



# IoT-enabled household battery distribution via micro-retailer networks in Senegal

## Pilot Report

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# The Team

**The Pioneer:** Phil Outram

**Implementing partner:** 4R Digital

# The Context

## The problem the pilot sought to address

The International Energy Agency (IEA) estimated in its World Energy Outlook 2021 report that about 30% of the population of Senegal (5 million people) lack access to electricity. The gap is especially pronounced in rural areas, where 66% of the population does not have access to electricity. In these communities, households may not have access to grid-based electricity and may rely instead on expensive and polluting energy sources such as kerosene or diesel generators.

A key obstacle to affordable, and reliable energy provision for many rural households is the upfront connection costs for connecting to the grid –with connection costs representing more than one month's income for the poorest 40% of households in 'access-deficit countries'. Where households are connected to the electric grid, reliability and availability of power can be a major issue, with many customers preferring instead to pay for an off-grid solution that has a known energy output.

While the Pay As You Go (PAYG) solar home system (SHS) market has unlocked clean energy access for some in the Sahel, low-income customer segments are often excluded as they're unable to take on the considerable long-term debt of a complete system (there has been a general movement of providers toward urban/peri-urban areas leaving a segment in the market still seeking a solution). Low-income customers' energy needs tend to be served by not-for-profit organisations distributing lanterns or market actors selling low-cost, low-quality devices. Neither approach supports a sustainable market-based solution, and customers frequently revert to burning carbon-based fuels. Many PAYG SHS customers also experience battery failure, which takes time and is costly to resolve. As the customers have paid a deposit for the SHS, they consider themselves liable for fixing the battery failure.

## The idea conceived for this pilot

Through the Frontier Technologies program, 4R Digital sought to develop and test whether digitally-financed clean energy charging stations could be made available via micro-retailers in Senegal, to meet some of the energy needs of low-income households. This pilot aims to serve those at the bottom of the pyramid and offers services to these households that cannot afford to pay the initial deposit to sign up for a rent-to-own solar panel system.

The pilot aimed to provide households with access to rechargeable batteries, which they could then use to power and recharge devices such as lights or mobile phones, via micro-retailers in rural Senegal. In this case, mobile money agents or MMAs, who run out of kiosks in rural areas, were chosen because they operate as part of wider distribution chains throughout Sub-Saharan Africa, and are very localised and ideally situated to serve the needs of mass market and low-income customers. The pilot sought to test whether MMAs could serve as crucial hubs and customer touchpoints for this solution, not only driving the uptake of the battery units but also offering in-person customer support and education on the benefits of rentable batteries as well as offering device troubleshooting and initial diagnostics.

The pilot sought to learn whether micro-retailers could generate income by offering smart household-battery energy solutions to low-income customers on a lease basis, by serving as a charging and

distribution point for smart batteries. Currently, due to the saturation of mobile money services in key markets and the digitisation of formal financial services, MMAs face significant competition, dilution of commissions and decreasing Cash-in Cash-Out (CICO) transactions. The pilot sought therefore to understand whether MMAs could be incentivised to offer smart household-battery energy solutions as a means of diversifying their income and increasing revenues. If successful, this could be the first of a number of additional services provided by MMAs to their customers that will help to increase and diversify their income streams.

A large number of MMAs operate from kiosks that lack access to a reliable power supply. These agents trade on their smartphones and quite often run out of power during the day, and therefore have to stop trading. As well as benefiting from diversified income, and increased footfall from customers drawn to their kiosks daily, the pilot identified additional benefits for agents who could also get access to reliable energy, through the surplus energy generated by the systems for kiosk use.



MMA Kiosk in Guinguineo, Senegal

For the proposed technical solution, portable lithium-ion batteries were chosen to mitigate the cost barrier as they are cost-effective, have a high capacity and are capable of a long life cycle. Micro-retailers were fitted with solar-powered charging points, so that they could recharge batteries, before distributing them to customers. The model that was tested was 'daily rentable batteries' that customers return to micro-retailers each day to replace the battery for a freshly charged unit. These rentable batteries were seen to represent a compelling solution for underserved communities because:

- Pay-per-swap pricing enables customers to manage energy use and cost, as a full charge can be utilised over more than one day.
- No PAYG plan means customers do not have to commit to long-term repayments, and there is no large, upfront deposit.
- No peripheral costs ensure customers only pay for leasing the battery and do not have to purchase solar panels and peripherals.



A prototype battery charging station developed throughout the pilot for charging four lithium-ion batteries.

The pilot tested smart technology, where data was collected from depleted batteries each time they were plugged into the charging station at the micro-retailer shop, so that retailers could understand battery health, and 4RD could better understand usage patterns, and identify how this data could be used within functionality on the digital platform (for example to enable mobile money payments for each rental).

Existing initiatives have already started providing battery rentals to households in other countries in Sub-Saharan Africa. Mobile Power has over 50 hubs in Sierra Leone, providing battery rentals to over 100,000 customers. Jaza Energy has hubs in over 80 locations in Tanzania and Nigeria (with many in off-grid communities).

While other companies continue to scale operations, the pilot sought to test a different approach to scaling access to battery rentals, by seeing whether existing Mobile Money Operator networks could be leveraged to provide intermediate energy services to low-income customers.

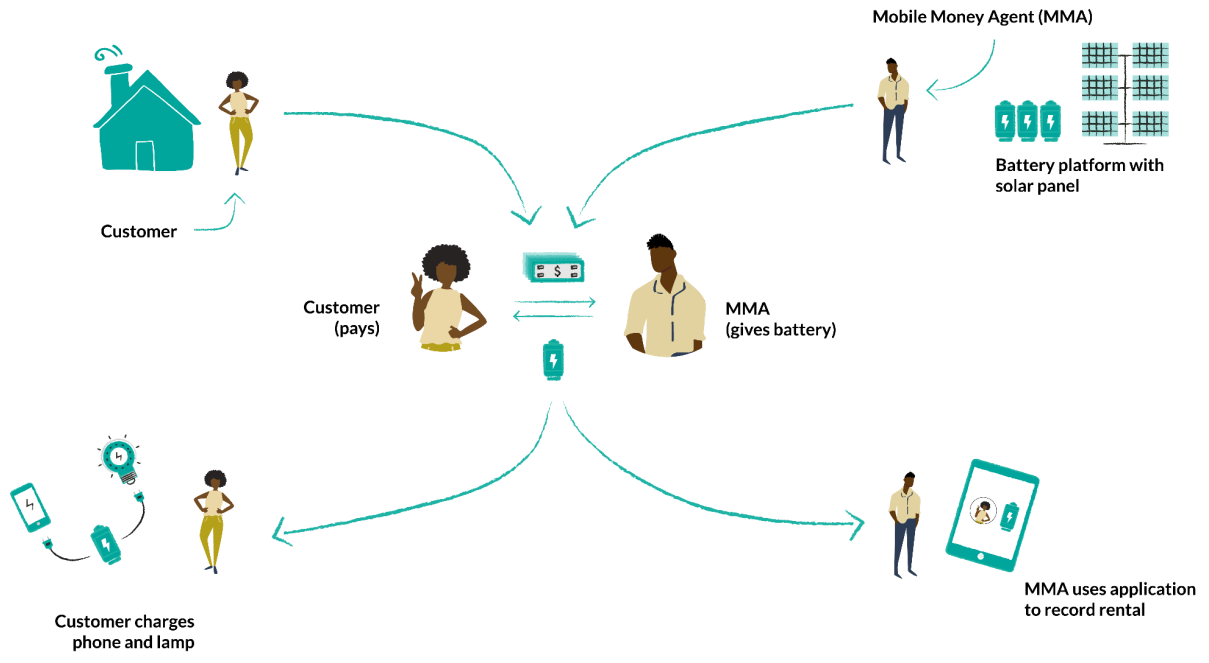


Diagram of proposed solution and service model

# Goals of the pilot

The pilot explored the following key questions.

## **1) Can rechargeable IoT batteries be developed and delivered to meet some of the energy needs of households in Senegal; and can solar-powered charging units be easily adopted by Mobile Money Agents?**

To answer this, the team sought to develop and test a prototype product consisting of batteries, charging stations, and a digital platform that could collect data from batteries each time they were returned to the agent. The pilot sought to identify whether the technology could meet the needs of customers and micro-retailers and whether it was fit-for-purpose and practical to use within the local context. This included validating that:

- The hardware was sufficiently robust and reliable and had the necessary energy capacity for customers' home needs (charging phones, charging lamps, etc).
- The batteries were simple enough for households to use and compatible with the devices households needed to power and recharge.
- MMAs will be able to adopt and operate solar-powered charging units within their existing businesses.
- The hardware can be developed alongside, and communicated with, a digital platform so that information on battery health and usage can be collected.

## **(2) Is there a viable business model for Mobile Money Operators to scale the technology through Mobile Money Agents in their network leasing batteries to households in rural Senegal?**

To test this question the pilot sought to understand whether:

- Low-income households have the necessary incentives (from the perspective of cost, utility and conveniences) to adopt the service.
- A price point and pricing structure for the battery rentals can be identified which is affordable for low-income households, but also covers the charging station's costs while generating a surplus for MMAs, and therefore offering a viable business model for MMAs.
- MMAs will have the necessary incentives to adopt and operate this new service offering.
- There is a business case and interest from Mobile Money Operators to invest and support the scaling of the proposed solution via agents in their network.



# Key Activities

Across four sprints the pilot completed key activities relating to developing a proposed technical solution (and testing it met the needs of low-income households and MMAs), and building and testing a business model for scaling the proposed solution.

To determine whether products could be developed that met the needs of both low-income households and MMAs, the team first surveyed low-income households, and in-person interviews with MMAs. Technical prototypes of the batteries and charging station were also developed, and a digital platform was created which could read data from the IoT batteries. The team then conducted an iterative process of testing the technology with two MMAs and their customers and updating the hardware and software components to ensure that it met user needs.

Over the course of the pilot, as the product design for the proposed solution became clearer, the team were able to estimate different costs associated with manufacturing the product, as well as engage customers and MMAs to identify a viable price point for the solution. Using this information, the team built a business model for the solution, model costs and revenues over a five-year period, in order to determine longer-term economic viability for both MMAs and MMOs investing in the solution. The team sought to present this model to Mobile Money Operators (MMOs) to determine whether they could be interested in scaling the solution within Senegal, or the Sahel more widely.

Activities took place over three sprints and a follow-on phase of work:

- **Sprint 1 (March 2020 - October 2020):** user research through in-person and telephone-based interviews with MMAs and their customers and MMAs. During this sprint, the team also began the initial work to build the digital platform and create designs for the hardware (batteries, charging stations).
- **Sprint 2 (March 2021 - February 2022):** Deployed and tested a prototype with two MMAs and their customers.
- **Sprint 3 (March 2022 - March 2022):** During this sprint, the team continued to trial the proposed solution with MMAs and their customers, including conducting willingness-to-pay tests. They also began developing a business model for scaling the solution via MMA networks.
- **Follow-On Phase (November 2023 - July 2023):** After completing the pilot, and having developed a working technical proof of concept that met the needs of both end customers and MMAs, the team conducted a follow-on phase of work, to perform some ongoing iterations to the technical products, and develop and test the overall business case for the solution.

# Findings from pilot activities

## **Finding 1: The pilot was able to develop a smart battery solution that met the consumption needs of low-income users, and was able to develop charging stations that Mobile Money Agents could adopt and use in order to provide battery recharge services to customers**

### **Key questions the pilot sought to test:**

The pilot sought to test whether they could develop and trial batteries to low-income households that:

- provided sufficient power to meet the demands of low-income
- were easy for households to use
- were compatible with the devices households needed to power and charge (mobile phones, lights, etc)

They also sought to validate that the task of returning the batteries to agents was not deemed overly burdensome for households.

The pilot also sought to test that alongside batteries, they could deliver solar-powered charging points that:

- could be easily deployed in MMA kiosks in rural Senegal
- were easily adopted by MMAs in order to provide batteries to customers on a daily basis.
- could collect data from batteries on battery health and usage and transmit it onto a digital platform.

### **The methods used for testing:**

To explore the key questions outlined above, the pilot first conducted research with households and MMAs to understand their respective needs using or operating a solution. The pilot then sourced and repurposed solar home system batteries, and built RFID-enabled charging stations capable of charging the batteries. RFID enabled the team to identify which battery is connected to which port as well as the charging current values. A digital platform was built which was able to gather and store data from the RFID-enabled stations.

Once an initial technical prototype was developed, two mobile money agents were selected for testing Minimum Viable Product (MVP) units between February 2022 and April 2022.

The first mobile money agent selected for testing (MMA1) runs a shop from the town of Fimela that is accessible from the main tarmac road and has access to the grid. As well as mobile money services she offers basic goods and also has a freezer in the shop.

Her customers who took part in the pilot are within a 1-kilometre radius and usually visit her shop a few times per week. While the grid is available to customers off the main road in nearby villages, for households slightly further away there is no grid access.



Photographs from Pioneer and team visit MMA 1 in Fimela

The second mobile money agent selected for testing (MMA 2) is based in the electrified town of Kayemor (about a 5-hour drive from Dakar) and also has a smaller shop in the nearby village of Kapay which isn't electrified, which is where the battery charger is based. Currently, the shop shares a large Solar Home System with neighbouring houses, and other households in the village also have their own Solar Home Systems. Customers recruited to participate in the pilot mainly used candles or torches for lighting while charging their phones at neighbours' houses.



Photographs from Pioneer and team visit to MMA 2 in Kayemor

Customers of these agents were given the opportunity to trial batteries (with two lights and a phone charging cable) to take home. They were required to return to the MMA to recharge the batteries. Over the course of the trial, customers were asked for feedback on usability and desirability, and research was also conducted with MMAs to test whether they were able to use the solution, and identify how it could be improved. Following the initial trial, the team undertook a continuous process of improving and testing the

prototype to ensure it met the functional needs of all users, and could generate the necessary data needed to support MMAs with leasing and managing the batteries.

In preparing for the trial, the pilot faced a setback in shipping components from overseas (especially the lithium-ion batteries). This led to severe delays in piloting the solution and limited the time available testing products with end users.

### **Key findings from testing:**

Through testing the batteries with customers, the team were able to confirm that the batteries met their consumption needs and were compatible with their home devices. Customers expressed a wish for an additional light (3 lights in total) to meet their needs, and some customers felt that the lights could have been brighter. Benefits reported by trial customers included not having to buy batteries for solar torches or candles, helping children to study in the evening, and not having to leave mobile phones in town or at neighbours for charging.

The trial found that agents were able to operate solar charging stations from out of their kiosks, and successfully recharge batteries to meet the daily demand of their customers. Both agents who took part in the trial reported that they would be happy to offer the battery rental service as a commercial proposition to their customers.

The trial validated design choices made when developing the charging stations, including the need for dust covers for ports, and the need for LED lights on both the charging station and battery units - in order to provide MMAs with information on connectivity status and charging levels, allowing for better usage monitoring and more efficient energy management. The trial validated that the compact and modular nature of charging stations was suitable for MMA kiosk environments, as they didn't take up too much space, and their modular nature would enable agents to incrementally add capacity to meet growing demand when needed.

Battery charging devices and rental batteries communicated with the digital platform as intended and the data provided the necessary information to process sales on the platform, facilitate the management of the batteries, and support end users to understand consumption patterns of customers. 4R Digital believe that the data collected could be used to facilitate mobile money payments for battery usage, and could allow those managing the scale-up of the technology (e.g. MMOs) to better understand the need and customer base for the service across Senegal, and make more informed decisions on scaling the solution (for example on the types of locations where the solution is likely to scale most effectively). For the digital solution to work effectively, charging stations require ongoing mobile connectivity.

## **Finding 2: Both Mobile Money Agents and their customers expressed interest in leasing/renting rechargeable batteries, and price points were identified that might work for both parties.**

### **Key questions the pilot sought to test:**

Before the team could develop a business model, and determine the viability of the proposed solution in the Senegal market, the pilot first sought to validate that both mobile money agents and customers were

interested in adopting the solution and that there were viable potential price point(s) that would be affordable for customers and drive profit to micro-retailers.

Once price points were identified that worked for both agents and their customers, the pilot sought to check whether these were below existing pay-as-you-go Solar Home System options that were already available on the market - in order to validate a market gap for the proposed solution.

The pilot also sought to understand the behaviours of end users, so that these could also be included within the business model assumptions. This included identifying how frequently customers might use the service and swap batteries.

### **The methods used for testing:**

During Sprint 1 of the pilot, a team from CRDES conducted in-person interviews with 13 agents to understand their ability and willingness to offer an additional battery rental service, in addition to existing service lines, as well as their needs for adopting the technology. All agents surveyed were open at least five days per week. Most served more than one mobile money provider, and all offered cash-in-cash-out services already (for example taking cash from customers to top up mobile money accounts). 70% of the agents surveyed already offered other non-mobile money services to their customers (such as phone charging services, hardware products and food).

The team from CRDES also surveyed 118 low-income households over the phone to understand their needs and interest in adopting the solution. Households were identified through agents who took part in agent interviews. Basic Willingness To Pay tests were conducted with the test group of customers to gain an indication of the desirability of this service, and potential price points.

In Sprint 3, as trials were conducted with two mobile money agents in Fimela and Kayemor, further data was collected from both the agents and their customers, to further understand their behaviour using the technology, their willingness to pay, and potential price points.

### **Key findings from testing:**

Through surveying mobile money agents and their customers, the team were able to identify a demand from customers to rent the batteries, and mobile money agents to lease batteries, and were able to identify potential price points for the service that might work for both parties. In particular, findings indicate that most agents and customers would accept a price point of between \$0.15 and \$0.20 per swap.

This finding informed business model development in subsequent sprints. Further findings relating to customer and MMA demand have been outlined below.

### **Customer demand**

The customer survey found that there was considerable demand for the technology. Out of 118 respondents, 90 stated an interest in renting portable batteries from agents, 22% of these respondents were from households which currently don't have access to energy via grid or SHS solutions, and 16 of these respondents reported lacking the money to buy a solar energy system. The data showed an overlap between households that have grid access but would still like to have access to a rentable battery service (indicating issues with the reliability of grid services). Almost all households (116 of 118) owned a mobile device, and 28 respondents reported that they charged their mobile devices outside of the home (normally at a friend/ family member's home).

Of those interested in renting batteries, over half stated they would use the service daily, and over 80% stated they would pay for the battery rental service at least 3 days per week. This finding was supported through data from the trial which indicated that most customers would tend to return rental batteries after 1 or 2 days, when they would then also pick up a fully charged one from the agents. The survey and trial confirmed that accessing batteries from their nearest MMA would fit with the behaviours of their existing customers, who often access over-the-counter services from MMA already.

The survey found that all interested customers would be willing to pay between \$0.08 to \$0.15 per day/ use of the batteries, although over 75% of interested customers stated that they could afford to pay at least \$0.19 per day. Of the households that participated in the trial, all expressed they would be willing to pay for the service. Customers of MMA 1 were all willing to pay \$0.17 a day, and customers from MMA 2 (where households have lower incomes) were willing to pay between \$0.09 and \$0.14. Across both trials, 5 of the 8 customers that took part were willing to pay up to \$0.25 per swap. Above this price, they said they would prefer to go back to their previous solution such as solar torches or candles.

### **Mobile Money Agent demand**

Survey data demonstrated that Mobile Money Agents were also interested in diversifying their service lines and offering battery rentals to their customers. Over 90% (12 out of 13) agents responded they would be interested in offering a battery rental service to their customers and 85% (11/13) of agents believed this would be a popular service due to the perceived lack of energy access. All but 1 agent identified that the commission required per transaction would need to be at least \$0.09 with 6 of 11 respondents believing they would need at least \$0.14 in commission from each rental to make the service worthwhile. All but 2 agents identified that they would need at least \$0.19 in commission from each rental.

Two-thirds of agents responded that while they have access to the grid, reliability is an issue and they require a more reliable energy source to help them with their businesses. This indicates that charging stations could provide additional benefits to agents in helping them power their own businesses. Indeed, 8 of the agents who responded to the survey identified that having access to a reliable energy source would help them to bring in more business.

The survey also explored how MMAs might be able to pay for solar charging installations, and identified that 60% of MMAs were already restricted from offering new services and products to their customers due to a lack of working capital. This led the team to develop a business model where agents would pay for the product through monthly repayments, rather than paying for hardware upfront.

The survey data indicates Mobile Money Agents are interested in delivering the service, and (in most cases) would expect a commission per swap of \$0.14 and \$0.19. However, given the sample size further research and piloting is needed to validate this data, especially as out of those 13 agents who expressed interest in the technology during interviews, only 3 volunteered to take part in the trial. Many of these agents explained that in between taking part in the survey and being invited to participate in a trial, many of their customers received access to the grid.

## **Finding 3: Using data from the pilot, a range of scenarios were modelled, and a viable business model was identified that generates returns on investment for all actors. More rigorous testing and buy-in from MMOs is required to validate assumptions within the business model and enable transition to scale.**

### **Key questions the pilot sought to test:**

The pilot sought to identify whether a business model could be developed for scaling rechargeable renewable batteries through mobile money operators and their network of agents, that could generate sufficient return on investment for all actors involved in scaling the solution.

The pilot assumed to scale the solution, a consortium (made up of a Mobile Money Operator and 4R Digital) would provide the upfront capital investment, which would cover a range of upfront costs associated with recruiting agents and procuring and installing technology. It was assumed that a proportion of the revenue generated by agents through battery swaps would be needed to provide investors with a return on their investment and cover ongoing operating costs for MMOs/4R Digital to provide support services.

### **The methods used for testing:**

Over the course of the pilot, a range of activities were undertaken to generate the information needed to develop a business model.

The pilot team identified potential price points for each battery swap and the frequency with which customers would need to swap batteries by conducting surveys with both agents and their customers. Findings from these can be found in the section above.

To identify the key costs that would be incurred by different parties in order to scale the solution, the pilot team modelled the costs on a per-agent basis. This included the costs associated with procuring the technology, onboarding each new agent (including installation, and last-mile delivery), and delivering ongoing support for each agent (e.g. replacement of components, management of e-waste (at device end of life), after-sales support and device management). Hardware costs were modelled based on an analysis of the MVP product that was developed through the pilot, and via consultation with engineers to identify optimum approaches and costs for developing the solution at scale (including, for example, exploring which elements of the charging station could be 3D printed).

Once data points were captured, the team identified a range of additional underlying assumptions for the business model and then identified what costs and revenues would be incurred, over time, for different parties, based on the assumptions. The assumptions included:

- Each Mobile Money Agent would operate 30 days per month.
- There would be 15 customers/battery swaps for each mobile money agent each day.

- Each agent would be provided with a single solar-powered charging station, capable of recharging up to 22 batteries simultaneously, which they would pay for via monthly repayments.
- Each battery unit would have a lifespan (covered by warranty) of 1,000 swaps.
- The consortium would cover all upfront costs associated with procuring the technology and onboarding agents, and agents would pay-back these costs over a three-year finance term in order to own the charging station outright.
- The consortium would scale the solution to over 6,000 agents over a period of 5 years. Onboarding 3,270 agents in Year 5 alone. This assumption was informed through desk-based research to understand the number of MMAs in Senegal, and the size of the market in Senegal which currently lacks access to reliable energy.

Adopting these assumptions, the team modelled two scenarios – Scenario 1, where end customers pay \$0.20 per battery swap, and Scenario 2, where customers pay \$0.15, with the aim of validating whether either scenario presented a viable commercial opportunity for all parties involved in scaling the solution.

After a business model was developed the pilot team engaged Mobile Money Operators to evaluate capacity and interest in expanding services to include rentable batteries/energy services in rural locations via their own networks.

### **Key findings from testing:**

After developing a range of assumptions and modelling the finances for two separate scenarios, over a multi-year period, the team was able to identify that in both cases, the proposed business model delivered a positive return on investment for both mobile money agents and those mobile operators investing in the technology. This indicates a potentially viable route to scale for the solution, although more work is required to validate the assumptions held within the model.

The model indicated that over a three-year period from leasing batteries, an agent would generate a total gross profit of \$1,152 when leasing batteries at \$0.20 per swap (Scenario 1), and \$504 when leasing the batteries at \$0.15 per swap (Scenario 2). This included profits from revenues, subtracted by costs associated with repayments, which occurred over a three-year finance term. Once an agent has completed the three-year finance term for the charging stations, they could expect gross profits per annum of over \$800 (under Scenario 1) and over \$600 (under Scenario 2) respectively.

For Mobile Money Operators, the model indicated that if they were to help finance and scale the solution to 3,000 agents over a five-year period (with increasing number of agents onboarded each year), they would begin to see a return on that investment by Year 7.

The business model contained a large number of assumptions that to date have only been tested through a trial in which customers were not expected to pay for rentals. Consequently, further testing is required to validate the underlying assumptions within the model, including the willingness and ability of low-income households to pay. The model contains a number of assumptions relating to the operational and logistical costs for scaling the solution that would need to be tested and scrutinised in the early stage of rolling out the solution to MMAs. The model is also capital-intensive by nature, requiring long-term financial commitments for all parties, which are sensitive to price changes. This poses inherent risks to both agents and operators, and further work is required to determine the willingness of agents to commit to the solution (and required repayments for charging stations), especially given the relatively few number of agents who volunteered to participate in the pilot.



While the pilot contacted a number of MMOs in order to share the business model, and see if they would be interested in supporting the scale-up of the solution within their networks, MMOs weren't available or engaged over the course of the pilot. Separately the pilot team consulted existing market data to check whether operators in the mobile money market in Senegal would likely be interested in adopting the solution, to support agents to diversify their revenue. This included consulting GSMA's Mobile Money Regulatory Index. Findings from this consultation indicated that as Senegal is an emerging market, Mobile Money Operators are more likely at this stage to be interested in investing to gain a market share, rather than diversifying revenues and providing new services and products such as rechargeable batteries.

### **Additional revenue from carbon markets**

During the Follow-on-Fund phase of the project, the team also identified that there are likely additional income-generating opportunities for the proposed solution. The data generated through the technical platform on battery usage, for example, could be used to generate and sell carbon credits. The sale of credits in turn could then be used to offset rental costs for end users, and/ or generate increased profits for mobile money agents - further strengthening the proposed business model.

Through a review of existing emission reduction methodologies for solar lighting, and comparable projects developed by existing companies to generate carbon credits, the pilot team identified that the carbon emissions were avoided as a result of customers adopting solar batteries in place of polluting alternatives (e.g. kerosene lamps) could be estimated at 0.26 tonnes of CO<sub>2</sub>e per battery unit per year (assuming a customer leases a battery 95% of the time). Each fully operational charging station was estimated to help generate emissions reductions of 3.93 tonnes of CO<sub>2</sub>e per year. At an assumed carbon price of \$15 per tonne, the project could potentially generate \$3.93 per customer per year and \$59 per charge station per year.

Over the course of the follow-on-fund the team enabled a data feed from their platform into the Carbon Value Exchange (CaVEx) which connects micro-small projects to carbon markets. Through this work, they demonstrated that the platform was already capturing the data required to meet many of the reporting and verification requirements for generating carbon credits (as set out by existing standards). In practice, however, before data could be used to generate carbon credits, additional checks would need to be conducted to validate assumptions on the additional impact solar-powered rechargeable batteries were having on carbon emissions.

# Conclusion

The pilot validated that rechargeable rentable batteries can be made available by Mobile Money Agents in order to meet some of the key energy consumption needs of households in Senegal. The pilot was able to repurpose and test prototype charging stations and batteries that could easily be adopted by agents and their customers. The technical solution could also produce the necessary data for enabling actors to monitor battery health and usage, via a digital dashboard. The pilot identified longer-term opportunities for this digital solution, including integrating with existing platforms to enable access to carbon markets, and diversifying the platform so that mobile money agents and operators can use it to manage the delivery of additional digitally enabled products and services to their customers. Through trialling the technology, the team were able to validate interest from both customers and MMA operators for adopting the solution.

Using the data generated by the pilot, the team were able to generate a business model for scaling the solution which provides a long-term return on investment for both mobile money agents and mobile operators. To date this model is underpinned by a number of assumptions which have only been tested through an initial trial of the solution - including assumptions related to the level of demand and interest in adopting the solution, the price customers will pay, and revenue levels agents will consider viable. The model rests on an assumption both agents and operators will be willing to make relatively long-term financial commitments, despite a currently volatile economic environment. While the business model demonstrates a potential route to scaling the solution, further work is required, particularly as the solution is made available to additional MMAs and their customers, to review and test business model assumptions, and validate that a route to scale actually exists.

Towards the end of the pilot Mobile Money Operators were contacted by the pilot team, but weren't available to review the solution or business model, and no MMOs committed to support the scale-up of the proposed solution. Market research indicates that the Senegal mobile money market might be at too early a stage in order for MMOs to embrace the solution, as they will be more concerned with growing their core offering rather than diversifying revenue streams, although research with MMOs is required to validate this assumption.

## Recommendations for further work

In order to proceed the work of this pilot further, three key next steps are required:

1. Find a partner: Scaling the solution requires the buy-in from a Mobile Money Operator who is interested in leveraging their network of agents in order to support the roll-out, as well as providing upfront capital investment. Follow-up discussions are required with potential partners to review the solution and business case, agree on necessary modifications to reflect changing market conditions and establish buy-in.
2. Launch and transition to scale: Once a partner is secured for scaling the solution through Mobile Money Agent networks, the next step would be to co-develop a plan for continuing to scale the solution, including identifying key activities around engaging and recruiting agents, and ensuring necessary operational and technical readiness involved in supporting the scale-up. This work would include the development of a comprehensive service delivery model and risk register to ensure that the approach is calibrated to achieve scale and mitigate risk.

3. Develop KPIs and continue testing business case assumptions: in the early stages of transitioning the solution to scale, and recruiting agents to take up the solution, it is essential for the team to continue testing the underlying assumptions within the business case developed over the course of the pilot. This includes assumptions relating to the price point and revenues for battery rentals, and the costs for operationally supporting agents to adopt the service. The team scaling the solution should define KPIs that each partner expects the solution to achieve, and monitor these in the early stages of the roll-out, to enable agile decision-making around whether to continue investing and rolling out the service.

# Pioneer Reflections

## Implication of findings for the FCDO

The project was initially linked to an off-grid energy programme being developed by the pioneer, covering the G5 Sahel countries, but it ran out of Senegal. However, due to ODA cuts, that programme was cancelled, which reduced the immediate opportunity to take learnings from the pilot and incorporate them into FCDO programming.

Findings from the pilot also suggest that Sahel countries are unlikely to be well-suited to this initiative. This is because their mobile money markets are nascent and mobile money operator efforts will be directed at recruiting agents for their core business rather than diversifying income streams.

This pilot's finding will be fed back to the Ayrton Fund programme which is the FCDO's main vehicle for energy innovation work.

## Pioneer experience of working with the pilot and applying the FT method

The experience of working with entrepreneurs following the FT's lean and agile sprint methodology was extremely rewarding and educational.

A key observation is that the pilot didn't manage an even spread of sprints. The hardware development (second sprint), including shipment, took the bulk of the time and left little time for the final test sprint. In hindsight, the pilot didn't have the luxury of doing sequential sprints and needed to take some risk by starting hardware development earlier, before the initial research findings were finalised.

This is because a) the real value of the pilot was at the end when we were testing the product in the field, and b) the research in the initial sprint was not robust enough (without a product to actually test) to definitively disprove the hypothesis so the likelihood of us not proceeding to sprint 2 in some form was very low, and the initial hardware design steps could therefore have been started in parallel.

The follow-on-funding did not use the same sprint methodology or have regular catch-ups in the same way that the pilot had. As such, the connection with the pioneer was weaker and the delivery of results has not been shared as effectively.

The Follow on Fund (FoF) is designed to support those pilots that are demonstrating the greatest potential for scaling and generating impact for end users. As tech partners become more experienced with lean/agile methods, the need for hands-on sprint method and innovation coaching decreases. The design of the FoF reflects this and agreements with implementing partners are structured around specific milestones, including sharing learning with FCDO and wider audiences. While Pioneer engagement is not a criteria for securing follow on funding the FT Hub recognises that some Pioneers are interested and able to continue to engage. The expertise and connections Pioneers can offer are highly valued and coaches will work with teams to facilitate the ongoing input of Pioneers."

