



Électricité de Madagascar: Enabling Access to Electricity through Mobile-enabled Rural Mini-Grids





The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with almost 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

For more information, please visit the GSMA corporate website at www.gsma.com

Follow the GSMA on Twitter: [@GSMA](https://twitter.com/GSMA)



USAID is the world's premier international development agency and a catalytic actor driving development results. USAID's work advances U.S. national security and economic prosperity, demonstrates American generosity, and promotes a path to recipient self-reliance and resilience.

Scaling Off-Grid Energy (SOGE) Grand Challenge for Development is a global partnership founded by the U.S. Agency for International Development, Power Africa, the U.K. Department for International Development, the African Development Bank, and the independent charity, Shell Foundation. Our aligned partners include Acumen, GSMA, Microsoft, and the UN Foundation. By optimizing the collective resources and expertise of SOGE Partners, we are accelerating the growth of a dynamic, commercial off-grid energy market to provide clean, modern, and affordable energy access to the millions of households and businesses beyond the grid in sub-Saharan Africa.

Mobile for Development Utilities

The Mobile for Development Utilities programme improves access to basic energy, water and sanitation services in underserved communities using mobile technology and infrastructure. Our work encompasses any energy, water and sanitation service provided to a community, which includes a mobile component, whether it is voice, SMS, USSD, Machine-to-Machine, NFC, a mobile operator's agent network or tower infrastructure. We aim to seize the opportunity, leveraging mobile technology and infrastructure to enhance access to affordable and reliable energy, clean and safe water and sanitation services in underserved communities. The GSMA Mobile for Development Utilities programme receives support from the UK Government and Scaling Off-Grid Energy.

For more information, please contact us:

Web: www.gsma.com/m4dutilities

Email: M4DUtilities@gsma.com

Authors: Nafeesa Punjani

Contributors: Ilana Cohen



This publication is the output of a project funded by UK aid, Department for International Development (DFID), for the benefit of developing countries. The views expressed are not necessarily those of DFID.

CONTENTS

OVERVIEW OF THE GRANT PROJECT	5
SERVICE DESIGN AND USE OF MOBILE	6
RESULTS FROM THE PROJECT	8
LESSONS FROM THE PROJECT	11
ORGANISATIONAL GROWTH AND NEXT STEPS	14

Électricité de Madagascar (EDM)

GSMA Mobile for Development Utilities Market Validation grant, 2018-2019
Mobile-enabled solar mini-grids in Madagascar

7 AFFORDABLE AND CLEAN ENERGY



Overview of the project

Électricité de Madagascar (EDM) constructed solar-hybrid mini-grids in three rural villages in northern Madagascar where previously there was no clean or reliable source of electricity. EDM is an energy solutions provider and supplier of solar energy for mobile towers, and thus sought to leverage the mobile operator's towers as an anchor client to also supply power to nearby businesses and households following an anchor-business-community model.

EDM connected 300 households and businesses, and provided lighting for public services including police stations, schools, churches and medical clinics, impacting over 10,000 people.

PROJECT OUTCOMES



Aside from using mobile for energy voucher purchases, 33% of customers reported using voice and SMS more on their mobile phones, as a result of EDM's service.



Mobile ARPU for mini-grid adopters was **22% higher** compared to non-adopters. However, the proportion of increase directly from mini-grids is unclear.



EDM installed **30 streetlights** in three villages, resulting in **71% of customers** reporting an increased sense of safety in their neighborhoods.



Customers reported a **savings of 21% in monthly expenditure** on energy since connecting to the mini-grids.



53% of customers agreed that their monthly income increased after subscribing to the mini-grid service as a result of the service's ability to efficiently charge phones and light their homes.



72% of customers reported that mini-grid access provided **more than nine hours of artificial light per day**. Parents also reported that children could study for an average of **1.4 hours longer per day** with artificial light.

In May 2018, the Mobile for Development (M4D) Utilities Programme awarded Électricité de Madagascar (EDM) a Market Validation grant to test the commercial viability of providing electricity to off-grid villages in northern Madagascar. EDM is an energy solutions provider specializing in the installation and maintenance of solar power plants and of back-up energy sources for service providers in the telecommunications and banking sectors, among others.

Prior to the grant, EDM was already managing the power supply for Telma's off-grid mobile base stations in Madagascar and sought to leverage the mobile operator's towers as an anchor client to also supply power to nearby businesses and households through disconnected, but proximate mini-grids (known as the "anchor-business-community model", or ABC model). Through the grant, EDM and their technical and smart-metering partner, Sagemcom, constructed three solar-hybrid mini-grids in the villages of Betsiaka, Bemaneviky and Maevatanana where previously there was no clean or reliable source of electricity. EDM cumulatively connected 300 households, businesses and public service offices including police stations, schools, churches and medical clinics that were located within a two kilometre coverage radius of the mini-grid sites.

To identify the most opportune villages to launch the mini-grids, EDM leveraged Telma's geo-marketing insights to select villages with the highest socio-economic potential. In Betsiaka, Bemaneviky and

Maevatanana, the cultivation of cocoa, sugar, maize and rice is the predominant source of income.

Using Sagemcom's backend platforms, EDM digitised multiple components of their rural mini-grid service. The mini-grids incorporated machine-to-machine (M2M) technology to monitor power generation at the mini-grid level as well as tracked individual energy consumption through the smart-metering connection. This information, relayed in real-time through Telma's GSM network, provided EDM with insights on customer behaviour and energy consumption trends. Customers used Telma's mobile money service, MVola, to pre-purchase energy vouchers and logged complaints using SMS to communicate with EDM in real-time.

As an outcome of the grant, the mobile ARPU for mini-grid adopters was 22 per cent higher (May – November 2019) compared to non-adopters across all three mini-grids. While some proportion of this increase in ARPU may be attributed to the launch of the mini-grids, without a view of the historical data prior to the launch of the mini-grids, it is unclear what the specific impact has been on mobile services.

Based on the learnings from the grant, EDM and their parent company Axian Group will continue to invest in mobile enabled off-grid energy access. In 2018, Axian Group and Sagemcom, formed a joint-venture company called WeLight, with the purpose of developing, operating and one day becoming one of the major mini-grid players across Sub-Saharan Africa.



Service design and use of mobile

Approximately 75 per cent of Madagascar's population does not have access to electricity.¹ In rural areas, the electricity access gap increases to 83 per cent.² Jirama, the national electricity operator, is only present in main cities and faces severe issues both in technical capacity and financing, with a debt level estimated at over \$284 million in 2019.³ Jirama has faced revenue deficits for several years resulting in no additional investment in grid expansions beyond suburban areas.

As a provider of off-grid energy solutions for mobile towers, EDM saw an opportunity to extend energy services to rural unelectrified homes. Prior to the grant they had already begun to develop mini-grids in rural areas where they were servicing off-grid mobile towers. Through the grant they developed three solar-hybrid mini-grids that offered the following service levels:

1. A Medium Connection (MC) service connecting customers to the mini-grid through mono-phased meters on a 230V line, enabling connection to appliances such as fridges, freezers and televisions. This is the same level of energy service to which households in developed countries are connected.
2. A Professional Use (PRO) service connecting customers to tri-phase meters at 400V. This service level offers customers with enough power to supply productive use appliances such as welding and woodworking machinery.

To enhance local development, foster economic growth and increase knowledge on uses of electricity for business, EDM paired their field visits with educational sessions. These demonstrated the benefits of productive use of electricity to stimulate economic development through investment in cold chains (i.e. refrigerators, freezers etc.) for improved food supply chains, and through developing skills in computer literacy.

As part of the grant, EDM established a mutually beneficial partnership with Telma, one of the largest mobile network operators (MNO) in Madagascar, which shares the same parent company as EDM, Axian Group.

EDM leveraged multiple mobile channels from Telma. The mini-grids incorporated GSM machine-to-machine (M2M) technology to monitor power generation. In the event of power storage failure, EDM would receive alerts in real-time, via Telma's network, from the monitoring device located at each mini-grid power station to EDM's monitoring platform. In addition, Sagemcom's smart meters monitored and relayed individual level energy consumption to EDM's backend platforms to offer insights on customer usage and energy behaviour patterns.

EDM also sought to leverage economies of scale by siting their mini-grids near-by Telma's off-grid base stations, for which EDM was already providing solar-

hybrid power supply and regular maintenance services. However, due to geographical distances and terrain, the mini-grids operated on a separate power supply from the telecom towers.

Customers exclusively used Telma's mobile money service, MVola, to pre-purchase energy vouchers by using a USSD short code, giving customers transparency in their energy payments. Customers also used SMS to log complaints and communicate with EDM agents.

As part of the commercial operations of the mini-grids, EDM hired and trained local agents in each village to

represent EDM locally. EDM and Telma worked closely to train agents to double-up as mobile money agents, on-board customers and facilitate mobile money payments in areas where Telma did not have a full-time agents present. During the grant, three local agents (one from each village) were hired, ensuring a level of familiarity for customers.

The mobile components of EDM's service also offered Telma the ability to observe the impact of energy services on key mobile operator indicators including usage of mobile services and to determine whether energy purchases would serve as an attractive use case for mobile money transactions among customers.

How does the service work?



STEP 1: Purchase energy credit using MVola. Dial #111*1*5*3*3#

STEP 2: Receive your energy voucher code via SMS

STEP 3: Enter your energy voucher code using the keypad on your smart meter

STEP 4: Energy access is unlocked

1. Madagascar: \$150 Million to Increase Access to Electricity Services for Households, Enterprises, and Health Facilities', March 2019 <https://www.worldbank.org/en/news/press-release/2019/03/01/madagascar-150-million-to-increase-access-to-electricity-services-for-households-enterprises-and-health-facilities>

2. Aiming to Increase Access through Quality Off-Grid Products', June 2018 <https://www.lightingafrica.org/country/madagascar/>

3. Iharihiva, M (2019, August 8) 'Energie - L'état pense à éponger la dette de la Jirama' L'Express de Madagascar

Results from the project

Betsiaka was the first village to be connected to a mini-grid in May 2019. With a household population of approximately 478, EDM acquired 77 new customers (households and businesses) in three months against a target of 95. By the end of the grant, EDM connected 10 per cent of households, 26 small businesses and five public service offices including Betsiaka's town hall, public school, local church and health centre.

The under-performance in terms of connections was largely due to an unforeseen situation beyond EDM's control. In August 2019, the Malagasy Government decided to build a major new national road through the centre of Betsiaka, leaving many residents unclear whether their homes would be destroyed during road construction. This uncertainty resulted in many villagers holding off paying a deposit for the service in the event they would need to move to areas too far from the mini-grid's coverage.

Nonetheless, customers that did sign up for the service in Betsiaka had high individual energy consumption. The average revenue per user (ARPU) for customers under the MC profile was \$17.42 from May to November 2019.

In Bemaneviky, the second village to be connected, the initial adoption rate was lower than expected. EDM noted an increase in subscriptions only after first adopters could show tangible benefits of the service to friends and neighbours. After several months, the majority of the relatively wealthier customers had already subscribed to the service and the remaining non-adopters were either too far from the mini-grid's coverage, could not afford the service, or did not find value in the service. Out of the approximately 750

households in Bemaneviky, the percentage of total households connected to EDM's service was 15 per cent. EDM also connected 26 businesses and 10 public facilities including the local police station, mosque, health centre, church and town hall. The average ARPU in Bemaneviky for MC profiles reached \$8.09 from May to November 2019.

Bemaneviky is a relatively large village and has a main street filled with night activities such as bars, karaoke clubs and shops that residents from other neighbouring villages also frequent. The surge in late night activities was higher than EDM initially anticipated and in August 2019 the growing demand for energy at night caused the mini-grid's battery storage supply to deplete. This triggered the mini-grid's backup generator to activate much earlier each night than expected. In November, the generator's fuel eventually ran out, and as a result, late night activities and lighting at night were temporarily unavailable.

At the time, EDM did not have a dedicated refuelling process. While there was a refuelling process dedicated to mobile operator towers that EDM's anchor- business - community model intended to leverage, the mobile operator towers were too far from the village to be able to refuel both the mobile towers and the mini-grid. Eventually, in mid- December the generator was refuelled, however, the delay left customers frustrated with EDM's service. To mitigate further energy outages in villages, EDM plans to implement an alternate tariff for electricity use at night and to encourage consumption in the afternoon when battery storage supply is high. The peak night tariff, which will take into account the cost of the generator's active hours, will also help limit night time consumption.

Maevatanana was the third village connected by EDM in September 2019. With a household population of approximately 460, Maevatanana is the smallest village in terms of population, size and installed solar power capacity compared to Betsiaka and Bemaneviky. Today 12% of households, 14 businesses and four public service offices such as the local public school and health centre, are connected to EDM's service.

In Maevatanana, EDM ran into challenges around their selected agent's availability. The local agent was not a full-time agent. He was a full time director at the local school, lived a wealthier lifestyle than his neighbours, and did not face the same challenges faced by others in the community. With another full-time job,

the agent was not available to help on-board new customers or provide assistance, causing frustration among customers when he couldn't be reached. EDM temporarily handed over the agent's responsibilities to the representative in nearby Bemaneviky.

While not having a local mobile money agent located in Maevatanana initially affected acquisition and sales growth, it also forced customers to make their energy purchases independently using their own mobile wallet instead of walking to the agent in the next village. At the end of the grant period 89% of customers in Maevatanana transacted independently instead of giving cash to an agent.

Commercial impacts

One of the key objectives of EDM's collaboration with Telma was to determine if EDM's customers increased their mobile usage behaviour as a result of using mobile money for energy purchases.

Based on month-on-month comparisons, mobile ARPU for mini-grid adopters was higher by 22 per cent compared to non-adopters across all three mini-grids from May to November 2019. However, without additional historical data prior to the launch of the mini-grids, it is unclear what proportion of this increase is solely attributed to the mini-grid's and what proportion is a result of seasonality behaviour. For example, those connected to the grid may already be the relatively wealthier households, and they may have already had higher ARPU prior the launches. Unfortunately, at the current time we have been unable to access historical data to further assess this.

The following findings came from a qualitative and quantitative end-line survey of 137 customers. This research was conducted in October 2019 by an external agency.

- Customers reported spending \$8.15 on energy a month prior to EDM's service, for sources like batteries, kerosene and wood. Since connecting to the mini-grids, customers now spend \$6.40 on energy a month – a saving of 21 per cent in monthly expenditure on energy.
- As a result of EDM's service, 12 per cent of customers that subscribed to the service were new Telma customers, of which nearly 79 per cent were female customers.
- 37 per cent of EDM's customers were also new to MVola. Women comprised 22 per cent of those who had never used MVola before.
- Beyond using M-Vola for electricity top-ups, 96 per cent of customers indicated using mobile money for fund transfers to family and friends and for bill payments.
- Aside from using mobile for energy voucher purchases, 33 per cent of customers reported using voice and SMS more on their mobile phone.

Social impact

In terms of customer benefits, 88 per cent of customers interviewed agreed that the EDM service improved their quality of life, which reflects some of the following improvements:

- 71 per cent of both male and female customers reported feeling an increased sense of safety as a result of the streetlights installed as part of EDM's service.
- 53 per cent of customers agreed that their monthly income increased after using EDM's service as a result of service's ability to efficiently charge phones and light their homes.
- 72 per cent of respondents reported that mini-grid access allowed for more than nine hours of artificial light per day. Parents also reported that children could study for an average of 1.4 hours longer per day with artificial light.



Picture 1: Solar array for the mini-grid in Betsiaka



1 Involving the MNO partner early in the partnership is key

EDM had the benefit of securing a mobile operator partnership and integrating with Telma's mobile money platform relatively seamlessly. The following are operational learnings from EDM's partnership with the mobile operator:

- Working closely with Telma was key to ensure adequate network quality in each village. EDM leveraged reliable feedback from customers to inform Telma when customers could not make energy voucher payments using mobile money as a result of poor coverage zones.
- Developing customer facing processes and aligning on commercial activities with the mobile operator was a pre-requisite for launching the mini-grids. It was important for EDM to work with Telma to plan marketing and awareness activities, train and register customers with mobile money

accounts ahead of launching each mini-grid. This helped reinforce Telma's presence to EDM's target customers and inform them of Telma's product offerings.

- Despite EDM's role in power supply for Telma, the mini-grid provider found that getting face-to-face time with a large mobile operator against competing business priorities was challenging, at times. However, EDM's existing collaboration with the mobile operator also meant that EDM understood how their service could better support the MNO's existing products. For example, by aligning on mobile usage KPIs and supporting agents to double-up as Telma agents, this helped reinforce the collaborative nature of EDM's partnership with the MNO. This played a role in ensuring the mobile operator would in return support EDM's priorities and timelines.

2 | Logistics are a challenge when operating in remote, rural contexts

Madagascar's landscape is diverse with both coastal plains and high mountain plateaus, making transport and construction an arduous task, particularly during rainy season. The delay in procurement and delivery of the mini-grid materials to Madagascar meant construction of the mini-grid started six months later than initially planned, largely due to the challenges of transporting material on dirt roads.

In northern Madagascar, where the level of rainfall between December and April is particularly high, one of the more challenging aspects of the grant was

transporting the raw material to construct the mini-grids. The last mile transportation between the nearest city and the village were less than optimal during the construction phase. To get to the first village, Betsiaka, from the nearest city, Ambilobe, what is normally a two-hour (30km) journey during the dry season, took two days for a truck to make the same trip.

For the remaining two villages, Maevatanana and Bemanevika that are close in proximity to one another, most of the equipment was transported by boat from the nearest main city.



Picture 2: Transport truck carrying raw material for EDM's mini-grid between Ambilobe and Betsiaka, during rainy season.

3 | Building demand and getting buy-in for a new energy service takes time

Encouraging uptake of EDM's service in rural villages presented many challenges that highlight the dynamics of selling a new service to underserved populations:

- In general, rural Malagasy people place immense trust in their local Mayors and other political representatives. EDM recognised that to be successful in selling energy credits in an area

untouched by the national grid, they would need buy-in, or a vote of confidence from local officials. By showing the benefits that electricity would bring to the social and economic development of their villages and constituents, EDM was able to build close relations with key individuals in each village to meet EDM's long-term objectives.

- Often when being introduced to a new service, there is a level of unease on the reliability of both the service provider and the offer. EDM's target customers preferred to evaluate the effectiveness of the product before investing in the service themselves. They did this by observing the value it brought to first adopters of the service. This pattern of behaviour is understandable given the promises for new roads or infrastructure that rarely come to fruition and are often forgotten.
- A ripple effect often helps growth once local leaders are happy with the service and their neighbours desire to have the same social status.

This was advantageous to EDM especially in Maevatanana where residents were initially wary about the service but ended up subscribing to it once their neighbours were connected.

- EDM recognised early on that strong uptake of the mini-grid service would also require providing clear, easy to understand marketing material written in the local language. EDM paired this with specialised trainings to encourage the use of electricity and in particular the benefits and economic impacts of productive use appliances to uplift activity in the villages.

4 | Leveraging the Anchor-Business-Community model to streamline operational efficiencies is challenging

One of the objectives of the grant was to determine whether the operations and maintenance expertise, and logistics planned for EDM's servicing of Telma's mobile towers could also be leveraged for power stations at the mini-grid locations. Optimising Telma's maintenance field visits for both the grid power supply and the tower power supply, would minimise EDM's logistics costs and maximise their response levels to villages when faced with technical issues.

Due to Madagascar's extensive hilly landscape, Telma's mobile towers are not situated within villages, but instead on hilltops, in order to offer extensive

network coverage to customers. As a result, these mobile towers were too far away from the villages where EDM's mini-grids were installed, leaving EDM to manage the mini-grid operations separately from the tower power supply.

Additionally, power stations for mini-grids are not the same as power stations for telecom towers in terms of voltage requirements, as well as training for technicians and spare part requirements. Hence, EDM did not find as much benefit from this model, however, other collaboration with Telma around agent training and mobile payments was particularly important.



Organisational growth and next steps

The grant has been catalytic for EDM and their parent company Axian Group. In 2018, Axian Group and Sagemcom, the technical and smart-metering provider for the grant, formed a joint-venture company called WeLight, with the purpose of developing, building and operating off-grid mini-grids in sub-Saharan Africa. Though this grant was awarded to and implemented by EDM, the service is now branded “WeLight” for communication in the villages, and the three mini-grids will be legally transferred to WeLight in the course of 2020.

During the grant period, WeLight was awarded a tender by the European Commission and Swiss NGO, CEAS to implement and operate an off-grid mini-hydro electrification installation across two villages in Madagascar. WeLight also received a tender from GIZ in Uganda to electrify 15 villages in the south-west of the country. Implementation of this project

is expected to start in early 2020. In Madagascar, WeLight will continue to roll out new mini-grids in the north and east coast, with 15 new mini-grids in the pipeline for 2020.

Related to the mini-grids supported by the Mobile for Development Utilities Innovation Fund, WeLight will continue to use data insights and customer feedback to improve the energy access experience in each village. WeLight will also continue to work closely with Telma, who recently launched their own pay-as-you go solar home system solution ideally for prospective customers too far from the mini-grid, but still in need of energy access. Additionally, to encourage increased demand, WeLight hopes to collaborate with GIZ to further educate local agents on the business opportunities in using electric appliances. This activity is expected to launch by mid-2020.





For more information on the Mobile for
Development Utilities programme visit:
[www.gsma.com/mobilefordevelopment/
programmes/m4dutilities](http://www.gsma.com/mobilefordevelopment/programmes/m4dutilities)

GSMA HEAD OFFICE

Floor 2
The Walbrook Building
25 Walbrook
London EC4N 8AF
United Kingdom
Tel: +44 (0)20 7356 0600
Fax: +44 (0)20 7356 0601