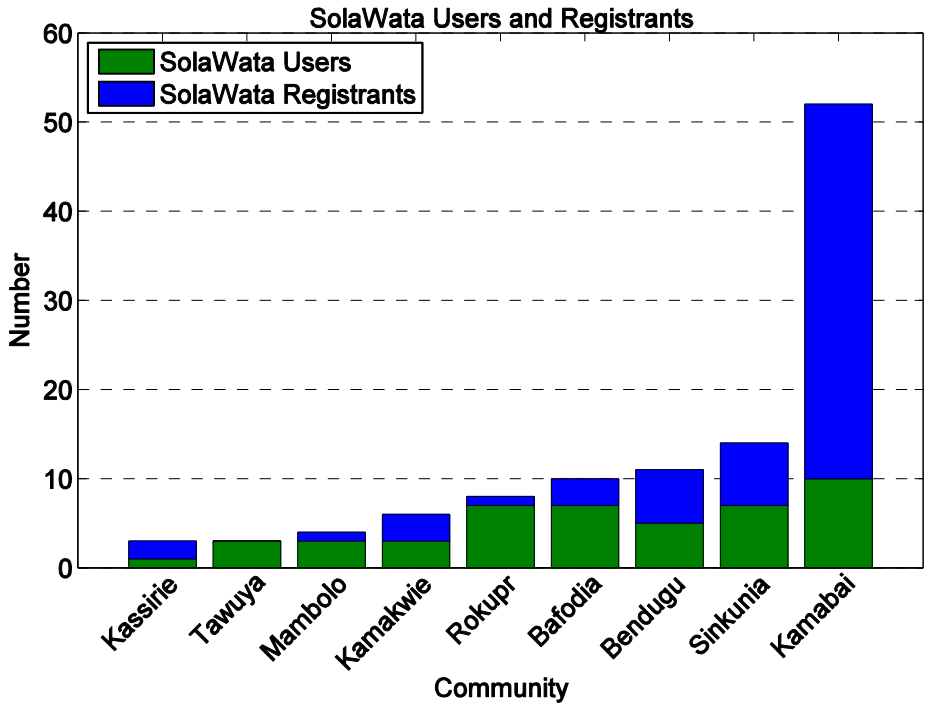

Figure 5: The number of households in each community that purchase and use SolaWata. SolaWata users are those who purchase SolaWata on a regular basis as their main source of drinking water. The registrants are those who have registered for the SolaWata container, but only purchase a refill occasionally. These numbers were given by the SolaWata sales records kept by the CCS operators.

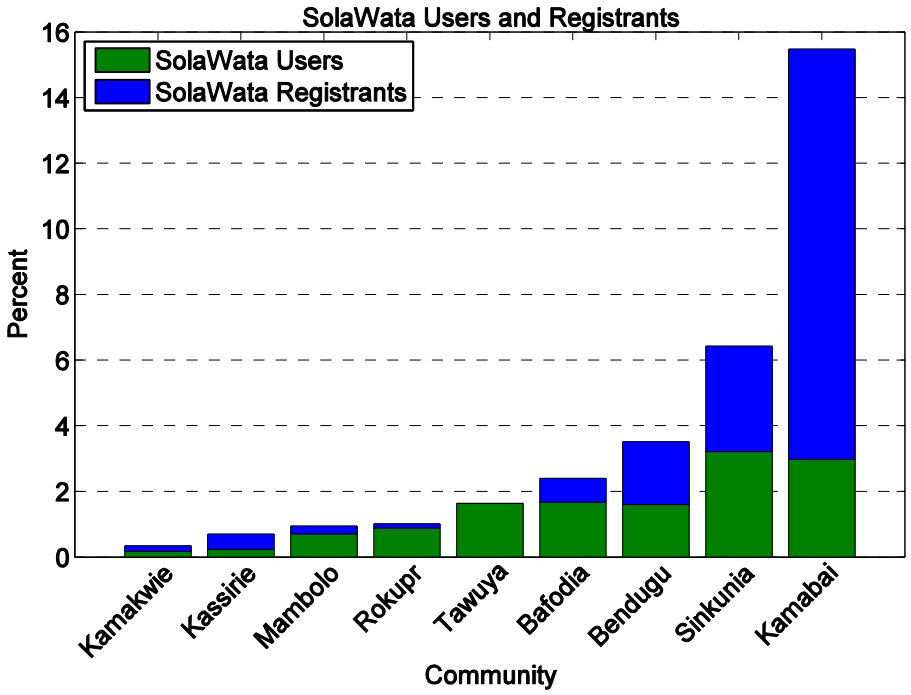

Figure 6: The percentage of all households that use SolaWata, calculated using the total number of users as given in Figure 5 and the approximate number of households in each community as given in Table 1.

While all the nine sites are fully operational with regular customers, some of the communities have experienced much more success than others, as seen in Figures 4, 5, and 6. Sinkunia and Kamabai are clearly the most successful SolaWata sites, followed by Bafodia, Bendugu, and Rokupr. Various reasons can explain the success at some of these sites. In both Kamabai and Bafodia, ENFO spent an extended amount of time in the community during the installation. Instead of the typical SolaWata installation trip of only a couple of days, ENFO staff members spent multiple weeks in both of these communities. Additional time was used in Bafodia to repair and improve a series of community water taps. In Kamabai, several weeks were spent improving the water source used for SolaWata, a project which required building or repairing three storage reservoirs, laying pipe for the pumping system, and installing a new public tap. Given the current success of SolaWata in these two communities, it is likely that the extended time spent in the area built a strong and trusting relationship between ENFO and the community members. The community felt more connected to the project and saw ENFO as an organisation that truly cared for their livelihood. This connection resulted in a community that

was more willing to accept and use the SolaWata project, which explains the significant success of Kamabai and Bafodia.

While only the usual amount of time was spent installing the systems in Sinkunia and Bendugu, both of these sites use adjusted pricing systems for SolaWata. The community members of Sinkunia made a unilateral decision to lower the price of the five gallon refill from Le 3,000 to Le 1,000. This Le 1,000 fee matches the typical price in the communities for hiring someone to fill a regular five gallon container with well or stream water. Given that Sinkunia produces and sells the most SolaWata on a weekly basis, it is likely that this price reduction has attracted more customers to the product and enables them to purchase more water for their households. Bendugu has adopted a policy that allows community members to bring their own containers to be filled with SolaWata. Although it is still possible to register for and use a SolaWata container, the CCS operators will wash and fill any closed mouth, five gallon container that a customer wants to use for SolaWata. While this policy has only been implemented recently, in May 2013, it could partially account for Bendugu's SolaWata success.

3.2 Health Impact

Across all nine sites, there have been significant positive effects on the health of individual SolaWata consumers. Ninety-eight percent of SolaWata users said their health has improved since drinking SolaWata and several households who drink only SolaWata indicated that stomach sicknesses have been completely eliminated. One of the users in Tawuya who can only afford SolaWata for some members of his household even noticed a distinct difference in health between individual family members, as those who drank SolaWata were much healthier than those who continued to depend on the stream water. In fact, SolaWata users across the nine communities reported an average of half as many cases of stomach sicknesses per year compared to respondents who do not purchase the water. All nine of the health clinics at SolaWata sites recommend SolaWata to their patients, endorsing its positive effects on individual's health.

However, given the limited uptake of SolaWata, the project has not yet affected health at the community level. Though health clinic staff from six of the nine communities reported that the number of water borne illnesses in the community have decreased over the past two years, they indicated that this trend is most likely due to increased government programs promoting the

use of pure water and various well chlorination projects. Additionally, despite having heard of SolaWata and recognising it as a pure source of water, only the health clinic in Kamabai regularly uses the water in their facilities. This limited use in the main health clinics for each community has also restricted SolaWata's impacts on the village level. Indeed, since a negligible percentage of each community currently purchases SolaWata, it is unlikely that any positive trends in community health have been a direct result of the SolaWata project. Nevertheless, the vast positive health impacts of SolaWata on the individual indicate that as the SolaWata market grows, there will likely be notable health effects at the community level.

While it is too early in the project to gauge SolaWata health impacts on the community in general, statistics on household health were collected in both the baseline study and the most recent survey. Table 2 compares the data from the two different surveys, for both the number of water-borne sicknesses and the number of health clinic visits per year in the average household. Though SolaWata has not had a direct effect on any community wide trends, these statistics have been included for interest's sake. Also, as noted in the methodology, collecting such numerical data at a community level is quite problematic so the numbers should be treated as being broadly illustrative rather than exacting.

Community	Average Household Water-Borne Sickness Per Year			Average Household Health Clinic Visits Per Year		
	Data from July 2012	Data from June 2013	Change	Data from July 2012	Data from June 2013	Change
Kamabai	12	6.2	Decrease	14.4	3.3	Decrease
Kamakwie	20.4	6.4	Decrease	19.2	3.2	Decrease
Kassirie	18	15.8	Decrease	19.2	14.2	Decrease
Mambolo	18	13.5	Decrease	22.8	17	Decrease
Rokupr	18	21.4	Increase	20.4	13.6	Decrease
Tawuya	12	14.3	Increase	12	14.4	Increase
Bafodia	13.2	7.6	Decrease	14.4	3.4	Decrease
Bendugu	12	7.5	Decrease	12	3.4	Decrease
Sinkunia	13.2	6.5	Decrease	14.4	3.2	Decrease
Average	15.2	11.0	Decrease	16.5	8.4	Decrease

Table 2: Health statistics for each of the nine communities from the baseline study in July 2012 and the most recent study in June 2013. The number of water-borne sicknesses per year and the number of health clinic visits per year were reported by the heads of the households during the community interviews. Due to the small percentage of the communities currently using SolaWata, it is unlikely that the project has had a direct impact on any of these trends.

3.3 Community Acceptance of SolaWata

SolaWata has experienced various levels of community uptake across the nine sites. On the district level, Koinadugu is the most successful with nineteen regular SolaWata users, followed by Bombali with seventeen regular users and Kambia with fourteen regular users. Though the majority of these users are very satisfied with the product, these relatively low numbers reveal SolaWata's limited customer base. It is important to note, however that this relatively limited customer base for SolaWata is partially due to the short amount of time the product has been available. Some of the sites have also had slight disruptions in their SolaWata production. At the Kamakwie CCS in particular, production was often delayed by poor management of the hospital compound that houses the SolaWata facility, which probably attributes for much of its lack of success. All of CCSs have been selling SolaWata for six months or less; while this is enough time to establish the product on the market, it is a crucial limiting factor for SolaWata's current impact. With more time in production, it is likely that SolaWata will develop a larger customer base.

One of the biggest successes of the SolaWata project during its first several months of production, besides contributing to the community appreciation of the CCS and its facilities, was the branding of the product throughout the nine sites. As Figure 7 shows, the knowledge of SolaWata has spread to a majority of residents in each community.

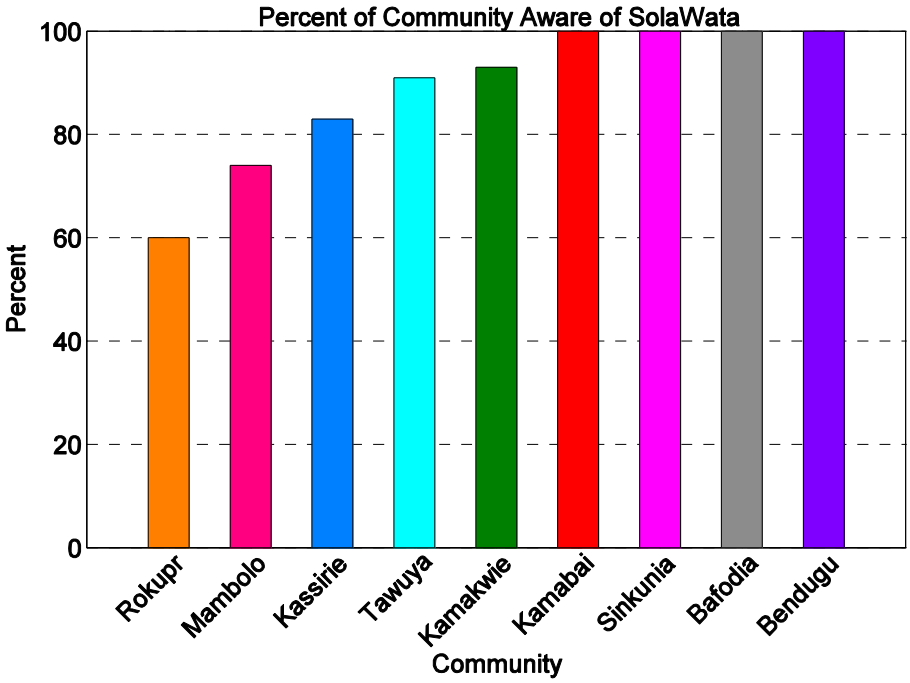

Figure 7: The percentage of interviews in each town who have heard of SolaWata. While some communities show that the branding of SolaWata has spread successfully on the large scale, others indicate a need to reach a wider range of community.

This data shows the initial success in branding SolaWata through radio campaigns, community meetings, and printed advertisements. The most successful form of advertising appears to have been radio in Bombali and Kambia Districts and a mixture of meetings, wall posters, and noisy campaigns in Koinadugu District where radio reception was not available at the sites.[2] However, the data also reveals the ongoing need to promote awareness throughout certain communities. In Rokupr in particular, one of the largest communities with SolaWata, interviewers noted that fewer people had heard of SolaWata when interviews were conducted at households longer than a fifteen minute walk away from the CCS. Nevertheless, SolaWata has experienced much success in creating a known brand name throughout the communities during its first four to six months of production.

Another major success of the project has been in developing an understanding of SolaWata throughout the communities. As Figure 8 shows, the majority of people who have

[2] For a noisy campaign, CCS employees drive a vehicle around the community announcing the SolaWata product advertisements through megaphones.

heard of SolaWata in each community know that SolaWata is a purer water source than other community sources like wells and streams. While this data indicates that the CCSs have succeeded in promoting a basic understanding of the SolaWata product to the general public, the significant portion of people who do not know the difference between SolaWata and well water demonstrates the need to build on this initial success to encourage more of the community to adopt SolaWata as a source of purified drinking water.

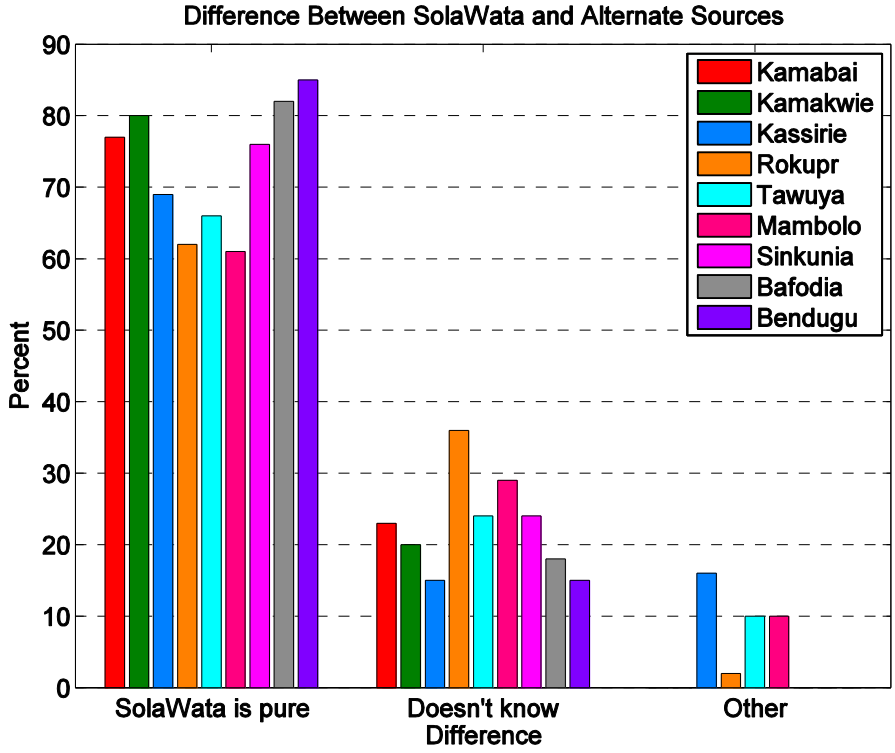

Figure 8: The percentage of respondents' answers to the question "How is SolaWata different than community sources?" This question was only asked of those respondents who indicated they had heard of SolaWata. While the majority of respondents understood that SolaWata is a purified source, the significant percentages of those who do not know the difference reveal a need to better inform the general public of the benefits of SolaWata.

Despite these successes, there has been limited uptake of SolaWata on the community level. As shown previously in Figure 6, the low percentages of SolaWata customers indicate this limited success, while the notable difference between the registered users and the regular users further implies that SolaWata is not usually adopted as a sole source of drinking water among its current customers. Those who have registered provide a foundational customer base for

SolaWata which needs to be expanded for the project to have lasting success on a community level. However, even if the number of SolaWata customers increases, it will be necessary to increase the number of people who drink SolaWata regularly for the project to have a significant impact on the communities and be economically viable. Even the Kamabai CCS, clearly one of the most successful sites, has significantly less regular users than registered users. This reveals that even in the community that has accepted SolaWata most eagerly, there is still limited success of the product as a main source of drinking water amongst its current customers. The Kamabai CCS operator indicated that many of the registered customers do not come for regular refills because they do not understand how to use solawata as a sole source of drinking water and as such do not feel the need to replenish it on a weekly basis. Thus far, it has been difficult for SolaWata to make a difference on the community level, since not only is its customer base very limited but few of the customers are using the product on a regular basis.

3.4 Desire for SolaWata in Plastic Packets

In Sierra Leone, the main source of purified water is plastic packets. Sold by various companies, a packet contains approximately 500ml of purified water and is sold on an individual basis or in a bulk bundle of twenty.[3] This water is most widely available in the urban centers of the country, while in the rural villages the packets are scarce and significantly more expensive. In Freetown, the capital city, a bundle of packet water typically costs Le 3,000, while in the rural villages this price varies from Le 4,000 to Le 10,000. While many households, particularly in rural communities, do not buy the packet water in bundles as a sole source of drinking water, the individual packets are purchased much more frequently. Each individual packet usually costs Le 200 in Freetown, while it costs Le 500 across all rural areas. Regardless of issues with price and availability, this packet water is the accepted form of commercialised water across all of Sierra Leone.

By far, the dominant request from community members across all nine sites was for SolaWata to also be sold in plastic packets, with ninety-seven percent of all respondents stating they would buy SolaWata in packets. The most common reason behind this desire was that the packet water is easier to use. Individual packets can be easily distributed among family members

[3] Although the packets are advertise as containing 500ml, of water, independent testing by ENFO indicated that the average amount of water in each packet tended to be closer to 425ml (Munro and Kebbay 2012).

or among guests at special occasions. The packet water, either individually or in a bundle of twenty, is also easier to transport than the SolaWata containers, which would make SolaWata in packets more practical for community members that live far from the CCS. In addition, several interviewees indicated that having the water in packets would enable them to sell or trade them in other villages, which would further their livelihood. This would also increase the market for SolaWata beyond the communities with the production sites. Many of the operators in the Koinadugu CCSs cited a similar reason, as having the water in packets would allow them to partner with businessmen to sell SolaWata to communities in the surrounding area. Another major reason given by respondents was that packaging SolaWata would enable them to buy the water in smaller quantities. Many interviewees indicated that if the SolaWata was sold in packets, they would buy a few packets at a time when they had the money available, while they were unwilling to ever pay the higher cost for the large five gallon container. Additionally, the packet water serves as a status symbol in many villages throughout the country; those who drink the packet water are perceived as being wealthier than those who cannot, increasing the appeal of packets over the current SolaWata containers.

This request for packaged SolaWata was even one of the most popular recommendations among current SolaWata users. Out of the forty-seven SolaWata users interviewed, twenty-five of them answered that the best improvement for the CCS would be to package SolaWata, while nearly every CCS operator also supported this recommendation wholeheartedly. Thus even among those who already work with and purchase SolaWata, the addition of packets was the main suggestion for improving production. Furthermore, given that packet water costs more in rural areas than it does in Freetown, there is great potential for SolaWata to directly compete with this market at the nine SolaWata sites and its surrounding areas.

However, some SolaWata users voiced concerns over the system being changed from containers to packets because the containers provide large quantities of water for a very cheap price. The five gallon container refill is currently offered for a lower price than a bundle of twenty packets which only contains a little over two gallons of water. These SolaWata users were concerned that selling SolaWata in packets would eliminate their current source of cheaper purified drinking water.

3.5 Response to the Container and Pricing System

The pricing strategy of an initial deposit for the SolaWata container with a small fee for refilling the container was established at all nine sites. While the prices for the deposit and the container were designed to cover expenses while providing profit to the CCSs, many of the reasons people cited for not purchasing SolaWata were monetary, as seen in Figure 9. With thirty-nine percent of all interviewees citing that SolaWata in general is too expensive, it appears that in many cases people felt that both the cost of the deposit for the container and the cost of the water itself were too high for them to buy it for their household. An additional twenty percent cited the deposit cost in particular as a reason for not buying SolaWata, illustrating the limitations of the structure of SolaWata's pricing strategy to meet community needs.

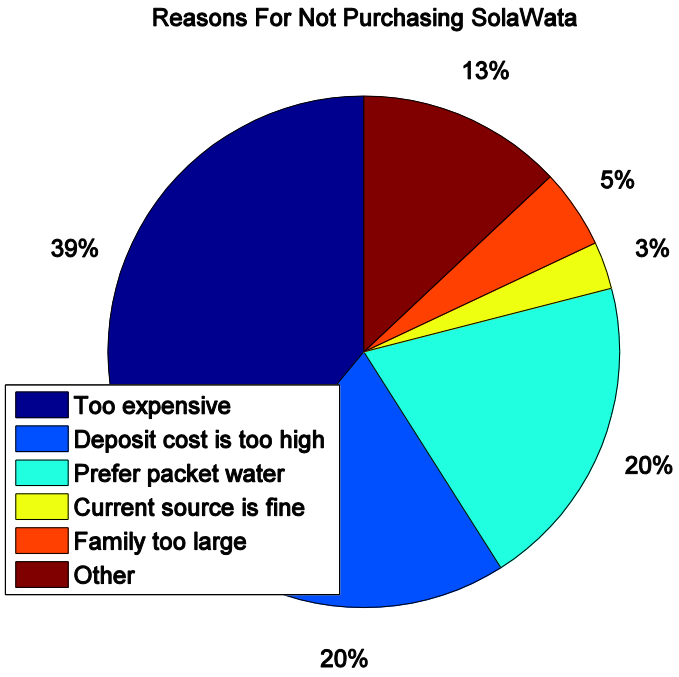

Figure 9: The responses to the questions "Why do you not drink SolaWata?" from non SolaWata users across all nine communities. The majority of answers were monetary reasons, revealing that the current pricing system for SolaWata is a possible barrier to its success. Other responses given included not knowing that SolaWata is available for sale and fearing damaging the container and thus losing the deposit.

At all nine sites, interviewees were asked what price they would be willing to pay for the deposit and the refill of the five gallon SolaWata container but at the Bombali and Koinadugu

sites, the responses were heavily biased because the respondents were informed of the current prices. However, at the four Kambia sites this bias was not introduced and thus the answers revealed a more accurate willingness to pay for SolaWata among community members. As can be seen in Figures 10 and 11, a majority of respondents from Kambia want to pay less for both the container and the refill than their current prices of Le 15,000 and Le 3,000 respectively. In fact, forty-nine percent of respondents in the Kambia District said they would be willing to pay the same amount or less for the deposit as they would be willing to pay for the water itself, showing a lack of understanding of how the deposit functions. This result, in addition to the general lack of SolaWata uptake at all nine sites, suggests that the current deposit system has not been accepted by the communities.

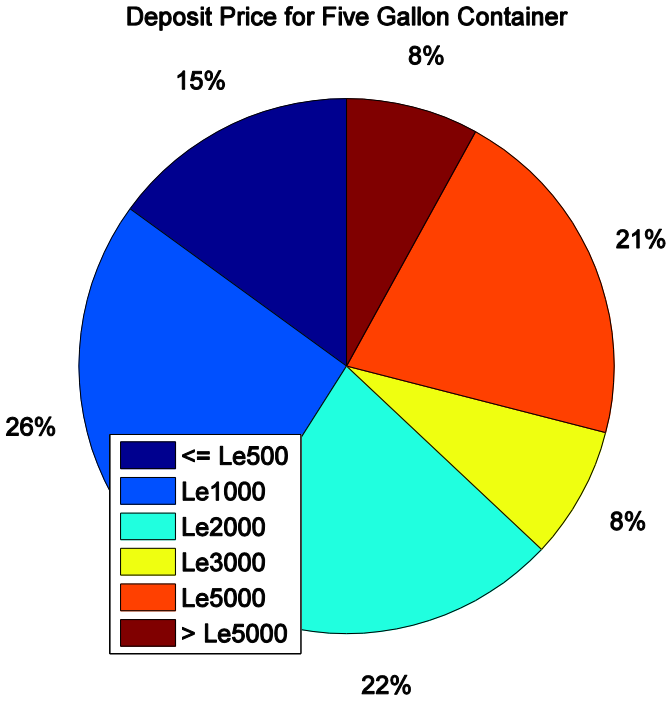

Figure 10: The responses for willingness to pay for the five gallon container deposit across Kassirie, Mambolo, Rokupr, and Tawuya, the four communities in the Kambia District. Though it is true that consumers always want lower prices, the fact that the vast majority of responses were Le 5000 or lower shows that the current deposit price of Le 15,000 is prohibitively high in these communities.

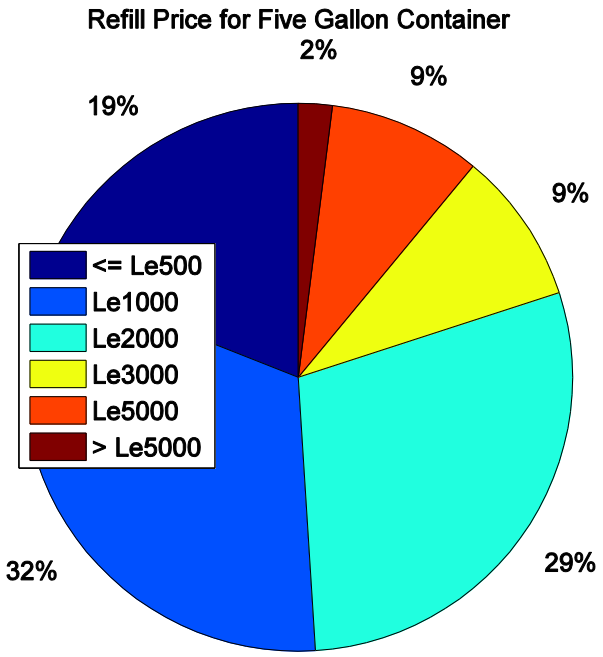

Figure 11: The responses for willingness to pay for the five gallon container refill across Kassirie, Mambolo, Rokupr, and Tawuya, the four communities in the Kambia District. Interestingly, the differences between the majority of the responses and the current price of Le 3,000 were not large and were probably motivated by the consumers' desire to always pay less. However, the similarity between the Figures 10 and 11 reveals a lack of understanding and acceptance of the current deposit system.

While this data suggests that lowering prices in general will make SolaWata more accessible to the community, observations of current community practices reveal that the prices themselves are not the only barrier to gaining more customers. Purchasing a container, as required by the SolaWata deposit, is not an unprecedented concept in any of the nine communities. Community members must buy the buckets or plain five gallon containers they currently use for transporting and storing water from a well or stream; the typical price for a five gallon container is Le 12,000. In addition, the deposit system has been adjusted in some communities. In Kambia, all four sites offer the option of paying for the deposit in Le 5,000 increments instead of the Le 15,000 fee all at once and in Bendugu, customers are allowed to bring their own container, thus bypassing the deposit altogether. There has not yet been any noticeable change in the SolaWata customer base in these communities, though it is possible that these changes will take effect with more time as they were implemented fairly recently. Given

that the precedent of paying for a container at a comparable price to the SolaWata deposit exists throughout Sierra Leone and the lack of immediate success from changes in the deposit system, it is likely that price itself is not the only cause of the limitations of the container system.

Instead, the crux of the problem is probably the community member's perception of the container and pricing system. First, as suggested by the similarity between Figures 10 and 11, the communities do not understand or accept a system with an initial high cost, as many people want the price of the deposit to be comparable to the price of the refill. The initial higher price of the deposit prohibits people from starting to purchase SolaWata, even if they'd be willing to pay the lower price for refilling the five gallon container. It is likely that people would prefer a system similar to the way they buy the packet water on an individual packet basis when they do not have enough money to buy an entire bundle. The higher price of deposit prevents people from using this strategy with SolaWata as well, since they are required to pay the higher fee first. In addition, water in containers is typically associated with collection from wells and streams, while the packets are the only widely commercially available form of purified water. This leads to the perception among the general public that water in packets is pure and water in containers is not, which presents a crucial barrier to SolaWata's success. The community members do not place high value on water in containers, even if they know it is purified SolaWata, resulting in their complaints that the product is too expensive relative to their willingness to pay.

4. Discussion

While each community responded differently to SolaWata, several significant trends emerged across all nine sites. The major patterns that emerged revolved around the sale of SolaWata in packets and the current container and pricing system. In addition to these concerns, it is also critical to analyse the current understanding and perception of SolaWata throughout the communities. These points will be the key components for building SolaWata's success in the future.

4.1 Plastic Packet Considerations

As discussed earlier, selling SolaWata in plastic packets was a major request at all nine sites. The reasons behind this recommendation included ease of use in the home and the possibility of transporting the SolaWata packets and selling them in other villages as a source of livelihood. The packets of water currently sold in the communities have limited availability and are sometimes prohibitively expensive; by providing SolaWata in packets, the CCSs would be able to meet these demands from the community. Also, in Sierra Leone many people believe that water in plastic packets is guaranteed to be of high quality and people who drink packet water are perceived to be the wealthier members of the community. It is likely that the limited success of the current container and pricing system is partially due to this perception. Because water in packets, not containers, is viewed as pure, community members are unwilling to pay for SolaWata because they do not accept the water as a purified source that is worth the current prices. Selling SolaWata in packets to respond to this perception could be used to increase the appeal of the product.

If SolaWata were sold in packets, more people would view it as a pure source of drinking water. This would serve as a way to transition customers into the container system. Community members would be more likely to buy the packaged SolaWata first as the packets are accepted form of purified water. However, once people begin to purchase and drink SolaWata packets in their homes, they will begin to appreciate the benefits and value of the water itself. It is then probable that after drinking SolaWata in packets for several months, customers will realise that the container system provides the same water for a cheaper price, even though containers are not typically connected to purified water. Thus, packets may attract the customers initially through their perception of purified water and give them an opportunity to appreciate the SolaWata. Once customers accept SolaWata as a purified source, there will be the potential for transition into the original system of cheaper containers.

However, there are major drawbacks to selling SolaWata in packets. First, packaging the water would make the SolaWata installations more expensive. Each SolaWata station would have to be equipped with a machine for packaging the water and additional funds from the profit of the CCS would have to be used for machine maintenance. There is also limited space in many of the current CCSs and thus funds might have to be used to expand the sites to include the packaging process. Furthermore, the packaging machines would also have to use power from the

solar systems; almost all of the sites do not currently have enough power to support this extra equipment and thus would require an additional solar system installation. The projected cost of implementing the packaging process at a current SolaWata site is approximately Le 300 per litre, as calculated in detail and compared to the current costs in the included business plan. In addition to the financial concerns, selling water in plastic packets raises an environmental concern. Though there is a market for empty packets in some rural communities, Sierra Leone lacks wide-scale recycling services and therefore the plastic packets may contribute to environmental waste. These concerns need to be weighed against the aforementioned benefits to evaluate the possibility of SolaWata being sold in packets.

4.2 The Current Container and Pricing System

The pricing strategy for SolaWata based on a deposit system is currently used at all nine sites, with some variations in certain communities. The deposits provide security for ENFO and the CCSs on their investment in the containers. The system also fosters a stronger relationship between the CCS and the customer, as it requires them to trust the CCS with their deposit money while also encouraging them to make use of the container on a regular basis. In addition, SolaWata users registering for the container provides an easy way for CCS operators to keep track of customers.

However, while this pricing system is reliable for the CCS, it has been ineffective in attracting SolaWata consumers. The initial high cost of the deposit discourages people who may have been willing to pay the refill fee for the water itself. Purchasing a container is not an unprecedented concept in these communities, but many of the respondents still felt that SolaWata prices were too high. Though the deposit system has been modified to include paying in increments at the Kambia sites and has been completely waived in Bendugu where the customers bring their own container, none of these sites have seen a significantly larger SolaWata customer base since the changes have been made. However, lowering the price of the refill has seen much success in Sinkunia. The only village where the five gallon refill price has been reduced to Le 1,000, Sinkunia sells the most SolaWata on a weekly basis. This success indicates that the current price of the water itself in other communities may also be a barrier to a successful SolaWata market.

In addition, containers are not typically viewed as storing purified water even when they are sold from the SolaWata facilities. This perception regarding purified water limits the value community members place on SolaWata containers, contributing to their unwillingness to pay. However, it is not clear that further subsidising the cost of the deposit to meet community demand would completely solve the problem. Most of the interviewees did not understand a single system that requires paying a higher price for a deposit and then a lower price for water, thus limiting their likelihood to purchase the product even with a lowered deposit cost. In addition, the containers themselves are expensive, which is the reason why the deposit is necessary in the first place. Also complaints about the deposit system from the CCS operators indicate that in order for them to gain more customers, the deposit would have to be lowered or the system changed completely. With these drawbacks in mind, supported by negative feedback from the communities, it is likely that the current container and pricing structure is a major obstacle for potential SolaWata customers.

4.3 Understanding of the Product

General Public

A key component to increasing SolaWata's customer base is responding to the low level of public value for the product. While performing SolaWata demonstrations at the CCS facilitates better understanding of SolaWata, many households still do not accept its value as a purified source due to existing perceptions about purified drinking water and their own current water sources.

Attempts to increase the product's value in the eyes of the community members are hindered by the availability of alternate water sources. The problems for SolaWata that arise from these sources are twofold. First, the sources are easily accessible for the community. All of the villages have at least one regular water source that is free for public use. The availability of free drinking water, especially during the rainy season, makes people reluctant to spend money on SolaWata despite the fact that it is purified. At many of the sites, ENFO improved the existing source that provides the water to be filtered for the production of SolaWata. In particular, ENFO fixed a system in community taps in Bafodia which now regularly provide clear water throughout the village and in Kamabai they provided a complete new system for storing and pumping water, including a security light and new public tap, at the water source used for

SolaWata production. In Kamabai, revenue from the CCS is even used to hire a security guard for SolaWata's source and the public tap. Ensuring the security of these sources was necessary to the success of the project and respecting original sources built trust between ENFO and the community. It also allowed ENFO, as a community development organisation, to not monopolise the community's water supply by keeping current community sources available even when those sources are used to provide water for the production of SolaWata. However, it did make an alternate source of drinking water readily available for free to the community. In all of the communities, the availability of various other water sources, including local streams and previously built wells and hand pumps, limits the uptake of SolaWata.

Another component of limited SolaWata use is the community members' lack of value for the product. Not only are other sources readily available, but these sources have often been used and trusted by the community for years. It seems that community members do not place much value on SolaWata as a pure source because they already have a regular source of drinking water that works for their household. These community sources, in addition to the perception that all purified water is sold in packets, limits the value of SolaWata for the general public. Perhaps once the positive health impacts of drinking SolaWata become more visible at a community level, the value placed on SolaWata will start to increase. However, for now it appears that the availability of alternate water sources and packet water and consequent lack of value for purified water in containers is crucial barrier to widespread SolaWata success.

In addition to difficulties in promoting appreciation of the product itself, the communities have various levels of understanding that SolaWata is a community development project. In many of the communities, respondents felt a strong sense of pride in the CCS because of its benefits for the community. Tawuya interviewees in particular were very grateful for all the opportunities for development that have come from the CCS and were eager for the SolaWata project to be adapted to their needs so that they could continue to take advantage of projects that directly benefitted their community. However, in some communities, this understanding was limited. This problem was most acute in Kamakwie, where the production site for SolaWata is located on the hospital compound. Many community members felt that SolaWata belonged to the hospital and did not see it as a community project even though it is sold from the CCS in the community hall. This sense that the project is separate from the community, in addition to the hospital's poor management and lack of use of the system, limits the success of SolaWata in

Kamakwie. In all of the sites, it is likely that increased understanding of how the SolaWata project develops their community will encourage more households to become SolaWata customers.

Health Clinic Staff

As with the general public, there is a lack of understanding and value for SolaWata's benefits among health clinic staff. Out of the nine health clinics serving the communities with SolaWata, only the one in Kamabai currently uses SolaWata to provide patients with drinking water. The disappointing lack of SolaWata in health centers that could benefit greatly from pure water can be traced to the limited involvement of health officials in the installation of the SolaWata systems. In Rokupr in particular, the Chief Health Officer (CHO) was very interested in SolaWata, but did not know any of the details of how it was filtered and purified. Since the health clinics were not engaged in the initial SolaWata installation and promotion, they do not have a clear understanding of the product. If health clinics had been informed of the filtration and purification process of SolaWata, they would be more likely to understand the benefits of using it in their facilities.

5. Recommendations

The survey results give ENFO critical insights into the various successes and limitations of SolaWata. These insights have informed the following recommendations for the future of the project, which focus on the main trends that emerged from community interviews.

5.1 Experimenting with Plastic Packets

Given SolaWata's current limited success and the overwhelming request for packets, it is advisable to experiment with selling SolaWata packets. In addition to widening the customer base by appealing to those community members who wish to buy the SolaWata in packets, the ease of transporting packets also opens the opportunity for SolaWata to spread beyond the installation sites. Since some current users, particularly in Koinadugu and Bombali, emphasised that they preferred the containers over the packets it would be advisable to keep the option of purchasing the container available as well. By utilising the container system alongside selling

packaged SolaWata, the CCS will be able to retain current consumers while appealing to the broader community who desires SolaWata in packets. As mentioned earlier, providing packets can also serve as a transition into the container system; customers who start drinking the SolaWata in packets will begin to value the water as a purified source and thus be more willing to pay for the containers, which ultimately provide more water for less cost.

Kassirie stands out as the best candidate for a trial site for selling SolaWata in packets. A community in Kambia, the district with the most water borne illnesses, Kassirie has great need for access to purified drinking water (Munro and Kebbay, 2012). The health officials at the Kassirie clinic stressed the need adjust the SolaWata system so that the community could afford to drink it and ninety-four percent of interviewees stated that they would buy SolaWata if it were sold in packets. Currently, the only packet water available is brought in from Freetown and is sold at a higher price. As such, SolaWata in packets would have very little competition from other brands, but would still be entering a market where the idea of buying water in packets has already been accepted. In addition, the CCS is located at the wharf on the Great Scarcies River, which is the prime location for having packets available to sell to people traveling through Kassirie by boat. Many interviewees from Kassirie stressed that SolaWata in packets would be easier to use on the boats, as users would not need to worry about losing the container or having to return it. Several respondents also believed that if SolaWata was sold in packets in Kassirie, people from surrounding villages would travel there to purchase their water instead of waiting for the packets from Freetown.

5.2 More Health Clinic Involvement

Given that Kamabai is one of the most successful SolaWata sites and its health clinic is the only one that strongly supports the use of SolaWata in their facility, there is the potential to utilise the active promotion of SolaWata by local health clinics to encourage consumer acceptance of the product. However, in most of the nine communities, support of SolaWata by the health clinics was disappointingly low. While ENFO has attempted to build a relationship between the SolaWata facilities and the health clinics before, it would be advisable to increase and continue health clinic involvement in the project. To achieve this end, ENFO should include a health clinic outreach component to all of their monthly monitoring trips to the SolaWata sites to explain SolaWata to the staff members. These visits will build a more personal relationship

between the CCS and the health clinic and will give clinic staff firsthand knowledge on how SolaWata is produced and sold. In addition, free samples of SolaWata should be provided to all nine health clinics. On the monitoring trips, a five gallon SolaWata container should be brought to the health clinics that should then be refilled for free on a weekly basis. This will increase SolaWata's visibility in the community in addition to establishing a long-lasting relationship between the CCS and clinic. Over time, these efforts will hopefully build a stronger relationship between the CCSs and the health clinics based on a better understanding of the system and have the potential to result in more health clinics adopting SolaWata as a central part of their facilities.

5.3 Encouraging the Community to Value SolaWata

In order to increase SolaWata's consumer base, the existence of SolaWata must be spread throughout the entire community. It is crucial that community members do not only hear about SolaWata, but that they also understand its value compared to other water sources. While there have already been many demonstrations performed in the communities to promote SolaWata, these promotional programs need to continue to increase the project's success. To promote awareness across the community, it would be advisable to continue holding SolaWata demonstrations in other areas of the community besides the CCS itself, such as a market, a wharf, or a health clinic. As with previous demonstrations, free samples should be available and the information given out at these demonstrations should focus on how SolaWata purification works and why that makes it superior to other water sources. This would broaden SolaWata's visibility beyond those who regularly visit the community centers. In addition, given that a high proportion of each community uses the CCS for charging their mobile phones, another effective promotional effort might be to establish an introductory period during which CCS customers are given a free trial of half a gallon of SolaWata with any phone recharge. It would also help enhance SolaWata's appeal if ENFO asked chiefs and other highly respected members of the community to support the product. This strategy has been successfully implemented in Bafodia and should be encouraged again in other communities. If the community's chief spoke in favor of SolaWata at demonstrations, the general public would be more inclined to listen and purchase SolaWata themselves.

6. Conclusions

Over its first several months of production, SolaWata has established itself in its target communities. A vast majority of those interviewed across all nine sites have heard of SolaWata and an encouraging number of people also understand that it is a source of purified water. In addition, SolaWata has had notable positive health effects on the households who drink it. Despite these successes, the current SolaWata customer base makes up a small percent of the communities and even those who have purchased the SolaWata container are slow to adopt it as their sole source of drinking water. Since SolaWata has only been in production for six months or less depending on the site, it is likely that this limited customer base is at least partially due to the short amount of time SolaWata has been on the market and that it will expand as SolaWata becomes more established in the community. However, the observations made in all nine communities provide crucial insights on how to improve the product and ensure its future success. The most common recommendations from respondents for improving SolaWata focused on use of plastic packets and changes to the current pricing structure. In addition, health clinics were revealed as a critical area to development more understanding and promotion of the product in order to increase its success in the communities. Given the success in promoting knowledge of SolaWata across the community and its substantial health impacts on the individuals using the product, it is clear that with some adjustments, SolaWata can successfully provide purified drinking water for many people in the target communities.

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