



Mobile for Development Utilities
PEG Ghana
Licensing Solar-as-a-Service in a New Market

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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.

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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 2016.



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Executive Summary

In December 2013, the M4D Utilities Programme awarded PEG Ghana (“PEG”) a Market Validation grant to replicate two different Solar-as-a-Service business models and technologies from Tanzania to Ghana. PEG licensed the technology and software, and built local sales, distribution and service operations to develop their own business providing off-grid, low-income Ghanaian households with lighting, phone charging, radios and TVs.

At the time of the grant, PEG was an investee of Persistent Energy Capital, as were the two companies from which PEG licensed the technology and replicated business models: Off Grid Electric (OGE), a solar home system (SHS) provider, and Devery, a solar micro-grid and smart meter provider. Following their models, PEG offered these two technologies as Solar-as-a-Service (i.e. perpetual lease), with PEG, rather than the customer, retaining ownership of assets.

These models leveraged multiple mobile channels. The micro-grids included GSM-based machine-to-machine technology (M2M) for communication and control via a data concentrator and ZigBee-enabled smart meters at each household. The SHS were not controlled remotely via GSM, but were turned on by customers entering a code manually into the SHS keypad, where the code was received by SMS following payment. For both services, PEG intended to have both customers and agents use mobile money for payments; however, in practice only the PEG agents used mobile payments, and even then only occasionally.

The objectives of the grant were to test the replication of two energy service models in a new market by licensing existing technologies and business models, while gaining market insights and attracting follow-on investment. A further objective was to demonstrate the benefits that mobile money would have for a remote energy business, mobile operators and customers.

The over-arching insight that emerged was that **licensing new technology and business models requires significant investment of time and resources from both parties through a robust agreement and partnership.** Therefore, licensing carries risks for both the licensee and licensor, and the opportunity to grow the sector through licensing requires an awareness of potential challenges. As a result of the experiences gained through this grant, PEG developed a partnership with a new solar home system provider, whereby both the new supplier and PEG allocated significant resources to build strong business operations from the start. Some of the specific learnings that support this over-arching insight are as follows:

- Limited licensing agreements may not be sufficient to support replication and mutual benefits to both parties.** It was largely assumed that replication would require importing the energy hardware and software and mirroring general business operations. However, given the nascent state of the mobile-enabled energy sector, replication requires a more hands-on approach from the licensor to transfer knowledge and technical support, and build local business operations. Therefore, licensees must ensure their licensors see licensing as a part of their own growth strategy, and look to their experience for planning the required level of investment.
- The business viability of micro-grids depends on a reliable service and minimum consumption from a certain proportion of households. This can be undermined by factors such as the following, which led to households consuming and paying less than predicted:**

- » Grid access was new to PEG customers and the **customers did not consume as much as they initially indicated they would;**
- » **Unanticipated complexity in operating the grids led to technical challenges:** as a result, PEG could not offer the service level anticipated, which reduced customers' willingness to pre-pay for an uncertain service;
- » **Customers preferred a kilowatt-hour pricing structure,** instead of a flat monthly rate, in order to save money by limiting their use, which resulted in consumption below financial viability, particularly after customers had been supplied with highly efficient LED bulbs;
- » **Relatively high national grid connection rates** (particularly compared to Tanzania) meant that many Ghanaians expected the national grid would eventually reach their village. They were therefore less willing to pay a rate higher than national grid prices, which are heavily subsidised, and many customers complained about the price difference; and
- » **A single and inconvenient payment channel,** that was primarily cash based, may have limited payment frequency and resulted in revenue leakage for both the micro-grids and SHS.

Based on these factors, PEG's grids were ultimately oversized for the level of customer use, outweighing any potential efficiencies that can come from load sharing through grids.

- **Benefits to mobile operators and energy providers from mobile payments do not materialise without strong partnerships and commitment to invest in increasing customer registration, training and agent networks.** Initially, PEG did not invest in the level of partnership and time required for backend system integration with mobile money, customer registration for mobile money, and adequate agent coverage. This may have been particularly important in Ghana where the mobile money ecosystem is less mature than in Tanzania. Instead, PEG relied on their agents to collect cash and occasionally make bulk transfers, thereby putting revenue collection at risk and by-passing intended benefits for mobile operators through increased mobile money usage. PEG ultimately had to re-prioritise this part of their business model by developing partnerships with operators for mobile money integration, and training PEG agents to register and teach customers to use mobile money.
 - **Investors prefer a focus on one business model/technology.** PEG found that while they did attract investor interest through their work under the grant, all investors were concerned about a lack of focus that could come from simultaneously operating two different business models and technologies. Ultimately, PEG decided to focus solely on the SHS model.
 - **Different regulations across countries may hinder the successful replication of a proven business model/technology.** Ghana's laws on Energy-as-a-Service models and regulation of micro-grids proved to be ambiguous, possibly more so than in Tanzania. This ambiguity suggested an uncertain future and hindered PEG's ability to raise continued investment for their operation of these models.
- This case study further discusses these learnings and other commercial and social impacts of PEG's grant. Ultimately, the progress and learnings from this grant helped PEG secure USD 3.2 million in September 2015 to grow their operations in Ghana and explore other markets. The investment was led by I&P Afrique Entrepreneurs and included several other investors.¹

1. http://www.ietp.com/entrepreneurs_en/#profil

Introduction

PEG's founders originally launched Impact Energies in April 2011 to sell solar lighting and charging products to underserved communities. The founders recognised the need to provide financing for customers to afford the products, and began to sell solar home systems (SHS) and lanterns to learn about the potential for financed purchase models (i.e. "rent-to-own") through partnerships with microfinance institutions. Impact Energies was acquired by Persistent Energy Capital in 2013, and rebranded as PEG. PEG focused on providing pay-as-you-go (PAYG) energy services in Ghana's off-grid market. The company did this by licensing technology from two other investees of Persistent Energy Capital from Tanzania: Off Grid Electric (OGE) and Devergy.

The GSMA Mobile for Development Utilities programme awarded PEG a Market Validation grant in December 2013 to support PEG's replication of these two Solar-as-a-Service business models and technologies: OGE's SHS and Devergy's smart

micro-grids. PEG set out to leverage mobile money for pre-payments for both energy services. The micro-grids had GSM-based machine-to-machine (M2M) communication to remotely turn household connections on and off and monitor functionality, while the SHS were turned on by the manual entry of a code sent via SMS after payment.

As of November 2014, PEG shifted away from both of these models and now offers financed purchase of SHS licensed from M-KOPA Solar. They have therefore wound down their previous solar services funded by this grant, giving SHS customers the opportunity to buy out the remaining cost of the systems, and the grid communities the opportunity to collectively purchase the infrastructure. In September 2015, PEG received USD 3.2 million in investment from I&P Afrique Entrepreneurs and several other investors.²

Key information about PEG is summarised in the following figure.

2. http://www.ietp.com/entrepreneurs_en/#profil

Key Facts about PEG

FIGURE 1

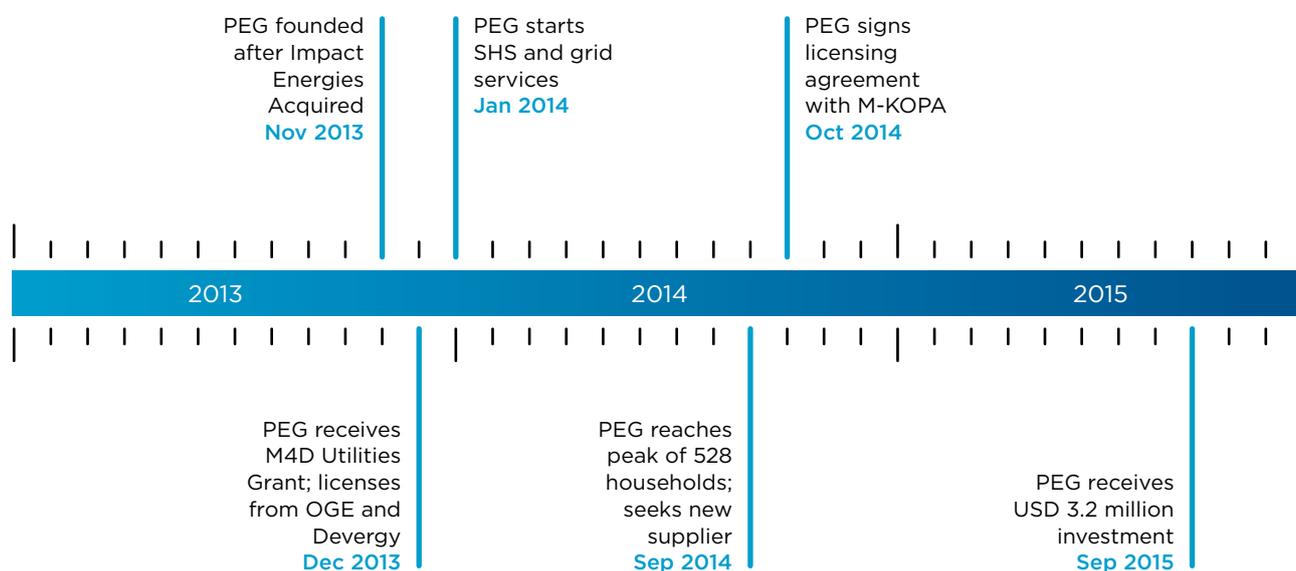
Company Overview as of January 2015

Name	PEG
Sector	Energy (Solar)
Year Established	Impact Energies in April 2011, acquired and re-branded as PEG in 2013
Country Footprint	Ghana
Product/Service	Original: Solar-as-a-Service SHS and smart micro-grids Current: Financed purchase SHS
Market Segment	Rural, off-grid households
Total Systems/ Customers Served	Original Solar-as-a-Service SHS and grids: 528 customers at sales peak
Use of Mobile Technology and Partnership	<p>Solar-as-a-Service SHS:</p> <ul style="list-style-type: none"> • Mobile application (mobile data) for agent to transfer credit to customer account; • SMS with code for turning on system sent to customer; • Bulk mobile money payment by PEG agent or mobile money agent; and • Mobile services for communication (customer care hotline and SMS notifications). <p>Solar-as-a-Service micro-grids:</p> <ul style="list-style-type: none"> • M2M connectivity at data concentrator for credit transfer, remote monitoring and control; and • Mobile payments and mobile services for communication, same as above. <p>Financed purchase SHS:</p> <ul style="list-style-type: none"> • M2M connectivity for credit transfer, remote monitoring and control; • Mobile money payments from customers; and • Mobile services for communication (customer care hotline and SMS notifications).

PEG's growth is depicted in Figure 2.

FIGURE 2

PEG's Growth



Grant Objectives

The overall objective of PEG's Market Validation grant was to test the licensing and replication of Solar-as-a-Service business models for SHS and micro-grids technologies from Tanzania to Ghana. They targeted a total of 600 households: 300 SHS customers across three villages and 300 households connected to micro-grids in three different villages.

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

- Comparison of two different solar technologies for rural electrification;
- Evidence required to attract energy investors;
- Characterisation of Ghana's off-grid energy market;
- Benefits/challenges of Solar-as-a-Service models;
- Benefits of integrating mobile money into the back-end of business systems; and
- Potential for mobile money energy payments to lead to increased customer usage of mobile money.

Market Opportunity

Addressable Market

The market opportunity for PEG's offering is the population without access to electricity that is covered by GSM networks, referred to as the addressable market. Given that Ghana has an electrification rate of 72 per cent,³ and GSM coverage (2G) of 81.5 per cent,⁴ this represents an addressable market of about 2.5 million people⁵ out of a population of 25.9 million. The relatively high rate of electrification in Ghana reflects high levels of grid connectivity in urban areas (90 per cent); however, there is lower grid connectivity (52 per cent) in rural areas where 47 per cent⁶ of the population lives. This indicates that PEG's ideal customers would be in peri-urban and rural areas covered by mobile networks but not electricity grids.

Mobile Ecosystem

Ghana's mobile ecosystem is still maturing, with a market penetration of unique subscribers just under 52 per cent.⁷ Yet, it is a competitive market with four primary operators: MTN has the highest market share (46 per cent), followed by Vodafone with 23 per cent, and Airtel and Tigo, each with approximately 12 per cent.⁸ Mobile money is currently offered by MTN (first to launch in July 2009), Airtel and Tigo, and is currently being launched by Vodafone as well. The mobile money ecosystem is maturing, particularly since new regulations in July 2015 have enabled mobile operators to lead stronger deployments,⁹ but the ecosystem is still underdeveloped in rural areas, with limited agent networks.

Market Assumptions

In their grant proposal, PEG characterised their target market based on their previous experience as Impact Energies selling off-grid solar products in Ghana, and the findings of a 2013 survey of 600 potential customers in 12 villages within their target areas: Afram Plains and areas near Accra in the Eastern Region, peri-urban Accra, and near Foso in the Central Region. Based on the findings, they originally estimated their customers would have the following profile:

- Farmers and fishermen with seasonal incomes of around USD 1,940/year¹⁰;
- Total energy spend of approximately USD 15.00/month based on;
 - » Lighting: up to USD 4.00/week on kerosene lanterns and battery powered lanterns;
 - » Phones charging: 2-3 phones per household, charged at businesses with diesel generators or grid connections for USD 0.24-2.02/week;
 - » Radios and TVs used by some at an additional USD 5.00/week to power;
- Access to GSM coverage within parts of villages, but not 100 per cent coverage.

To meet the energy demand and purchasing power of this market segment, PEG originally anticipated pricing their services at USD 11.80/month on average (20 per cent less than above) for basic lighting, phone charging, radio, and in the case of micro-grids, television as well.

3. International Energy Agency, World Energy Outlook 2014. <http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>

4. GSMA Intelligence, Market data for Q4 2014, as reported by MTN.

5. M4D Utilities Addressable Market Figures previously published here; these figures updated as of end 2013: http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/12/Sizing-the-Opportunity-of-Mobile_Nov-2013.pdf

6. World Bank Data bank, 2014. <http://data.worldbank.org/indicator/SPRUR.TOTL.ZS>

7. GSMA Intelligence, Market data for Q2 2014.

8. GSMA Intelligence, Market data for Q4 2014. The remaining four providers include Glo Mobile, Expresso, Surfline and Blu.

9. GSMA Mobile Money Blog on Ghana Regulations: <http://www.gsma.com/mobilefordevelopment/regulatory-reform-a-conversation-with-the-bank-of-ghana-on-the-journey-towards-the-new-guidelines-for-e-money-issuers>

10. PEG estimates originally provided in GBP as part of their grant application, all converted using OANDA exchange rate of 1.6 USD/GBP at the time the application was developed - 1 October 2013.

The SHS were ultimately offered in villages two to four hours' drive from Accra in the Eastern and Volta regions. The villages with micro-grids were in the Afram planes, outside the small town of Donkokrom and Bebuso, which required a full day's travel from Accra.

Different Market Opportunities in Tanzania and Ghana

PEG replicated their models from Tanzania to Ghana, which have key market differences as highlighted below. Notably, mobile money is far more advanced and electrification rates much lower in Tanzania compared to Ghana.

Country	Electrification Rate, National/Rural ¹¹	Unique Subscriber Penetration ¹²	GSM Coverage by Population ¹³	Mobile Money ¹⁴
Ghana	72% / 52%	52%	2G: 82% 3G: 53%	Mobile money in Ghana is still in early stages of growth, largely due to the more restrictive regulatory framework that did not allow non-banks to issue e-money during the pilot period. As of July 2015, regulations have improved, ¹⁵ and in the last year, the market has experienced strong growth.
Tanzania	24% / 7%	39%	2G: Not Available 3G: 28%	Mobile money is very mature with all operators offering mobile money services and 43% of the adult population actively using these services. ¹⁶ The regulatory framework has promoted the growth of innovative mobile financial services. Tanzania is one of the few markets where mobile money has achieved interoperability between mobile operators, demonstrating its market maturity.

11. International Energy Agency, World Energy Outlook 2014. <http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>

12. GSMA intelligence, Market data for Q1 and Q2 2015

13. GSMA intelligence, Market data for Q4 2014

14. GSMA, 2014. "The Mobile Economy, Sub-Saharan Africa." http://www.gsmapobileeconomyafrica.com/GSMA_ME_SubSaharanAfrica_Web_Singles.pdf

15. GSMA Mobile Money Blog on Ghana Regulations: <http://www.gsma.com/mobilefordevelopment/regulatory-reform-a-conversation-with-the-bank-of-ghana-on-the-journey-towards-the-new-guidelines-for-e-money-issuers>

16. As of September 2014

PEG's Business Model

The Value Proposition

PEG's original value proposition was selling continuous energy services to customers while maintaining ownership of energy assets. Customers would pay in perpetuity for subscription services, providing PEG with on-going operations and maintenance revenue and the flexibility to increase energy services, or stop providing services to delinquent customers.

This was achieved through the business model components described in the following sections, including products and pricing structure, sales, marketing, distribution, and customer service.

Products and Pricing

PEG licensed solar technologies developed by OGE and Devery, and offered services in Ghana at the rates shown in Figure 3. It is unclear how these rates compared to service pricing in Tanzania as this information was considered proprietary.

FIGURE 3

Solar Home System Components and Pricing¹⁷

System	Panel Size	Components Included	Down Payment	Continuous Payment
Level 1	5W	<ul style="list-style-type: none"> • 200-lumen light; • 100-lumen light; • Phone charger; and • Optional radio (bought outright, GHS 30 [USD 9.29]). 	GHS 30 (USD 9.30)	GHS 4/week (USD 1.24)
Level 2	10W	<ul style="list-style-type: none"> • Two 200-lumen lights; • 100-lumen light; • Phone charger; • Choice of additional phone charger or small light; and • Optional radio. 	GHS 30 (USD 9.30)	GHS 6/week (USD 1.86)

17. All prices converted using the OANDA rate of 0.309 USD/GHS on 1 July 2014. There was extreme depreciation of the Ghana Cedi during the project and the rate in July is taken to be somewhat representative.

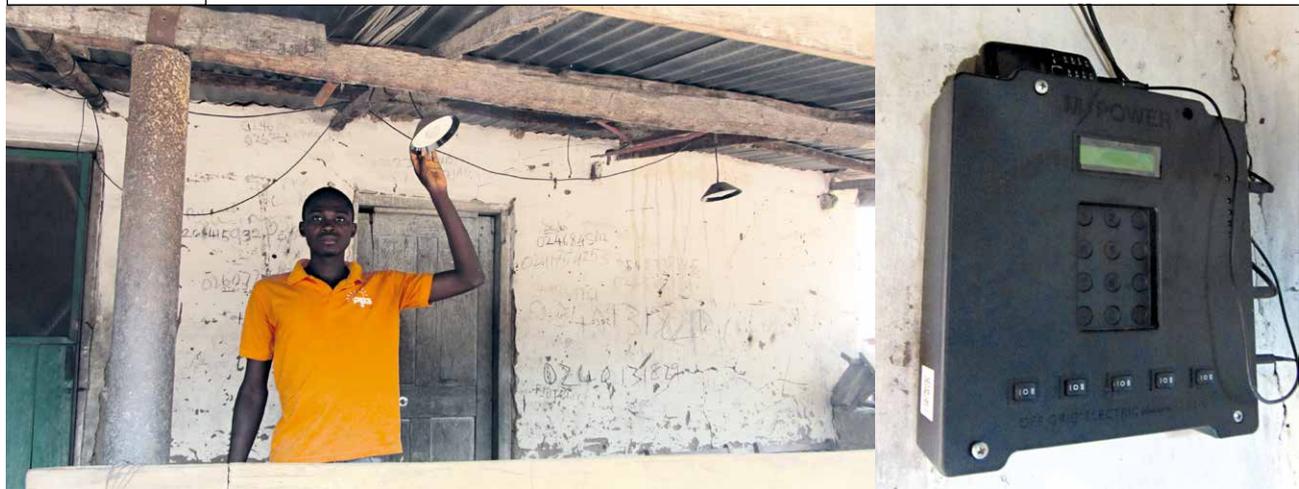
Micro-grids: The micro-grids each had an installed capacity of 1.5 kW, comprised of about 25 towers that each had two 30W panels and two 22 Amp batteries. The household appliance options and their pricing are shown in Figure 4.

FIGURE 4

Micro-grid Components and Pricing

Appliance Options	Down Payment	Continuous Payment	Additional Information
<ul style="list-style-type: none"> • Two lights • Phone charger • Optional purchase of additional lights 	GHS 30 (USD 9.30)	GHS 15 (USD 4.65)/month or on a per kWh basis	Expected to provide 12 hours of power during the night
Addition of radio	GHS 20-25 (USD 6.19 -7.75)	Pay outright	
Addition of 15W TV	GHS 300 (USD 92.97)	Flexible	Can pay in instalments, but cannot use until fully paid
Portable lantern with phone charger	GHS 40 (USD 12.40)	Pay outright	

Source: PEG Ghana



PEG agent with lights connected to SHS; SHS battery and control panel with keypad for manual code entry.

Source: PEG Ghana



Grid solar panel and battery in the background communicate with the household meter shown in the foreground via ZigBee.

Use of Mobile: Technology and Partnership

Technology

SHS: A voucher code was used to transfer credit to the SHS, rather than M2M communication via an embedded SIM, for two reasons: to allow the SHS to work for all households, regardless of patchy GSM coverage, and to keep the costs of the systems down for this market segment. The process was as follows:

1. Customer pays the agent (see Mobile Money Payments section);
2. PEG server generates a 16-digit code based on the payment amount and the customer's system ID and sends it to the customer via SMS; and
3. Customer transfers credit to the SHS by entering the code into the keypad on the unit.

Micro-Grids: Zigbee¹⁸ and GSM-based M2M enabled two-way communication between each household meter and PEG's customer management system. The process was as follows:

1. Customer pays the agent (see Mobile Money Payments section);
2. PEG server sends the new account balance via GSM to the data concentrator on the grid; data concentrator turns on household meter remotely via ZigBee; and
3. Data concentrator receives from each meter information about voltage, temperature and kWh used.

Due to variability in mobile coverage, the data concentrators were equipped with two SIM cards in order to rely on alternate GSM networks where and when necessary.

18. ZigBee is a non-GSM based wireless communication protocol that can be used to create a mesh network of connected devices, such as smart meters, over a large area.

Mobile Money Payments: PEG originally envisioned customers could choose to pre-pay via mobile money on their own phones, or give the PEG agent cash to buy energy credit as follows:

SHS: Customers would pay cash to the PEG agent who would use a mobile application (which was licensed from the supplier) to transfer the desired amount of credit from the agent's own pre-loaded account to the customer's account. This would automatically trigger the SMS with the voucher code for the customer to enter the credit into their unit. When a PEG agent's account ran out of energy credit, the agent would send the accumulated cash from customers via mobile money to PEG, and PEG would again pre-load the sales agent's account with energy credit.

Grids: Customers would pay cash to the PEG agent who would manually alert the PEG customer service centre via mobile (WhatsApp). The customer service centre would manually credit the customers' account on the customer management system and this would be communicated from the database to the customer meter via GSM and ZigBee. Similarly to the SHS process, the PEG agent would send the accumulated payments to PEG via mobile money.

Partnership with Mobile Operators

PEG originally sought partnerships with Airtel, MTN and Tigo that would include integration of their mobile money platforms with PEG's backend customer management systems for instant account reconciliation, and increased mobile money agent presence and training of customers in sales areas. Along a spectrum of possible operator engagement levels, representing different degrees of possible risk and reward, this level of engagement can be classified

as "collaborative," as it requires a medium level of operator engagement at medium risk to them.¹⁹

However, in practice, PEG's initial models operated with more limited operator engagement, at only a "cooperative" level. PEG and the MNOs did not pursue customer payments from their own mobile wallets. This would have required more development or technical support for integrating mobile payments with a customer accounting system, growth of mobile money agent presence and customer training. In practice, this meant that customers could only make payments through PEG agents, and the use of mobile money was limited to PEG agents transferring bulk sums to PEG by one of the following:

- PEG agent visited an MTN store (not an MTN agent) where an MTN agent would send it directly to PEG's mobile money account (via person-to-person transfer) for a specially agreed flat fee of GHS 0.5 (USD 0.15).²⁰ Later, MTN agreed to transfer these funds directly into PEG's EcoBank Account for free, thanks to a partnership that MTN had with EcoBank.
- PEG agent used their own mobile wallet (either MTN, Tigo or Airtel) to make a person-to-person transfer to PEG's mobile money account, and PEG would eventually transfer funds to their own bank. PEG did not have agreements for any special rates on this.
- PEG agent handed the cash over to a PEG central office employee when they came to the field to deliver stock or make a general visit.

For M2M communication with the micro-grids, PEG used normal, pre and post-paid SIMs from MTN and Vodafone (depending on which had the best coverage in each area).

19. Read more about the spectrum of operator partnerships in the GSMA M4D Utilities Annual Report, 2013: <http://www.gsma.com/mobilefordevelopment/predicting-the-future-of-mobile-enabled-community-services-meacs-annual-report>

20. In comparison, MTN's normal fees for mobile money transfer to an account would have been 1.50 GHS for transactions between 1-50 GHS, and 3 per cent for transactions above 50 GHS. <http://www.mobilemoney.com.gh/index.php/fees-rates-and-pricing>

Marketing, Sales, Distribution and Customer Service

FIGURE 5

Description of PEG Operations for Core Business Components

Business Component	Structure & Strategies
Marketing	<ul style="list-style-type: none"> Below the Line only: SHS agents had a demo unit to show members of their community; micro-grid agents visited households.
Sales	<ul style="list-style-type: none"> A single agent assigned to each village was responsible for all initial sales and collection of regular customer payments; and Agent incentivised by commission based on a percentage of down payments plus percentage of subsequent customer payments.
Distribution	<ul style="list-style-type: none"> SHS: Agents kept a small stock of systems, which was replenished by driving units from Accra; and Micro-grids: Grid lines laid to all households during initial deployment with the potential to easily connect households by adding a meter upon down payment.
Service	<p>Installation:</p> <ul style="list-style-type: none"> SHS: Agent installed; and Grid: Agent connected each household. <p>Customer Support:</p> <ul style="list-style-type: none"> Customer service centre available by phone 24 hours/day; SHS: Agent swapped faulty units based on Solar-as-a-Service model (assets owned and maintained by PEG); and Micro-grid: Local technician and maintenance team made any repairs necessary.

Source: PEG Ghana



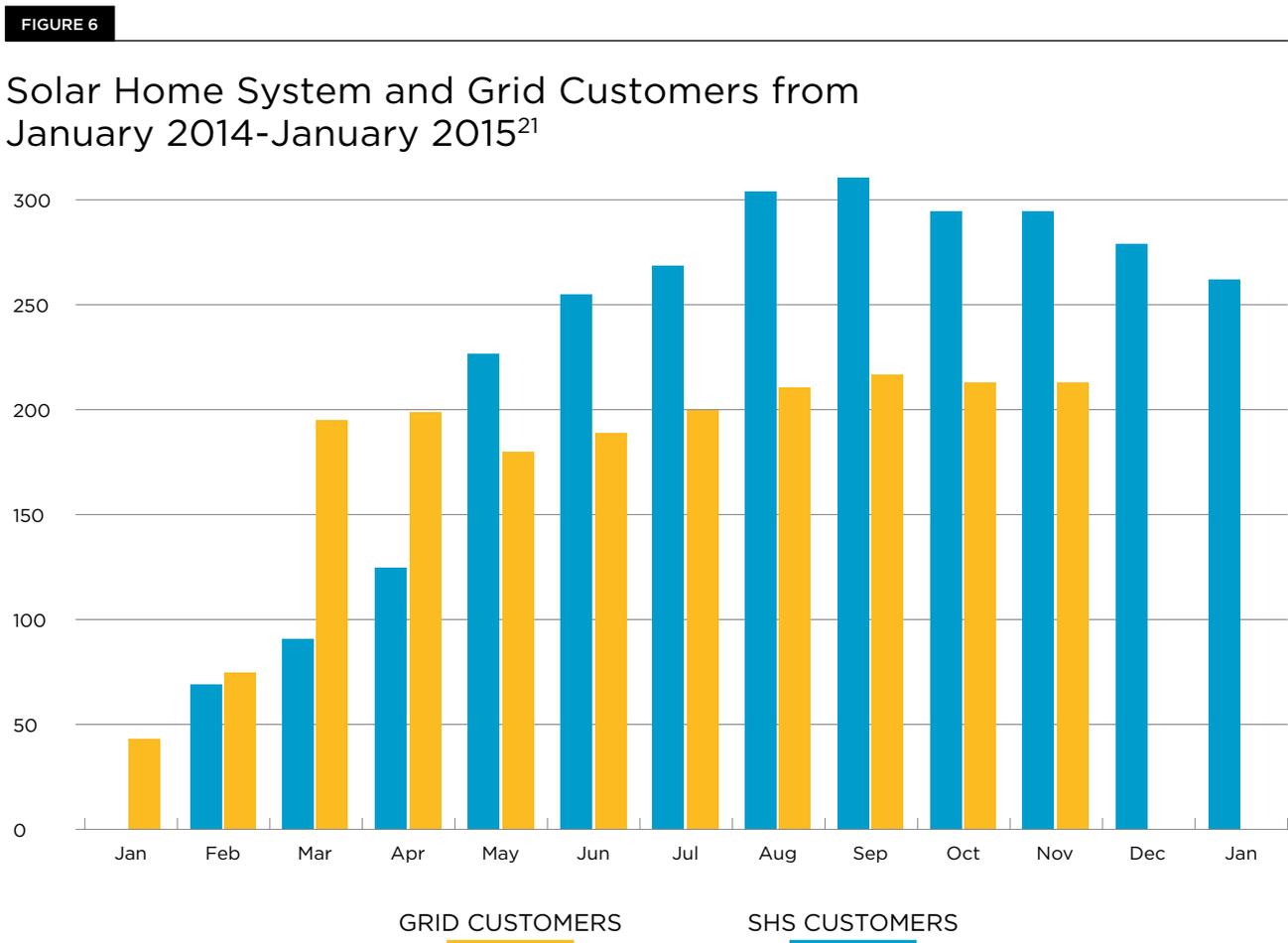
PEG grid technicians performing maintenance on the grid; household meter.

Early Results

From January to September 2014, PEG provided Solar-as-a-Service through SHS and micro-grids to a total of 528 customers (see Figure 6). Based on the results and learnings discussed in this section, they sought a more robust licensing agreement with a new SHS provider that included greater focus on developing their business operations, including integration of mobile money with their customer accounting system. PEG began sales of the new SHS in different areas in November 2014, reaching 400 new customers by the end of January 2015. PEG withdrew their original SHS and micro-grid services starting in December 2014, giving customers the chance to pay off the cost of the energy assets for full ownership.

Viability of the Model

Sales



21. Grid customers dropped off in December because the grids were de-activated after customers stopped paying during negotiations with PEG on the possible sale of the infrastructure to the community.

Sales were lower than expected for the micro-grids and slow to expand for SHS: PEG fell short of their original grant target of 600 customers (300 for each technology), based on the following challenges:

Micro-grids: Technical faults with the grid smart metering system occurred frequently. Despite the data concentrator having SIM cards from two different operators for redundancy, PEG hypothesized that network outages led to customer meters being reset to zero credit, preventing them from accessing power. This would occur many times a week. On a few occasions, the prepaid SIM card in the data concentrator, which required top-ups,²² ran out of credit shutting down the grid until the technician could address it. Although PEG employed a local technician to address these issues, the problems undermined trust and some community members were reluctant to become customers.

It is not fully clear why the technology seemed to have more challenges in Ghana than in Tanzania. PEG hypothesized it might have been from higher frequencies of network interruption in Ghana than in Tanzania, yet PEG had no ability to solve the technical challenges as a licensee, nor did PEG have an agreement with their supplier that explicitly outlined how (and if) technical support would be provided.

SHS: SHS sales were comparatively easier. However, agents had the responsibility for both new sales and selling energy credit to existing customers, so they could not easily expand sales into new villages.

Given these results, PEG was inclined to continue with SHS technology, rather than micro-grids.

Average Revenue per User and Payments

Average Revenue per User (ARPU)²³ did not meet the target for business viability suggesting the value proposition was not strong enough for customers:

The ARPU target of USD 8.00, based on estimates of what customers were already spending for similar services, was only achieved in early months for the SHS, and never for the micro-grids. From January to May 2014, a higher ARPU actually reflected high sales months in which there were many down payments

(GHS 30/ USD 9.30) compared to regular usage payments. ARPU decreased from May 2014 onward to USD 2.00-4.50 for micro-grids and USD 4.00-6.50 for SHS when new sales were not as high. The reasons for low ARPU, as listed below, suggest that the services were less desirable than existing alternatives:

- **Poor quality of service reduced willingness to pay:** The poor service level of the micro-grids caused by technical challenges likely reduced willingness to pay. Customers with limited incomes are slow to trust new technologies, and after a negative experience they are reluctant to commit funds in advance for an unreliable service. Households consumed less than they suggested they would and the grids were therefore oversized for the actual demand.
- **Pricing structures for micro-grid power can be difficult, particularly in comparison to the national grid:** Micro-grid customers preferred to pay a fee per unit of energy, rather than a flat fee for a specified duration, reflecting their previous consumption behaviours (small, frequent purchases for kerosene or batteries) and the national grid payment structure. However, this allowed them to buy less from the micro-grid than their total energy needs, continuing to use substitutes (e.g. kerosene) in small quantities. Furthermore, in one village, rapid pricing experimentation during initial operations led to customer confusion and mistrust, resulting in reduced energy purchases for the duration of the grant. Finally, due to high expectations that the national grid would eventually reach them, customers often complained that micro-grid rates were higher than those of the national grid, which is heavily subsidised.
- **Payment solely through agents limits the ability of customers to purchase services:** In reality, SHS and micro-grid customers were only able to pre-pay through agents rather than directly via their own mobile money wallet because of the limited mobile money reach and absent investment to address this. When agents were unavailable, customers could not purchase their energy service and would resort to alternatives.

22. PEG did use post-paid SIM cards from some operators; however, due to varying coverage levels by each operator at each location, they needed to use different SIM cards in the grids and faced lengthy delays in getting these post-paid SIM cards from some operators.

23. Average Revenue per User was calculated by dividing the total amount of revenue paid by customers by the total number of customers.

These factors suggest that PEG's services were not considered to be more convenient and reliable than alternatives. The lack of usage undermined the viability of the business model. Consequently, PEG had to change their business model significantly and take a new approach to replication through licensing.

Replication through Licensing

Replication through licensing new technology and business models requires significant investment of time and resources from both parties through a robust agreement and partnership: PEG's original licensing approach largely assumed a singular transfer of technology and instruction from suppliers would enable straight-forward replication of the same sales, marketing and service practices. Thus, the licensing agreements were limited in some aspects and did not include sufficient support from licensors. In reality, the challenges that PEG faced on the ground required side-by-side trouble shooting with licensors and more nuanced adaptation and development of business operations. This resulted in PEG's ad-hoc improvements and underdeveloped business operations until it was ultimately apparent that replication in this manner was not viable. The specific examples of this situation are as follows:

- **Lack of clarity on licensed components and support to be included:** In some instances, PEG's agreements with suppliers did not have sufficient information about the software components and functionalities included, nor the allocation of time that would be provided by licensors for support.
- **Different levels of technical expertise between the technology supplier and the licensee:** PEG faced technical challenges with the grid that had not been experienced by the supplier. For example, more frequent GSM network interruptions may have impacted performance. It became apparent that, at the time of licensing, the grids were developed to be operated by the original engineers, rather than external, non-technical staff, and PEG did not have the necessary support in-house or through a licensing agreement.

- **Different data requirements about customers' behaviour from back-end systems:** The licensed backend software for customer account management provided PEG with customer payment information at a single point in time, but not a clear progression of customer consumption over time. Manual data manipulation was therefore required to understand exactly how business changes and service events led to increased or decreased ARPU. This required unexpected resources and caused a lag in response, as well as limited opportunities to scale. Again, the issue was that the software was designed for use by the original developers who could have more easily manipulated the software for their data analysis needs; however, PEG lacked the internal expertise or support through licensing.
- **Investment in business operations:** PEG implemented the same general operations as their licensors but did not invest significant resources in adapting operations that were proving to be ineffective in PEG's context. In some cases, this was because they did not have the in-house capacity to make the necessary changes, as described above. Following this, ad-hoc solutions (such as only relying on agents to collect cash) seemed to work reasonably well on a small scale, but as PEG realised they would need more substantial improvements to scale, they also started to see that their licensing agreements were simply not sustainable.

These demonstrate how all parties underestimated the challenges that arise from replicating new technologies and business models, and the level of support required to address them.

Licensors' priorities may change; licensing should be a key strategy for licensor's own growth: The difference in priority levels between PEG and the licensors for expanding these energy service models was a key factor underlying the issues above. During the pilot, it became clear that both Deveryg and OGE were not going to be focused on licensing as a core business opportunity at that time.²⁴ Therefore, PEG sought a relationship with a PAYG SHS company that was going to be dedicated to a licensing relationship, and was positioned to invest significantly in the partnership.

24. PEG's original licensing partners, OGE and Deveryg, have continued to develop their models and have gone on to receive significant investment as well. In the second phase of the GSMA Mobile for Development Utilities Innovation Fund, Deveryg has been awarded a Market Validation grant to scale their operations in Tanzania through a partnership with a mobile operator.

Refinements to the Business Model

The low ARPU and change in suppliers led PEG to adopt a new business model through a partnership with M-KOPA Solar to replicate their model of financed purchase of solar home systems. Some of the specific changes to their business model are highlighted below, where all are supported by a more robust partnership that involves service-level agreements.

Technical Support

New technologies need more technical support: PEG trialled early-stage technologies for energy access in remote areas, where they faced challenging physical environments and uncertain customer demand. When PEG encountered challenges with micro-grid faults and backend software, they did not have internal expertise nor support from suppliers to address these problems.

Consequently, PEG's new business model relies on technologies (both hardware and software) that have already been tested and replicated in new markets by the supplier itself. As a result, the technology has been made more adaptive for new contexts (such as flexibility in the backend customer management system) and robust, while the supplier has been able to anticipate the level of training and support they will need to provide to PEG.

One notable difference in the specific technology is that M-KOPA's SHS units are equipped with GSM-based machine-to-machine monitoring and control. Although PEG did not seek this as a necessary change to the technology, this feature has required them to invest more in integrating mobile money and improving their customer service as described below.

Source: PEG Ghana



PEG agents demonstrate the new SHS hardware and financed purchase model at a market day.

Payment Methods and Pricing Structures

Investment in collaboration with mobile operators is required to integrate customer payment through mobile money: In PEG's original models, they anticipated collecting customer payments by mobile money, but this did not materialise for the following reasons:

- PEG had general agreements with MTN, Airtel and Tigo to use these payment services, yet PEG did not pursue technical integration with these mobile money platforms as they did not have internal expertise on the backend customer management systems to support this integration and did not have agreements with their suppliers to receive sufficient support for this.
- PEG did not have the high-level engagement with the mobile operators required for the operators to prioritise mobile money agent coverage in PEG's areas of operation.
- PEG did not want their own sales agents to become mobile money agents because they wanted them to focus on registering new customers and supporting PEG customers rather than risk distraction from doing mobile money transactions for non-PEG customers. Moreover, PEG sales agents were not set up to register new PEG customers for mobile money.

Consequently, PEG's payment collection was dependent on the availability of PEG's sales agents, and those agents securely holding cash for a few weeks until they handed it off to a PEG central office staff member or transferred it by mobile money (either via person-to-person transfer or a modified bill-pay function available through MTN). Again, this was part of what led to lower than expected ARPU.

In PEG's new business model for financed purchase of SHS, they have adapted to do the following:

- Formed more robust partnerships with all mobile operators, giving PEG sales agents the ability to register customers for mobile money on any of the three networks - currently MTN, Tigo, Airtel - and soon Vodafone;

- Leveraged technical support from their supplier for integrating with mobile money platforms for instant account reconciliation across all three (soon to be four) operators;
- Require PEG customers to pay the transaction fee when making mobile money payments, which is at a somewhat reduced rate compared to other bill payment transactions, as negotiated with the mobile operators.

Increased pricing has not exceeded customer willingness to pay: Pricing is a key component of PAYG business models, yet PEG found that customers' ability and willingness to pay is somewhat flexible, and also depends on the level of service. Under PEG's model for financed purchase of SHS, the standard pricing structure is a down payment of GHS 99 (USD 25.58) and GHS 2 (USD 0.52)²⁵ per day for a year, which is about three times higher than PEG's previous Solar-as-a-Service model. Despite this, PEG estimates that about two-thirds of their customers under the current model have a similar economic profile to their previous customers. This is apparent in some current customers' requests to pay the GHS 99 (USD 25.58) down payment in instalments, which PEG allows them to do, giving them the unit when the down payment is complete. While pricing for the Solar-as-a-Service models and the financed purchase model cannot be directly compared, PEG's other business refinements in their current model suggest that willingness to pay may be more influenced by aspects of the business model beyond pricing.

Customer Service

Customer care teams should be responsible for pushing repayment rather than sales agents: In the original models, low ARPU was also attributed to the lack of agent availability for customer pre-payments and support. Agents were often focused on acquiring new customers rather than helping existing customers pay since they received more commission for registering new customers. Under PEG's current model, sales agents solely focus on new sales, while payments are done directly by customers, with support from the customer care department, which also manages maintenance and other after-sales support.

25. Exchange rate based on OANDA currency exchange of 0.258 USD/GHS on 31 October 2015, at the time of writing.

Proactive customer communication to educate and build trust:

In the original model, agents responded to customer concerns if and when customers contacted them. The result was that some customers did not always seek the assistance they needed and shifted back to alternative energy sources. Currently, customer care is a key part of the business model and customers speak to customer care when activating the system upon purchase and after installation. Furthermore, the current SHS units have M2M connectivity, so the customer care team can monitor the usage and functionality of the system and proactively identify when there might be a problem and contact customers to provide support. This likely drives an increased sense of reliability and trust (even when customers do not seek support) that is needed for customers to make regular payments for a new technology.

Appeal to Investors

Investors prefer a focus on one model: PEG did not necessarily envision picking just one model, as they thought both would be suitable to different market segments and settings. While PEG was able to attract interested investors based on their anticipated reach through this grant, investors unanimously expressed concern about simultaneously operating two different models. When shifting to a single business model, PEG realised that focusing on just one market segment is a big enough target, and is more appealing to investors.

This was validated by PEG raising USD 3.2 million in September 2015 from I&P Afrique Entrepreneurs, the Impact Assets Emerging Market Climate Fund, French corporate impact investment fund “ENGIE Rassembleurs d’Energies,” the German based development finance institution DEG Deutsche Investitions - und Entwicklungsgesellschaft mbH, US based debt provider SunFunder, as well as other impact investors.

MNO Benefits

Anticipated MNO benefits through greater investment in collaboration with MNOs:

Under the original service models, the potential benefits to the MNOs were not realised due to a lack of investment by all parties in enabling direct customer payments. Therefore, the benefits to the MNOs were limited to revenue from sending unlocking codes via SMS for the SHS systems, the mobile data used to remotely monitor the grids, and the periodic mobile money transfers from PEG agents. Under the new model, and as part of their licensing agreement, PEG has made it a priority to collaborate with operators to enable direct customer payments through mobile wallets.

Driving greater MNO collaboration by building relationships and providing evidence:

PEG has seen significant interest and investment from all four mobile operators to enable PEG customers to make direct payments on their mobile money platforms, which may reflect the following:

- PEG’s significantly increased efforts to collaborate with MNOs;

- MNOs’ interest in growing mobile money services may have increased over the last year;
- Evidence from M-KOPA becoming the third highest contributor to Safaricom mobile money transactions in Kenya;
- M-KOPA’s experience working with mobile operators in three markets to integrate their customer management system with mobile money platforms, and in some cases, grow the presence of mobile money agents; and
- M-KOPA’s technical support for mobile money integration through a robust partnership agreement.

As a result, PEG has become the biggest business for MTN bill pay services, outside of key government services and urban utilities. PEG’s arrangement of partnering with all MNOs for mobile money payments is different from many PAYG solar services and it will be particularly interesting to see how operators compete to receive a greater share of the benefits associated with the PEG offering.

Customer Benefits

Limited benefits to original customers; anticipated future benefits: From the above results, it is clear that many customers of PEG's original models did not feel the benefits of the service were worth paying for. PEG spent time troubleshooting and speaking with customers to resolve issues, and ultimately reclaiming systems. They did not undertake formal customer surveys to assess benefits. However, some customers, particularly those with the SHS, did value the benefits of improved access to lighting, phone charging and radio.

Unfortunately, some of those customers were negatively impacted as PEG could not support legacy services and needed to end the operations of their original models as they transitioned into their new business model. PEG offered customers an "expedited financed purchase" model over three months (and extended to six) to keep the original SHS: level 1 SHS were sold for 300 GHS (USD 92.97), and level 2 SHS for GHS 500 (USD 154.96), minus what customers had

already paid for usage. Ultimately, very few customers could afford this. The remainder of the systems are currently being reclaimed by PEG to avoid distorting the market by giving customers solar equipment that was not fully purchased. The grid communities were given the opportunity to collectively buy the grids, but none were able to organise and agree on a reasonable price. PEG reclaimed all solar assets and plans to resell them. It is not yet clear if PEG will return to these villages under their new business model.

Anticipated customer benefits from more reliable and convenient energy access may come from PEG's business model refinements, particularly from the registration for mobile money services and the ability to make payments independently from agents, a proactive customer care centre, and M2M connectivity that will allow PEG to know more about their customers' usage and maintenance issues.

Conclusions

As more businesses seek to scale their mobile-enabled models for energy access, PEG's grant resulted in highly valuable lessons for the sector around replication into new markets, the need for robust partnerships, and the investment required to reap the benefits of leveraging mobile money.

Replication by licensing innovative energy access models for new markets still requires a high level of adaptation, rather than a "copy-paste" approach. There will be key differences in market contexts in terms of energy alternatives, customer demand and how nascent technology performs under new conditions; therefore, there is a need to invest significant resources in building localised operations to support innovative business models.

Achieving this kind of adaptation requires a close partnership between licensees and licensors, supported by a service level agreement, rather than a single technology hand-off. This is particularly true given early stage technologies and differential levels of

technical expertise. The time and resources required of both parties point toward the need for licensing to be a core part of the licensor's growth strategy.

Finally, leveraging mobile money requires close collaboration with mobile operators for technology integration and building agent networks for accessibility. In Ghana, mobile operators' appetite to grow mobile money services appears to have increased over the past year, possibly indicating that mobile operators are increasingly aware of the benefits of pay-as-you-go solar models such as increased mobile money usage.

PEG has gone on to refine their business model based on many of these learnings and initial success has led to USD 3.2 million in investment. This outcome highlights one of the key impacts that this innovation fund seeks to achieve. Through their current licensing partner M-KOPA, PEG anticipates reaching 500,000 households (2.5 million people) by 2018. PEG's success in 2015 resulted in their 22 per cent month-on-month growth.

Appendix: Case Study Methodology

Overview: This case study is based on learnings that emerged throughout PEG's Market Validation grant through the Mobile for Development Utilities programme. These were tracked through the following:

Grantee reporting: Monthly reports were completed on activities, grant 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.

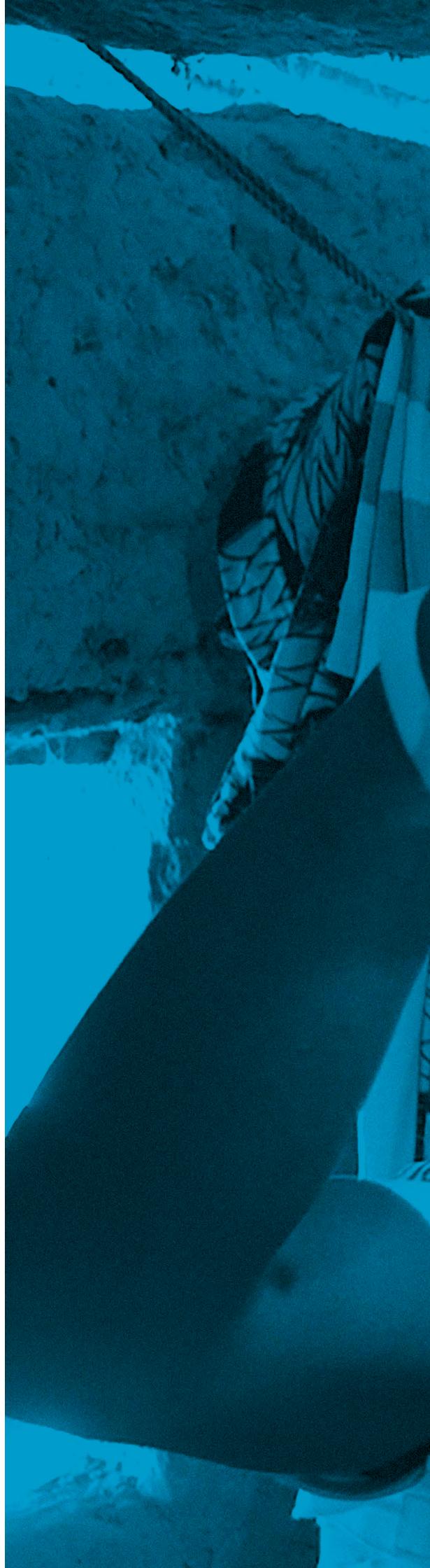
Limitations of this study: The study aims to provide only the key learnings from PEG's grant and cannot possibly cover all the day-to-day learnings from PEG. It also aims to share learnings with the broader sector without releasing commercially sensitive data from PEG or its partners.





For more information on the Mobile for
Development Utilities programme visit:

<http://www.gsma.com/mobilefordevelopment/programmes/m4dutilities>



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