



Mobile for Development Utilities
EcoEnergyFinance
Distribution of Solar Pay-as-you-go in Pakistan



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Mobile for Development Utilities

The Mobile for Development Utilities Programme promotes the use of mobile technology and infrastructure to improve or increase access to basic utility services for the underserved. Our programme focuses on any energy, water or sanitation services which include a mobile component such as mobile services (voice, data, SMS, USSD), mobile money, Machine to Machine (M2M) communication, or leverage a mobile operator's brand, marketing or infrastructure (distribution and agent networks, tower infrastructure). The Programme receives support from the UK Government.

Author: Rahul Shah

The Innovation Fund

The Mobile for Development Utilities Innovation Fund was launched in June 2013 to test and scale the use of mobile to improve or increase access to energy, water and sanitation services. In two phases of funding, grants were competitively awarded to 34 organisations across Asia and Africa. Seed grants were awarded for early stage trials, Market Validation grants for scaling or replication of business models, and Utility Partnership grants to foster partnerships between utility companies and innovators.

The specific objective of the Innovation Fund is to extract insights from the trial and scaling of these innovative models to inform three key questions for growing the sector:

- How can mobile support utility services?
- For a mobile-enabled solution to be adopted at scale, what building blocks are needed?
- What are the social and commercial impacts of delivering community services to underserved mobile subscribers?

These insights, as well as grant-specific learning objectives, are included in individual case studies such as this one, as well as thematic reports that will be published throughout 2015 and 2016.



This document is an output from a project co-funded by UK aid from the UK Government. The views expressed do not necessarily reflect the UK Government's official policies.

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Executive Summary

In January 2014, the M4D Utilities Programme awarded the Pakistan-based company EcoEnergyFinance (EEF),¹ a GBP 24,614 Seed grant to sell 50 solar home systems (SHSs) with GSM-based machine-to-machine (M2M) connectivity and 750 solar lanterns on a pay-as-you-go (PAYG) basis in Sindh, Pakistan. EEF sourced SHSs from BBOXX and lanterns from Greenlight Planet which were integrated with Angaza Design's PAYG technology. The key objectives of the grant were to validate the viability of EEF's distribution models for the two PAYG products as well as to verify to what extent the GSM network coverage would support the deployment of M2M-enabled SHSs.

M2M connectivity in the SHS enabled EEF to monitor system usage and performance, while providing the ability to remotely switch on or off the SHS. EEF developed a partnership with UBL Omni, a third-party mobile money operator for payment collection. EEF used Vodafone's global roaming SIM through an arrangement with BBOXX, its SHS vendor, for M2M connectivity which allowed EEF's systems to roam on Ufone, Warid and Mobilink's mobile networks.

Initially, EEF anticipated selling systems in partnership with the Karachi Relief Trust (KRT),² a humanitarian organisation, where KRT would identify potential customers. However, due to changes in KRT's priorities, EEF also took on the task of identifying potential customers.

Key findings of the grant include:

Although the lanterns and home systems were both powered by solar technology, selling them required entirely different skills: EEF expected to exploit operational efficiencies using the same sales force to sell lanterns and SHSs. However, EEF came to the conclusion that selling lanterns and SHSs was not synergistic due to the difference in the nature of the sale. Specifically, EEF found that village agents could easily sell lanterns, but struggled with the more complicated configuration and sale of an SHS. As a result, EEF shifted to direct sales of the SHS through its staff.

Small business owners³ have a higher repayment rate for SHSs at 94% as compared to households dependent on other sources of income at 81%: EEF found that small business owners typically already have a regular expenditure on energy which can be re-allocated to the SHS. EEF plans to focus on small business owners going forward.

For 68% of EEF's customers, the nearest mobile money agent was at least 5km away: The sparse presence of mobile money agents in EEF's sales area requires EEF staff to be involved in payment collection and dampens EEF's potential to scale.

Affordability is a barrier despite adjustments to SHS pricing and configuration: After experimenting with SHS configurations and pricing in early 2014, EEF settled on an 18-month term with prices ranging from PKR 2500 to PKR 4500 per month (USD 24.12⁴ to 43.41). To reduce the monthly payment, EEF also experimented with a rental plan for a short time. EEF is now considering longer term loans (24-36 months) to further increase affordability.

The repayment rate of EEF's PAYG lantern portfolio was 94% as compared to the non-PAYG portfolio rate of 70%:⁵ EEF has been selling lanterns without

1. See EEF's website for details about the organisation: www.ecoenergyfinance.org

2. See KRT's website for details about the organisation: www.karachirelief.org/whoweare.php

3. Includes small business owners who use the SHS at home or at their place of work, not just those who use the SHS for income generation

4. Prices in PKR converted to USD using OANDA Online Currency Converter for December 2015. Average: 103.658

5. Although repayment rate is defined differently for the two portfolios, the significantly higher repayment rate for the PAYG portfolio indicates that PAYG technology considerably improves repayment.

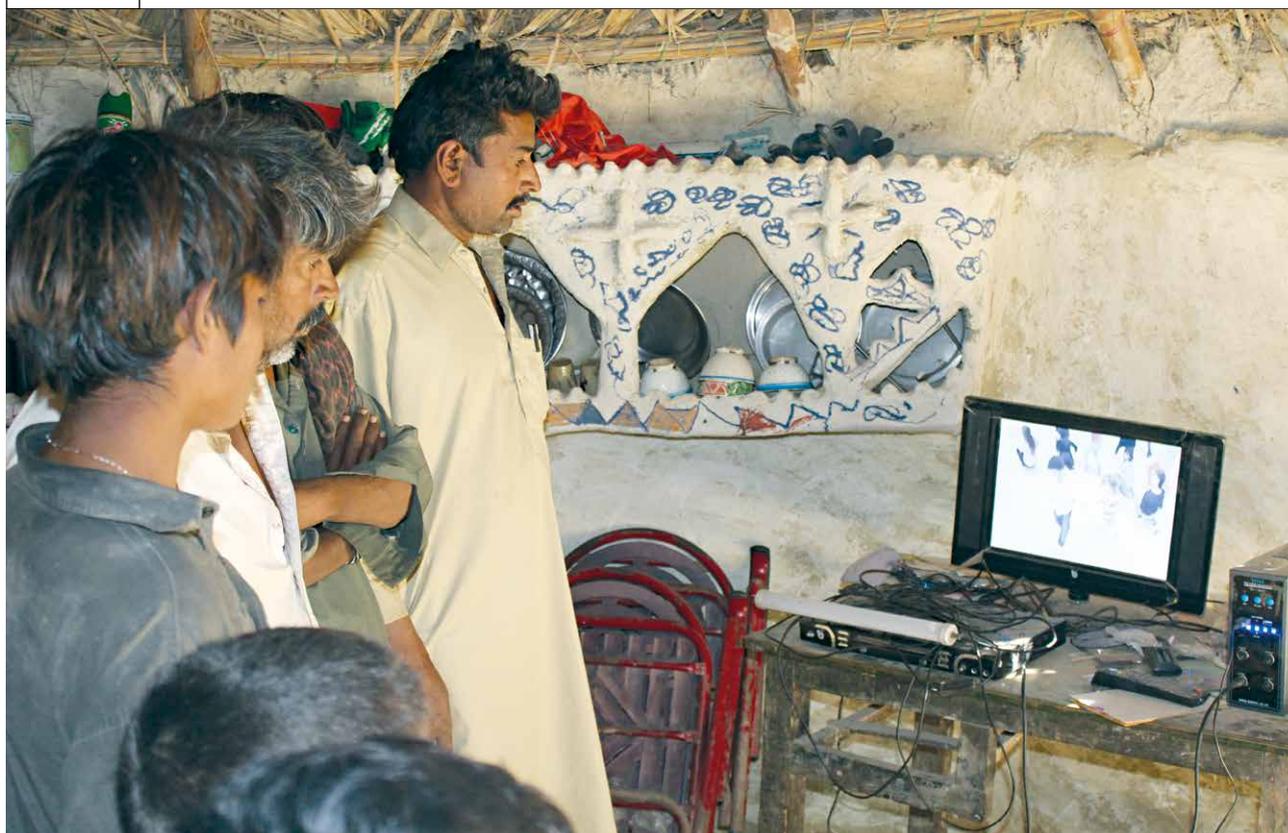
PAYG technology on cash or credit since 2013. During the project, EEF reduced PAYG lantern pricing from PKR 360 (USD 3.47) to PKR 295 (USD 2.85) per month for five months. Despite the price reduction, PAYG lanterns are still more expensive than non-PAYG lanterns. The significantly higher repayment rate clearly indicates the benefit of PAYG technology to ensure timely repayments.

With declining roaming costs, global roaming SIMs can provide both convenience and flexibility: EEF estimates that Vodafone's global roaming SIM had a lower total cost of ownership than a local SIM even when cost of the monthly plan for the global SIM was more than twice as much. This was because the global SIM can roam on the best available network and keep SHSs connected, comes preconfigured to disable calling and data, and frees EEF from having to manage billing with a local MNO.

EEF's sales targets were reduced to 26 SHSs and 657 lanterns to enable EEF to maintain sufficient spares to fulfil its warranty commitments to customers and also due to technical faults with BBOXX SHSs that stalled sales.

EEF sold 652 lanterns, nearly achieving its revised target for lanterns. EEF's sales remained stalled at 26 SHSs at the end of 2015, due to the unavailability of working systems. The EEF team received support from BBOXX in the form of support staff, free spare parts and an engineer visit, but faced technical issues that prevented the deployment of all units. However, as a result of its extensive efforts to understand and resolve the problems, BBOXX was able to make significant improvements in the new version of its product. Furthermore, EEF gained confidence in BBOXX's commitment to support it and decided to form a closer, longer-term relationship with BBOXX. With the stronger partnership, EEF aims to sell 1,000 BBOXX SHSs in 2016.

Source: EEF



SHS customers watching TV

Introduction

EcoEnergyFinance was founded by Shazia Khan and Jeremy Higgs in 2010. EEF is a hybrid organisation, composed of a non-profit 501(c)(3) in the USA and a Private Limited Company in Pakistan.

EEF delivers affordable solar energy solutions to remote and off-grid customers in Pakistan through its integrated sales and service network. It fills the missing distribution link between product manufacturers and customers. To achieve this, EEF does the following:

- Operates a fleet of sales staff and village agents that can reach off-grid customers, under-served by

government institutions, micro-finance institutions and NGOs alike;

- Screens potential customers for their ability to make regular payments for solutions;
- Utilises PAYG technology and financing mechanisms, such as rent-to-own and rental plans, to ensure payment collection and make solutions affordable;
- Provide high-quality service to customers, through remote GSM monitoring, phone support and technical visits.

Key Facts

FIGURE 1

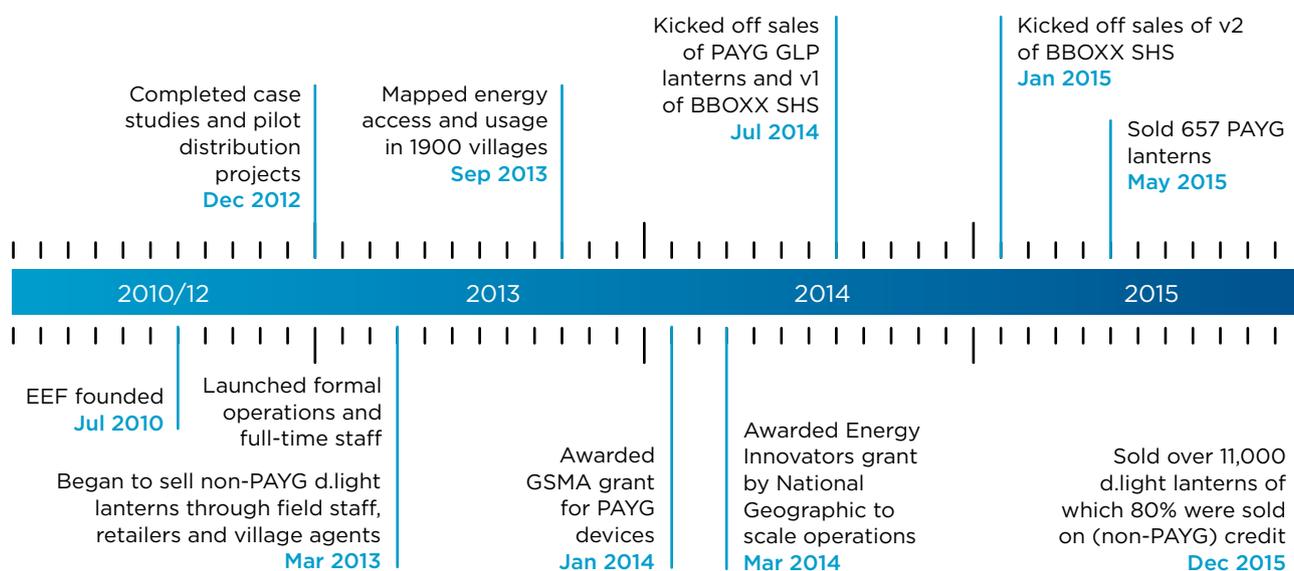
Company overview as of December 2015

Name	EcoEnergyFinance (EEF)
Sector	Energy (Solar), specifically, distribution of solar solutions
Year Established	2010
Country Footprint	Pakistan
Product/Service	<ul style="list-style-type: none"> • Pay-as-you go solar home systems (30W, 50W) and pay-as-you-go solar lanterns (1W) • d.light lanterns without PAYG technology
Market Segment	Off-grid households and small enterprises
Total systems/ Customers served	<p>26 solar home systems and 652 solar lantern sold by December 2015 under the grant-funded project with an estimated 4050 direct beneficiaries.</p> <p>Apart from the grant-funded project, EEF has sold over 11,000 d.light lanterns without PAYG technology since 2013</p>
Use of Mobile: Technology and Partnership	<ul style="list-style-type: none"> • M2M connectivity for remote monitoring and control (SHS only) • Mobile money for customer payments • SMS and phone call reminders • Mobile phone app with GPRS connectivity for agents and sales staff to manage payments and credit

EEF'S growth timeline is depicted in Figure 2.

FIGURE 2 Source: EEF

EEF'S growth



Grant Objectives

The objectives of EEF'S Seed grant were as follows:

- To sell 50 GSM-enabled SHSs and 750 solar lanterns to improve access to energy for 4800 direct beneficiaries
- To use M2M communications with the SHSs to remotely monitor and control them to better understand consumption patterns and improve maintenance
- To integrate UBL Omni mobile money to collect payments as a key element of EEF's building blocks to scale.

The expected learnings for the broader pay-as-you-go solar sector, as defined by EEF at the outset of the project were:

- The effect that mobile-enabled PAYG has on increasing the affordability of solar energy solutions
- Customer usage of mobile payment accounts against over-the-counter (OTC)⁶ transactions
- Impact of increased access to solar energy on the quality of life for off-grid communities.

6. A transaction is considered OTC when it is conducted through an agent's account on behalf of the customer. See Mobile Money 2015 State of the Industry Report: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/03/SOTIR_2015.pdf

Market Opportunity

Addressable Market

Pakistan had an electrification rate of 69% in 2012 with 57% access in rural areas and 88% access in urban areas as per the International Energy Agency (IEA). In contrast, about 85% of the population of 182 million has access to GSM networks.⁷ Thus, Pakistan's energy addressable market, defined as the number of people who have access to GSM networks but not to electricity, is estimated at 29 million people or 16% of the population.

An IFC Lighting Pakistan survey⁸ conducted in 2015 estimates that the total population that is off-grid or has unreliable grid access is significantly higher. Specifically, it estimates that:

- There are around 144 million people (about 78%) in Pakistan who are either off-grid or experience more than 12 hours of load-shedding per day.
- Pakistanis with no or unreliable access to electricity spend nearly USD 2.3 billion each year on poor-quality lighting solutions, such as diesel generators and battery-powered torches, that fail to meet their needs.

Mobile Ecosystem

Pakistan's market penetration of unique mobile subscribers is 43% which is above the South Asia regional rate of 36%.⁹ In 2014, there were nine mobile operators in Pakistan. Mobilink led with a market share of 28%, closely followed by Telenor (26%) and Zong (19%).¹⁰

Pakistan has a vibrant mobile money ecosystem served by seven mobile money services, five of which are led by mobile operators and two by banks. Telenor Pakistan's easypaisa was the first mobile money service to launch in 2009 and is the current market leader with 8.8 million accounts followed by Mobicash (2.2 million) and UBL Omni (1.9 million).¹¹ Mobicash, UBL Omni and easypaisa maintained an active¹² to total account ratio of 93%, 73% and 17% respectively. OTC transactions accounted for 69% of all customer transactions. Across these services, there were a total of 267,914 mobile money agents serving the market, 79% of whom were active as of September 2015.¹³

Market Assumptions

In 2013, EEF surveyed 1,900 villages to assess energy access. It found that 40% of these villages did not have access to the electricity grid and another 40% had grid electricity for 1-9 hours per day. EEF began operations based on the following assumptions about their target customers:

- The typical customer resides in a small village (20-40 households) that is not connected to the electricity grid, or has a connection with low availability (5-6 hours/day).
- Such customers generally spend PKR 200-500 per month (USD 1.93-4.82¹⁴ per month) on hazardous or wasteful lighting solutions, lack access to clean energy solutions, and utilise products such as torches that require replacement every 3-6 months.

7. GSMA estimate

8. Potential for Financing Off-grid Solar Devices through Pakistan's Microfinance Industry: http://www.ifc.org/wps/wcm/connect/d72aa0004886746d8388f7299ede9589/Pakistan+Solar+Consumer+Study+Overview_26thMay2015_LQ.pdf?MOD=AJPERES

9. GSMA Intelligence, Q4 2014

10. GSMA Intelligence, Q4 2014

11. Branchless Banking Newsletter, Jul-Sep 2015, issued by the State Bank of Pakistan: <http://www.sbp.org.pk/publications/acd/BranchlessBanking-Jul-Sep-2015.pdf>

12. As per the State Bank of Pakistan's definition, a customer account from which at least one transaction was done in the past 180 days is considered active.

13. As per the State Bank of Pakistan's definition, an agent account from which at least one transaction was done in the past 90 days is considered active.

14. Prices in PKR converted to USD using OANDA Online Currency Converter for December 2015. Average: 103.658

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- They also spend PKR 100-500 per month (USD 0.94-4.82) on mobile prepaid credit, and up to PKR 300 per month (USD 2.89 per month) on mobile phone charging including transport costs. Based on this information, the target customers fall within the BOP500 classification, as defined by the World Resources Institute.¹⁵
 - Income is often seasonal, based on harvests that have a peak period of October-March, which constrains purchasing power in the remaining half of the year.
 - Existing solar energy solutions are not viable alternatives because local vendors do not provide warranties and support; expect upfront payment in cash; and access to microfinance for solar products is poor due to tough lending criteria and long distances to the nearest branch.

15. People with incomes below USD 500 in local purchasing power, i.e., those at the very bottom of the BOP. See https://www.wri.org/sites/default/files/pdf/n4b_executive_summary_graphics.pdf

Business Model

Value Proposition

At the time of designing the project, EEF operated a network of field staff and third-party retailers, through which it sold portable solar lanterns. Affordability was a challenge for end consumers, which is why EEF introduced payment plans. This project was initiated to see if mobile-enabled PAYG technology could help with enforcement of customer payments to reduce the risk of offering payment plans to customers.

The PAYG lanterns were meant to replace the carbon-based fuels that customers used for lighting, as well as provide mobile charging capability at

the customer’s premise. Lanterns would belong to customers within a few months and thus release them of dependence on hazardous fuels as well as save time and money spent on mobile phone charging.

The PAYG SHSs were meant for customers who wanted not only several lights and mobile charging capability, but also the ability to run appliances either at their home or place of business. Shop owners particularly could use TVs to attract footfall and increase revenue.

Products and Pricing

Lanterns

EEF sourced Greenlight Planet’s SunKing Eco lanterns enabled with Angaza Design’s PAYG technology. EEF also utilised Angaza Design’s PAYG billing platform and mobile application for credit management.

The SunKing Eco has three intensity settings that allow customers to extend the usable hours. Angaza worked closely with EEF on supplying products, problem diagnosis and repairs, and responded to EEF’s feedback for product improvement. Figure 3 shows lantern pricing.

FIGURE 3

EEF lantern prices

Greenlight Planet SunKing Eco with PAYG technology	Monthly prepayment	Total cost
Initial payment plan	PKR 360 (USD 3.47) per month for five months	PKR 1,800 (USD 20.84)
Final payment plan	PKR 295 (USD 2.85) per month for five months	PKR 1,475 (USD 14.23)

Source: EEF



Customer reading by the light of a SunKing Eco

Solar Home Systems

BBOXX provided 30W and 50W BB17 SHSs equipped with a GSM chip and global roaming SIM and accessories. Through a combination of a web dashboard and an Application Programming Interface (API), EEF had the ability to remotely monitor the devices for problems, to implement software updates and to disable customer devices in the case of non-payment.

Apart from supplying the SHS to EEF, BBOXX supported EEF with problem diagnosis and repairs and incorporated feedback for product improvement.

SHS pricing is shown in Figure 4 for the current portfolio of products. All loans were for 18 months. Although payments were specified as fixed monthly amounts, customers were allowed to pay for either lantern or SHS whenever they had cash available.

FIGURE 4

EEF SHS products and prices

System name	Included components	Monthly prepayment	Total price
"Roshni" Light System - Basic	BBOXX BB17 Control Unit & Battery 30W Solar Panel 6W Tube Light 1W Light Bulb	PKR 1,900 USD 18.33	PKR 34,200 USD 329.93
"Roshni" Light System - Advanced	BBOXX BB17 Control Unit & Battery 30W Solar Panel 6W Tube Light 1W Light Bulb 16" Pedestal Fan	PKR 2,200 USD 21.22	PKR 39,600 USD 382.03
Mobile Charging System - Basic	BBOXX BB17 Control Unit & Battery 30W Solar Panel 6W Tube Light 1W Light Bulb 9-port mobile charging hub	PKR 2,200 USD 21.22	PKR 39,600 USD 382.03
Mobile Charging System - Advanced	BBOXX BB17 Control Unit & Battery 50W Solar Panel 6W Tube Light 1W Light Bulb 9-port mobile charging hub 16" Pedestal Fan	PKR 2,800 USD 27.01	PKR 50,400 USD 486.21
"Autaaq" TV System - Basic	BBOXX BB17 Control Unit & Battery 50W Solar Panel 6W Tube Light 1W Light Bulb (2) 15" LCD TV	PKR 3,000 USD 28.94	PKR 54,000 USD 520.94
"Autaaq" TV System - Advanced	BBOXX BB17 Control Unit & Battery 50W Solar Panel 6W Tube Light 1W Light Bulb (2) 15" LCD TV DVD Player	PKR 3,500 USD 33.76	PKR 63,000 USD 607.77

Use of Mobile: Technology and Partnership

EEF employed mobile in contrasting ways for PAYG lanterns and PAYG SHSs. The SHSs had GSM-enabled M2M communication but the lanterns did not. Credit status was maintained on the BBOX backend for the SHSs. On the other hand, credit status was maintained autonomously by the lantern and the Angaza backend.

Use of mobile for lanterns

The steps in the PAYG process for lanterns are outlined below and illustrated in Figure 5. An Android smartphone equipped with the Angaza mobile app¹⁶ and cable activates lanterns at the time of sale. The lantern retains credit balance.

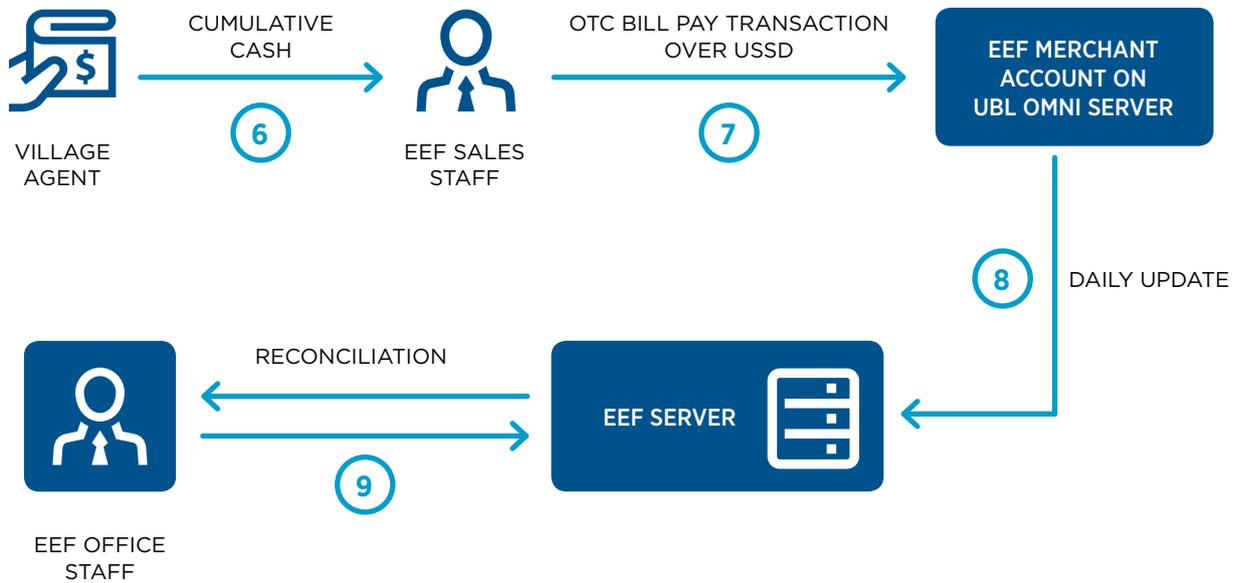
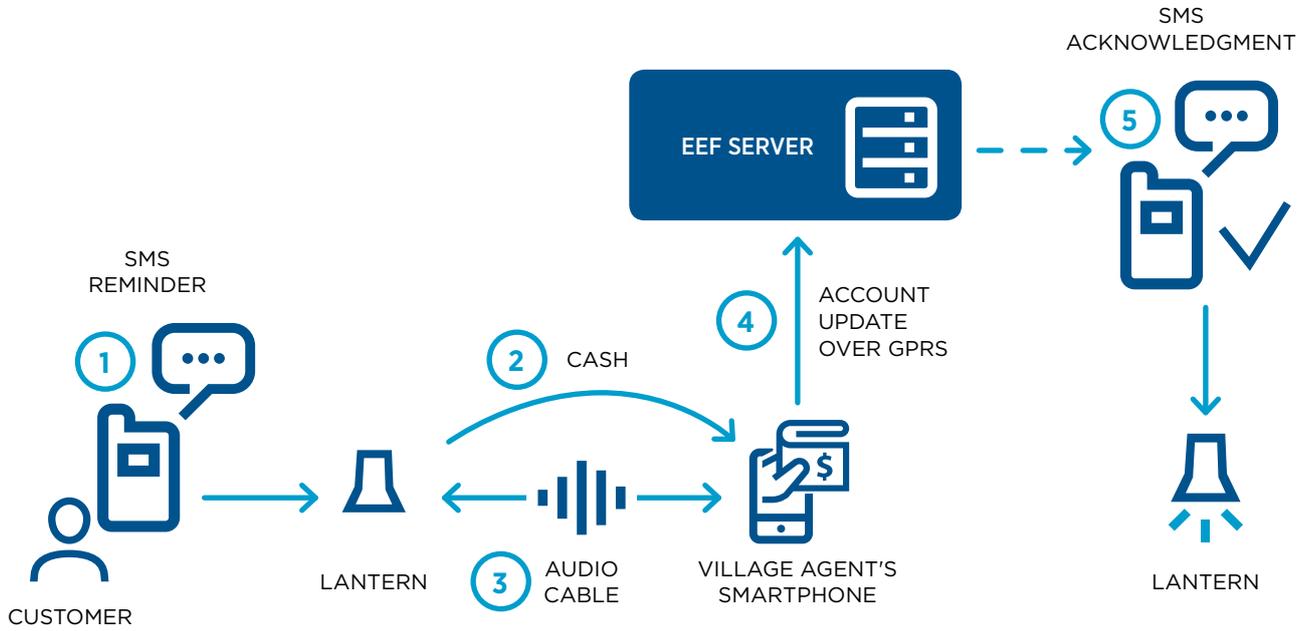
1. Customers receive automated SMS reminders¹⁷ from Angaza's billing system regarding credit status five days before credit expiry with repeat reminders three days and one day before credit expiry. When the lantern has zero available credit, it displays a specific light sequence.
2. Customer pays cash to village agent (or EEF sales staff) who uses an audio cable to connect his smartphone's headphone jack to the lantern's power port.
3. Through Angaza's mobile app, the agent credits the payment to the customer account thus unlocking the lantern for the appropriate number of days.
4. The updated account balance is uploaded over GPRS. Optionally, the mobile app also downloads usage and performance information from lantern.
5. The village agent disconnects the lantern from his smartphone. The customer receives an SMS acknowledgement of the credit purchase.
6. The village agent keeps cash until EEF sales staff collects it.
7. EEF sales staff transfers the amount collected to EEF's merchant account using bill pay with a bulk payment from his own UBL Omni mobile money account.
8. EEF receives information daily about the payments through a spreadsheet from UBL Omni.
9. EEF office staff reconciles customer account information received through the app in Step 4 with mobile money payments to EEF's merchant account.

16. The Angaza mobile app was downloaded to smartphones of all village agent and EEF sales staff. In addition, EEF sales staff also used an Open Data Kit (ODK) form filling app to report on payments collected, sales, etc.

17. SMS has somewhat limited efficacy wherever a significant proportion of the populace is illiterate, as was the case in many of EEF's sales areas. To mitigate this, Urdu SMS support is typical. Roman Urdu is particularly popular for digital communication as illustrated in this [article](#).

FIGURE 5

EEF'S PAYG process for lanterns



Source: EEF



Lantern connected to smartphone for credit transfer

Use of mobile for SHSs

EEF sells SHSs directly through its sales staff so there is no village agent in the SHS PAYG process. The steps in the PAYG process for SHSs are outlined below and illustrated in Figure 6.

1. Customer receives SMS reminders as the payment day approaches and a phone call on the payment date to recharge the account.
2. Customer visits UBL Omni mobile money agent or calls EEF sales staff¹⁸ to collect cash.
3. The UBL Omni agent or EEF sales staff uses his own mobile money account to make an OTC bill pay transaction to transfer the payment to EEF'S merchant account with UBL Omni. The transaction is made through the USSD channel of the mobile network on which the UBL Omni agent or EEF staff is registered.
4. The customer receives an SMS acknowledgement once the OTC transfer is made.
5. The UBL Omni server transfers payment and account information to the EEF server once daily. The EEF server calculates and maintains credit status.
6. EEF office staff generates a list every morning of SHSs to be switched off¹⁹ and the list of accounts for which payment was received. The staff logs into BBOX dashboard to select the SHSs to be switched off as well as SHSs to be switched on.²⁰
7. The BBOX server sends a switch off/on command to the appropriate SHSs over GPRS. The SHSs receive only state change commands; no credit information is transferred to the SHS.

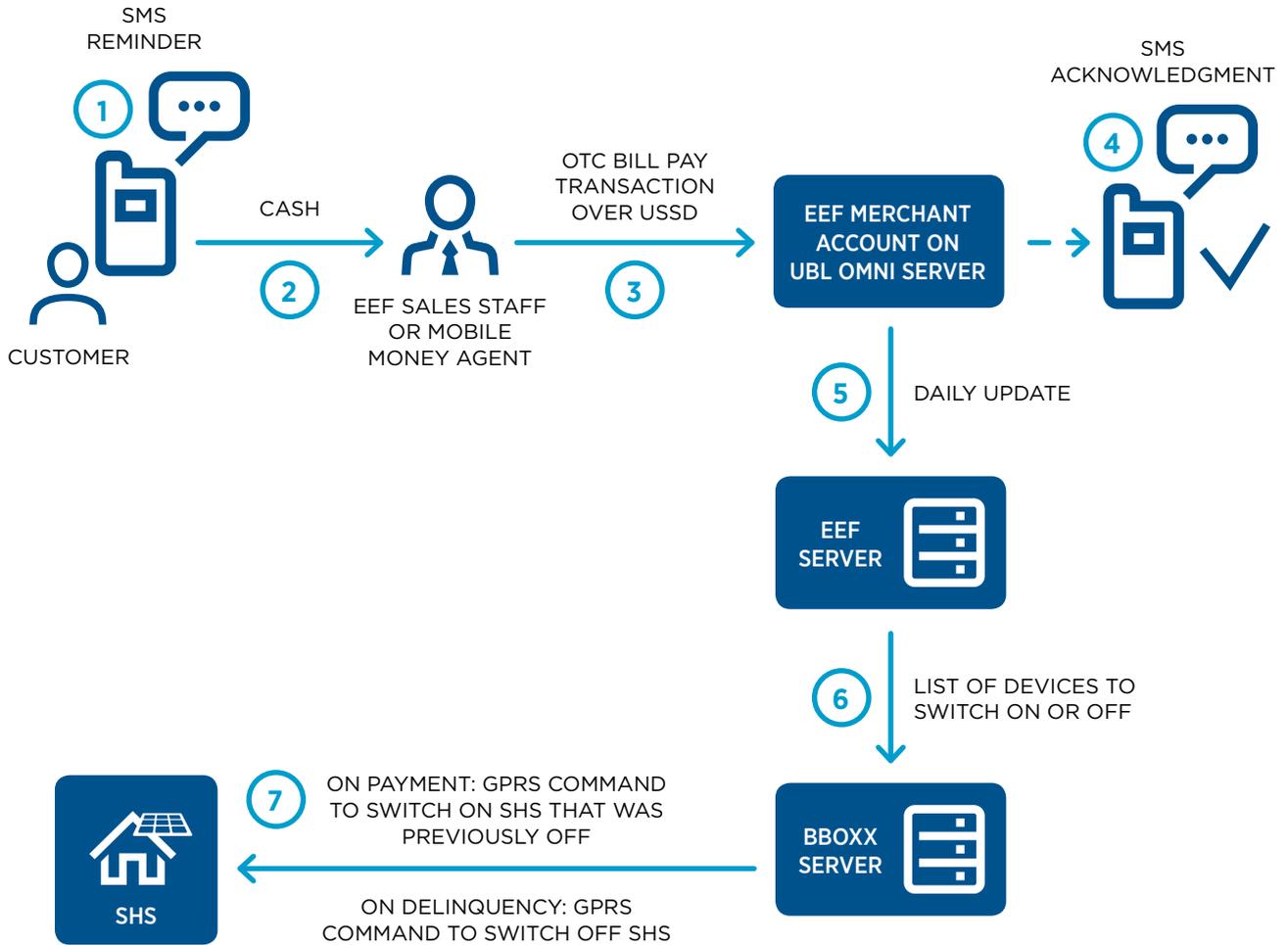
18. Customers often paid EEF sales staff when UBL Omni and other mobile money agents were not available in the vicinity of the customers.

19. SHSs are disabled as soon as they run out of credit. If an account is more than 30 days delinquent, the SHS is repossessed.

20. EEF made a conscious choice to not fully automate the payment process as integrating the fully automated software would have required a large upfront payment. For a small pilot with 50 SHSs, manual intervention was operationally manageable and also a free service from BBOX. As it scales in the future, EEF plans to incur the expense of the fully automated process.

FIGURE 6

EEF'S PAYG process for SHSs



Apart from using M2M communications in the pay-as-you-go process, EEF also uses it to monitor usage and performance as well as to do software updates of the BBOX SHSs over Ufone, Warid and Mobilink's GPRS network. Information on the SHS is collected every 30 seconds but uploaded every four hours to understand usage patterns, analyse system functionality and performance and inform future design. This is illustrated in Figure 7.

FIGURE 7

EEF'S M2M communications with SHSs



BBOX SHSs incorporate sensors and M2M communications to be able to control the SHS and monitor its health. They provide the ability to control the SHS with a variety of commands such as:

- Switch on/off
- Software upgrade/downgrade

EEF monitored the following parameters during the project:

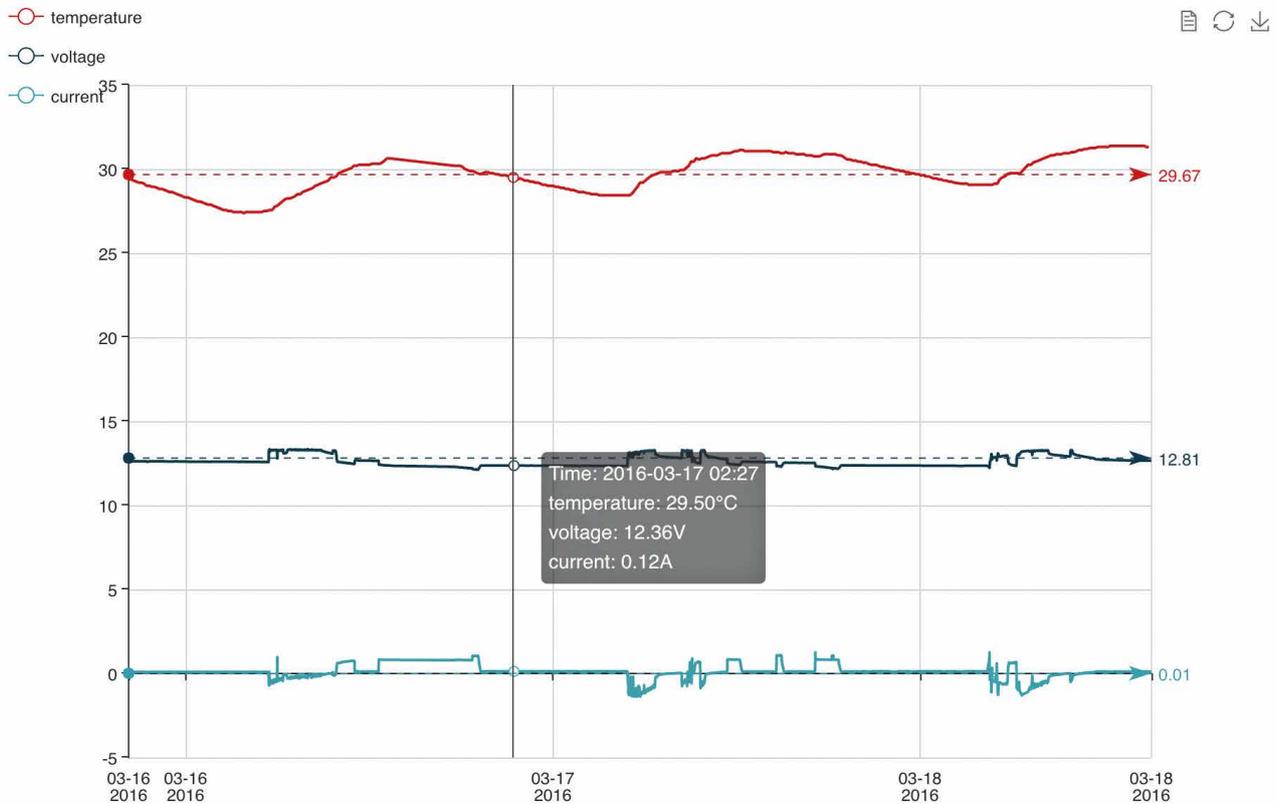
- Device location
- Failures of parts such as fuses
- Identification and system data such as
 - » IMEI²¹
 - » Hardware and firmware version
 - » System status, including faults and tampering
- Power data such as
 - » Battery voltage
 - » Currents in and out
- GSM network strength and carrier

An example plot of battery temperature, voltage and current is shown in Figure 8.

21. The International Mobile Station Equipment Identity (IMEI) is the electronic serial number of a mobile phone or other terminal device on a GSM network. It is used to identify devices on a network.

FIGURE 8

Battery waveforms from an SHS



Partnership with a mobile operator: EEF did not have a formal partnership with a mobile operator. For mobile network connectivity to its SHSs, BBOXX has an agreement with Vodafone who supplies the SIMs for the SHSs. Vodafone negotiates a global roaming agreement with local operators on BBOXX’s behalf that ensures connectivity for BBOXX SHSs across a large number of countries around the world. EEF’s SHSs were served by Ufone, Warid and Mobilink’s mobile networks.

UBL Omni was EEF’s mobile money partner for this project. UBL Omni gave a significant discount of up to 75% on its transaction charges to EEF.

Local or Global SIM?

BBOXX's BB17 SHS has a single SIM slot with a global roaming SIM from Vodafone. At the start of the project, the monthly cost for roaming connectivity plus the ability to do remote diagnostics on the SIM was several times the cost of a local SIM. Midway through the project, BBOXX and Vodafone reached an agreement to significantly reduce the monthly cost but it was still more than twice that of a local SIM. At this new rate, EEF preferred global SIMs for the following reasons:

1. Global SIMs can roam on different networks. This means the SIM can roam on whichever MNO has the strongest network in the area. With local SIMs, EEF would have had to use SIMs of a particular MNO depending on which area the SHS was installed in. This would be a logistics challenge leading up to the sale as well as a billing challenge after the sale.
2. The global SIM is preconfigured to bar calls, texts and data thus ensuring there is no incentive to steal the SIM.
3. BBOXX can do remote diagnostics on the SIM in case there is an issue such as the SHS is unable to connect to a mobile network.
4. Finally, global SIMs release EEF from the tasks of managing mobile billing for each SIM.

There are no complications in making mobile money payments for devices that have a global SIM because the mobile payments are not linked to the SIM card in the SHS. For its operations, EEF found that the total cost of ownership for a global SIM was lower than that for a local SIM despite its higher monthly cost. Furthermore, the cost of roaming is expected to become level with that of local plans in the near future which would make the global SIM even more attractive.

Sales, Import, Distribution and Customer Service

Beyond product and pricing, EEF'S success depends on careful attention to the key business components of sales, payment collection, import, distribution and customer service. Figure 9 describes EEF'S operations within these business components in Pakistan.

FIGURE 9

Description of EEF'S operations for core business components

Business Component	Structure & Strategies
Sales	<p>Recruitment:</p> <ul style="list-style-type: none"> • Hired and trained 50 village agents to use smartphones and sell SHSs and lanterns • Gave village agents used, spare smartphones for free <p>Structure of sales force:</p> <ul style="list-style-type: none"> • Sold SHSs directly through staff because village agents struggled to make concept sales • Carved out PAYG sales force from the mainline sales force and restructured incentives to balance sales with repayment
Payment collection	<p>Processes:</p> <ul style="list-style-type: none"> • Village agent or EEF staff collected cash payments from customers and transferred to EEF using mobile money • Improved information flow regarding delinquent accounts to increase repayment rates
Import	<p>Worked through maze of import regulations:</p> <ul style="list-style-type: none"> • Worked with customs agents to import and clear inventory and replacement parts • Set up bank accounts to be able to make payments to vendors based outside Pakistan • Acquired all necessary permits and licenses for future imports
Distribution	<p>Established single, central distribution and service centre in Karachi</p>
Service	<p>SHS installation:</p> <ul style="list-style-type: none"> • Used own workforce to install SHSs. Installation took only about 30 minutes <p>Customer communication:</p> <ul style="list-style-type: none"> • Made follow up call one week after installation • Sent reminder SMSs and made calls to customers in advance of payment date to warn about impending device shut-down <p>After-sales service:</p> <ul style="list-style-type: none"> • Provided free maintenance during 18-month warranty • When customers reported a problem to customer service, dispatched a technician to repair or replace the defective unit, usually occurred within one day.

Source: EEF



EEF agent with customer

Results

Business Viability

Lantern sales

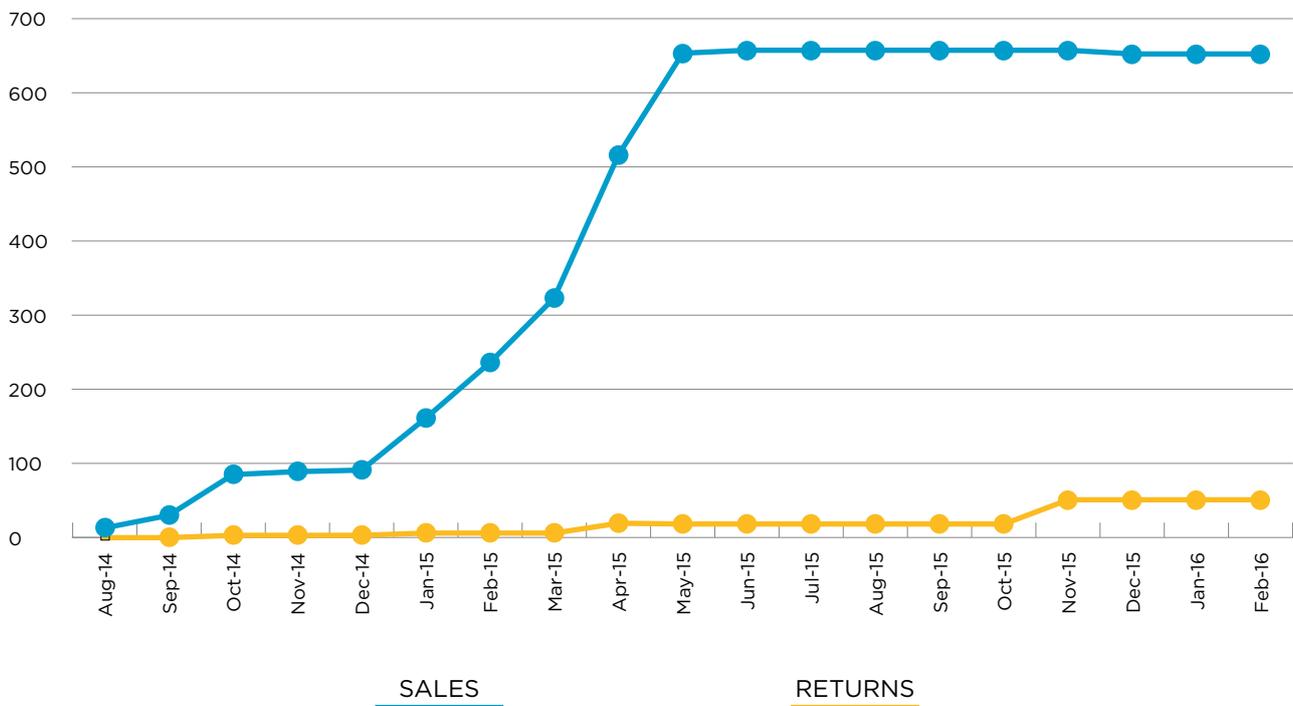
From August 2014 through December 2015, EEF sold a total of 652 lanterns.²² Sales were initially slow for various reasons but began to pick up in January 2015 with over 85% of sales occurring between January 2015 and May 2015. The primary reason that sales were initially slow was that EEF had to find and then train the village agents before it could sell the lanterns. Further, EEF had to first train the village agents to use smartphones and then to use them to

charge lanterns with credit. EEF provided most village agents with old smartphones it had previously bought.

In May 2015, EEF stopped selling lanterns because spare units were required to honour the customer warranty, and the failure rate was higher than expected.²³ Over the project duration, customers returned 50 lanterns due to defects. Figure 10 shows the number of lanterns sold and defective lanterns returned in each month.²⁴

FIGURE 10 Cumulative sales progression and returns for lanterns

Cumulative sales progression and returns for lanterns



22. Lanterns were bought exclusively by male customers.
 23. GSMA allowed a downward revision of the target number of lanterns to 675 because EEF had not budgeted for spares
 24. No particular trends were found in lantern failures. EEF replaced defective lanterns.

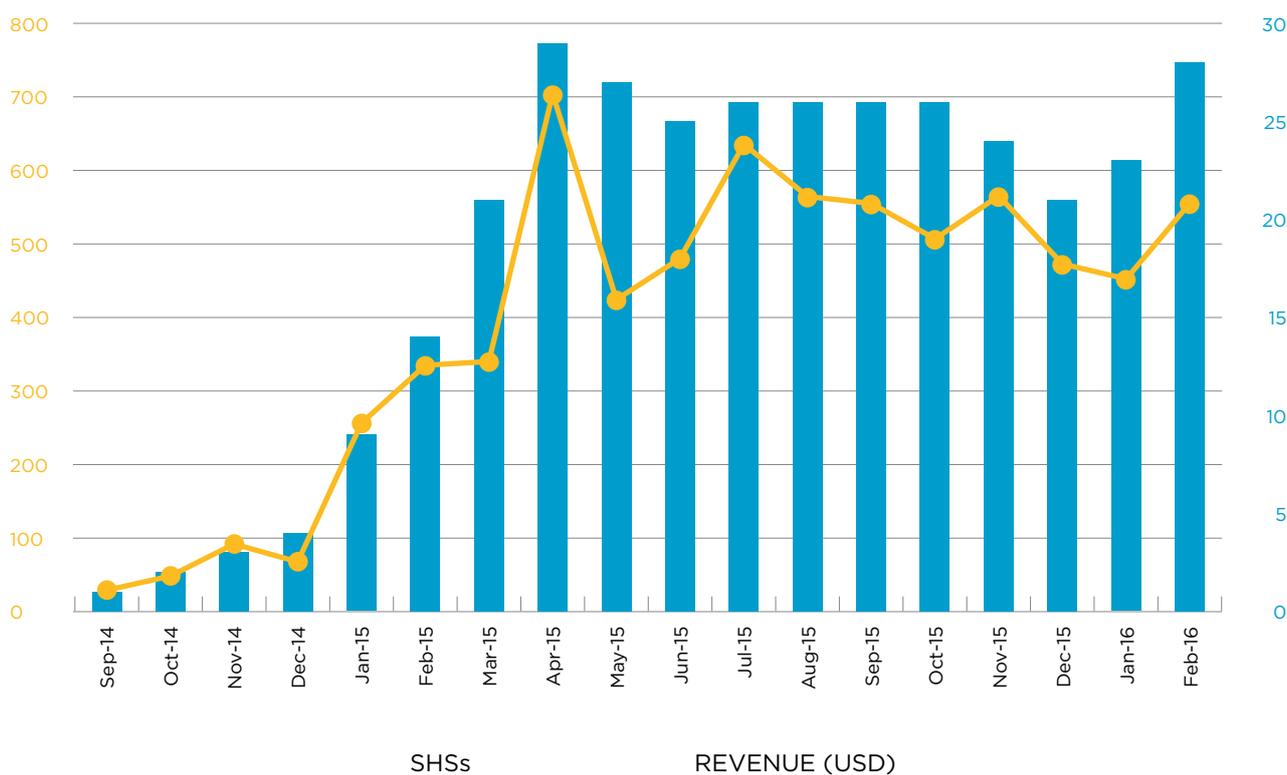
SHS sales

Figure 11 shows the number of SHSs sold and the revenue generated. Sales of SHSs followed a similar

trajectory to that of lanterns although at a very different scale. Overall sales fell well short of the target of 50 primarily due to defects in the SHSs which prevented sales.

FIGURE 11

Cumulative SHS sales progression and revenue



EEF and BBOXX worked closely throughout the project duration and resolved several, but not all, problems. The number of customers in Figure 11 fluctuated because some customers returned their systems or they were repossessed and then re-sold. Specifically:

- One customer’s device was repossessed due to non-payment
- Three customers were unhappy with the performance of the solution
- Seven rental customers returned their solution in November 2015 because they had grid electricity available already and their hours of access improved. EEF stopped sales or rentals to anyone with grid access once they realised that such customers were unreliable because the SHS was not the primary source of electricity.

The fluctuations in number of customers were accentuated by fluctuations in repayment resulting in larger fluctuations in revenue as shown in Figure 11.



Technical issues with BBOXX SHSs

EEF purchased 52 v1 and v2 of BBOXX's BB17 SHS which work well in other countries such as Rwanda and Kenya. However, environmental conditions, mobile network frequencies and usage are all different in the Pakistan market. Across the grant period, 48 of the 52 SHSs encountered a fault. Key problem areas were:

- **Some SHSs could not connect to the mobile network:** This issue was attributed to different GSM frequencies used in Pakistan than in other markets where BBOXX had previously sold its SHSs. BBOXX resolved this problem with a new antenna that has better reception characteristics.
- **Defective charge controllers:** This was the most common issue and resulted in batteries not being fully charged or batteries deteriorating.
- **Some SHSs would switch off when a fan was switched on:** This happened because the SHSs were unable to handle the current surge when a fan was switched on. Since fans are an important accessory in Pakistan, this defect led to dissatisfaction among customers.

The latter two faults were exacerbated and seen at significantly higher levels in Pakistan in comparison to BBOXX's devices in East Africa, for the following reasons:

- EEF's customers primarily use their devices to power fans and TVs, which consume more power and result in more battery discharge cycles
- Devices operate at higher temperatures (30 degrees Celsius and above), which deteriorated battery performance and lifetime

BBOXX was supportive in addressing these issues, through the following measures:

- Providing dedicated support staff
- Sending spare parts free of cost. Due to the availability of spares, EEF was able to repair many faults throughout the grant period
- Sending an engineer to diagnose significant issues

Through this experience, BBOXX has made significant improvements to its next generation (v3) of its product platform, including:

- Improved antenna design
- More robust, easy to assemble and repair unit
- Increased efficiency of the charge controller
- Better GSM communications hardware
- Reduced the number of components that can break in normal usage: backup battery, rear socket, internal wiring, plastic SIM (instead using a SIM on a chip), etc.

Thus, although the defects led to a stoppage in sales by EEF, the experience has enabled BBOXX to make a more robust product that will benefit customers across markets. Further, EEF and BBOXX have moved forward with a larger shipment of 150 BBOXX units and are working towards a deeper partnership to replicate BBOXX's securitisation deal with OikoCredit²⁵ in Pakistan.

25. First securitization deal for off-grid solar in Africa: <http://www.oikocredit.coop/k/n171/news/view/138533/462/first-securitization-deal-for-off-grid-solar-in-africa.html#VvDkUHodzNs>

Repayment rates for lanterns

There are not yet standard or de facto industry-wide definitions of repayment rates. EEF experimented with ways to measure and represent portfolio health. EEF defined repayment rate for lanterns as the proportion of the number of days a month when customer accounts had credit. On days where the customer account had no credit, the customer’s device would be disabled.²⁶

Figure 12 illustrates two interpretations of repayment rate (a) by percentage of accounts and (b) by the absolute amount collected or due in USD. When lantern sales began to pick up in October 2014, only 75% of accounts were “Complete or Good”²⁷ but that proportion continuously improved to a healthy 94% in February 2016 with better customer education

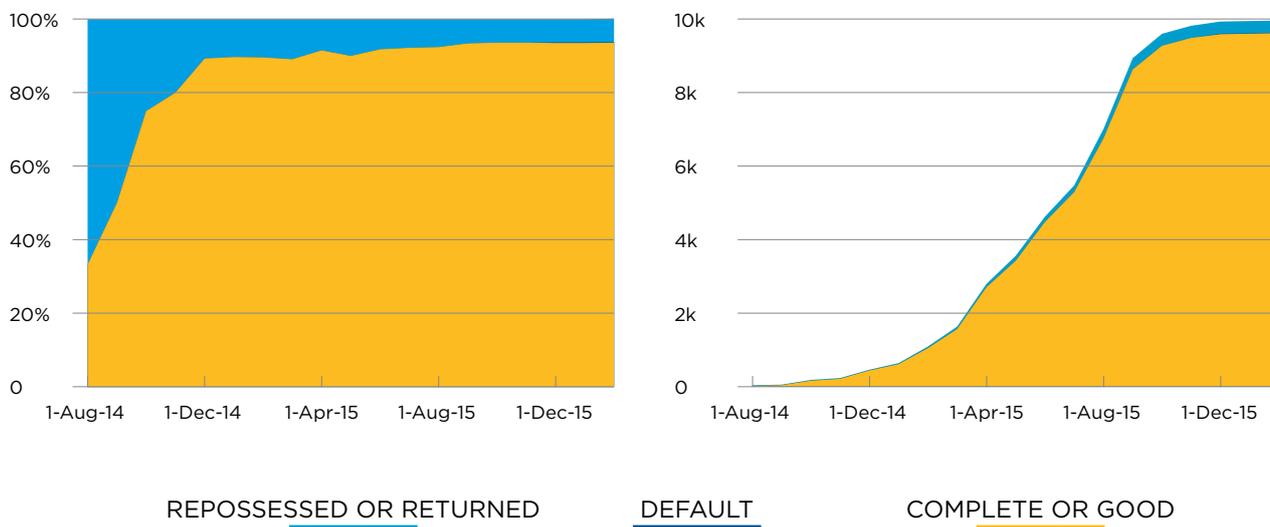
and stricter enforcement. Conversely, 6% of accounts were either in “Default” or terminated. However, the outstanding amounts due to EEF from these accounts totalled only USD 344 or 3% of EEF’s expected collection of USD 9,958.

A very small number of customers in “Default” state²⁸ have had devices without credit for more than 30 days, but have refused to let their lanterns be repossessed. Some have indicated that they intend to make payments when they have the money.

Since 2013, EEF has sold over 11,000 solar lanterns without PAYG technology, 80% of them on credit. The repayment for the PAYG-enabled lanterns is a significant improvement over the 70% repayment for EEF’s non-PAYG lantern portfolio.²⁹

FIGURE 12

(a) Repayment status by percent of accounts and
(b) By amount collected or due (USD)



26. Such days are referred to as “days in the dark” in this report. It is a measure of how many days a solar device did not generate revenue. For 100% repayment, days in the dark would be 0.
 27. Lanterns that were fully paid off or had credit were classified as “Complete or Good”.
 28. The proportion of customers in Default state is too small to be visible in Figure 12.
 29. For non-PAYG portfolio, repayment rate was defined as the ratio of number of payments received to number of payments due. Although repayment rate is defined differently for the two portfolios, the significantly higher repayment rate for the PAYG portfolio indicates that PAYG technology considerably improves repayment.

Repayment rates for SHSs

Figure 13a plots two measures for SHSs – repayment rate and the average number of days in the dark in that month. In December 2014, the repayment rate dropped to 50% and the average days in the dark was 13.3.

This means that an average SHS customer purchased credit for only 57%³⁰ of the month. In December 2015, repayment rate was 86% and the number of days in the dark had reduced to 2.5 with increased follow up and stricter reinforcement.

FIGURE 13A

Repayment rate and per customer days in the dark for SHSs

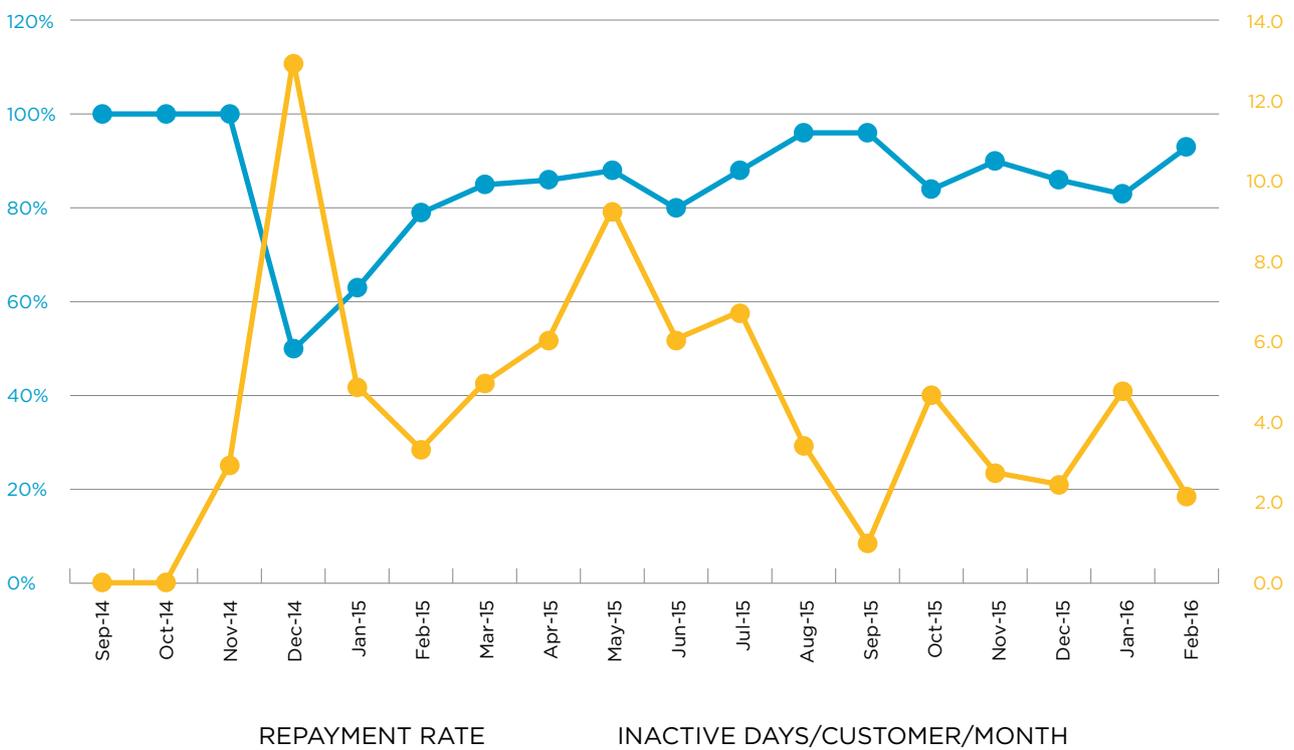


Figure 13b presents another view of SHS portfolio health that EEF uses most extensively because it combines the information from Figure 13a with the total number of device-days.³¹ The total height of each bar represents the number of device-days in that month. The blue portion of the bar depicts the total number of device-days for which credit was purchased.

The yellow portion depicts the device-days in the dark for that month. The months of December 2014 and March 2015 through July 2015 were the worst months because the yellow portion is a significant fraction of the total length of the bar.³² September 2015 was the best month in terms of portfolio health.

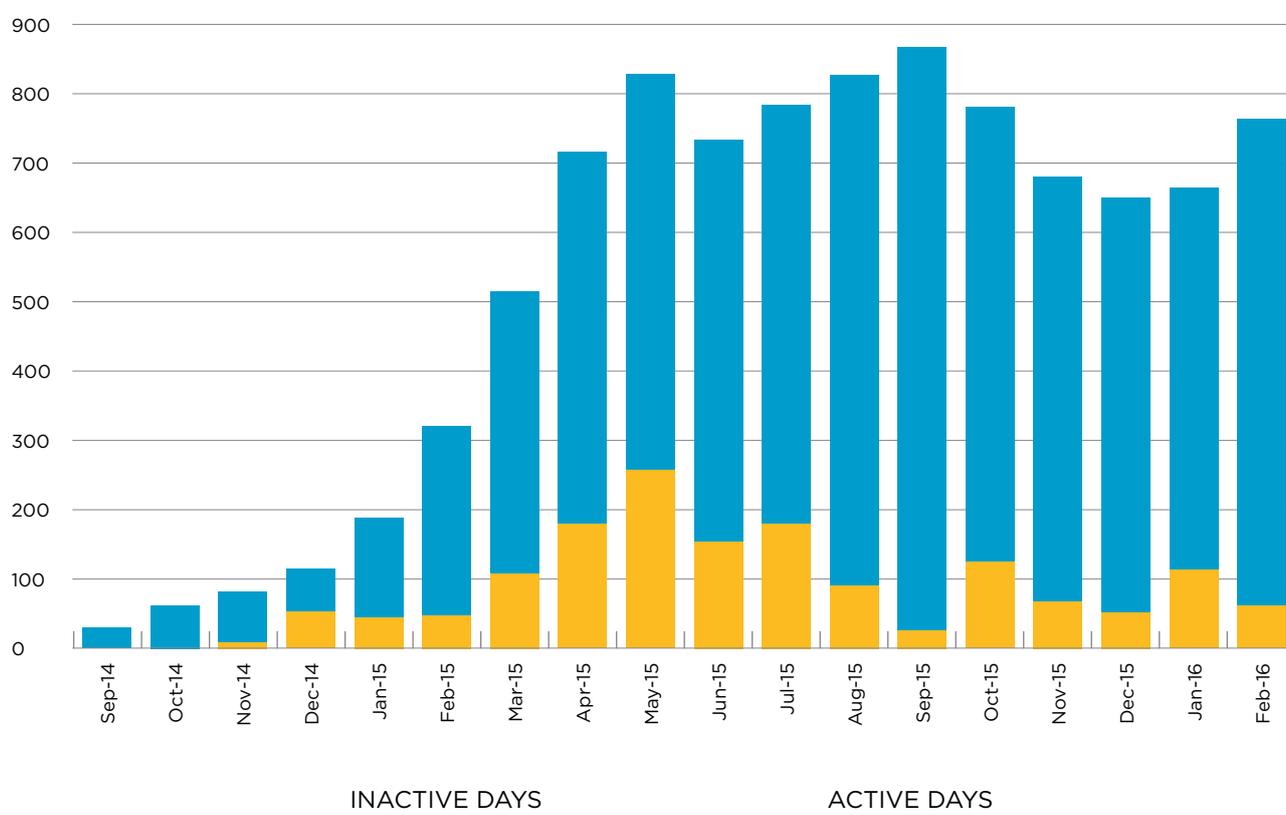
30. $(31-13.3)/31 = 57\%$

31. The number of device-days represents the maximum revenue generation potential for a time period. For example, EEF had sold three devices in November 2014 and one more on December 10. Thus, three SHSs were at the customer premises for all 31 days of December and the fourth was at the customer premise for 22 days. Then, the total device days in December 2014 is calculated as $(3 \times 31 + 1 \times 22) = 115$.

32. The height of the yellow portion is a function of the number of days in the dark.

FIGURE 13B

Month-by-month SHS account history in device-days



Other key lessons learned about repayments are as follows:

- Repayment rate of customers who run a business³³ was 94%, compared to an overall repayment rate of 81%:** Customers running a business were more reliable customers because they had a more uniform cash flow than those dependent on agriculture as the main source of income. They were also easier to reach, since their home or shop would be located in a town, instead of a remote village.
- Access to grid electricity dis-incentivised timely repayment for SHSs and led to customer returns, but did not affect repayment for lanterns:** For solar lantern customers, as the lantern could be used as a primary or supplementary source of light, no difference was noticed between the repayment rates of on-grid and off-grid customers. SHS customers, on the other hand, were extremely sensitive to the availability of grid electricity. Off-grid customers used the SHS as their primary source of electricity, incentivising them to make consistent payments. On-grid customers with weak grid access, on the other hand, preferred grid electricity when it was available. In periods where the number of hours of electricity access increased, on-grid customers would return their devices.

33. Refers to customers who own a business but do not necessarily use the SHS for income generation

Cost-benefit using M2M communications

BBOXX SHSs incorporate sensors and an M2M communications module to be able to control the SHS and monitor its health. EEF experienced the following benefits and constraints of using M2M:

- **Improved customer service and customer understanding:** EEF uses the data collected over M2M to improve its quality of customer service by monitoring system charging and power consumption. EEF also proactively calls customers when they see a potential problem and send a technician to repair or replace the device. In the future, EEF and BBOXX plan to use the data to better understand customer consumption patterns and identify sales opportunities for upselling.
- **Improved operational efficiency of maintenance staff:** EEF found that although more complicated than using a cable or a code, M2M communications provides the ability to fix device issues through software updates, as well as monitor devices remotely which cuts down on field technician costs.
- **Reliance on local mobile network coverage for communication with SHS:** Using M2M communications for remote monitoring and control requires that each system have reliable mobile coverage. Initially, when Vodafone had a roaming arrangement with a single local MNO, some SHSs did not have mobile coverage. However, once the arrangement was extended to three MNOs, the SHSs roamed on the best available network and the problem was overcome.

Challenges of importing into Pakistan

EEF worked with partners to bring the solar products into the country and deliver them to customers but faced the following challenges:

- Regulations around customs duties fluctuated, resulting in some shipments incurring duties on solar products and additional time taken to obtain exemptions
- Approvals were required on the importing of spare parts with GSM chips, which led to a 3-month delay on repair work of SHSs
- Foreign exchange regulations in Pakistan prevent an importing organisation from prepaying for inventory that has not arrived in the country. EEF had to negotiate the terms and mode of payment with suppliers who did not accept a Letter of Credit.

Refinements to Operations

As EEF learned from the project, it made continuous improvements to tailor its offering in response to new consumer insights; increase sales and repayments; and make operations more efficient.

Product and service offering

Fans are a highly valued accessory in Pakistan: The maximum temperature in Thatta, Sindh, exceeds 30 degrees Celsius except in the winter months of December through February.³⁴ As a result, people there value fans much more than in East Africa where PAYG solar companies are able to sell lower capacity SHSs which are primarily used for lighting. EEF purchased fans from BBOXX and added them as accessories to some product configurations.³⁵

Structure of sales force

PAYG sales require a separate, dedicated sales force with a different incentive structure: EEF has sold lanterns other than the SunKing Eco, outright and on credit (but without PAYG technology) since 2013. Selling PAYG and non-PAYG products through the same sales staff created two problems:

- Sales staff who were used to selling non-PAYG products were not enthusiastic about selling the PAYG product because it was more expensive, and
- Potential customers were more familiar with the non-PAYG product and this familiarity bred trust. It was difficult to convince them to buy the PAYG product despite its better features.

EEF separated its PAYG sales force from the mainline sales force and devised incentives that balanced sales with repayment rates.

Village agents were unable to confidently demo the SHS and sell it: Village agents found it difficult to configure the SHS and did not have the skill to complete a concept sale. After initially attempting to sell both lanterns and SHSs through village agents, EEF began to sell SHSs exclusively through its sales staff and lanterns through village agents.

Repayments

Repayments for lanterns and SHSs increased due to specific and concerted efforts by EEF: Repayment rates improved due to the following reasons:

- When repayments dipped in May 2015, EEF informed staff every morning about low customer balances and instructed staff to call or SMS customers whose balances were running low. Staff sent reminders to customers as the credit balance approached zero to warn them about the impending disabling of their device. This led to a significant reduction in days in the dark.
- EEF more aggressively disabled SHSs when credit balance ran out
- EEF suggested to customers facing issues with payments to make smaller payments throughout the month.

34. Source: <http://en.climate-data.org/location/3579/>

35. EEF also experimented with fans from local suppliers when turning on the BBOXX fan caused the SHS to "trip". However the local fans were not of sufficient quality and EEF has decided to continue with the BBOXX fans now that the issue has been fixed.

Instance of tampering

Only one instance of tampering was encountered with an SHS customer. EEF observed that the SHS had not connected to the mobile network for some weeks and called the customer to check on the status of the unit. The customer admitted that he had opened the back of the device and taken out the SIM card. When asked why, he laughed and retorted that EEF keeps turning off the device [to enforce payment]. EEF sales staff then took steps to inform customers that tampering with devices would void the warranty. Improvements, such as an embedded SIM, have been made to the BBOXX v3 SHS to avoid such situations in the future.

Customer Benefits

The following key customer benefits emerged from EEF’s endline survey of 135 lantern customers and 17 SHS customers conducted in December 2015 and January 2016.

Time saving was the benefit most often cited by both lantern and SHS customers: 64%³⁶ of lantern customers cited time savings as a benefit. Other popular benefits of the lantern were health at 40%, entertainment at 39% and saves money at 29%.

47% of SHS customers cited time saving and 47% also cited money saving as a benefit. Other popular benefits are entertainment and comfort. Free-form responses received from customers highlighted the benefits of lights in household work, cooking, taking care of guests and childbirth.

Source: EEF



Poultry farm owner with BBOXX SHS



Lady cooking by the light of a BBOXX SHS

36. Percentages are calculated using the number of responses received rather than the total number of customers surveyed. Customers could select as many options as they liked.

Source: EEF



Religious ablutions aided by a lantern

Lantern customers reported a decrease of PKR 369 (USD 3.56) in monthly expenditure on traditional lighting sources: Even at the higher monthly payment of PKR 360, the lantern can be a source of savings to households primarily dependent on kerosene, batteries, generators, etc. In fact, all customers reported no expenditure on kerosene after buying the lantern, saving an average of PKR 202 (USD 1.95) per month. Despite the fact that customers saved money by purchasing a lantern, the majority (63%) said the lantern was either expensive or very expensive.³⁷

Surprisingly, only 57% of customers reported being satisfied or very satisfied with their lantern. Of the 42% who were dissatisfied or very dissatisfied, over 77% were located in a single area.³⁸ This may be related to a specific village agent who managed that area.

SHS customers reported a decrease of PKR 484 (USD 4.67) in monthly expenditure on traditional sources,³⁹ but an overall increase of PKR 2314 (USD 22.33) on energy expenditure: The increase in expenditure on energy correlates with the nearly 70% of SHS customers that thought that the SHS was expensive or very expensive. Despite this, 64% of customers reported being satisfied or very satisfied with their SHS.

Fewer than 20% of customers used their solar devices for business: Only 18 lantern customers (13%) used their lantern for a business purpose, such as a small retail shop, and only three SHS customers (18%) did so. Customers using solar lanterns in their businesses cited the following major benefits: saving money (33%); access to customer service and warranty from EEF (33%); and respect from their community for using a new technology (33%). SHS customers most highly valued customer service and warranty from EEF (100%) and monthly savings (66%).

Majority of customers rationed the use of their solar device: Exactly half of lantern customers switched it off to conserve energy and 93% reduced the intensity of the light. Among SHS owners, 43% switched off lights, 29% switched off the fan, 29% stopped charging their mobile phone and 21% switched off their TV to conserve energy. From these responses, it is evident that customers want more energy but based on their perception of affordability, they may not want to pay for it.

37. This possibly indicates customers reference the price of the lantern to other solar lanterns in the market rather than to their expenditure on traditional sources.

38. A sub-division of a district

39. Includes spend on grid, diesel generators, kerosene, batteries, etc.

Source: EEF



Obhayo Khaskheli (left) who owns a BB17 with 50W panel, 15" LCD TV and DVD player

“Ten twenty years ago we had electricity but then it was lost. After that we had to rely on generators, which used to break down frequently. Ever since I installed solar energy, I save some money, and it is quiet and peaceful. My clients used to be disappointed because they would come here to watch films and the generators wouldn't start sometimes. This is better for my restaurant. - **Obhayo Khaskheli**”

Mobile Industry Benefits

EEF leveraged M2M communications with connectivity through Vodafone's global roaming SIM and formed a partnership with UBL Omni's mobile money service. The scale of this pilot was relatively small so the absolute numbers in terms of benefits to the mobile industry are correspondingly small. For lanterns, payments were collected in cash from several customers and remitted as a single payment to EEF. For SHSs, customers generally paid using an agent's mobile money account. Thus, this project increased slightly the number of OTC-type transactions for UBL Omni.

An interesting insight related to the lack of mobile money adoption emerged from the endline survey. For 68% of EEF's customers, the nearest mobile money agent was at least five kilometres away. As the PAYG model gains customer acceptance in remote areas, mobile money operators will have to improve their presence.

Conclusions

The key objective of the Seed grant to EEF was to support the trial of a PAYG distribution business. EEF was unable to achieve the sales targets primarily because of technical issues with the SHSs. Notwithstanding the support provided by BBOXX, sales of SHSs were stalled for months. Despite these difficulties, EEF and BBOXX are moving forward in their partnership, with additional PAYG SHSs on order, the provision of supplier credit by BBOXX to EEF and work underway to replicate BBOXX's securitisation deal with OikoCredit in Pakistan.

Even though sales targets were not met, EEF was able to test customer acceptance of the PAYG model for lanterns and SHSs. Although PAYG lantern sales targets were almost met, EEF has decided to focus entirely on PAYG SHS sales in the near term because it realised

that these two devices need entirely different sales and distribution structures. Further, EEF believes that any competitive advantage it has in PAYG lantern sales can be overcome by a well-funded organisation with efficient logistics. On the other hand, an SHS is a high involvement purchase and requires a very different sales approach than a lantern. With a longer term loan than a lantern, the SHS also presents an opportunity to build a relationship with a customer and upsell or cross sell. These aspects give EEF the opportunity to build a defensible competitive advantage.

Apart from helping EEF to make a strategic choice, the grant also enabled the organisation to build capacity and prepare to execute its plans to scale up to acquire 1,000 PAYG solar system customers in 2016.

Appendix 1: Case Study Methodology

Overview: This case study is based on learnings that emerged throughout EEF'S Seed grant through the Mobile for Development Utilities programme. These were tracked through the following:

Grantee reporting: Monthly reports were completed on activities, project risks and mitigation, and key performance indicators. These were discussed during a one-hour call with the grant manager each month. Quarterly reports were completed to document progress on milestones, the grantee's learning objectives, barriers and other key project developments as well as financial compliance.

Customer Surveys: EEF carried out initial market research through conversations with customers and an endline survey as part of this project. The market research was carried out across the districts of Thatta and Mirpur Khas in June 2014.

The endline survey was done with 135 lantern customers and 18 SHS customer in the Thatta district of Sindh province.

All interviews were carried out in-person.

Limitations of this study: The study aims to provide only the key learnings from EEF'S grant and cannot possibly cover all the day-to-day learnings from EEF. It also aims to share learnings with the broader sector without releasing commercially sensitive data from EEF or UBL Omni.

The customer surveys are meant to be representative while not necessarily statistically significant to a specified degree of certainty. Customer surveys are known to have limitations in accuracy, particularly around expenditures, income and previously carried out activities, where people often fail to recall these correctly or are influenced by perverse incentives (e.g. stating a lower income than reality thinking it will reduce the future pricing).





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