ENERGY
CATALYST

How are digital technologies impacting energy access markets?

ENERGY CATALYST

UKRI Innovate UK

UKaid from the British people

Transforming Energy Access

Contents

This research is aimed at energy access innovators to provide an up-to-date status of the digital landscape. It introduces and discusses:

1. the **major enabling digital technologies** that are impacting the energy access sector
2. a selection of **innovative applications** of these technologies
3. the **key digital trends** in the the sector, pointing to its future direction

Hyperlinks are found throughout the report. Use these to be taken to relevant sections within this document, or to external resources like websites.

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Author: Chris Browne, Country Specialist, Energy Catalyst

Accompanying this report

During the research phase of this report it became clear that, in the energy access sector, mobile money is far more widely used in African countries than Asian ones. The situation in South and South East Asia is less well documented but it is clear that many payment methods and models exist. Therefore, accompanying this report are two pieces of research carried out by our ECAP consortium partners *New Energy Nexus* and *Intellecap*, investigating the prevalent payment methods (digital or otherwise) in energy access in key Asian economies.

Because of the level of complexity and information beyond the scope of the digital theme of this report, this research is contained in the Annex and can serve as reports in their own right:

Annex 1:
Digital Payments for Energy Access in South East Asia

Authors: Ralph Ebora, Stanley Ng, Brenda Valerio, & Naufal Musri

Annex 2:
Digital Payments for Energy Access in India and Bangladesh

Authors: Prachi Seth & Kavya Hari

Interviews

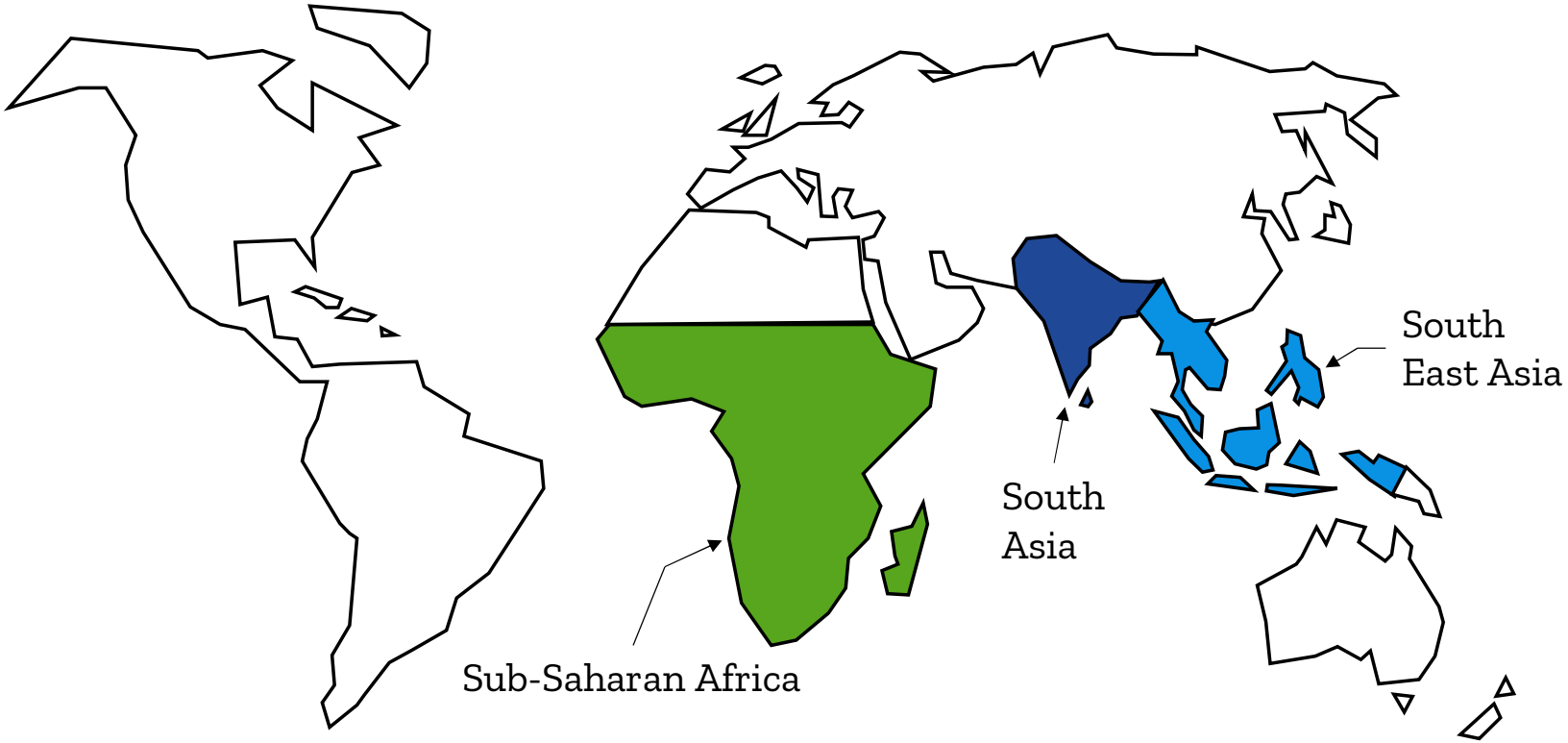
This research was made possible by interviews with leading industry stakeholders. These are referenced throughout the report:

Interviewee	Company
Arvind Murarka	Arohan Financial Services
Solene Gondrexon	Ate Co
Farmina Hossain & Bijoy Bhowmick	BURO Bangladesh
Dr. Jay Taneja	e-GUIDE
Ayu Abdullah	Energy Action Partners
Paul van der Linden	Enviu & SokoFresh
Jit Bhattacharya & Michael Emmerson	Factor[e]
William Duren	Ferntech
Jackie Mwaniki	Fraym
Ashish Dhankhar	GIZ Myanmar
Abhishekh Shah	Intellecap Advisory Services Private
Sebastian Groh	ME-SolShare
Sandeep Pandey	Mera Gao Power
Udeesh Ullas	Muthoot Microfin
Min Chan Win & Ye Thu Win	Myanmar Eco Solutions
Kate Steel	Nithio
Preye Ivry	Nortech
Hunter Dudley	Odyssey
Nithya Menon	Okra Solar
Erel Narida	One Renewable Energy Enterprise
Andre Susanto	PT Inovasi
Saurabh Chandra Rai	Simpa Energy India Private
Sam Duby & Nabin Raj Gaihre	TFE Energy & Village Data Analytics

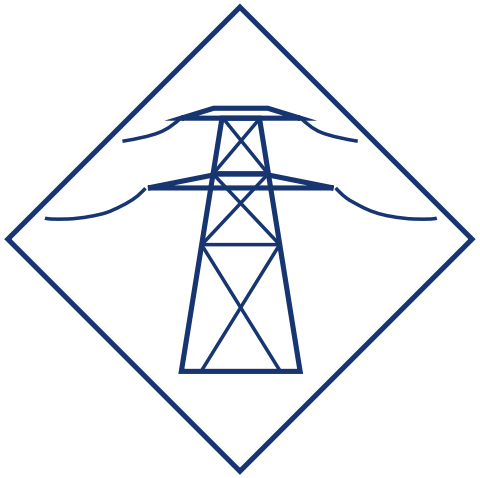
Additional information was gathered from mini-grid players in Bangladesh: Rahimafrooz, Green Housing and Energy, Exelon Bangladesh, and Blue Marine Energy.

Regions of interest

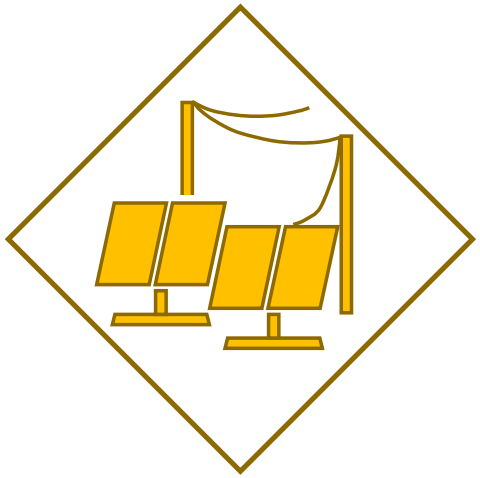
This research covers technologies present in energy access contexts in **three regions**:



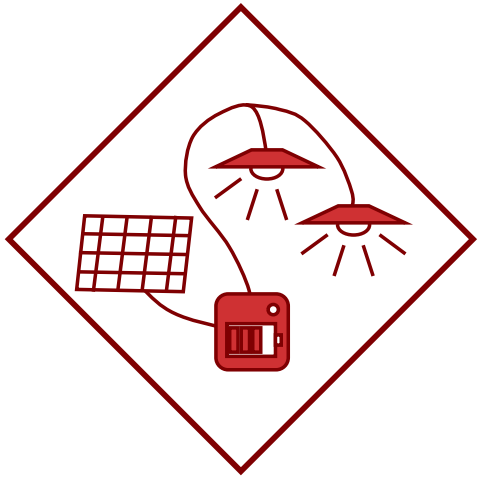
Digital technologies presented here cover the four main **energy access subsectors**...



Grid



Mini-grid

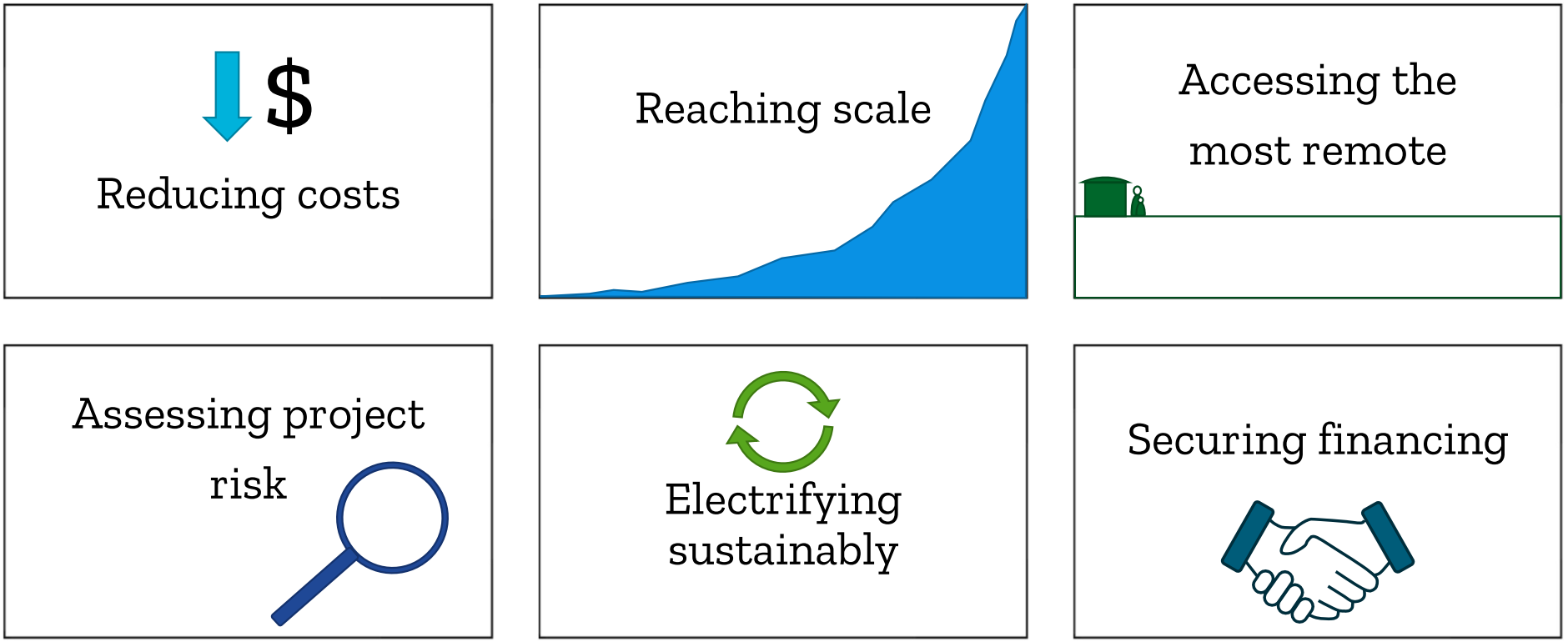


Off-grid solar (OGS)[1]

Clean cooking

[1]Off-grid solar-powered products, including Solar Home Systems and pico-solar – TFE Energy (2020)

...and address the **major challenges** facing the sector



Source: TFE Energy (2020)

ENERGY
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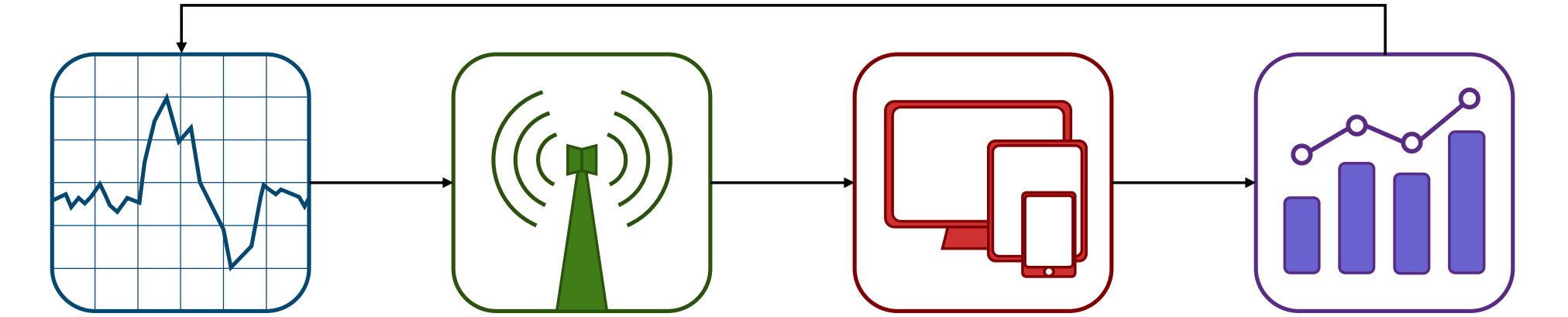
1. Enabling technologies

ENABLING TECHNOLOGIES IN ENERGY ACCESS

The range of technologies that are enabling digital innovation in the sector can be divided into **four pillars**:



Sensing & data	Communication	Platforms	Analytics
• System data • GIS • Customer and national data	• Mobile networks: SMS, USSD, GSM, 4G • Satellite communication	• Mobile devices • Cloud computing • Mobile money • Internet of Things (IoT)	• Statistics & machine learning • Optimisation

Sensing and data-collection

SYSTEM DATA

WHAT?

Taking measurements of **key energy system parameters**, and storing digitally

WHERE?

Grid **Mini-grid** **OGS**

Recording data from **any device in any system**

HOW?

- **Onsite hardware**
- **Relevant parameters for that device**
- Some **record data on their own**, others require a **stand-alone measuring device**
- Hardware often **part of the service offered** by remote monitoring platforms

WHY?

Visibility into a system's health and usage

ENABLING

Understand the system: Predictive maintenance, fault detection, efficient design/upgrades, remote monitoring, smart metering, PAYG

TRENDS & THE FUTURE

Installation in **new types/smaller systems**, e.g. smart appliances/PU, and EVs

REMAINING CHALLENGES

- **Balancing** amount of data produced vs. cost to transmit and store it
- **Standardising** data from the huge range of devices

WHO?

Most equipment manufacturers

Schneider Electric, SMA, GE, Bboxx, M-KOPA

Remote monitoring & smart metering

nortech, FERN TECH, AMMP, steamaco, SPARKMETER

Sensing and data-collection

GIS

WHAT?

Satellite imagery and **geo-tagging**

WHERE?

Grid **Mini-grid** **OGS**
Clean cooking

HOW?

- Take **high resolution images** of any part of the earth
- Access and link images to a database of **known customers/locations/landmarks** (geo-tags)
- **Identify** new features:
  - **Day**: structures, roads, settlements
  - **Night**: distribution of electric lighting

WHY?

Surveying an area without going onsite → time & cost efficient enough to do at scale

ENABLING

Scale: survey very large areas (e.g. countries)
Access: to the most rural areas
Analytics: data fed into models, insights generated
Deliveries: Uber-style product deliveries

TRENDS & THE FUTURE

Wider use, and in more contexts

REMAINING CHALLENGES

- Low availability of geo-tagging data in many rural locations
- Tree cover obscuring satellite imagery

WHO?

Satellite imagery:

esa NASA

Geo-tagging:

OpenStreetMap Google Maps

Sensing and data-collection

CUSTOMER AND NATIONAL DATA

WHAT?

Data directly related to customers (**socio-economic**) and their **energy consumption**

WHERE?

Grid **Mini-grid** **OGS**
Clean cooking

HOW?

Data obtained from:

- **Collection**
  - Own surveys
  - Governments – statistics bodies / census
  - Development agencies & NGOs
  - Utilities and other energy developers
- **Modelling & analytics**
  - Data produced by academia
  - Data provision specialists

Also through:

- Free online repositories / databases
- Professional or personal relationships with data-gathering organisations
- Providers: service / license / marketplace

WHY?

Understanding the customer: factors impacting an individual's energy access & consumption

ENABLING

Insights & analytics: data used directly or fed into further modelling. Informing energy policy, site selection, system design, and risk profiling

TRENDS & THE FUTURE

Increased access as:

- Technology improves and scales
- Value of data is realised by wider industry
- Govts increase data collection capabilities
- More companies provide data as a service

REMAINING CHALLENGES

- **Availability**: organisations lack capacity and incentive to share data → require strong relationships & demonstrated value
- **Ethical collection** and data privacy

WHO?

WORLD BANK OPEN DATA · fraym · Village Data Analytics · CARMA · e-GUIDE · Nithio

Digital communication and control

MOBILE NETWORKS

WHAT?

Networks/services enabling **communication through mobile devices**: SMS, USSD, GSM/3G/4G

WHERE?

Grid **Mini-grid** **OGS**

Clean cooking

HOW?

- Communicate with **customers** and **in-field tech**: mobile phones, system data collection, electricity meters
- Service selected based on **availability**, and **amount & type of data** transmitted
- Communication with customers with more limited technology as uses simpler services

WHY?

Communication made possible in the absence of fixed phone line/internet infrastructure

ENABLING

Mobile money, customer engagement, surveys, site-to-internet data transfer (remote monitoring and smart metering)

TRENDS & THE FUTURE

- **Increased service availability** and bandwidth with network expansion
- **Increased demand** with adoption of more digital technologies

REMAINING CHALLENGES

- Limited or no service in many rural locations
- Low mobile ownership - especially smart phones

WHO?

National telecom operators

Digital communication and control

SATELLITE COMMUNICATION

WHAT?	Communication with in-field devices via satellite when no mobile network is available
WHERE?	**Mini-grid**
HOW?	• Is used to monitor energy systems at sites when mobile network not available • Recent cost reductions have made this communication viable for mini-grids
WHY?	Access to system data is vital for mini-grid viability and worth the additional cost for satellite communication Not viable for smaller systems like solar home systems

ENABLING	Remote monitoring & control
TRENDS & THE FUTURE	More prolific use of this channel as coverage increases and costs reduce
REMAINING CHALLENGES	• Still more expensive than mobile networks • Price is much higher in places with limited mobile network coverage
WHO? (click the logo)	HUGHES

Digital platforms

MOBILE DEVICES

WHAT?	**Portable devices (phones, tablets, & laptops)** that can interact with the wider digital ecosystem via the mobile networks
WHERE?	**Grid**  **Mini-grid**  **OGS**  **Clean cooking** 
HOW?	Used in the field by customers and operators
WHY?	• Digitising information at the source • Platform for communities / technicians to engage with digital resources and connect to digital internet services

ENABLING	Digital surveying, community engagement, remote support
TRENDS & THE FUTURE	Increased usage of mobile devices
REMAINING CHALLENGES	Low ownership amongst energy-poor communities
WHO?	Major electronics manufacturers

Digital platforms

CLOUD COMPUTING

WHAT?

Data and software that is stored and accessed over the internet

WHERE?

Grid **Mini-grid** **OGS**

HOW?

- Connect energy systems and customers to the internet
- Transmitted data is stored and processed online by servers in a remote location
- User-interfaces created where data, communications, and analytics can be accessed by users from anywhere
- Cost of computing assets replaced by service fee for use of the cloud system

WHY?

- Minimises storage and computing power required onsite
- Quick and cheap to scale cloud operations
- High computing performance & redundancy, benefiting large data & analytics applications

ENABLING

Large-scale data collection, storage & analytics, remote monitoring, IoT, digital surveys, internet-based applications

TRENDS & THE FUTURE

Increased movement of assets and storage to the cloud

REMAINING CHALLENGES

Connectivity to the cloud in many rural locations

WHO?

aws Microsoft Azure Google Cloud

Digital platforms
API

WHAT?

An *Application Programming Interface*, commonly known as an API. They are protocols written so that digital systems can interact with each other

WHERE?

Grid **Mini-grid** **OGS**

HOW?

- Developers of a digital platform often allow external applications or services to interact with it, giving commands or extracting information
- This is a set protocol that is defined by the makers of the software
- Documentation is provided by the developers so that others can understand how it is works
- An API can be written for any digital product: a platform, a website or digital hardware

WHY?

- Communication in the most efficient way that the designers of the system can create
- Users who are not familiar with the inner workings of a system can use simple commands to extract data or give commands

ENABLING

IoT: interconnected digital devices and platforms, creates an ecosystem where nodes efficiently communicate with each other using minimal human intervention

TRENDS & THE FUTURE

Increased interconnection as more digital technology is used in the energy access sector

REMAINING CHALLENGES

N/A

WHO?

Any digital service – ask the developer!

Digital platforms

MOBILE MONEY

WHAT?

Financial transactions through mobile phones and networks

WHERE?

Grid **Mini-grid** **OGS**

Clean cooking

HOW?

- Users have a mobile wallet that is connected to a mobile phone number, which acts like the account number at a bank
- The wallet can be topped up using cash at a licensed vendor, or directly by sending money from a conventional bank account
- Transactions are made from the device using USSD or mobile internet services

WHY?

- "Banking the unbanked" – allowing customers to access services that rely on mobile money
- Traceability: automatic transaction records

ENABLING

PAYG, credit scoring, performance monitoring, project risk profiling, securitisation

TRENDS & THE FUTURE

- Increased penetration of mobile money especially in West Africa, and East & South Asia
- Reduced transaction fees
- Providers creating a digital ecosystem around their platform – "payments as a platform" model

REMAINING CHALLENGES

Some countries have limited penetration (e.g. much of Asia) which is challenging when implementing the applications above

WHO?

Mobile operators typically have their own mobile money platform

Digital platforms

INTERNET OF THINGS (IOT)

WHAT?

Interconnected devices that record and exchange data via the internet, for the same purpose / objective

WHERE?

Grid **Mini-grid** **OGS**

HOW?

- Small, embedded sensors and devices that communicate with the internet are installed in energy tech
- Data from these are shared via the internet or another network to other devices
- Data tracks system energy flow & other features, and can be used to determine the optimal operation of all devices as well as facilitate transactions

WHY?

- Distributed data collection & computing
- Smaller, cheaper data-collection devices/sensors are viable
- Heavy computing carried out in the cloud

ENABLING

Very broad field with many and varied applications: remote monitoring, smart metering, PAYG, distributed energy grids / 'prosumption'

TRENDS & THE FUTURE

- Increased prevalence in energy access applications, particularly in the applications listed above
- Countries formalising regulation

REMAINING CHALLENGES

- Penetration of enabling technologies, e.g. mobile networks, mobile money
- Gaps in regulation that do not allow for IoT compatibility in devices

WHO?

Examples within energy access:

nortech, FERN TECH, AMMP, SPARKMETER, steamaco, solshare, ODYSSEY

Analytics

STATISTICS & MACHINE LEARNING

WHAT?

Models that make predictions from data

WHERE?

Grid **Mini-grid** **OGS**

HOW?

- Large amount of data is collected, relevant to the system / application (hardware, consumption, payments, GIS)
- Data is used to build a model of how a system behaves
- This model is then used to predict certain characteristics of new data
- The 'accuracy' of a model describes how well it can predict these characteristics

WHY?

Uncover patterns and make predictions that would not normally be possible

ENABLING

Insights: policy-making / market intelligence, site selection & demand assessment, credit scoring, 'prosumption'

TRENDS & THE FUTURE

- Increased adoption and wider set of applications with industry acceptance and shift to large-scale data-collection
- Higher accuracy models as more is learnt about the sector

REMAINING CHALLENGES

- Lack of awareness of the value that these kinds of insights can have
- Inherent variability limits accuracy of models → understanding of where models can be used
- More accurate models require more data, so needs balancing with individual privacy

WHO?

fraym, Village Data Analytics, e-GUIDE, Nithio, solshare, ODYSSEY

Analytics

OPTIMISATION

WHAT?	Determining the best possible operation mode for a system
WHERE?	**Grid** **Mini-grid** **OGS**
HOW?	• Large amount of data is collected, relevant to the system / application (hardware, consumption, payments, GIS) • Mathematics is used to determine optimal hardware configuration / operating mode • Often using predictions made with machine learning models • Can be done both when designing a system and during its operation
WHY?	• More efficient systems, enabling new types of electrification models • Leads to cost and price reductions

ENABLING	Network design, 'prosumption', dynamic pricing, demand-side management
TRENDS & THE FUTURE	More opportunities for optimisation will emerge as more IoT devices are connected and more data is collected
REMAINING CHALLENGES	Penetration of enabling technologies, i.e. mobile networks, IoT devices
WHO?	nortech solshare OKRA

ENERGY
CATALYST

2. Applications

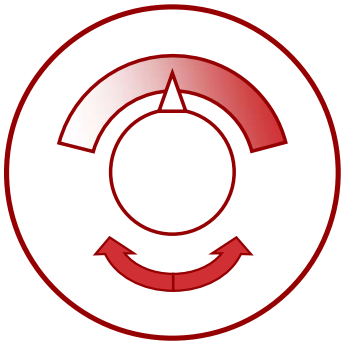
Applications

Planning & design

- Smart Maps
- Demand assessment
- System design

Finance

- PAYG
- Crowdfunding & P2P lending
- Credit scoring
- Grant performance tracking



Optimising operations

- Prosumption
- Defining quality of service
- Demand-side management
- Remote monitoring
- Remote technical support
- Fault detection
- Predictive maintenance

Communication and engagement

- Market linkage
- Community engagement

Planning and Design

Smart maps
Demand assessment
System design

Planning & Design

SMART MAPS

Technologies used:

Established: Establishing:

WHAT?

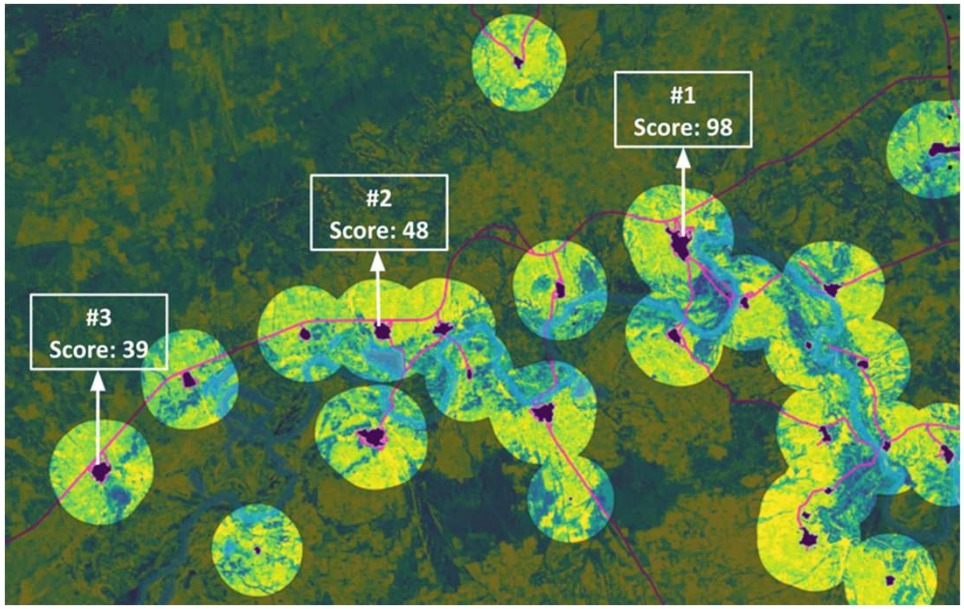
Smart Maps[1]: maps of large areas which provide localised characteristics like **socio-economic level**, **energy consumption** and **ability to pay.**

HOW?

Large amounts of data are collected for certain regions. **Machine learning models** are trained using this data to predict characteristics of interest. These models are applied to **untested regions** to predict those same characteristics from more limited data – sometimes just satellite imagery. These predictions are tied to specific locations and form a **Smart Map**:

Data → Models → Predictions → **Smart Map**

It is possible to feed the predictions into other models as data– for example using predictions of socio-economic level to estimate ability to pay. In this way, an ecosystem is growing where specialised data sets are created, maintained, and combined to produce Smart Maps that are tailored to an organisation's or programme's needs.



Ranking settlements for mini-grid viability from only satellite imagery

Source: Village Data Analytics (VIDA)

[1]'Smart map': e-GUIDE & VIDA (2020)

Planning & Design

SMART MAPS

Technologies used:

Established: Establishing:

What can this be used for?

Primarily used as a planning tool:

- **Developers**: site & customer identification, and other market intelligence: where to deploy most effectively? what is the right product for this community? how can you support credit? what is the right supply chain?
- **Investors**: investment planning and due diligence.
- **Governments / Institutions:** informing energy policy, e.g. which energy interventions are best suited to an area.

Benefits?

Huge scale can be achieved at relatively low increase in cost:

- Satellite data are **available globally**, so images of anywhere on the planet can be fed into a satellite-based model.
- **Low cost and effort** to apply modelling across a region, compared to visiting & surveying all settlements → scalable to countries and continents.

Challenges?

- **Data availability**. Energy consumption and socio-economic data, used to build models is often limited or difficult to access. Of the companies interviewed, this data was obtained through own surveys or long-term personal relationships with governments and energy providers – both time and resource intensive.
- **High variation**. The highly varying human world, even within countries, means that models trained in one context may not be applicable to others close by. Broad data collection is required to overcome this.
- **Terrain aspects**, e.g. tree cover can limit what is seen by satellite imagery, impacting effectiveness in certain biomes.
- **Industry acceptance**. A common challenge is that industry is yet to understand the benefits of this kind of data.

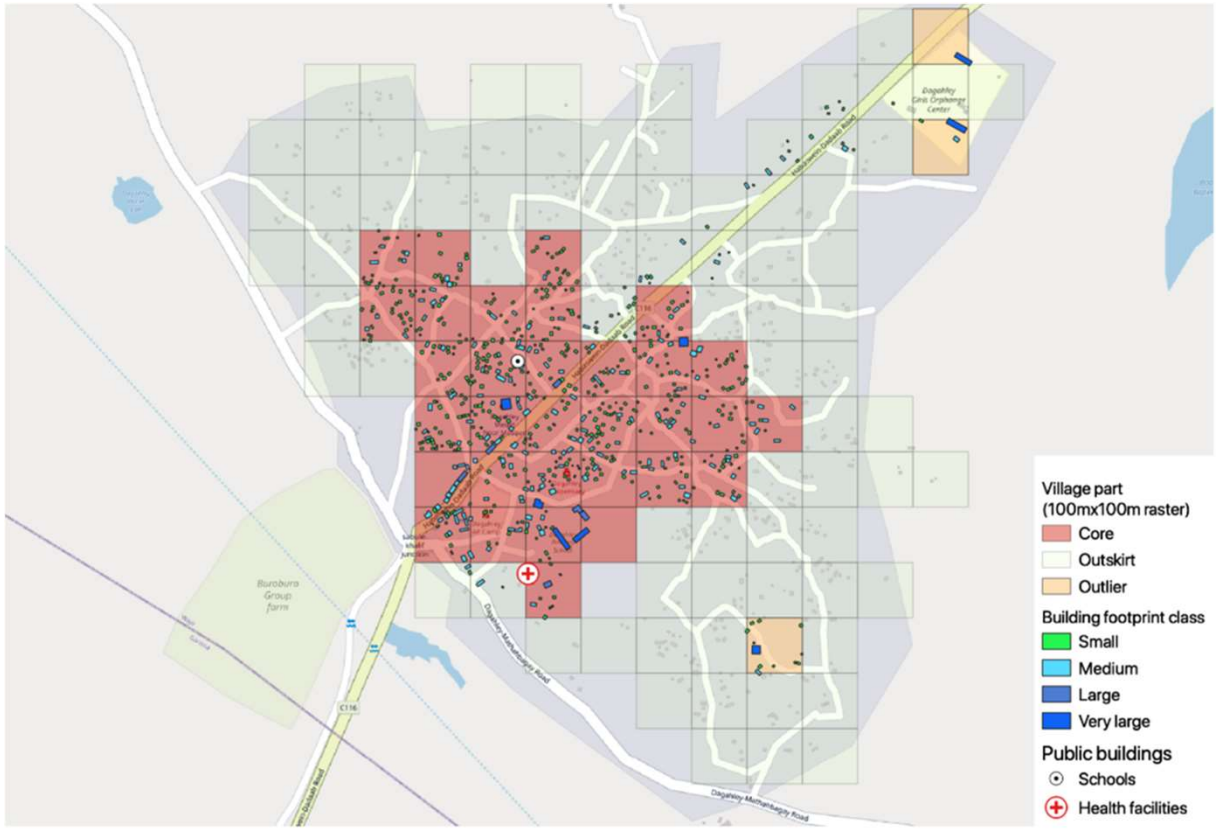
Who?

(Click the logos)

fraym · Village Data Analytics · e-GUIDE · Nithio

Planning & Design

SMART MAPS – Open Source



Selection of high value mini-grid customers, based on estimated demand and location
Source: e-GUIDE & VIDA (2020)

Partnership between:

e-GUIDE

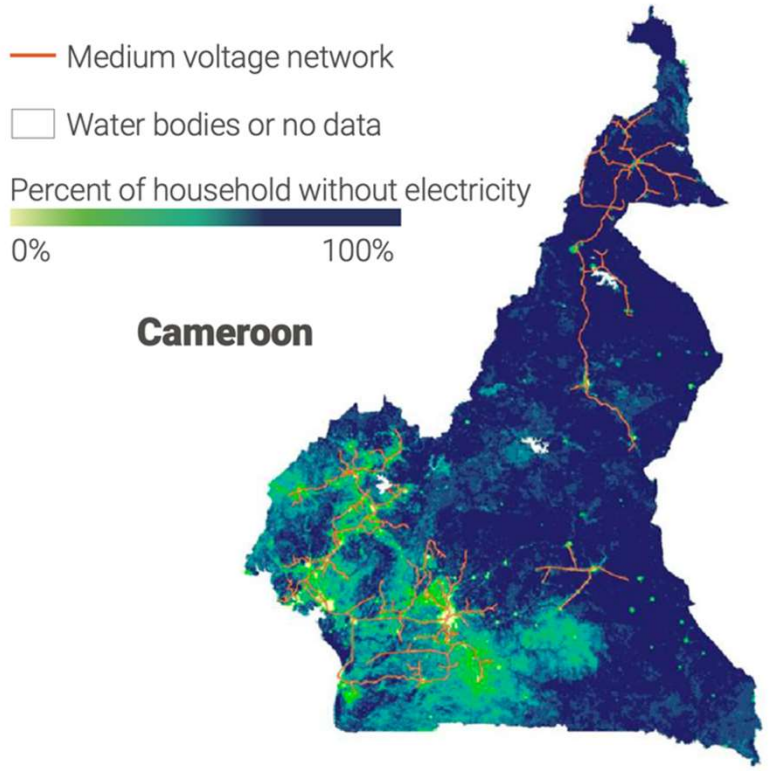
Village Data Analytics

They have produced an open-source database of predictions linked to locations:

1. **energy consumption** for residential structures
   - data for all of Kenya released in 2020
   - including SMEs & other countries in future
2. **reliability** of grid electricity supply
   - using night-lighting observed in satellite imagery
   - in development, with an Africa focus for now

Planning & Design

SMART MAPS – as a service



Electricity supply mapping for Cameroon, providing estimate of electrification rate with 1km² resolution.
Source: Fraym (2020)

Fraym is a geospatial data services provider specialising in data for energy development (& other areas). Including:

1. **Data provision**: **DataFraym®** smart map digital platform covering Africa, Asia, and Latin America
   - Energy, infrastructure, and socio-economic data at 1km² granularity
   - Data can be viewed on their platform or fed into any system via an API
2. **Custom Analytics**: bespoke geospatial analytics for governments, donors, developers, and other commercial stakeholders. Recent examples:
   - Customer profiling & identification
   - Electricity supply mapping for targeted intervention, e.g. Cameroon (left)
   - Sites with highest growth potential
   - Socio-economic impact over time

Planning & Design

DEMAND ASSESSMENT & SYSTEM DESIGN

Technologies used:

Established:

Establishing:

WHAT & WHY?

Demand prediction is necessary for determining the size of a renewable energy system which, in turn, has a huge impact on the eventual success of an energy project – particularly in larger applications like mini-grids. The challenges of accurately predicting electricity demand of rural customers, and the subsequent issues when oversizing or undersizing equipment are well documented. Recently, digital solutions are being explored to overcome these challenges.

HOW?

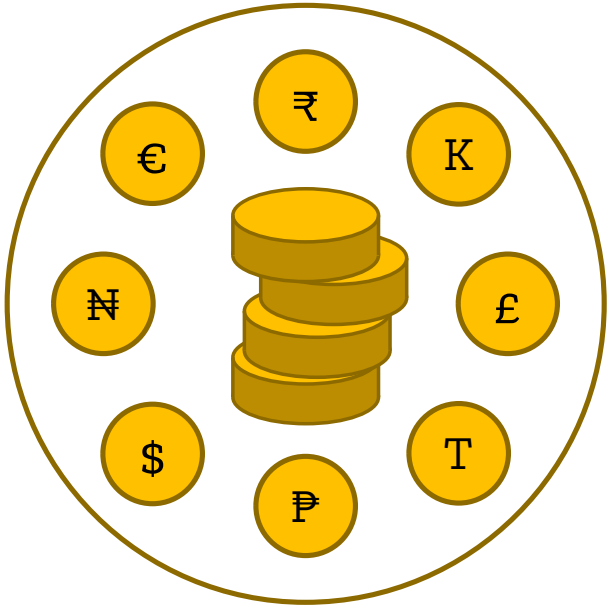
Now:

- **Digital surveys** are the industry standard data collection method for energy developers. Data collected on these platforms are digitised at source and can be fed directly into electrification planning tools like **GeoSim** & **HOMER**.
- The traditional method for demand assessment is well established and can be seen in tools like **GeoSim.** These **predict demand analytically** – calculating an estimated demand from households and businesses based upon their survey responses.

The future:

- In recent years, research has been carried out into using **machine learning techniques to predict electricity demand** from survey responses.
- **Challenges with prediction accuracy remain**, however it's been found that machine learning algorithms can predict aggregated energy demand (e.g. for an entire village) to a relatively high degree of accuracy.
- With **large databases of energy data** being built (e.g. in Odyssey), it is likely these models will become more accurate and will be included in the system design processes soon.

Sources: GIZ (2016), Williams, N., et al (2019), e-GUIDE & VIDA (2020), Next Billion (2019)



Finance

PAYG
Crowdfunding & P2P lending
Credit scoring
Grant performance tracking

Finance

PAY AS YOU GO

Technologies used: 

Established: 

Establishing: 

WHAT?

Pay as You Go (PAYG): paying for an energy system as you use it – a way to defer a large upfront payment for customers who can't afford it. This model is applied to **solar home systems**, **appliances** like fridges, and **clean cooking technologies** like stoves.

HOW?

Digital technologies underpin this ecosystem:

- **Recording and transmitting usage data** from the system to a central database
- Linking a **digital wallet and payments** for usage or energy consumption
  - These are topped up with cash at a vendor, or directly linked to a customer's mobile money
- System **switched on/off** automatically and remotely depending on the balance of the wallet

Penetration of PAYG as a model **varies significantly with geography**. It follows the **penetration of enabling technologies** – particularly mobile money – and the most **prevalent local sources of credit**. The following slides explore the status of the PAYG and digital payments in Africa, and in selected energy access markets in Asia.

Sources: TFE Energy (2020), Interview with Factor[e]

Finance

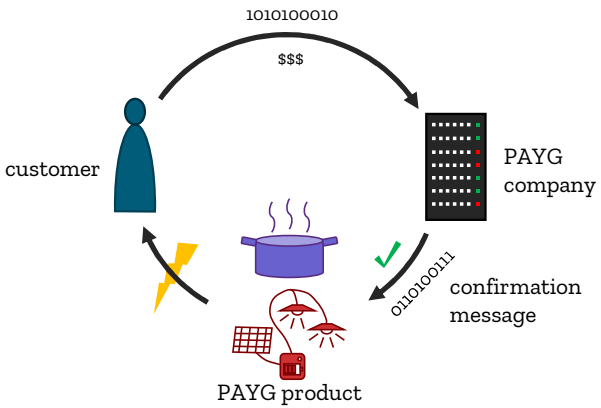
PAY AS YOU GO – Africa

HOW?

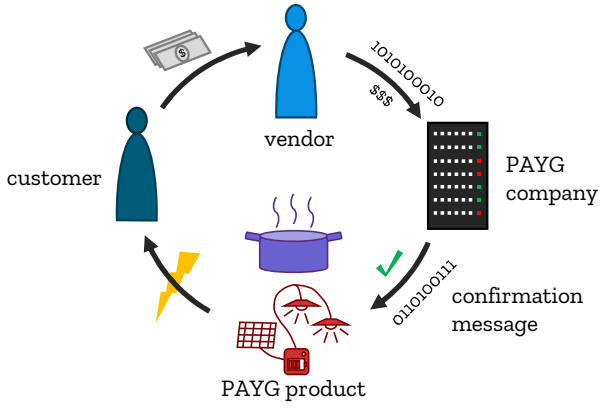
PAYG is well established across the African continent, largely due to the high penetration of mobile money technologies and the efficiencies that introduces to the PAYG ecosystem.

Two payment models are common across the continent, determined by the penetration of mobile money in that area:

High penetration: (more common) customers have their own mobile money wallets, and digital payments are made directly by them.



Low penetration: customers pay cash to vendors who digitise the transaction, and send it onto the PAYG company.



Once a payment has been received by the PAYG company, a **confirmation message** is sent to the PAYG system activating it for use. The entire ecosystem relies on digital technologies to work.

Finance

PAY AS YOU GO – Africa

KEY TREND IN PAYG IN AFRICA

A trend in OGS has been observed by our interviewees – the PAYG business model is evolving:

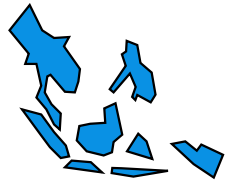
Vertical integration moving to **off-the-shelf**

- *Vertical integration*: By necessity, many of the incumbent OGS companies in Africa (e.g. Bboxx, Fenix, & M-Kopa) were built **vertically integrated**. PAYG has a huge reliance on interconnected and specialised digital systems. Nothing was available to these companies in the wider market and so the **digital solutions had to be developed in-house** – an expensive process. The benefit of this is that companies can have a system that does exactly what they want.
- *Off-the-shelf*: More recently companies are providing **off-the-shelf digital platforms** that manage **all aspects of last mile distribution**. These allow OGS and clean cooking companies to focus on the sales, marketing, & customer engagement aspects of the business. New companies are emerging with a lighter structure, who take advantage of the efficiencies brought by off-the-shelf platforms.
- angaza, PaygOps, and Paygee, the largest of such platforms, have recently announced their systems will be designed to interface with each other, increasing interoperability, data sharing, and collaboration.

Sources: Interview with Factor[e]

Finance

PAY AS YOU GO – South East Asia



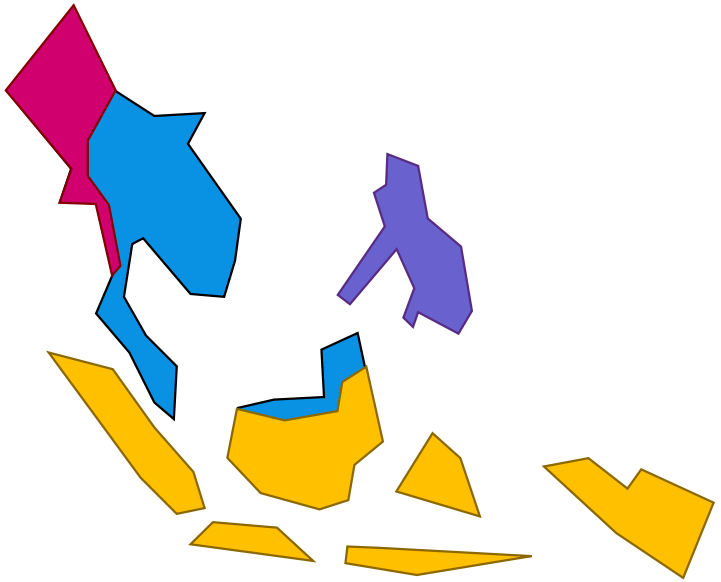
A STUDY OF COUNTRIES IN THE REGION

A study was carried out in South East Asian countries to understand the use of PAYG as a model for OGS providers in the region, and the prevalence of digital payments specifically in energy access contexts. It focused on three countries (right): the **Philippines**, **Indonesia**, and **Myanmar**.

In the three countries considered, it was found that the **PAYG model is rare,** although some examples were found. The range of payment models used in energy access projects **explored in depth in Annex 1.**

For payments, cash is still the **most prevalent method of payment** for electricity in energy access contexts. The research found little evidence of digital payments for energy access in the Philippines. However, they are starting to penetrate in Indonesia and Myanmar. In both countries, these payments go through the widely-used, general-purpose payment platforms.

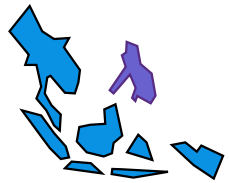
The following slides explore the three countries in more detail.



Location of the South East Asian countries studied in this research: **Philippines**, **Indonesia**, and **Myanmar**

Finance

PAY AS YOU GO – Philippines



IS PAYG MODEL USED?

Most OGS systems in the Philippines are donated, however PAYG is used by some commercial OGS distribution companies – most notably ATE Co:

- Payments are made in **cash** to an onsite vendor who manages activating/deactivating systems via an app.
- ATE Co. have partnering with digital wallet provider PayMaya to start the first fully digital PAYG process in the Philippines. This is using the Angaza management platform. ATE Co. are also partnering with Okra Solar to integrate digital payments.

DIGITAL PAYMENTS FOR ENERGY ACCESS

Digital payments are **not prevalent** in the country – in both mini-grids and SHS. The example above is the only case found during this research.

Mini-grids predominantly use prepaid meters, which communicate and are controlled remotely but are topped up using cash at a local vendor.

REMAINING CHALLENGES FOR DIGITAL PAYMENTS IN ENERGY ACCESS

- Poor mobile & internet connection in remote areas (the country is mountainous with over 2000 inhabited islands)
- Low smartphone penetration in remote areas

Digital payment platforms

PayMaya

GCash

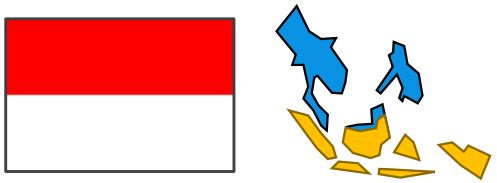
Company implementing digital PAYG:

ACCESS TO ENERGY ate

Sources: Entrepreneurs du Monde (2017), Interviews with One Renewable Energy and Okra Solar, ATE Co. (2017), Light of Hope Project (2017)

Finance

PAY AS YOU GO – Indonesia



IS PAYG MODEL USED?

No examples of companies using PAYG were found in this research. In fact the term 'PAYG' is used for on-grid systems when applied to net billing / metering.

DIGITAL PAYMENTS FOR ENERGY ACCESS

Digital payments for prepaid electricity are common only in **private grant-funded mini-grids** (e.g. developers like PT Inovasi). This type, however, only represents 5% of the mini-grid sector in Indonesia. The other 95%, government-funded projects, remain cash-based.

There are several platforms used for energy payments (right), chosen because they are in wide and general use (not only for energy access).

Digital payment platforms

OVO Payment.Points. · gopay · LinkAja! · DANA

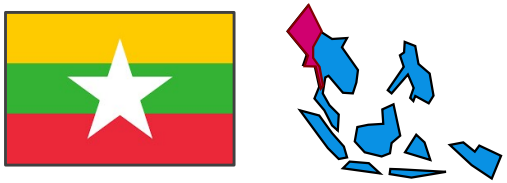
Fully commercial OGSP

INOVASI DINAMIKA PRATAMA

Sources: Interview with PT Inovasi

Finance

PAY AS YOU GO – Myanmar



IS PAYG MODEL USED?

SolarHome is one the major commercial OGS provider in Myanmar. They offer PAYG, **partnering with a digital payment platform** to facilitate digital payments. Customers without a digital wallet are able to pay cash to a registered local vendor.

DIGITAL PAYMENTS FOR ENERGY ACCESS

Similar to PAYG, digital payments are used in the **mini-grid** sector. **40%** of mini-grids in the Government's 60/20/20 (pg. 7) mini-grid project use **digital payments** through the platforms listed here (right), while the other 60% used card-based systems – pre-paid cards that are topped up at vendors.

Digital payment platforms

Wave Money

KBZ Pay

PAYG OGS solar providers

solar home

sun king from Greenlight Planet

Sources: Interview with GIZ Myanmar, Interview with Myanmar Ecosolutions, Oxford Business Group (2020), GOGLA (2018), University of Tokyo (2018), CSIS (2015)

Finance

PAY AS YOU GO – South Asia

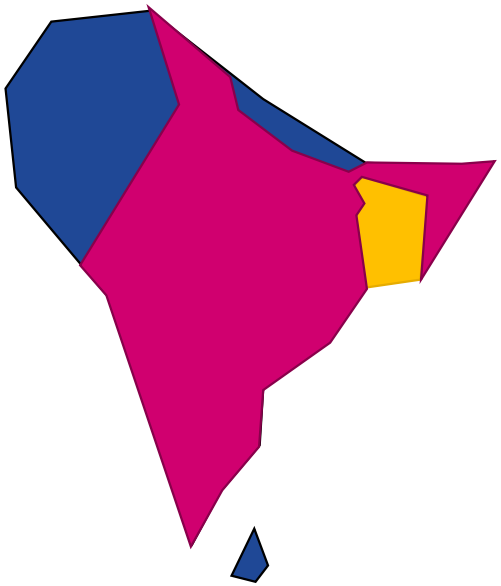
A STUDY OF COUNTRIES IN THE REGION

A similar study was carried out in South Asian countries to understand the use of PAYG as a model for OGS providers in the region, and the prevalence of digital payments specifically in energy access contexts. It focused on two countries (right): **India** and **Bangladesh**.

Like in South East Asia, it was found that the **PAYG model is very rare.** One example, found in India, has had to **move away from many of the integral PAYG digital technologies** and have doorstep agents collect cash and manage the energy systems.

Cash is still the **most prevalent method of payment** for electricity in energy access contexts. However, **there are signs this is changing** in both countries. Energy System loan repayments are being tested in India and Bangladesh. In general, there is higher usage of digital payment platforms in Bangladesh – mostly for peer-to-peer transfers, cash-in, and cash-out transactions.

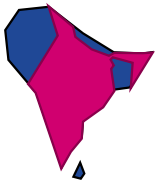
The following slides explore the two countries in more detail, and an in-depth discussion of other payment models used in energy access is presented in Annex 2.



Location of the South Asian countries studied in this research: **India**, and **Bangladesh**

Finance

PAY AS YOU GO – India



IS PAYG MODEL USED?

SIMPA Networks is the only SHS provider in India that uses a PAYG model for financing systems. The customers have always topped up with cash and, due to various challenges (e.g. tampering), SIMPA's model has moved further away from digital technology, from using SMS activation codes to having doorstep service agents who collect cash & manage systems onsite. See Annex 2 for an in-depth description of the prevalent models and payment platforms used in India.

DIGITAL PAYMENTS FOR ENERGY ACCESS

Micro Finance Institutions (MFIs) have started using the **Aadhaar Enabled Payment Systems (AePS)** for loan repayments. In this service each customer has a 12-digit unique ID (Aadhaar Card) which allows digital transactions through their bank accounts. Typically most customers **still pay cash to 'business correspondents'**[1] who complete the transaction on their behalf while capturing relevant data of the customer (e.g. Aadhaar number and biometrics).

REMAINING CHALLENGES FOR DIGITAL PAYMENTS IN ENERGY ACCESS

- Cash economy (especially wages paid in cash) means that customers do not always have significant balance in their bank accounts.
- Little motivation from MFIs to move away from cash-based system.
- Low smartphone penetration, and mistrust of digital services.

Digital payment platforms

AePS – AADHAAR ENABLED PAYMENT SYSTEM

UPI – UNIFIED PAYMENTS INTERFACE

BBPS – BHARAT BILL PAYMENT SYSTEM

Company offering PAYG:

simpa – An ENGIE Company

[1]Business Correspondents are retail agents engaged by banks for providing banking services at locations other than a bank branch/ATM

Sources: Aadhar Enabled Payment System, Interview with SIMPA Networks

Finance

PAY AS YOU GO – Bangladesh

IS PAYG MODEL USED?

PAYG is not common in Bangladesh, with only one OGS provider (ME SolShare) found during this research that has adopted a PAYG model. The most common purchase method for SHS is through a loan from MFIs, with regular repayments. Despite PAYG not being prevalent, digital payments are being adopted for loan repayments but at a small scale.

DIGITAL PAYMENTS FOR ENERGY ACCESS

Penetration of digital money is relatively high compared to the rest of the region. The market saw strong growth in 2020 as the Bangladeshi government issued support payments through digital platforms during the COVID-19 pandemic. Cash payments are the predominant mode of loan repayment, however MFIs are pushing for digital transactions. One significant example is the Sajida Foundation who receive over **GBP 440,000 in digital loan repayments per month**.

REMAINING CHALLENGES FOR DIGITAL PAYMENTS IN ENERGY ACCESS

- Cash withdrawal limits stop customers withdrawing entire loan amount in a day
- High transaction costs (up to 2%)
- Poor financial and digital literacy among customers (especially elderly) limit uptake
- Loss of face-to-face contact, when going digital, **leads to rise in defaulters**.

Digital payment platforms

Company offering PAYG

Sources: Interview with ME Solshare, ME Solshare (2016), GSMA (2015), UNCDF (2019), Next Billion (2018), The Finance Today (2020)

Finance

CROWDFUNDING & P2P LENDING

Technologies used:

Established:

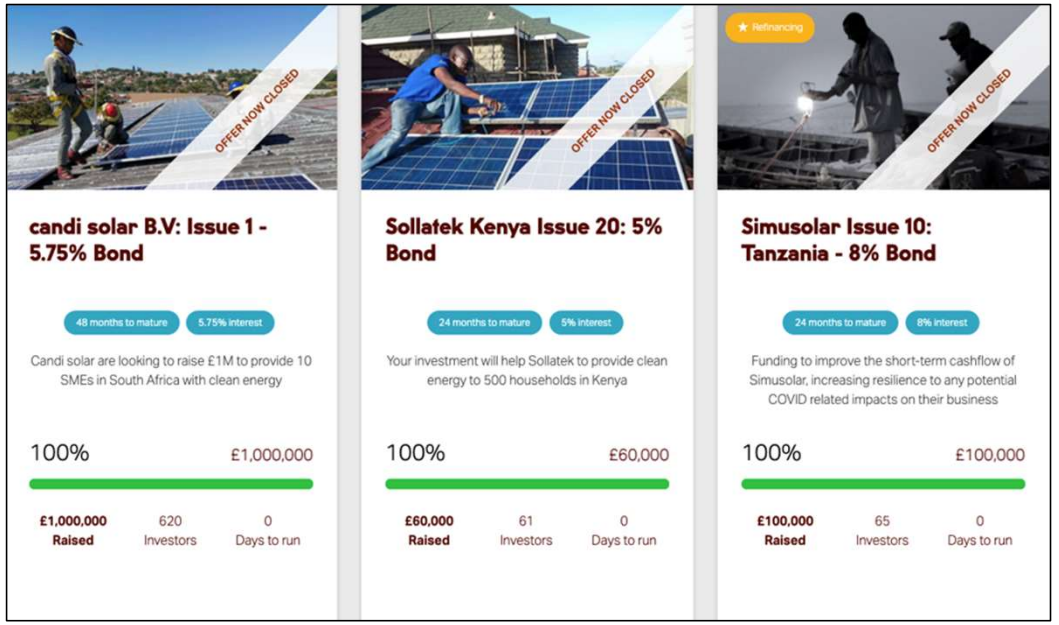
WHAT?

- **Crowdfunding**: funding that is raised for an individual, project, or business, from many individuals – 'the crowd'. Reasons for providing capital can be philanthropic, or in return for a non-monetary reward or equity.
- **Peer-to-peer (P2P) lending**: investors provide loans to individuals or businesses, who pay it back with interest
- In 2018, of all crowd & P2P fundraising for energy access **88%** was P2P lending to businesses.

HOW?

All types of fundraising require digital platforms to host fundraising campaigns, attract investors/donors and facilitate transactions.

All are internet-based services, where investors can log in and manage investments. There are many platforms operating in the energy access space, most specialise in one type of investment/donation.



Fully funded projects on the Energise Africa investment platform.
Source: Energise Africa

Sources: Energy 4 Impact (2018), Energy 4 Impact (2020)

Finance

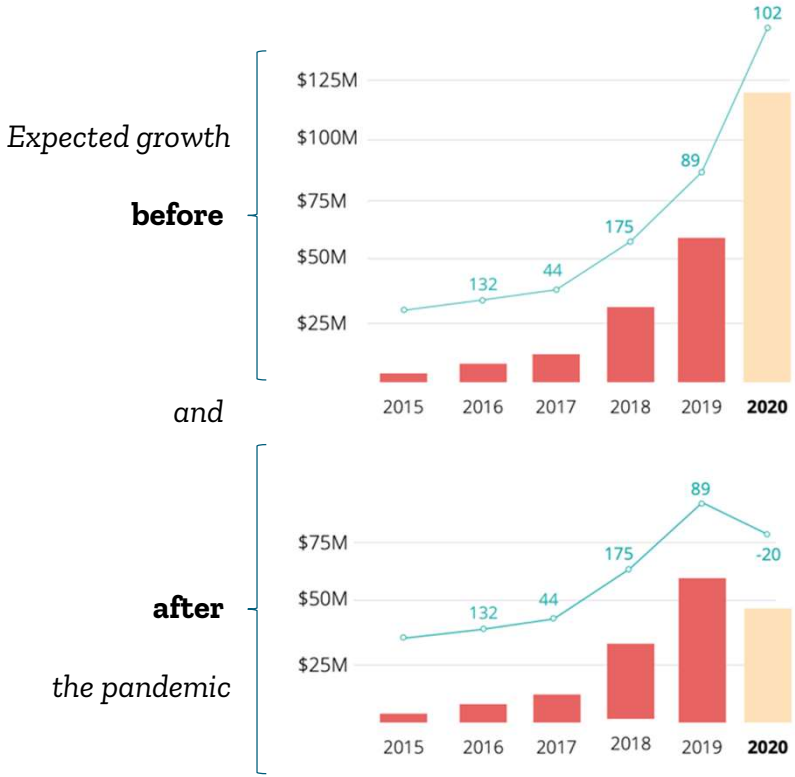
CROWDFUNDING & P2P LENDING

WHY?

- **Exposure:** Platforms for crowdfunding and P2P lending expose companies to sources of funding that would not otherwise be available, and investors who are increasingly seeking moral or ethical investments.
- **Flexibility:** Different funding options (donations, equity, and debt) give flexibility to companies in different financial positions.

CHALLENGES?

- **Pipeline:** before COVID-19, particularly in P2P business lending, investor demand was high following a trend toward ethical investment. A common challenge for platforms was finding companies with a good enough credit rating to meet this demand.
- **COVID-19:** between 2015-2019 crowdfunding investment was doubling year-on-year. Significantly reduced investing activity during the COVID-19 pandemic in 2020 is expected to result a 20% reduction compared to 2019 (right).



Growth in crowd-funding between 2015-2020, that has been entirely made possible by online platforms.
Source: Energy 4 Impact (2020)

Sources: Energy 4 Impact (2018), Energy 4 Impact (2020)

Finance

CROWDFUNDING & P2P LENDING

WHO? Many platforms offer P2P & crowdfunding, each with their own specialties:

Platform	Business loan	Micro loan	Donation	Reward	Equity	ICO[1]
Bettervest	✓					
CrowdCube					✓	
Energise Africa	✓					
Lendahand	✓					
Kiva	✓	✓				
M-Changa			✓			
SunExchange						✓
Pozible				✓		
StartSomeGood				✓		
Trine	✓					
Zidisha		✓				

[1]ICO: initial coin offering. Cryptocurrency-based investing.
Source: Energy 4 Impact (2018), Energy 4 Impact (2020)

Finance

CREDIT SCORING

Technologies used:

Established:

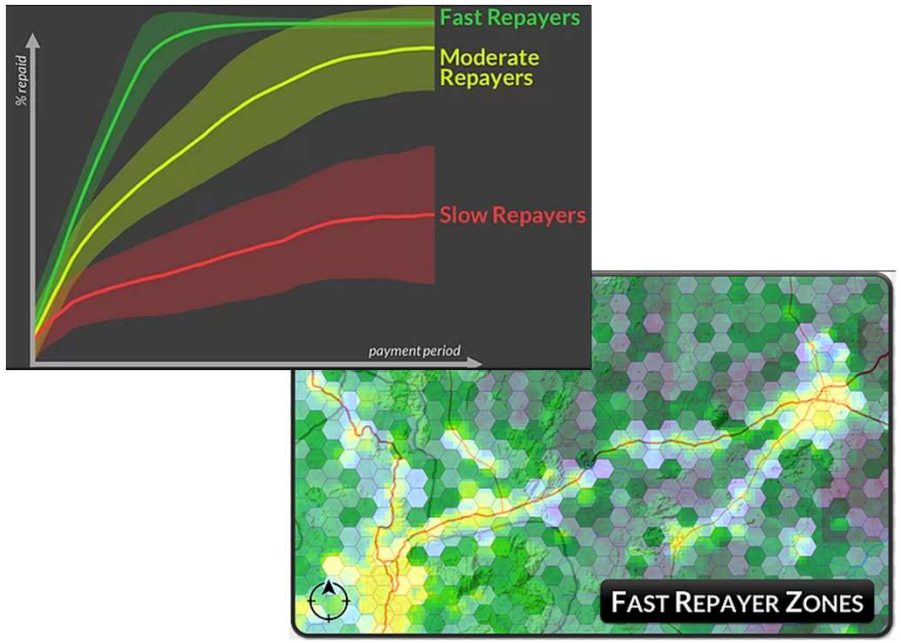
Establishing:

WHAT?

Different models (e.g. leasing-to-own, pay as you go, borrow-to-buy, and others) carry their own **credit risk** and companies must be able to assess this risk in environments where **traditional credit-scoring metrics are not available**. Risk is poorly understood in the sector and is not standardised. Products are being developed to give investors and developers the **insight into the credit risk** that's needed.

HOW?

- Customer **payment** and **socio-economic** data, along with **GIS**, are used to train machine learning models which can predict credit-worthiness of groups of customers in large smart maps, or classification of individual customers within organisations / projects.
- Data provision can be bespoke projects, or pre-built data libraries.



Customer credit risk classifications (top) and simplified example smart map showing zones with more Fast Repayers (bottom)
Source: Nithio

Finance

CREDIT SCORING

WHY?

- **Customer targeting:** Target customers who present the lowest credit risk, or tailor service or intervention to customers' profiles.
- **Due diligence:** Investors are able to take high level credit scoring data to evaluate investment decisions. Examples:
  - verifying credit worthiness at proposed mini-grid sites
  - give confidence to retail investors on a crowdfunding platform

WHO? *(Click the logos)*

Nithio

SUPERFLUID LABS
DATA·INTELLIGENCE·ADVANTAGE

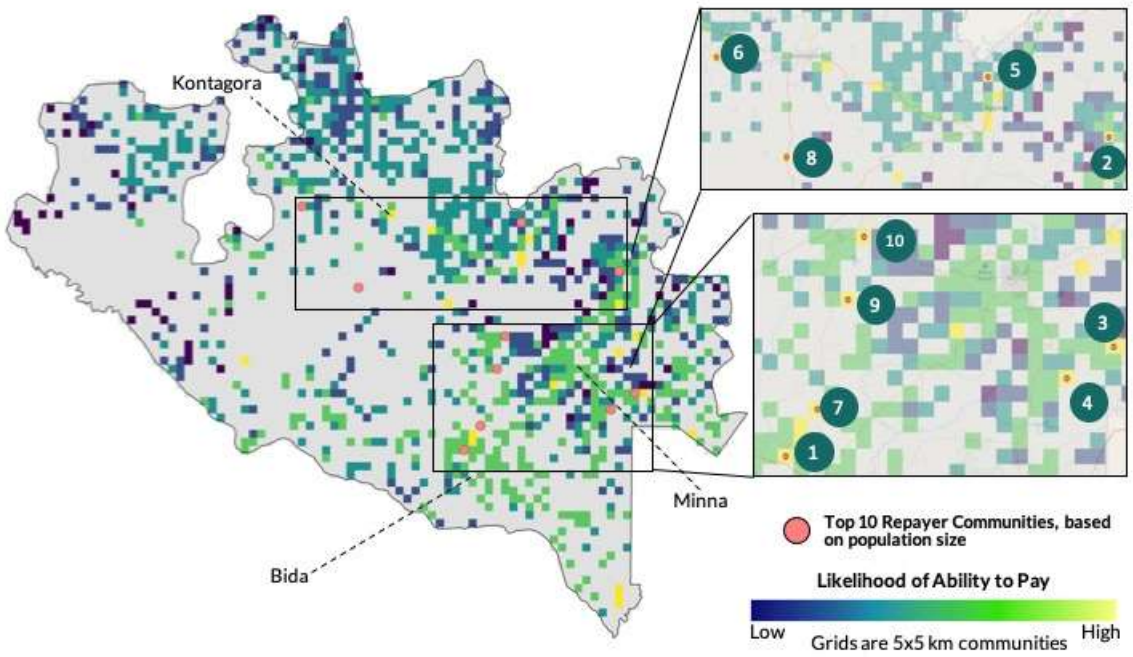
CHALLENGES?

- **Data availability:** As with other analytics applications in energy access markets, data can be difficult to access, if it even exists. Currently, client companies or commercial data providers provide input data for their models.
- **Cash economies:** In economies that are not digitised (more commonly in Asia) accurate payment records are unavailable. In these contexts, large-scale credit scoring is much more difficult.
- **Standardisation:** There is yet to be a standardised measure for credit worthiness in the energy access space – this research suggests that worthiness metrics are often defined on a project-by-project basis. Companies like Nithio are challenging this and hope to create industry-standard credit scoring.
- **Industry acceptance:** There is a lack of awareness from within the sector of the insights that power data analytics can bring to credit scoring. Companies interviewed suggested that it is common for in-house analysts to perform this task, with access to fewer resources and less data.

Sources: Interview with Nithio, Superfluid Labs (2020)

Finance

CREDIT SCORING – Example



Smart map of credit worthiness of communities in Niger State, Nigeria

Source: Agrilinks

Nithio

Nithio is an analytics company who specialise in **credit risk profiling**.

- Some of their products are **state- and country-scale smart maps** which show estimates of customers' **ability to pay** down to resolutions of 1km².
- They are trying to build a **standardised approach to credit scoring** that can be applied to any context and by any stakeholder.
- The main users of this kind of data are **investors**. With their product, Nithio aims tackle what interviewees have cited as the largest challenge to energy development: **attracting investment**. Accurate credit profiling builds investor confidence and informs investment decisions & risk planning.

Source: Interview with Nithio

Finance

GRANT PERFORMANCE TRACKING

Technologies used:

Established:

Establishing:

WHAT?

Result-based financing (RBF): grants that are contingent on pre-defined performance metrics have become a standard mechanism for energy funding.

→ Donors often manage many projects under a particular grant program, and it takes a large amount of work to verify the performance of these projects in order to issue payments.

→ **Solution:** Digitally track and verify performance of a portfolio of such grants.

HOW?

A digital platform to manage entire RBF flow:

1. **Grant applications:** grants are applied for through a platform, information about the applicants is collected and stored under a single "project".
2. **Project assessment:** tools are included which help to assess submitted projects for eligibility and viability, this can include in-built financial modelling.
3. **Data collection:** interfacing directly with smart meters, payment systems, and other data sources to collect the relevant information about operational projects.
4. **Performance verification:** automatically determine whether the submitted data are legitimate and if the project reaches the predefined performance metric for grant – e.g. if the PAYG systems have been deployed and are really being used.

Finance

GRANT PERFORMANCE TRACKING

WHY?

- **Resource management:** Manual process for donors & program managers becomes automatic. Their time and focus can be put towards enrolling more developers, or administering a greater number of projects.
- **Scalability:** application, approval and verification can be handled by a single platform. This efficiency means that the program can be easily scaled, leading to more projects in more countries being funded.
- **Intelligence:** having projects from across the energy access ecosystem on one platform gives the operators and donors exceptional visibility on trends and potential efficiencies in the sector. E.g. using platform data to:
  - **understand demand for appliances** to aggregate procurement, benefitting payment terms, inventory, and warranties
  - understanding impact of COVID-19 pandemic on energy access projects

CHALLENGES?

- **Digital transition:** transforming processes that have largely been manual to an automatic and digital format requires significant effort, usually with consultation from the platform provider themselves.
- **Process standardisation:** investors & governments have their own, varied ways of preparing financial models, tendering, and administrating grants. Workflows differ, as well as the information that is collected. A single platform requires standardisation of these processes, and some stakeholders have been very resistant to changes in their workflow. The customer-facing parts of the platform therefore need to be flexible, while maintaining its functions in the background.

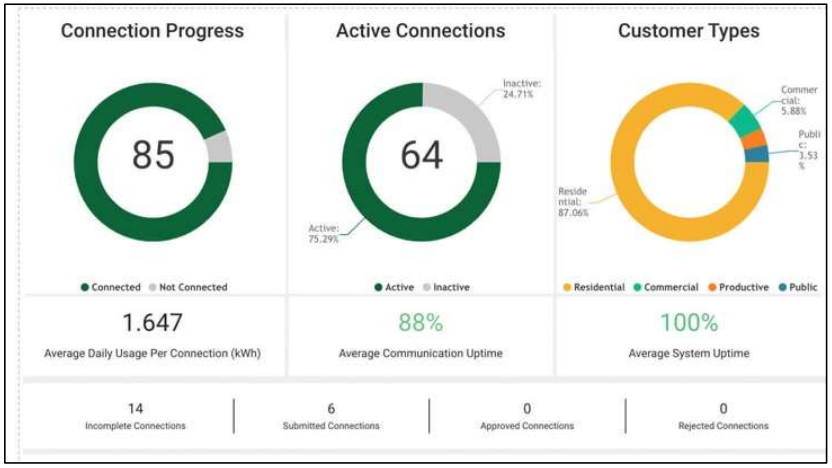
Who?

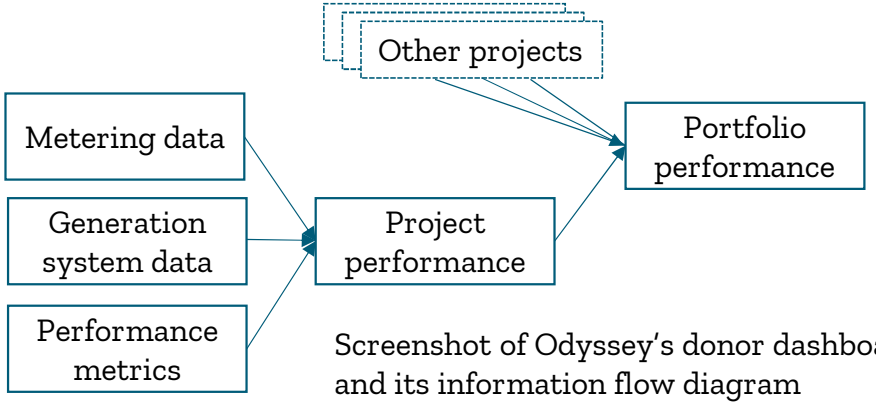
(Click the logos)

ODYSSEY

Finance

GRANT PERFORMANCE TRACKING - Example





Screenshot of Odyssey's donor dashboard and its information flow diagram

Source: Odyssey

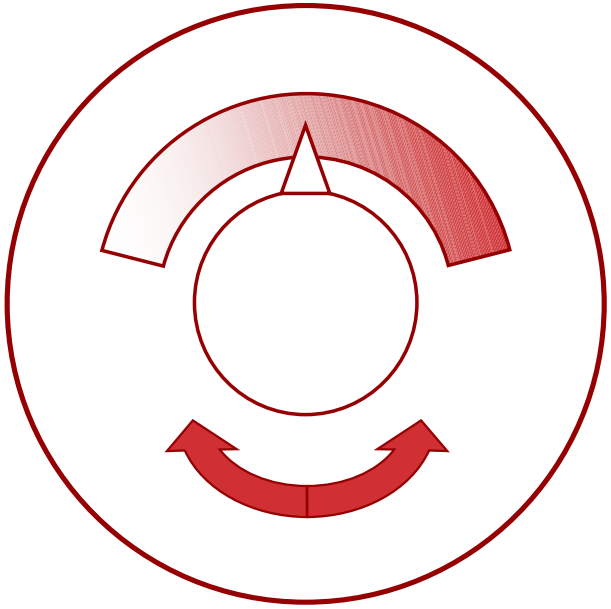
Odyssey is operational in many parts of Sub-Saharan Africa (SSA), and developing in Asia with a project in Myanmar.

Their product is a **digital platform** for energy developers, investors, governments & donors, and technology suppliers. It serves different functions for each kind of stakeholder.

Donors are able to manage the progress of an **entire portfolio** of mini-grid or SHS projects, including the validation of performance-based grants:

1. Manage tenders & grants
2. Monitor & validate project performance

Their platform has been deployed by funders across SSA, and most recently for the multi-donor RBF financing facility: Universal Energy Facility (UEF)



Optimising Operations

Prosumption
Defining quality of service
Demand-side management
Remote monitoring
Remote technical support
Fault detection
Predictive maintenance

Optimising Operations

PROSUMPTION

Technologies used: 

Establishing: 

WHAT?

'Prosumption' describes individuals who both produce and consume energy. Networks of such 'prosuming' individuals are particularly interesting in energy access, and two scenarios are emerging with digital technologies at the forefront:

Distributed energy production and consumption from networked SHS-like systems

Standalone renewable energy (e.g. mini-grids) that get connected to the main grid down the line

HOW?

- Excess produced energy is stored and sold to other users or to a grid/utility. On the other side, consumers with a limited supply can purchase from others to meet their excess demand.
- This interplay requires interconnection and coordination at every level. IoT devices record and transmit energy production, storage levels, and demand. This information is fed into sophisticated optimisation programs that match demand with supply in such a way that no individual component is over-stressed or over-used.
- Facilitating this whole process is **cloud computing**. This has given companies access to huge amounts of computing power for relatively low cost. Also, devices that connect to the cloud can reduce in size and cost because there is far reduced requirement for onsite data storage and processing.

Optimising Operations

PROSUMPTION

WHY?

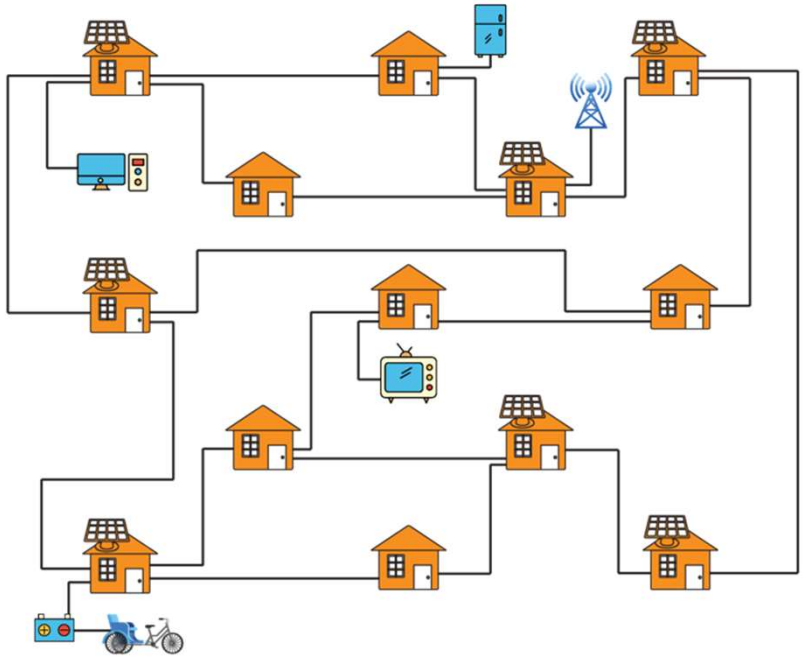
- **Optimal usage** of energy and components, that increase efficiency and component lifetime. For example, stand-alone SHS batteries are often drained fully in an evening, partly recharged the next day, then drained fully again in the evening. This cycle dramatically reduces their lifetime. In a network of 'prosuming' SHSs, the batteries all provide power at once, meaning that no single battery is drained to damaging levels.
- **Financial viability**. Selling energy is an income stream for the consumer. Whether it is a feed-in tariff from a utility or individuals receiving small payments for small amounts of energy, this income helps fund the cost of such power systems.

CHALLENGES?

- **Reliant on strong digital infrastructure**. This model relies on infrastructure that many areas don't yet have:
  - **Mobile internet**: IoT devices required to monitor and manage these networks must be able to connect to the internet. In rural settings this is through mobile networks which are unavailable.
  - **Mobile / digital money**: computer-controlled energy trading requires a digital wallet.
- **Interacting with the grid is a new challenge** that is yet to be fully addressed. To date, the industry has focused on building mini-grids away from the main grid and its expansion. When it does reach them, however, solutions need to be designed to efficiently merge these sites into the national system. This is something that Nortech are working to solve.

Optimising Operations

PROSUMPTION - Example



ME SolShare's set-up: SHS network forms a micro-grid where energy is traded between households

Source: ME SolShare

Two companies are leading the way with **'prosumption' in networks of SHSs**. They are both focussed in Asia, which traditionally has struggled to digitise the SHS market. Each one is developing a different model and both rely heavily on digital technologies.

Okra Solar: DESCO[1]-lead electrification:

- DESCO owns and installs solar systems into households
- Customers pay for what they consume

ME SolShare: Community-lead electrification:

- Households own and interconnect solar systems
- Households can buy or sell electricity from/to others, depending on demand

Sources: Interviews with ME Solshare and Okra Solar, ARE TIF (2021)

[1]Distributed energy service company

Optimising Operations

QUALITY OF SERVICE

Technologies used: 

Established: 

WHAT?

Data-backed validation of the quality of an electricity service.

HOW?

This process requires **two components**:

1. Industry standard quality of service metrics, described as "**levels of service**". These have been defined by large energy organisations like the NREL's Quality Assurance Framework, which has been expanded upon with AfDB's Isolated Community Power Quality Assurance Framework.
2. System data (e.g. hardware parameters and performance) is collected on site, matched against the service metrics described above.

As data collection has increased, with smart meters and remote monitoring platforms, so has the industry's ability to assess quality of service and optimise their business models further.

WHY?

The impact of measuring Quality of Service has been **significant**.

- **Customer**: How good is my service compared to what was promised?
- **Developer**: How good is the service I am providing, and where can be improved?
- **Investor**: Does my portfolio of projects meet agreed standards?
- **Industry**: How are things improving? What are the common areas where quality is lacking?

Sources: Interview with TFE Energy, TFE Energy (2020), Green Mini-grid Helpdesk (2020), AfDB (2017), NREL (2016)

Optimising Operations

DEMAND-SIDE MANAGEMENT (DSM)

Technologies used: 

Established: 

WHAT?

Using digital technology to influence the demand placed upon an energy system. This could be to reduce or increase demand, depending on the overall utilisation of the system, or to shift demand to a different time, mitigating against periods of excess demand or excess supply.

HOW?

There are many factors that can influence demand on an energy system – see Energy 4 Impact (2019) – however the intervention that requires digital technology is custom electricity tariffs. Smart meters and remote system monitoring are the digital lynchpins of this process:

- Monitoring energy generation and consumption gives developers insight into when DSM measures are necessary
- Smart meters can apply a custom tariff to a system to influence demand in the desired way:
  - **Time of use**: energy prices are cheaper at certain times of the day when demand is low and generation is high
  - **Progressive/regressive**: unit price of energy decreases or increases the more you consume in a set period – this can be to incentivise or disincentivise excessive consumption
  - **Dynamic pricing**: unit price of energy changes in real time in response to the balance of demand and supply – this can be set up in such a way that customers are alerted when prices are low or high

Sources: Inhouse experience at Energy 4 Impact, Energy 4 Impact (2019)

Optimising Operations

DEMAND-SIDE MANAGEMENT (DSM)

WHY?

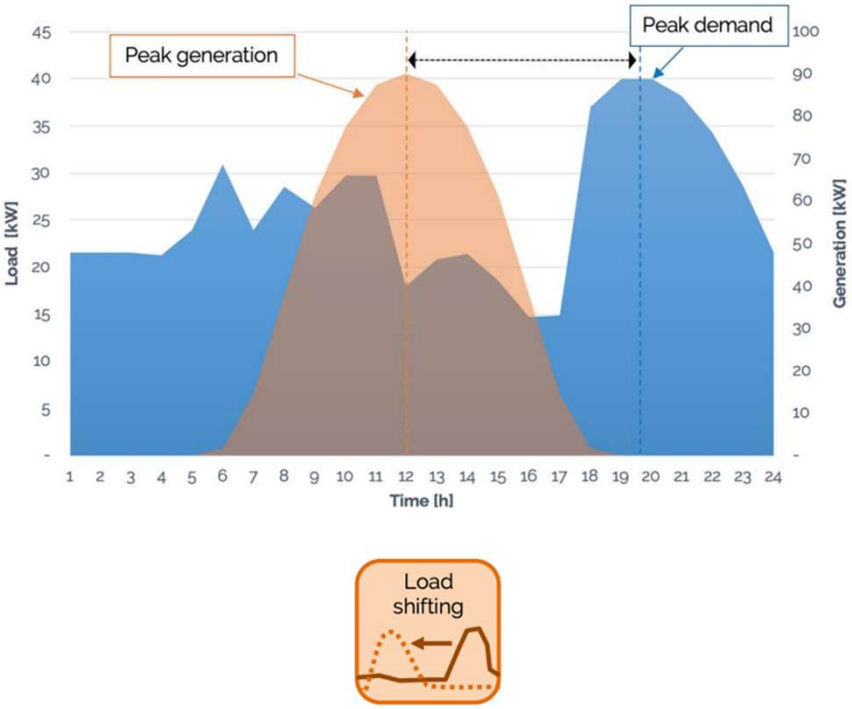
Effective demand-side management provides **optimal operation of your energy system**, matching times of peak generation and excess demand:

- **Cheaper**. Digital solutions can be far cheaper than the other, physical solutions explored in Energy 4 Impact (2019).
- **Reduced burden on energy storage** as demand is shifted to time when energy supply is high. Storage systems can therefore be smaller.
- **Customers can benefit from cheaper tariffs** for loads that are not time sensitive.

CHALLENGES?

- Impact of such tariffs is **not fully tested and quantified**. It would be beneficial to developers to understand how much these tariffs can impact demand.
- **External factors** may reduce the impact of a new tariff – e.g. farmers in their fields are not able to consume electricity during the day. To succeed, tariffs must be tailored to a community's habits and culture.
- **Community buy-in**. Tariffs must be simple so that they are understandable and accepted by the community.

Sources: Inhouse experience at Energy 4 Impact, Energy 4 Impact (2019)



Example generation and load profiles on a PV mini-grid, showing where a **time of use** tariff could be use for load shifting.

Source: Energy 4 Impact (2019)

Optimising Operations

REMOTE MONITORING & CONTROL

Technologies used:

Established:

WHAT?

System data is collected by major components in an energy system. This is **reported to the customer** so they are able to view a project's operational status. In the same platform, users are able to **control the system**, manually or by setting up **algorithms for automated control**.

HOW?

- Many manufacturers of major components in energy systems **include data monitoring as standard**. Data are collected by on-board sensors, and sent over the internet to the cloud. Often a product will include a **basic digital platform** where this **data can be viewed** and where the **component can be controlled**.
- With components from many manufacturers, **data is split over multiple platforms**. This is unwieldy for site operators, and so third parties are now offering **platforms that consolidate data** from many sources into one picture of the entire system. **Usually these platforms offer additional features**, like overall system control, maintenance scheduling, reporting, and integration with other services/platforms.
- An interesting feature of these systems is the ability to develop control algorithms which automate the operation of the site. Some products offer an existing library of optimisation algorithms that can be deployed by operators quickly.
- These systems generally require hardware – a computer or similar – **to be installed onsite** that manages data collection and transmission to the cloud.

Sources: Interviews with Nortech & FernTech, AMMP (2018)

Optimising Operations

REMOTE MONITORING & CONTROL

WHY?

- **Visibility**. These platforms provide incredible visibility into the ongoing status and health of an energy system, which enables **efficient fault detection & resolution**, and the **application of advanced analytics** – both discussed in the next section.
- **Centralisation**. Many projects can be monitored by the same team, consolidating many of the activities that require skilled staff.
- **Reduced OPEX costs**. As well as the efficiencies mentioned above, remote monitoring means fewer site visits and fewer technically qualified staff onsite. All of these drive down OPEX – by up to 30%, it is suggested in AMMP (2018).
- **Flexibility**. Platforms are built to be flexible to any system configuration, and in this way can be adapted to many different use cases.

CHALLENGES?

- **Rural communication**. In areas where mobile data is unavailable, satellite communications are becoming affordable – with Hughes as a popular service provider.
- **Compression**. Transmission costs increase with the amount of data sent. A balance must be struck between more data, compression, and affordable transmission.
- **Compatibility with devices**. With the huge range of manufacturers that are available in renewable energy systems, there is no standardised data collection protocol. Monitoring platforms to work with the major manufacturers to interface with their devices. Another strategy used by companies, like Nortech, is to provide their own devices which collect the data from different manufacturers' systems.

Who?
(click the logos)

Sources: Interviews with Nortech & FernTech, AMMP (2018)

Optimising Operations

REMOTE MONITORING & CONTROL - Example

System view, accessed on mobile devices or computers through a web-based dashboard.
Source: FernTech

FernTech has a platform which allows operators to remotely monitor and control off-grid power systems – primarily mini-grids.

Their system comprises of a **central controller** that is installed on-site. This connects to each component directly and logs data in an internal database, where they are then transmitted to the cloud. Control algorithms can be set up to manage the supply side, and improve safety & component lifetimes.

The web dashboard that comes with the product allows customers to view an **entire portfolio of projects**, **manage consumption**, and **diagnose faults**.

Sources: Interview with FernTech

Optimising Operations

REMOTE MONITORING & CONTROL - Example

Nortech's iHost platform is built to carry out remote monitoring and fault detection in large grid networks.

A range of Remote Telemetry Units (RTUs) and fault indicators, suiting different monitoring requirements, are installed in a network. These log and transmit system data, and raise an alarm when changes in conditions are detected.

Among other solutions, they are working on an Active Network Management concept – which is aimed at helping mini-grids and other distributed energy generation systems feed into the main grid – and have recently received funding to develop a mini-grid development and operating tool.

Nortech's iHost platform, and associated hardware.
Source: Nortech

Sources: Interview with Nortech

Optimising Operations

FAULT DETECTION, TECH SUPPORT, & PREDICTIVE MAINTENANCE

Technologies used: 

Established: 

WHAT?

Detecting the nature and location of faults in energy systems **as they happen**, providing **remote support** to onsite technicians, and predicting when faults will occur so maintenance can be done **before downtime occurs**.

HOW?

- Remote monitoring platforms are at the core of these services. Data collected give site operators extraordinary visibility into the health of their systems.
- At a basic level, **faults in the system are detected**, the operator is **sent an alert**, and the system status can be viewed on a digital platform.
- With knowledge of the type and location of the fault, either a **service team can then be dispatched** to repair it or, even better, **onsite technicians can be supported** by a centralised engineering team who have **access to system data** through the monitoring platform. This communication can be via text or video link.
- With the introduction of **advanced analytics** like machine learning, these platforms are able to **predict when components are going to fail**, and so maintenance can be scheduled before the fault occurs and there is downtime.
- This process uses **all four pillars of the enabling digital technologies**, with onsite sensing, data transfer over mobile networks, cloud computing and a digital platform to host and display the data, and advanced analytics to make predictions.

Sources: Interviews with Nortech & FernTech, AMMP (2018)

Optimising Operations

FAULT DETECTION, TECH SUPPORT, & PREDICTIVE MAINTENANCE

WHY?

Cost reduction. In a study by AMMP (2018), it was found that OPEX costs are reduced by 15-30% depending on the level of data collection, alerting, and analytics that are provided in the platform. This is due to:

- Quick response times and fewer blackouts leads to more electricity consumption and less lost revenue.
- Scheduled maintenance on many components can be done on the same visit, reducing the number of trips and man-hours spent onsite.
- Components' lifetimes are increased with effective maintenance schedules.
- Tasks can be delegated to less-skilled onsite technicians, supported by skilled staff with access to fault information through the monitoring dashboard.

CHALLENGES?

- **Connectivity**. Poor connectivity to a site can impact the ability for onsite technicians to communicate with a centralised engineering team.
- **Interfacing**. To interface and generate effective maintenance schedules and predictions, communication protocols and fault standards must be understood for the large range of available devices.

Sources: Interviews with Nortech & FernTech, AMMP (2018)

Optimising Operations

FAULT DETECTION, TECH SUPPORT, & PREDICTIVE MAINTENANCE - Example

AMMP

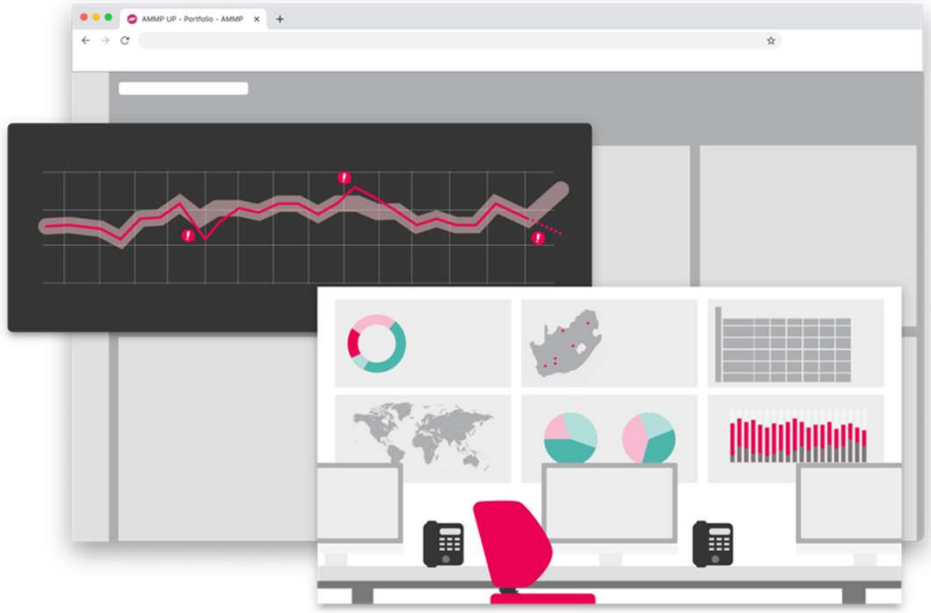
Off-grid Fault Detection

AMMP provide a platform that allows operators to view data from an entire operation in near real-time.

Within this package they include advanced analytics to enable predictive maintenance.

Their system is used by mini-grid developers and in stand-alone renewable energy installations.

Data from their platform is exportable as a .csv and, via an API, it can be fed into any other digital system – e.g. portfolio management tools like the Odyssey platform.



Fault detection and maintenance planning is done through their web-based platform.
Source: AMMP

Sources: AMMP, AMMP (2018)

Communication and Engagement

Market linkage
Community engagement

Communication and Engagement

COMMUNITY ENGAGEMENT

Technologies used:

Established:

WHAT?

Community buy-in is vital for any energy project to succeed. This is achieved through **engaging** with the community, and **tailoring an energy system** to their needs. It is a continuous process and should especially accompany major steps or changes during a project's development.

By its nature, engagement is a **soft activity** – opening dialogue and building trust needs to be a human-to-human activity. With that in mind, digital technologies can still have an enabling impact.

HOW?

Digital surveys (via mobile device survey apps or SMS-based survey systems)

- Collecting significant amounts of information from the community in an energy access project. Their use is well established in **demand assessments** and **connection targeting**, and they can be a powerful tool to receive feedback during a system's operational phase.

Educating communities and inform system design. ENACT are designing a digital platform that:

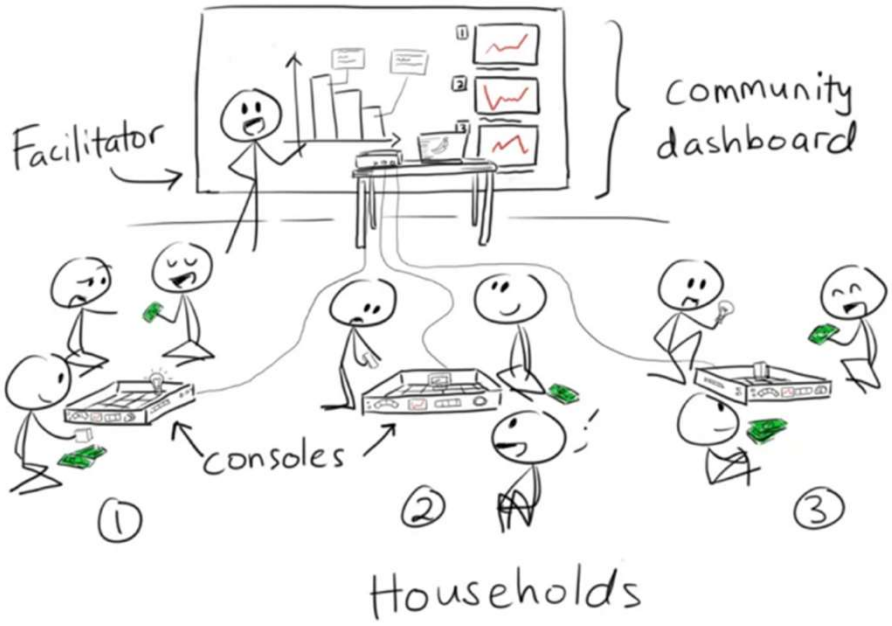
- Demonstrates to potential customers the capability and value of energy systems.
- Encourage discussion with the community to receive informed feedback, including preferences on tariff and likely load profiles.

Sources: Interview with ENACT, LEDS Global Partnership (2019)

Communication and Engagement

COMMUNITY ENGAGEMENT - Example

Establishing:



Energy Action Partners' ComET concept
Source: ENACT

ENACT's Community Energy Toolkit (ComET) is a virtual mini-grid simulation. This platform is used to **facilitate the human element** of project development. Developers hold a **workshop** with a new community to **simulate the operation of a planned** mini-grid.

Here **individuals act like connections**, they pay for energy, and select different appliances to operate. A community **dashboard displays the overall impact** of their consumption on the mini-grid.

The result of this process is that:

- **Community members learn the dynamics of a system before installation**: how usage affects cost, capabilities of power supply, and consequences of missed payments.
- **Feedback is received from the community**: potential energy demand, tariff and pricing structures, and agreement on load management strategies and penalties for missed energy payments.

Sources: Interview with ENACT

Communication and Engagement

MARKET LINKAGE

Technologies used:

Establishing:

WHAT?

Productive Use (PU) of Electricity is a well established concept within energy access. In order for energy developers to employ PU strategies effectively, **producers must have buyers to sell to**. This process is called market linkage. Digital platforms are being created to serve as a marketplace where **wholesale buyers are connected with small-volume producers** to fulfil orders.

HOW?

This research found solutions that are **focused on selling agricultural produce**. The concept is simple:

- Digital platform where small-holder **farmers are linked to buyers**
- Produce is brought from multiple sources to a **refrigeration facility** where it is stored and **collected in bulk** for the buyer

WHY?

There are three main benefits to combining PU with this technology

1. It brings buyers who can **purchase at fair prices** to farmers
2. It **reduces crop waste** through refrigeration and efficient collection & delivery of produce
3. Creation of a **sustainable value chain** leads to reliable consumption of electricity and a viable energy project

Incoming produce for cold storage being weighed
Source: SokoFresh

Sources: Interview with Enviu, SokoFresh, EcoZen, EasyKrishi, Farmsurge, BIID (2013)

Communication and Engagement

MARKET LINKAGE - Example

SokoFresh's cold storage technology provided by EcoZen
Source: SokoFresh

SokoFresh, in partnership with Enviu, is providing cold storage as a service. This productive use of electricity is only viable if farmers who use the storage are able to sell their produce afterwards. Key digital technologies used:

- Remote monitoring of the cold storage – **gives farmers and buyers confidence** that sold temperatures and produce quality are maintained. This monitoring is provided by the cold storage manufacturer, EcoZen.
- Digital market linkage platform that is based upon a traditional enterprise resource management tool, Odoo.
- A **simple customer-facing layer** is necessary to simplify the experience for farmers. They are typically not computer literate and do not have access to ICT. As much as possible, **communication with farmers is done via SMS**.

Sources: Interview with Enviu, SikiFresh, EcoZen, EasyKrishi, Farmsurge, BIID (2013)

ENERGY
CATALYST

3. Key trends

KEY TRENDS & LEARNINGS

INTERCONNECTEDNESS

Digital systems are being interconnected more than ever, and this trend is set to continue. Key examples:

- Large databases available by license or for free, feeding into advanced analytics and generating predictions on a huge scale. These predictions, themselves, become a new dataset that are used in yet more products.
- Data from onsite hardware feeding into remote monitoring services, then into portfolio management platforms and results-based financing.
- Networks of 'prosuming' individuals, with optimally managed energy flow and digitised transactions.

Physical infrastructure and digital ecosystems will continue to grow energy access contexts, enabling yet more interconnection.

CLOUD COMPUTING

The backbone of many new digital innovations explored in this research. It's safe to say that services like AWS, Microsoft Azure, and Google Cloud have democratised cheap data storage and computing power, and revolutionised what technology providers can deliver:

- massive data storage and computing power at relatively low cost
- low-power and low-cost components, as storage and processing is transferred to the cloud

KEY TRENDS & LEARNINGS

FLEXIBLE SYSTEMS

Historically, technology businesses in energy access have been forced to vertically integrate. Provision of off-the-shelf digital platforms that are flexible to a company's needs has reduced the burden of in-house technology development. This trend is best seen in the PAYG sector where off-the-shelf platforms like Angaza, PayGee and PaygOps have allowed for smaller companies who can focus on developing business models, profiling risk, and reaching customers.

MORE DATA

Following the trend in the rest of the world, more and more data is being collected in energy access contexts. Data is being aggregated on platforms like Odyssey giving the industry opportunity for greater learning:

- Which business models and technologies work? And why are some failing?
- Where are the safest investments?

Data is being provided as a service, by Fraym and Nithio, or open-source, by e-GUIDE & ViDA, allowing organisations at every level to make informed decisions about their strategy.

Many positives can come from data collection, aggregation and analytics, but an important discussion must continue about its responsible use.

KEY TRENDS & LEARNINGS

SIMPLICITY IN THE 'FRONT END'

Digital technologies have become vast and complex, but it cannot be forgotten that the infrastructure and computer literacy of many of the sector's customers does not grow at the same rate. Successful technologies remain simple on the 'front-end', for example SokoFresh's SMS customer communication, or simple and transparent energy tariffs in mini-grids. This is a trend that will continue for years to come.

THE HUMAN ELEMENT

This report has made much of the positive impact that digital technologies can have on the energy access sector. The research has also highlighted the inescapable fact that it is not the whole story. In order for projects to be successful, human-to-human contact must remain.

There are still contexts where digital technologies do not fit. In Bangladesh, for example, digitising SHS loan repayments meant there was a lack of face-to-face interaction with the borrowers. This actually lead to a rise in defaulters. In many places, digital tech cannot replace humans but it can work in parallel to facilitate the human element. Enact's ComET platform is an excellent example of this – enabling communities to learn about a planned mini-grid; and the developer to receive constructive feedback from them.

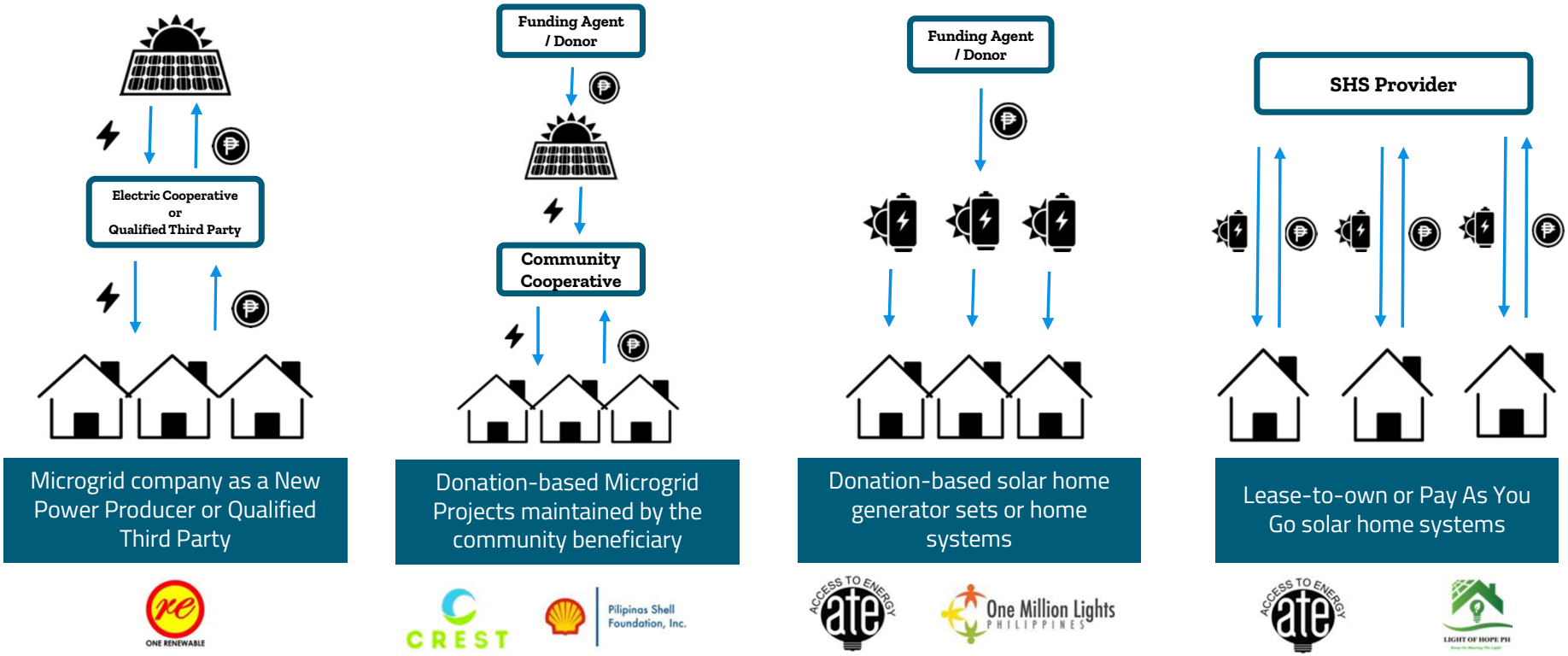
ENERGY
CATALYST

Annex 1:

Digital Payments for Energy Access in South East Asia

The Philippines

Rural Off-Grid Electrification Models - Philippines

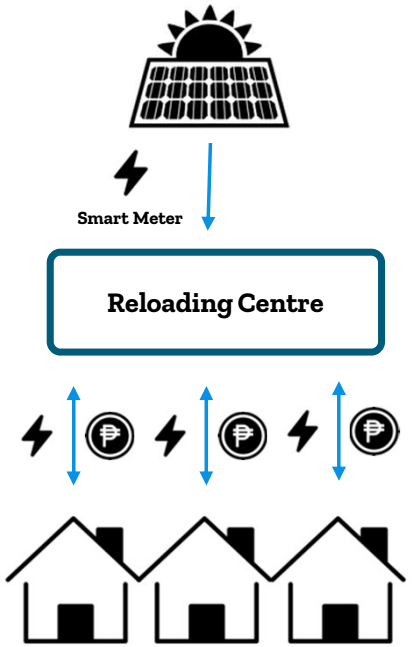


Solar Home Systems: Whether for single household or communal use, solar home systems provide pre-grid electrification pending extension of the electric cooperative's distribution system. For extremely isolated areas where line extension is not feasible, solar home systems are deemed "the only supply solution from the viewpoint of minimising subsidies and affordability". However, sustaining this mode of electrification is challenged by its limited battery life, system ownership and monthly payments.

Sources:

ACCELERATING RENEWABLE MINI-GRID DEPLOYMENT: A STUDY ON THE PHILIPPINES (2017). https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Philippines_Renewable_Mini-Grids_2017.pdf
Energy to access the future. (2018). Energy to access the future. Shell.com.Ph; Shell. https://www.shell.com.ph/energy-and-innovation/make-the-future/accesstoenergy.html
ABOUT | One Million Lights Philippines. (2011). Onemillionlights.org.Ph. https://onemillionlights.org.ph/about.html

Payment Models for Electricity Services



Prepaid Metering and Remote Loading via Smart Meters

- Off-grid: (1) time-based dongle that is attached to the solar home system– DOE[1] is calling it PV mainstreaming (2) what ORE[2] is using is server or cloud-based then EC has a prepaid meter + vending station in the office or near the community
- The meter either has a SIM card (as telco platform) or connected to the internet via satellite
- Normal size is 200 households
- Also used for reloading and other payments
- Hardware (smart meter, server, payment gateway) and software are used to enable interconnectivity between all parts of the system
- Operating for 2 years now: demand increased and then stabilised on the 2nd year

Risks and Challenges:

- Determining the number of data collectors in a community
- Blindspots for GSM loading
- Theft of scratchcards for the loads
- EC rates change every month so better to use peso value remaining instead of kWh
- Reliability of network and customer behavior with digital currencies
- Technology: non-acceptance of telco since it is SIM-based
- Infrastructure a problem if no data or signal
  - One solution: manual of a key in to "reload" meter
- Customer familiarity with prepaid systems like load (scratchcards)

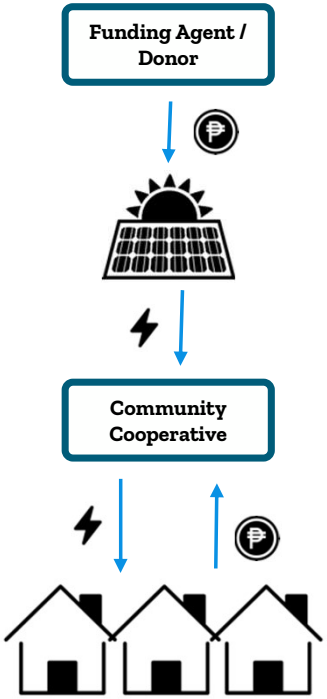
Sources:

Social Impact – One Renewable Energy. (2021). Onerenewable.com.Ph. http://onerenewable.com.ph/oree/socialimpact/

Interview with One Renewable Energy CEO, Mr. Erel Narida (January 2021)

[1]DOE: Department of Energy
[2]ORE: One Renewable Energy
[3]EC: electric cooperatives - the electric distribution utilities in the provinces/rural areas

Payment Models for Electricity Services



Donation-based Microgrid Projects maintained by the community beneficiary

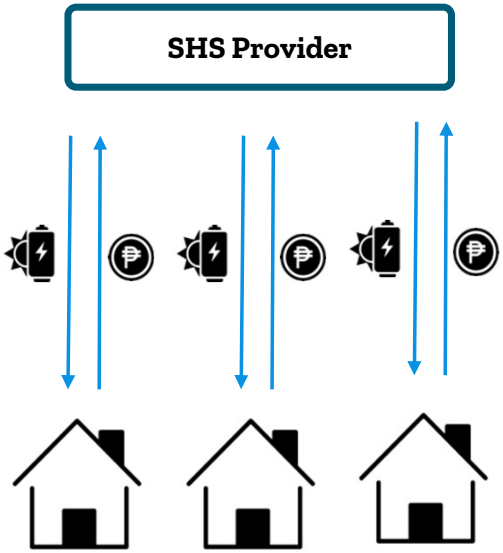
- Equipment and installation are funded by an external donor or from a grant
- In some cases, the project is also designed to help the community earn additional revenue to cover the costs of maintaining the system
- Locals are trained to manage and operate the sytem (basic troubleshooting and repairs)
- Use of electricity produced by the system is free for the community / residents

Risks and Challenges:

- Reliance on donations and grants to scale projects in other communities
- System revenues fund the operational costs (e.g. maintenance). Low or unreliable revenues impact ongoing project viability, where costs are not recouped from energy consumption

Sources:
Solar PV energizes Dumagat Heritage Village in Bulacan (2018). Panaligan, R., Divino, G., Formes, H., Lucero, R., & David, R. (n.d.). Editor-in-chief

Payment Models for Electricity Services



Lease-to-own or Pay As You Go Solar Home Systems

- Residents are given solar generator sets or home systems for a small upfront cost
- Payment system: **manual** (cash through collection agents, agents monitor through app/software inside the SHS, all prepaid)
- **Upcoming: fully digital payment system by Ate Co.**, partnering with Angaza and Paymaya, however according to Ate Co., agents might still need to come once a month
- Depending on their usage (some models include an income generating add on such as phone charging services and prepaid internet services), customers pay a fixed amount for a fixed schedule to the SHS provider to ultimately cover the cost of the system

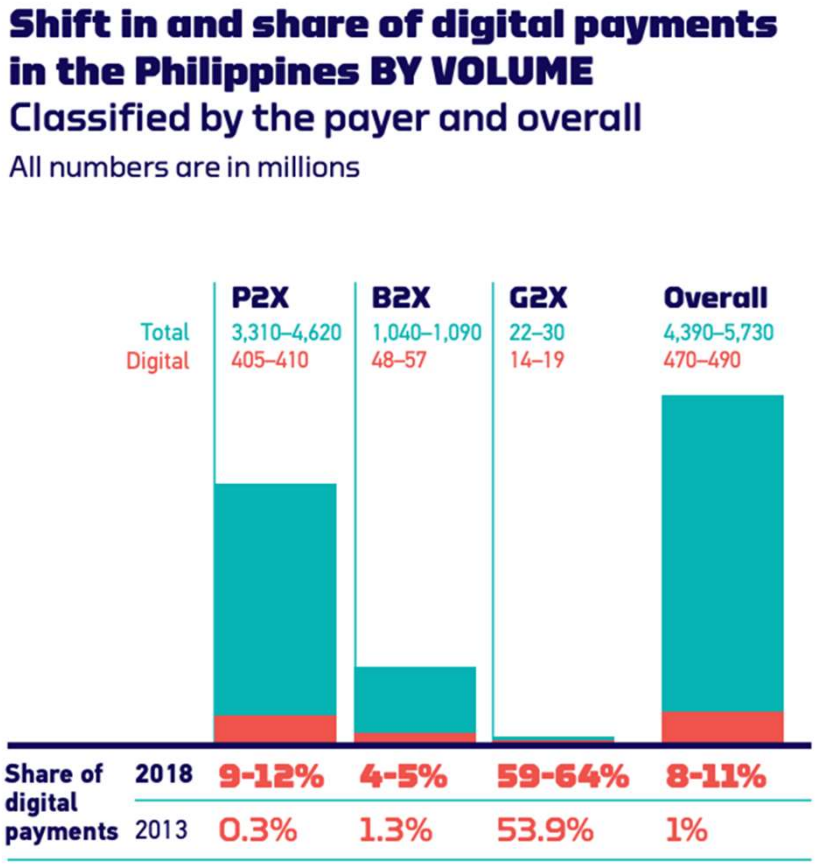
Risks and Challenges:

- Risks of the users damaging the system / equipment
- Lease to own model is difficult due to the limited capacity of some customers to pay
- Collection efficiency and scalability of repayment model
- Electric cooperatives are not supportive and sees SHS companies as competitors

Sources:

ATE Co : Access to energy in the Philippines - Entrepreneurs du Monde. (2017). Entrepreneurs Du Monde. https://www.entrepreneursdumonde.org/en/program/ate-co-acces-energy-philippines/
Light of Hope Project. (2017). Lightofhopeph.org. https://lightofhopeph.org/

State of Digital Payments in the Philippines



The Philippines' progress in digital payments in the past 5 years is outstanding - about **20X** the estimated digital transactions in 2013 (*see figure on left*). This is driven by the surge in digital payments made by individuals (P2X).

There is also rising adoption of Automated Clearing Houses (e.g. InstaPay and PESONet). Building solutions on top of these ACHs is predicted to become the driver of increased digital remittances and utility payments in the country.

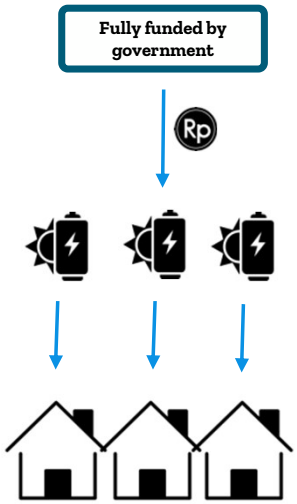
Although none were in operation at the start of 2021, it is only a matter of time before digital payments are applied to energy access in the Philippines.

Sources:

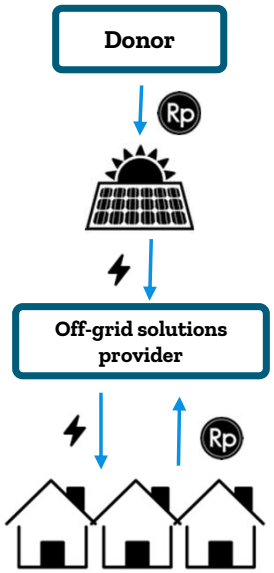
PHILIPPINES The State of Digital Payments in the Philippines. (n.d.). https://responsiblefinanceforum.org/wp-content/uploads/2020/02/The_State_of_Digital_Payments_in_the_Philippines-Feb20.pdf

Indonesia

Rural Off-Grid Electrification Models - Indonesia



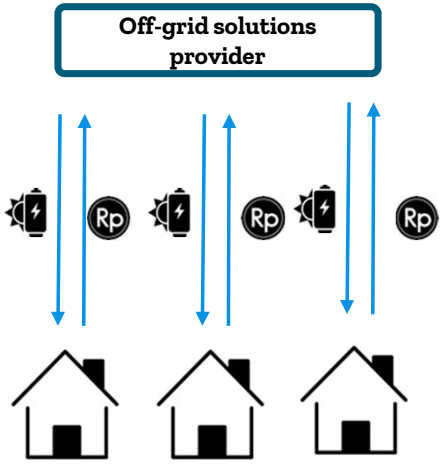
Fully-funded by the government; both mini-grids and SHS; maintained by community



Grant-based microgrid systems; operated as a commercial system

ELECTRIC VINE INDUSTRIES

INOVASI DINAMIKA PRATAMA

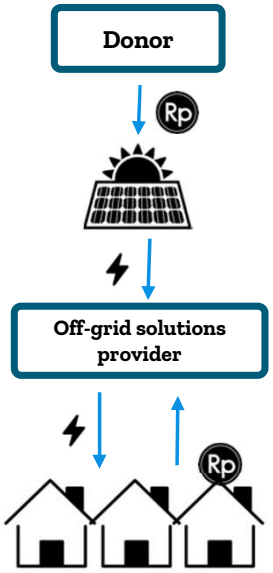


Commercial system

INOVASI DINAMIKA PRATAMA

Sources:
Interview with Andre Susanto, Founder of PT Inovasi

Payment Models for Electricity Services



Donor-based microgrids; operated as a commercial system

Grant-based Microgrid projects operated as a commercial system

- Equipment and installation are funded by an external donor or from a grant
- Tariffs for O&M and eventual replacement of batteries
- Digital payment of tariff is prevalent
- Payment system is either mobile banking or mobile money, latter could be in the form of phone credits or using cloud-based wallet (examples: LinkAja, GoPay, OVO, Dana)

Challenges in digital payment:

- Internet connection
- Additional cost of the transaction (i.e. cost of cash digitisation + digital payment to smart metering platform)
- Regulations (obtaining licenses to sell electricity)

Payment platforms

OVO Payment.Points.

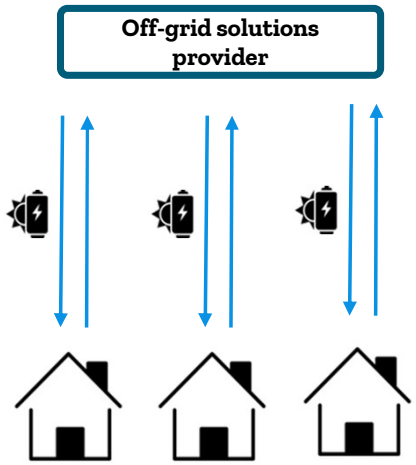
LinkAja!

gopay

DANA

Sources:
Interview with Andre Susanto, Founder of PT Inovasi

Payment Models for Electricity Services



Commercial system

Commercial microgrid systems

- Lowest penetration among Indonesia's off-grid electrification models
- PT Inovasi is the only company doing this model (as of early 2021)
- In addition to digital payments, other digital tech used:
  - Online survey system (to assess willingness and ability to pay)
  - O&M platform (mobile app to check system performance)
  - Crowdsourcing rural information (upcoming)

Sources:
Interview with Andre Susanto, Founder of PT Inovasi

Outlook - Energy access digital payments in Indonesia

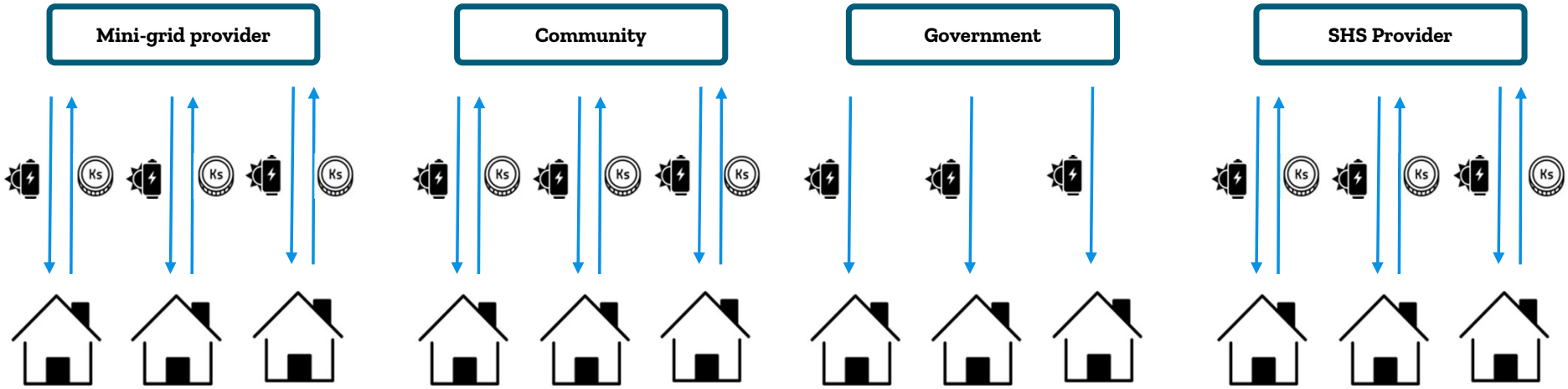
- Peer-to-peer lending for solar PV projects (on-grid and off-grid)
  - SolarKita, a solar PV developer, is partnering with Koin Works - the largest fintech P2P lending platform in Indonesia

- Great opportunity for digital payments in Indonesia
  - Smartphone penetration is at 60%
  - There are 37 local payment methods (GoPay, OVO, Doku, Dana, LinkAja have the largest shares) and this number is expected to grow

Sources:
SolarKita Instagram page, The. Jakarta Post (2021, January 13). Why Indonesia is the world's next digital payments battleground. Retrieved from https://www.thejakartapost.com/academia/2020/07/13/why-indonesia-is-the-worlds-next-digital-payments-battleground.html; Statista Digital Payments. (n.d.). https://www.statista.com/outlook/296/120/digital-payments/indonesia

Myanmar

Rural Off-Grid Electrification Models - Myanmar



Mini-grid programme: 60% subsidised by the government + 20% from the private sector + 20% from the community	Community-driven mini-grid systems	Government-supplied SHS systems	Commercial SHS system

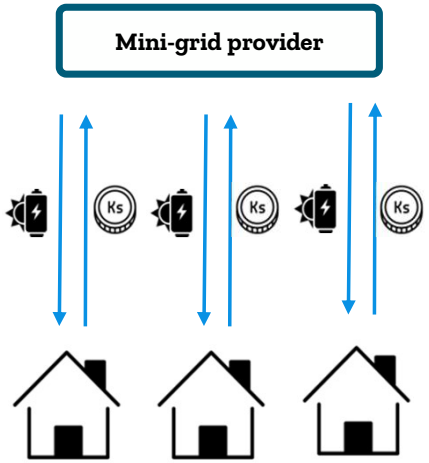
YOMA MICRO POWER · SolaRiseSys LIVE RIGHT. LIVE BRIGHT. · Myanmar eco solutions · solar home

Sources:

Interview with Ashish Dhankhar of GIZ Myanmar, Advisor to RELEC (Promotion of Rural Electrification); Interview with Myanmar Ecosolutions

Decentralized Energy Market Assessment in Myanmar

Myanmar Mini-grid Programme



Mini-grid programme: 60% subsidised by the government + 20% from the private sector + 20% from the community

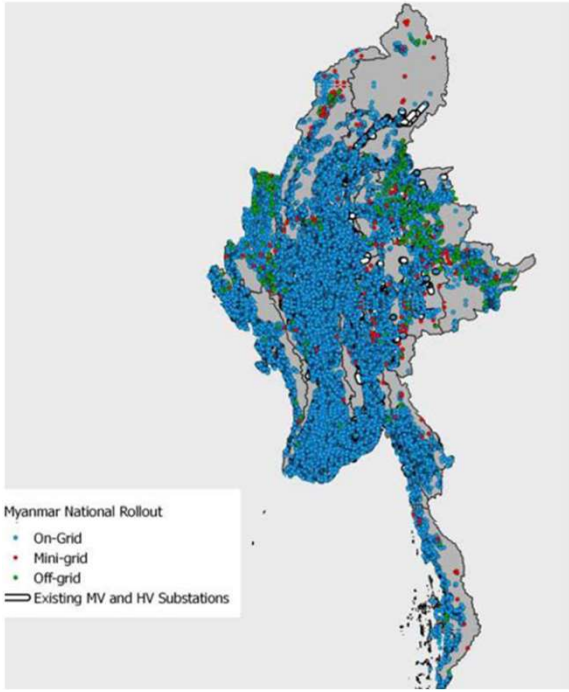
Myanmar Mini-grid Programme

- 60/20/20 program of the government
- 60% government subsidy, 20% private companies, 20% village electrification committees (VEC)
- VECs decide on matters pertaining to energy such as fuel procurement, tariffs, exemption of poor households, tariff collection (in some cases)
- All prepaid systems are pre-paid; 60% using card-based systems, 40% online systems

Challenges:

- Government's rapid extension of the electric grid - where plans are not publicly available, off-grid solutions providers risk making plans that will become obsolete if communities will be connected to the grid soon

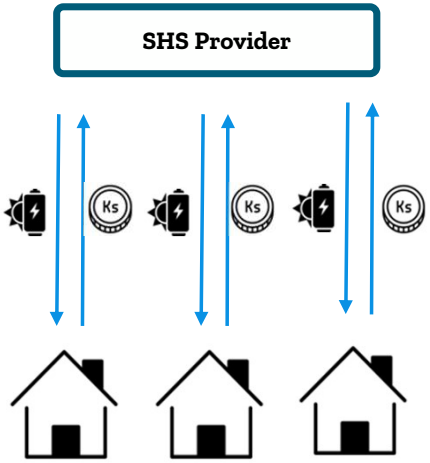
Myanmar National Electrification Plan



Sources:

Interview with Ashish Dhankhar of GIZ Myanmar, Advisor to RELEC (Promotion of Rural Electrification); Interview with Myanmar Ecosolutions
Myanmar's Path to Electrification by Rachel Posner Ross, Center for Strategic and International Studies
Universal Energy Access in Myanmar, Policy Alternatives Research Institute, University of Tokyo

Commercial SHS in Myanmar



Commercial SHS system

Commercial SHS systems

- Lowest penetration among the electrification models in Myanmar; communities have lukewarm response to private sector SHS providers.
- Example: SolarHome - installs integrated solar energy and appliance units in customers' homes. They operate PAYG and rent-to-own plans .
- PAYG systems integrate with one of the digital payment platforms (e.g., WaveMoney, KBZ Pay, etc.)
    - For these systems, users go to an agent (usually an MSME) and submit payment in cash to make payment or top-up the digital account

Challenges:

- Cheap, low-quality solar PV products are widely available from China, some households have purchased their own, making it more difficult for higher quality products to compete in the open market .
- Community acceptance of private SHS has been low in Myanmar.

Commercial SHS system providers

solar home

Payment platforms

wave money

KBZ Pay

Sources:

Interview with Ashish Dhankhar of GIZ Myanmar, Advisor to RELEC (Promotion of Rural Electrification); Interview with Myanmar Ecosolutions

Myanmar's Path to Electrification by Rachel Posner Ross, Center for Strategic and International Studies

ENERGY
CATALYST

Annex 2:

Digital Payments for Energy Access in India and Bangladesh

Summary

Key Insights on Digital Payments in India and Bangladesh

Types of Digital Payment Mechanisms in India (1/2)

In India, solar home systems (SHS) are primarily sold by manufacturers/distributors in partnership with Microfinance Institutions (MFIs), that finance these systems. Majority of these loan repayments are through cash collection, either via business correspondents or loan officers. MFIs are using a few digital payment platforms, but digital/cashless payments remain a very small percentage of their overall payments. E.g. In Aarohan, (an MFI) only 1% of their customers pay digitally (23,000 in a month) and success rate of these payments is less than 50%. Muthoot Microfin Ltd. claimed that only 2-3% of their repayments are made digitally. SIMPA Networks is the only SHS provider in India that used the PAYGO model for financing SHS (through cash). In the case of mini grids, majority of the players (e.g. Mlinda, Mera Gaon Power) collect loan repayments (in cash) door to door either weekly or monthly.

Digital Payment Mechanisms	Benefits	Challenges
Aadhar Enabled Payment Systems (AePS)	• **AEPS enabled device** allows online **interoperable financial transaction** at PoS (Point of Sale / Micro ATM) through the Business Correspondent (BC)/Bank Mitra of any bank using the **Aadhaar (a 12 digit unique number authentication)** and relevant data **(bank name and biometrics etc.)** • **Only 20-30% of AEPS transactions by MFIs are fully digital/cashless** (e.g. Aarohan). Majority of the **customers prefer giving cash to the BCs** who then transfer the money through their account	• **Interoperability** across various types of banks **(120 live members of AePS)** • **Ease of usage** • **Seamless tracking** of transactions through unique ID	• **High probability of transaction failures** due to **biometric mismatch or incorrect seeding** of the Aadhaar number with the bank account • Customers require **assistance from MFIs/BCs to make transfers**; resulting in increased travel and time cost
BHIM Unified Payment Interface (UPI)	• **BHIM UPI** enables **money transfer** between **bank accounts or other payment systems (NEFT/RTGS/IMPS)** through a **Virtual ID** created for a bank account • Expected **USD 425 billion** (15% of India's GDP) worth of transactions in **2020**; with over **175 million customers** and **60 million merchants** on UPI	• **Open architecture** allows **interoperability** among **20 third-party payments apps** (such as PhonePe, Google Pay, PayTM) • Enables easy and fast **peer-to-peer transactions**	• Change in mobile number requires **re-registration with banks to use the UPI app** • **Failure of transactions due to poor connectivity between the servers** (BHIM app - UPI server - bank server)

Sources: Microsave India Focus Note 55, 'Microfinance in India – Is Business Correspondent the Way Forward?', 2011 (Link); Live members of AEPS (Link); Aadhar Enabled Payment System (Link), BHIM UPI Enabled Money Transfers (LInk),, Stakeholder interactions

Types of Digital Payment Mechanisms in India (2/2)

Digital Payment Mechanisms		Benefits	Challenges
Bharat Bill Payment System (BBPS)	• BBPS is an **integrated bill payment system** which offers payment service to the customers (mostly recurring payments) through a **network of agents** • Few MFIs tie up with **"Bharat Bill Pay Operating Unit (BBPOUs)" to collect installments** via BBPS • **63 financial institutions** are registered as BBPOUs	• Allows **multiple payment modes** (cash, cheque, cards, e-wallets, UPI, AePS etc.) • **Increases efficiency of recurring collections** (for utility providers/banks etc.) at a **low cost**	• **Convenience fee** may be charged **from the customers** for a **transaction** through a **physical outlet or bank-branches**
RuPay debit cards	• It is a **domestic card payment** network by the government. A **free RuPay debit card** is provided to **low-income households** • Only **42% of the issued cards were active** in 2018 • **1 Bn transactions** through **online/offline** payment in 2019 • Some **MFIs also accept payments through RuPay**. E.g. **Arohan** sends its loan officers with a **debit card machine** to the centre meetings to accept repayments through RuPay	• **Enables financial inclusion** of low-income households • Offers additional benefits such as **cash-back on utility bills/ticket bookings, in-built accidental insurance coverage** etc.	• **Non-replacement of expired cards**, and **non-issue of cards** with new accounts by banks due to **low demand** • **Limited collection of cards by customers;** as they need to **traverse long distances** to reach bank branches • **Lack of acceptance infrastructure** (ATMS/PoS) in rural areas to enable transactions
Payment Gateway Link	• Some MFIs also send a **'payment gateway link' (**like RazorPay, CC Avenue, PayU etc.) to the **registered mobile number** of the customer • This link enables **digital transfer of payments** through the **customer's bank account**	• **Allows payment via multiple channels** (such as cards, e-wallets, UPI etc.)	• Merchants may have to pay **significant transaction costs** for services

Sources: The Bharat Payment System (Link); Payment Gateway Link (Link), Stakeholder interactions; RuPay Clocks 1 Billion Transactions, Surpasses Debit Cards in Usage, Aug 2019 (link); RuPay cards – A long road ahead, MicroSave, 2018 (Link)

Landscape of Digital Payments in India

Both government policies and regulations (such as Demonetisation, Digital India etc.) and the impacts of COVID-19 have boosted digital payments in India. India has not yet achieved its peak growth of mobile payments (UPI and e-wallets). It is expected that the mobile payments market will grow by a CAGR of 58% during 2020-25, mostly due to the supply-side push by the government. Currently, there are 160 million unique mobile payment users (11.7% of the population) in India. However, key barriers such as poor digital and financial literacy, the high value of a cash-based economy, and poor integration of digital wallets impedes market growth.

Key Trends in Digital Payments

- **Rising smartphone and internet penetration have boosted digital payments in India**. In rural areas, **smartphone penetration increased by 23%** between 2015-19. Also, **internet penetration** in rural areas witnessed a **growth of 35%** between 2017-18.
- **Users are shifting away from mobile wallets to UPI enabled transactions.** The **market share** of UPI increased from **1% in 2017** to **13% in September 2019**. As of October 2020, **2.2 billion transactions** were executed via **UPI**.
- **Mobile payments are mostly used for P2P transactions.** The other common transactions are for **mobile phone account recharges**, **utility bills**, and **retail transactions** at the point of sale and online.

Key Barriers Affecting Market Growth

- **MFI customers earn mainly in cash and therefore prefer to pay in cash**. **Less than 2-3% of repayments** are made **digitally** in rural areas (e.g. **Muthoot Microfin Ltd., Aarohan, Simpa Networks**). Customers need to **travel to the bank branch** at an **additional cost** to deposit money before committing to any mode of digital payments.
- Majority of rural customers do not have **significant balance** in their bank accounts to make digital payments. E.g. A representative from **Mera Gaon Power** (a mini grid operator) mentioned that **10% of 1000 mini grid customers** (part of a **pilot with Airtel Money**) maintained a **balance** of around **GBP 1** in their accounts at a time.
- **Low smartphone penetration (25% in rural areas in 2018) impacts uptake of digital wallets,** as the system requires registration of mobile numbers with bank accounts.
- There is **initial reluctance from customers** mainly due to **trust deficit**, **risk of fraud** and **poor awareness on benefits and usage** of digital payments, especially in rural areas.
- **Low literacy levels and poor financial knowledge** amongst rural customers (**especially elderly**) impacts adoption of digital services.

Sources: IJRAR , Digital Financial Services in India, 2019 (Link); The Economic Times, India to have 820 Smartphone Users by 2022, 2020 (Link); Bloomberg, India's mobile Banking Accounts Rise 95-Fold In Five Years: IMF, 2020 (Link); McKinsey Global Institute, Digital India: Technology to Transform a connected nation (Link); Digital Payments Grows At 55% Over Past Five Years, Inc42, 2020 (Link); NCPI Live UPI Members (Link); NCPI Live Customer BBPOUs, Oct 2020 (Link); Digital Payments Market in India likely to Grow 3-folds, Financial Express, Aug 2020 (Link); India Mobile Payments 5x Growth by 2025, RedSeer, Sep 2020 (Link); UPI Preferred over Digital Wallets, PwC, Dec 2019 (Link)

Digital Payment Mechanism in Bangladesh

Similar to India, SHS providers in Bangladesh partner with MFIs to finance their products. However, in Bangladesh there is a dedicated body called Infrastructure Development Company Limited (IDCOL), a non-banking financial institution that leads the SHS and mini grid program. IDCOL provides financing through loans/grants to SHS/mini grid providers. Cash payment remains the predominant mode of loan repayment by MFI customers in Bangladesh as well. However, a few MFIs (like Sajida Foundation, BRAC and BURO) have started using mobile financial services (such as bKash, Rocket etc.) through both USSD or mobile applications. SOLshare, has developed a P2P solar micro grid system (by interconnecting SHS) that allows trading of electricity. The payments are made via mobile money (like bKash). It also has PAYGO-enabled SHS that allows customers to pay installments by mobile money/cash. In case of mini-grids, all developers use prepaid meters for revenue collection. Customers recharge their cards at local offices/kiosks, and few pay directly via mobile money.

Mobile Financial Services (MFS)

Over-the-counter (OTC) bill-pay option via agents:

- The customer goes to the **MFS agent (eg. Rocket agent for Sajida Foundation)**, deposits cash for repayment and the MFS agent transfers the amount to the MFI wallet
- The customer **does not** need a **personal mobile money account**, and payment information is received **through SMS**
- Sajida Foundation (an MFI) enables **24,000 MFS transactions through Rocket agents, totaling GBP 440K every month**

Commission-based agents of MFS providers:

- The **agent** adds the **installment amount (received in cash)** to the **mobile money wallet of the customer**
- The customer then uses **USSD/mobile application** to initiate the digital transaction through their **personal mobile money wallet** to the merchant wallet (MFI branch)
- In BURO, **only 90,000 customers of 2 million (0.05%)** are paying loan installments **via bKash** across its 1,016 branches

Benefits

- **Flexibility of transactions as per customer's convenience.** E.g. Sajida Foundation observed that only **40% transactions** took place during **traditional timeframe** of community meetings
- Multiple payment options (**cash and digital)** for the customer
- MFI benefits from **improved operational efficiency** (i.e. time saving, productiveness of field officers) and **lower cash management risk**
- Easier method of payment collection from **migratory population**

Challenges

- **Consumer behavior restricts adoption of fully digitally enabled payments** via direct customer mobile money wallets
- **MFI's** may have to **pay a fee of 1% per transfer** (e.g. Rocket), thereby increasing their **operating expenses** significantly
- **Customer** may have to **pay a high fee of 1% of the amount of transfer** to the MFS provider (e.g. bKash)
- Time limitation of **90 seconds per cycle for a USSD transaction (in bKash)** requires multiple attempts by the customer to complete one transaction
- Existing regulatory framework **does not allow loan disbursements by MFIs** through mobile money services

Sources: Pioneering Cashless Microfinance in Bangladesh, OPTIX (Link); Mobile Money Killing Off the Group Microfinance Model, Next Billion (Link); Stakeholder Interactions

Landscape of Digital Payments in Bangladesh

In Bangladesh, the digital financial ecosystem within the MFIs is at a nascent stage. It will take 5-7 years for uptake at a wider scale. There is a need to improve the regulatory system for MFIs, increase financial and digital literacy of rural customers, enable wider application of MFS by rural customers for bill payments/grocery purchases, and build technical capacity among MFIs on digital technologies.

Key Trends in Digital Payments

- Bangladesh achieved **101.6% mobile phone penetration** in 2019 and **41% internet penetration rate** by Jan 2020.
- There is **higher prevalence of MFS in rural areas, with 58.6 million users** compared to 35.3 million users in urban areas (as of Aug 2020).
- The total **value of MFS transactions** was **GBP 4.6 Bn** as of Nov 2020.
- MFS was mostly used for **P2P transfers (30%)** by Nov 2020, followed by **29%** of **cash-in** and 28% of **cash-out** transactions. **Merchant payments** were a meagre **3.5%**.
- **15 private banks and one public sector department provide MFS. bKash** leads the market with **75% market share**, followed by **Rocket and Nagad** with **10-12% each**.

Key Barriers Affecting Market Growth

- In 2018, a change in **mobile money regulations** by the government **restricted the volume of withdrawals by customers to GBP 43 within next 24 hours.** This poses a huge challenge for MFIs as many clients want to **withdraw the loan amount on the same day.**
- **MFIs cannot participate in payment systems like banks**; hence, customers cannot avail all financial benefits such as saving products.
- **High loan repayment transaction charges** via mobile money reduces uptake of digital payment services. The customers may have to pay **transaction fee up to 2% of the transaction amount.**
- **Lack of face-to-face interactions** through group meetings (held by MFIs) can lead to **rise in defaulters** especially for larger loans, **impacts recruitment of new members,** and **increases cost** as field officers need to go door-to-door for interactions.
- **Low literacy levels and poor financial knowledge** among rural customers (**especially elderly**) impacts adoption of digital services. MFIs need to focus on financial and digital literacy programs to deliver new services.

Sources: Digital Transformation of MFIs in Bangladesh, UNCDF, 2019 (Link); Digital Payments in Bangladesh: A road to stability and growth, Lightcastle Analytics, 2020 (Link); Digital 2020 Bangladesh (Link); Digital Bangladesh 2021 Payment Systems and Fintech, Daily Star, Oct 2020 (Link); Mobile Financial Services Data, Bangladesh Bank (Link); Mobile Penetration Data, Statista (Link); The Mobile Economy Asia Pacific 2020, GSMA (Link); Covid triggers rise in Mobile Financial Services (Link)

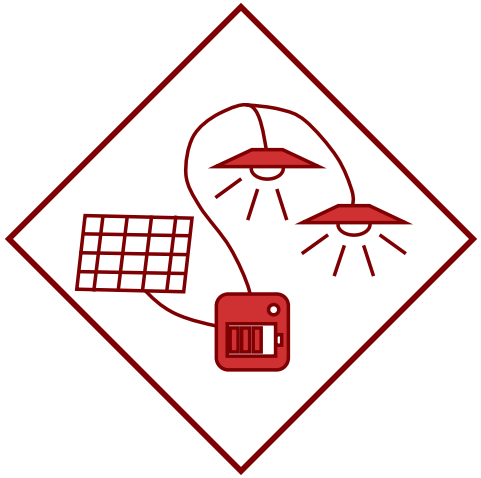
Comparison between India and Bangladesh MFS Market

		India	Bangladesh
Mobile Penetration	**Bangladesh has a higher mobile phone penetration than India** as of 2019. Bangladesh also has a lower gap between rural and urban mobile ownership.	**84.3%**	**101.6%**
Mobile Internet Penetration	**India fares slightly better than Bangladesh in terms of mobile internet penetration** i.e. it has higher number of mobile owners connected to the internet (2019).	**35%**	**25%**
No. of MFS users	India has more users of mobile financial services than Bangladesh. This could be attributed to its higher population as well as preferable govt. policies promoting digitisation. However, **as a percentage of total population, Bangladesh has more MFS users than India.**	**160 million**	**98 million (32 million active)**
Value of transaction done via MFS	The value of transactions via MFS in India were 4 times more than Bangladesh in 2019. However, **as a percentage of population, Bangladesh is ahead of India in terms of value of MFS transactions.**	**GBP 19 Bn***	**GBP 4.6 Bn**
Awareness about Mobile Money	**Mobile owners in India have significantly lower awareness about mobile money compared to Bangladesh.** In both the countries, men have higher level of awareness compared to women.	**26% of men 9% of women**	**73% of men 62% of women**

*Assuming that mobile money transactions were 0.9% of India's GDP in 2019

Sources: Mobile Cellular Subscriptions (per 100 people) Data: India, Bangladesh , WB (Link); 2020 Indian Mobile Payments Market Report, S&P Global Market Intelligence (Link); The Mobile Economy Asia Pacific 2020, GSMA (Link); The Economic Times: India ranks below Kenya, Bangladesh, Pakistan in urban-rural mobile ownership, 2018 (Link)

Payment Models for Solar Home Systems (SHS)



India

Different Payment Mechanisms used by MFIs in India (1/2)

In India, SHS are primarily sold by manufacturers/distributors in partnership with Microfinance Institutions (MFIs), that finance these systems. SHS providers pass on the financing risk to MFIs, as these are well entrenched in India and are already servicing the customers/borrowers who are likely to use SHS. MFIs benefit from additional revenue through commissions from SHS providers for cross-selling. MFIs use varied models for loan repayments such as cash collection (through business correspondents and loan officers) and multiple digital payment channels (including Aadhar Enabled Payment Systems (AEPS), BHIM UPI, BBPS etc.).

Cash Collection by Loan Officers

- The most **common payment collection model** in MFIs in India is **cash collection through loan officers/field staff.** They collect **cash payments** directly from the customers during **monthly centre meetings** held in the village or at a branch office.

Aadhar Enabled Payment Systems (AePS) enabled Business Correspondent Management Networks (BCMNs)

- Many MFIs in India have started partnering with BCMNs who manage a **network of Business Correspondents (BCs).** These BCs are **paid per financial transaction**. Typically, **small retail stores** double up as BC points (also called a **Micro ATM**) where borrowers can visit and make their payments, withdraw cash, check their account balance etc.
- The BCs are equipped with an **AEPS enabled device** through which customers can make **digital payments.** This system allows **basic interoperable banking transactions** at the **point of sale** (PoS or MicroATM) through the **business correspondent** of any bank by using **Aadhaar** (a 12 digit unique identification number) authentication. The customer needs to provide the **name of the bank, Aadhaar number** and **fingerprint** captured during enrolment to complete a transaction. AePS allows a customer to do **multiple types of transactions**, including **cash withdrawal, cash deposit, balance enquiry, payment transactions** and **fund transfers** among Aadhaar-holders. In India, AEPS is typically being used for cash withdrawals. 45 commercial banks, 44 rural regional banks, 19 cooperative banks, and 12 small finance banks and payment banks are live members of AEPS.
- However, it is observed that most **customers** prefer giving **cash to the BCs** who then transfer the money **through their account** while capturing relevant data of the customer (such as unique ID/Aadhaar number, customer's biometrics etc.), despite the option of making payments through AEPS. This is mainly because the borrowers mostly earn in cash and may not always have significant balance in their bank accounts to make digital payments via AEPS. E.g. Arohan mentioned that **only 20-30% of their AEPS transactions are fully digital/cashless.**
- **API integration between the BCMN's platform and the MFI's network** allows the MFI to track the transaction and customer details. For Self Help Groups (SHGs), BCs often go door to door with a **handheld ATM device** which uses **AEPS** to enable payment transfer.

Sources: Microsave India Focus Note 55, 'Microfinance in India – Is Business Correspondent the Way Forward?', 2011 (Link); The Bharat Payment System(Link); Live members of AEPS (Link)

Different Payment Mechanisms used by MFIs in India (2/2)

MFIs are using a few digital payment platforms, but digital/cashless payments remain a very small percentage of their overall payments. E.g. Arohan, one of the largest MFIs in East India mentioned that only 1% of their customers pay digitally (23,000 in a month) and the success rate of these payments is less than 50%. Muthoot Microfin Ltd. claimed that only 2-3% of their repayments are made digitally. This is mainly because most of their customers earn in cash and therefore prefer to pay in cash.

BHIM UPI Enabled Money Transfers

- **BHIM Unified Payment Interface (UPI)** is a payment platform managed by **National Payments Corporation of India (NPCI).** It enables **money transfer between bank accounts** or **other payment systems** (NEFT/RTGS/IMPS) through a **Virtual ID** created for a bank account.
- Although UPI is the most popular digital payment method in India, it isn't used extensively for making loan repayments to MFIs. Overall, the platform was expected to process close to **USD 425 billion** (15% of India's GDP) worth of transactions in 2020; with over **175 million customers** and **60 million merchants** on UPI. UPI's open architecture allows interoperability among all participating payments apps. Third part application providers in India such as PhonePe, Google Pay, PayTM, AmazonPay etc. have all enabled transactions via UPI.

Bharat Bill Payment System (BBPS)

- **It is an integrated bill payment system** which offers payment service to the customers **through a network of agents**, enabling multiple payment modes, and providing instant confirmation of the payment. Bharat BillPay offers all recurring payments like electricity, telecom, DTH, gas, water bills, insurance, loan repayments, education fees, FasTag Recharge, municipal taxes, housing society, subscription fees etc. at one single window. BBPS is being used by some **MFIs to collect installments**. This requires MFIs to tie up with a "**Bharat Bill Pay Operating Unit (BBPOUs)"** (licensed by NPCI)".

Payment Gateway Link

- Some MFIs also **send a 'payment gateway link'** (by tying up with companies like **Razor Pay, CC Avenue, PayU** etc.). The link is sent to the customers on their **registered mobile phone.** The customers can transfer the payment through their bank accounts using this link.

RuPay debit cards

- Launched in August 2014, **Pradhan Mantri Jan Dhan Yojna (PMJDY)** aims to provide at least one basic banking account to every household, along with a free RuPay debit card. Rupay is a product of NPCI. Some MFIs also accept payments through RuPay. For instance, **Arohan sends its loan officers with a debit card machine for any transactions through RuPAY at the centre meetings**. However, non-replacement of expired cards by banks, and non-issue of cards with new accounts is a challenge. This is mainly because several debit cards already issued are not being used and many customers do not collect debit cards issued to them. Banks, therefore, are often reluctant to issue new cards.

Sources: Aadhar Enabled Payment System (Link), BHIM UPI Enabled Money Transfers (LInk), Payment Gateway Link (Link), Stakeholder interactions

Key Challenges related to Digital Payments for MFIs in India

Preference for cash-based payments

- MFIs' customers earn mainly in cash and therefore prefer to pay in cash. They **may not always have significant balance in their accounts** to make digital payments. For instance, Arohan informed us that many customers need to make an additional trip to their banks to deposit money, before they commit to making any digital payments at the monthly centre meetings (via AEPS enabled devices, RuPAY debit card machines etc. carried by the loan officers). **Visiting the bank branches is an added cost** for the customers as these may be located far from their area.
- MFIs in India **also seem to be satisfied with cash payments** because it gives them an **opportunity to engage with the customer** and **cross-sell products.** However, they do acknowledge that **customer engagement can also go hand-in-hand with digital payments, as long as customers are willing to pay digitally. Customers will only pay digitally if their salaries and wages are transferred directly to their bank accounts.**

Technology issues with AEPS

- There are occasional technical glitches when **linking Aadhaar number with a bank account**
- **Customers need assisted transactions** requiring them to travel to the nearest agent/FI branch to carry out a transaction
- **There is a high probability of transaction failures** due to biometric mismatch

Poor integration of digital wallets

- **Low mobile penetration impacts uptake of digital wallets,** as the system requires registration of mobile numbers with bank accounts
- **There is usually an initial reluctance from customers** due to trust deficit and **risk of fraud**
- **There is high dependence** on functional **agent networks**

PAYGO Model - Case Study of Simpa Networks (1/3)

SIMPA Networks is the only SHS provider in India that used the PAYGO model for financing SHS. Their model evolved over time in three distinct phases as shown below:

Phase 1: Network of Sales and Service Agents

- Simpa Networks started with a **network of sales agents** (**called Urja Mitras**) for selling the product and a network of **service agents** for installation and maintenance of the SHS.
- Customers visited the **recharge points** (mostly manned by Urja Mitras) nearest to them. They paid for the **energy credits** (**mostly in cash**) to the agent. Subsequently, the agent sent the **customer's unique ID and authentication details** to Simpa's platform. The customer **received an SMS with a code from Simpa** to be **entered into the SHS to unlock it**.

Phase 2: Physical Collection

- Simpa decided to move to a physical collection model due to various challenges in the previous model such as many **customers bypassing the system, tampering with the device, buying cheaper parts (like batteries and panels) from secondhand markets, and not showing up at recharge points to pay their installments etc.**
- Instead of customers visiting the recharge points, Simpa leveraged its **service agents** (transferred onto the payroll of Simpa) to collect payments at the **customer's doorstep,** in addition to provision of installation and maintenance services.

Phase 3: Partnership with FIs

- To de-risk itself, **Simpa partnered with Ratnakar Bank Limited (RBL).** The RBL-Simpa partnership has **resulted in the solarisation of 8,000-9,000 households in Uttar Pradesh, according to RBL.**
- In this model, Simpa **sells the SHS to the customer**. The amount over and above the down payment made to Simpa by the customer, is financed by RBL.
- Simpa provides service and undertakes collections on behalf of RBL Bank. However, the customer continues to perceive Simpa as the financier, and therefore the risk of default payments persists incase of any challenge with the product.

Sources: Stakeholder Interaction (Simpa Networks); Domestic Banks are Moving into Rural Solar Power Space, Economic Times, 2019 (Link)

Operational Model - Case Study of Simpa Networks (2/3)

Step 1: Apply- Simpa's Urja Mitras (Village Level Entrepreneurs) or Rural Sales Associates visit the households to access the energy needs of rural customers and help them apply for one of Simpa's solar home system (SHS) by paying a small down-payment of INR 2,000-3,000 (GBP 20-30). Customers can make small installments over 2-3 years.

Step 2: Approve- Simpa's in-house credit team assesses the eligibility and the quality of the application basis Proprietary Credit Model and help customers get financing from its banking partners.

Step 3: Install- Simpa makes delivery of the SHS at the doorstep of the customers, which is installed by a Simpa Certified Technician.

Step 4: Pay-Go- Simpa Networks Customer Relationship Associates/ Service Agents provide doorstep collection and service to customers who make monthly repayments.

Step 5: Own- After repaying the loan for a contract period of 1-3 years, customers get ownership of the system and get free energy for lifetime.

Sources: Stakeholder Interaction (Simpa Networks)

Key Challenges - Case Study of Simpa Networks (3/3)

Tampering with the device	The remote lockout is a barrier to customers using their system (despite this indicating that they have not paid). Customers have tampered with the system to bypass this lockout which translates into a higher level of default. Simpa's representative also observed that a few customers complained about the cost of the product as they could get low-cost secondhand batteries and panels from local markets.
Defaults in payments	Customers perceive Simpa as the **financier of the product.** There is a risk of customers defaulting on the payment if they feel that the product is **not functioning properly,** or there are **cheaper alternatives available** on the market.
Growing energy needs of customers	**PAYGO SHS products typically cater to lower energy needs, but energy needs of customers in rural India are increasing.** According to Simpa's representative, rural customers are also demanding AC output systems, grid compatible systems, micro rooftop systems etc. which would need a robust Battery Management system (BMS) technology.
Poor digital literacy	**Low literacy levels and poor financial knowledge** among customers (especially elderly) impacts adoption of digital services. In majority of the cases, decision makers are elderly who are not comfortable using digital technologies.
Limited digital payments	Only **2-3% of their payments were collected digitally** in rural India. Mobile money payments are also tough **because rural customers change their phone numbers very often**. To make payments via Unified Payments Interface (UPI) they need to register their mobile number with the bank account.
Alternative means of getting electricity	With rapid grid expansion in India and low electricity tariffs, many customers are unwilling to pay for high cost SHS. In remote areas, there are instances of electricity theft, which can also adversely impact repayments for solar home systems.

Sources: Stakeholder Interaction (Simpa Networks)

Bangladesh

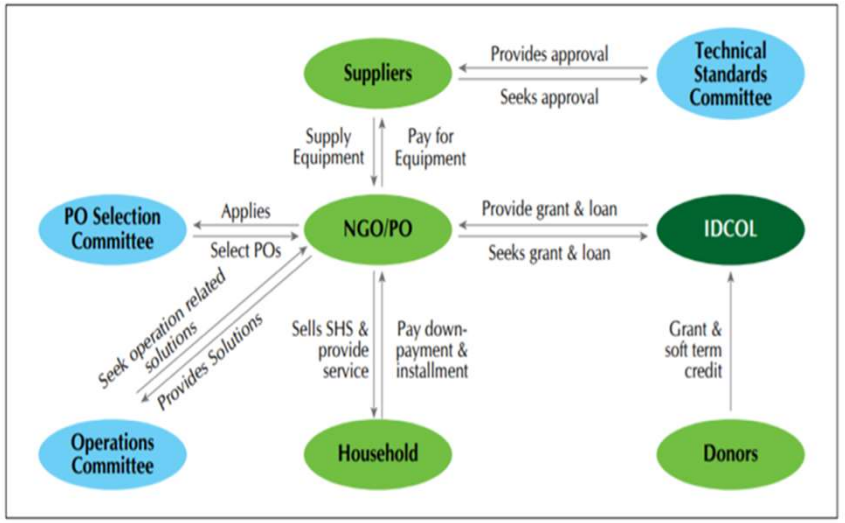
Microfinance Institution (MFI)- SHS Financing Model in Bangladesh

Similarly, to India, in Bangladesh as well, SHS providers partner with MFIs and NGOs to finance their products. However, in Bangladesh there is a dedicated body called Infrastructure Development Company Limited (IDCOL), a non-banking financial institution that leads the Solar Home System (SHS) programme and provides grants and loans to these MFIs and NGOs (called Partner Organisations) for financing SHS. IDCOL initially received credit and grant support from the World Bank and GEF, and was later supported by GIZ, KfW, ADB, IDB, GPOBA, JICA, USAID and DFID.

Implementation Modalities

- IDCOL provides **soft loans (at 6-9% interest for 5-10 years)** to Partner Organisations (POs) which are usually **Microfinance Institutions (MFIs) or NGOs.** At present, there are **56 POs** in Bangladesh. The POs procure and install the SHS from approved suppliers, sell the system through **micro-loans to customers,** and provide after-sales services. As of Oct 2020, a total **of 4.19 million SHS** were installed in Bangladesh.
- This is an **ownership-based business model**, whereby the customer make **payments in installments** over a fixed tenure and retain ownership of the SHS after recovery of loan amount. Customers generally make a **down payment** equivalent to **10–15%** of the cost of the SHS. The remainder is repaid in **2–3 years** at prevailing market interest rates (**12–15%**).
- **70-80% of the credit** extended by the POs to customers is eligible for refinancing from IDCOL at the market **interest rate of 6–9%**, with **a 5–7 year repayment period** and a **1–1.5-year grace period**. The credit and applicable subsidy is disbursed via **electronic transfer**. POs also receive **supplier credit** of up to 3 months as a bridge loan till refinancing from IDCOL.
- POs also extend a **buy-back guarantee** that allows customers to **sell their SHS** back to IDCOL at a **depreciated price**, in case the household/enterprise becomes grid-connected within a specified time of purchase.

IDCOL model for financing SHS



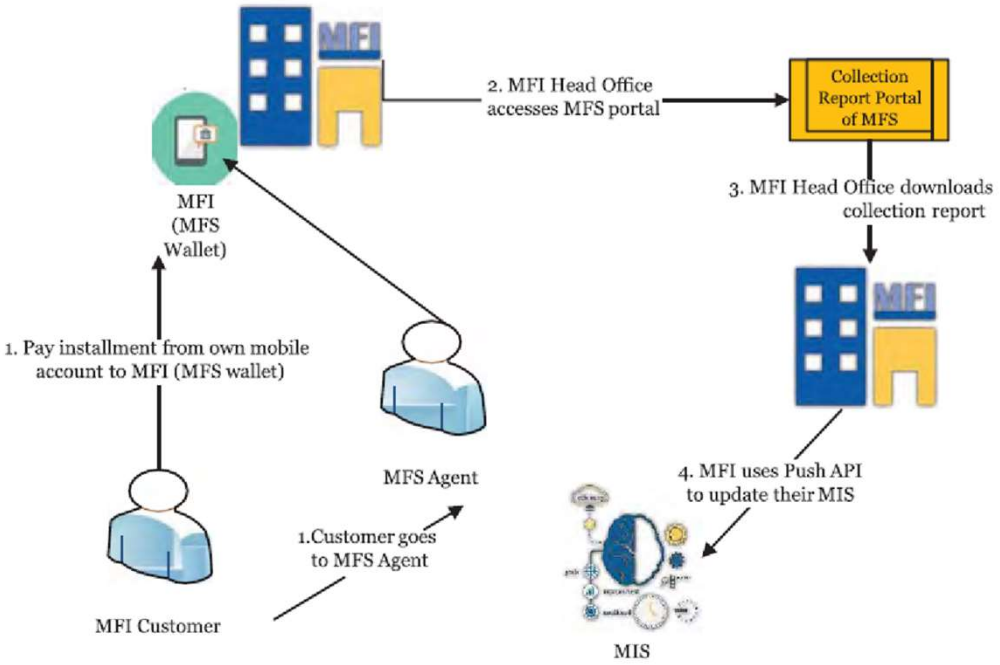
Sources: IDCOL Case Study, Global Delivery Initiative, 2015 (Link); Better than Cash Alliance Energy Case Study, UNCDF (LInk), IDCOL SHS Program (Link)

Different Payment Mechanisms used by MFIs in Bangladesh (2/2)

Cash payment remains the predominant mode of loan repayment by MFI customers in Bangladesh as well. However, a few MFIs have begun experimenting with different digital payment platforms.

Example of a Cashless Loan Repayment System by MFIs

- MFI maintains a **mobile money account with the mobile financial service (MFS) provider** to receive payments from the customer.
- **Customer creates** a **mobile money account** on the same platform.
- The two payment models followed by the customers are:
  - **a.** **Over-the-counter (OTC) transactions** wherein the customer goes to the **MFS agent**, **deposits cash for repayment** and the MFS agent **transfers the amount** to the MFI wallet; and
  - b. Customer **directly pays the installment from its own mobile money wallet** to the MFI account.
- The key advantages for the **customer** are **convenience of transaction as per their availability** (rather than being time-bound to weekly meetings) and **multiple payment options** (cash and digital). For the MFI, the benefits include **reduction in risk due to lower volume of cash transactions**, **decrease in operational costs**, **easier** method of payment collection from **migratory population**; and **effective time utilisation**.



Sources: Digital Transformation of MFIs in Bangladesh, UNCDF, 2019 (Link)

Mobile Financial Services - Case Study of Sajida Foundation

SAJIDA Foundation partnered with Rocket, a digital financial service (DFS) offering from Dutch-Bangla Bank Limited (DBBL), so customers could make loan repayments at any small merchant acting as a Rocket agent. Since 2017, Sajida Foundation offers digital loan disbursement and repayment via mobile money through a bill-pay option enabled by a network of Rocket agents. The MFI receives monthly loan repayments from 10,000 clients across 5 branches via mobile money. This amounts to 24,000 transactions totaling GBP 440K.

Model

- Customers can opt for **mobile money loans** and make **repayments through a network of agents** via **Rocket**. This does not require them to go to the MFI branch for repayments. The customers use the **OTC bill-pay option** offered by Rocket, that **does not require a personal mobile money account**. The transaction can be made through the agent's mobile money account. The customers **receive payment information through SMS instead of physical passbook.**
- Sajida holds **monthly group meetings** to **preserve the critical in-person contact with field officers.** These meetings are used to share monthly account statements, discuss challenges, recruit new members and deliver programs on financial literacy.

Benefits

- Customers prefer mobile money services as it **allows flexibility in payments as per their convenience**. For example, only **40% of the transactions** took place during the traditional repayment timeframe (the community meetings).
- The MFI benefits from improved **operational efficiency** (i.e. time saving, productiveness of field officers) and **lower cash management risk**.

Challenges

- **High fee of 1% per transfer** charged by Rocket for mobile money services represents a significant portion of MFI's expenses
- **Decline in savings by customers** due to lower engagement with the field officers
- **Poor financial and digital literacy** among the elderly limits uptake of mobile money services
- **Consumer behavior restricts adoption of fully digitally enabled payments** via direct customer mobile money wallets

Sources: Pioneering Cashless Microfinance in Bangladesh, OPTIX (Link); Mobile Money Killing Off the Group Microfinance Model, Next Billion (Link)

Mobile Financial Services – Case Study of BURO (1/2)

In 2015, BURO piloted digital payments for repayment of loans through mCash (a bank-led model). The pilot failed mainly due to technology bottlenecks, low mobile financial service penetration rate and limited human resource capacity. Recently, in 2019, BURO introduced bKash for digital payments across all its 1,016 branches across Bangladesh. However, only 90,000 customers of 2 million (0.05%) are paying loan installments via bKash.

Payment Mechanism

BURO has provided each customer with a **unique identification number (UIN)** for **verification of transactions.** The MFI is using **mobile money via bKash** to facilitate digital payment of loan installments. Customers have both options of **USSD** and **mobile application** for digital payments through bKash. The customers take cash installments to a **commission-based agent of bKash**. The **agent receives the cash** and **adds the installment amount** to the **mobile money wallet** of the customer. The customer then uses USSD/mobile application to **initiate the digital transaction** through their **personal mobile money wallet** to the merchant wallet (MFI branch). bKash also **allows direct mobile money payments from the linked bank account of the customer**. Only a few SME customers transact directly via linked bank accounts.

BURO has partnered with Samsung to provide **Wi-Fi-enabled tablets** to all its **loan officers** for **recording cash collections digitally**. The loan officers use the tablets during their **weekly group meetings** to input information on the transactions (including customer name, installment value, account number etc.). This **data automatically syncs** to the technology platform once Wi-Fi is enabled at the **branch office**. This has replaced the cumbersome process of physical book-keeping by the accountants.

Sources: Stakeholder interactions

Mobile Financial Services – Case Study of BURO (2/2)

Success

- **API integration** between **bKash platform** and **technology platform** (Skeleton) **of the MFI** enables **easy verification** of the information submitted by the customer for digital transaction.
- Initiate a program to provide **promotional cashback benefit** to the **customer's mobile money wallet** on bKash as incentive for digital payments.

Challenge

- **High fee of 1% of the amount of transfer** paid by customer to bKash
- **Time limitation of 90 seconds per cycle for a USSD transaction** requires multiple attempts by the customer to complete one transaction
- Existing regulatory framework **does not allow loan disbursements by MFIs through mobile money services**
- **Poor financial and digital literacy** limits uptake of mobile money services

Way forward

- Initiate an **MOU with Nagad** (a mobile money platform) to **reduce transaction costs** for the customers. Nagad charges **0.9% per transaction** compared to 1% by bKash
- Purchase **tablets with sim-based internet facilities** to capture realtime data and information on cash collection

In Bangladesh, the digital financial ecosystem within the MFIs is at a nascent stage. It will take at least 5-7 years for uptake at a wider scale. There is a need to improve the regulatory system for MFIs, increase financial and digital literacy of rural customers, enable wider application of bKash by rural customers for bill payments/grocery purchases, and build technical capacity among MFIs.

Sources: Stakeholder interactions

Key Challenges related to Digital Payments for MFIs in Bangladesh

Regulatory challenges

- In 2018, a change in mobile money regulations by the government **restricted the volume of withdrawals**. It states, "for any cash in transaction in a certain a/c, not more than BDT 5,000 **(GBP 43)** can be **withdrawn from that a/c within next 24 hours**." This poses a huge challenge for MFIs as many clients want to withdraw the loan amount on the same day.
- MFIs **cannot participate in payment systems like banks;** hence, customers cannot avail all financial benefits such as saving products.

High cost of transaction

- **Transaction fees charged from MFIs by mobile financial services providers** can significantly increase operational costs.
- **High loan repayment transaction charges** via mobile money reduces uptake of digital payment services. The customer may have to **pay transaction fees up to 2%** of the transaction amount.

Poor financial and digital literacy

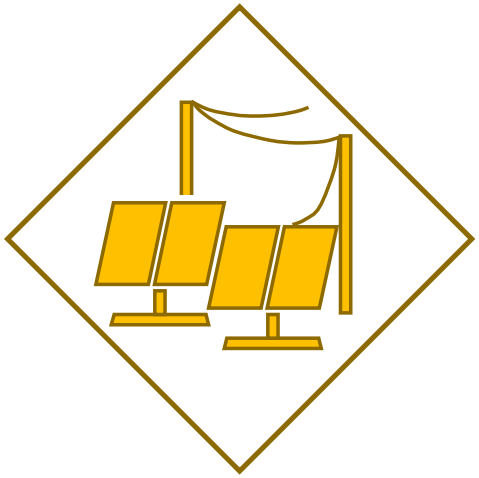
- **Low literacy levels and poor financial knowledge** among customers (especially elderly) impacts adoption of digital services. MFIs need to focus on financial and digital literacy programs to deliver new services.

Limited communication with customer

- Lack of face-to-face interactions through group meetings can lead to **rise in defaulters especially for larger loans**, **impact recruitment of new members**, and **increase cost** as field officers need to go door-to-door for interactions.

Sources: Digital Transformation of MFIs in Bangladesh, UNCDF, 2019 (Link)

Payment Models for Mini-grids



India

Mini-Grid Payment Model – Case Study of Mera Gaon Power (1/2)

Mera Gaon Power (MGP) noticed a significant increase in the repayment rate after shifting to a weekly payment collection model from a monthly model due to more sustained engagement with their clients. They introduced prepaid meters that enabled remote monitoring of usage and automatic disconnection of electricity once the energy credits were used. The customers were given recharge codes only after they paid for the energy credits.

Evolution of Mera Gaon Power's Business Model

Mera Gaon Power (MGP) builds, owns and operates solar microgrids in rural India. The co-founders are now exiting the business as they have achieved the goals they set out for themselves. However, the model is worth exploring to understand the payment mechanisms in the mini grid sector in India.

- MGP started off by forming **2-3 groups of 10 women** each per mini-grid facility. They **hired local cluster operators (COs)** from the village. Each CO managed 4-5 villages. 1 operator collected revenue from 10 facilities.
- **Prior to 2015**, they started with **monthly payment collection** at the customer's doorstep (INR 100 per month per customer) (GBP 1). This method failed because customers were unable to reliably pay for the service. This was because most of the women were not decision makers in their families and didn't have a regular source of income. They were dependent on the men in their families. Households continued spending on kerosene, charging, and other products.
- MGP then moved to a **weekly collection model** collecting **INR 25 (GBP 0.25) per week**. This **increased their OPEX slightly but also increased repayment rates to 99.9%** and enabled easy rotation of money. They realised that to ensure regular payments, it is **critical to have regular interactions with the customers** and engage them through weekly meetings.

Sources: Stakeholder Interaction (Mera Gaon Power)

Mini Grid Payment Model – Case Study of Mera Gaon Power (2/2)

Evolution of Mera Gaon Power's Business Model

- **In 2015**, MGP **developed their own prepaid metering system which was installed at the 25,000 households they served**. They also increased their tariff to Rs. 120 a month (GBP 1.2). **They charged not on the basis of units, but on the basis of duration of electricity use.** For instance, they provided electricity for 7 hours a day, totaling 49 hours each week. For 49 hours of usage, customers paid Rs.30 (GBP 0.3) charged before the service was provided. It was up to the customers to use their hours of energy over a day or spread it over 7 days as per their convenience. The electricity provide was sufficient to light 2 LED lights and charge a phone.
- They started giving **recharging codes via SMS to customers**, only once the customers had paid. **If the customer didn't pay, the service would be automatically disconnected**. Earlier, without the prepaid meters this had to be done manually, attracting negative attention on households who could not afford to pay.
- **Pilot project-** MGP tried various digital payment platforms. For instance, they ran a **pilot** with **Airtel Money (a payment bank in India**). However, they observed that **only 10% of 1000 customers maintained a balance of INR 100 (GBP 1) or more in their accounts at a time**. Typically, borrowers who buy more expensive products like SHS and have a fixed income, can easily maintain a substantial cash balance and pay through these digital wallets.

Sources: Stakeholder Interaction (Mera Gaon Power)

Mini Grid Payment Model – Case Study of Mlinda Foundation

Evolution of Mlinda Foundation's Business Model

The connected households are provided with smart prepaid meters of 5 kVA, which adds transparency to the system. The consumers can monitor and control the way they use electricity, thereby reducing their electricity costs. For Mlinda, the smart prepaid meters make for an easy revenue collection process. Single-phase meters cost approximately USD 65 and a three phase meter costs approximately USD 100. Payments are made in cash by all customers.

- The average village size is 120 households with approximately 5 family members per household.
- The village-wide mini-grids provide 24 hour, seven days a week energy for productive agricultural and commercial needs as well as domestic night-time use.
- **Each system is between 20 kWp and 30 kWp**, solar powered with diesel generators connected for peak load management or technical malfunction.
- **The consumers pay upfront connection fees and then pay for energy usage through prepaid meters. There are different day (USD 0.32/kWh) and night (USD 0.64/kWh) tariffs. These form the revenue sources.**
- **Part-time engineers and one full-time operator stays in each village and works with the communities** – individual entrepreneurs, women's self-help groups and farmer groups – to help them transition from diesel and kerosene to clean energy. These close ties ensure that Mlinda builds relations of trust with the community and that a quality service is provided.
- Local operators are also trained in maintenance and repair of the mini-grids.
- The grids are designed to increase in capacity as demand grows. Once the mini-grids reach 95% capacity utilisation, Mlinda installs an additional 5 kWp array to enable the community to meet its growing demand.

Sources: Private Sector Driven Business Models of Clean Energy Mini Grids in SEA;, 2020 (Link)

Bangladesh

Payment Models for Mini-Grids in Bangladesh

Unlike in India, where most mini-grids collect cash payments, in Bangladesh, there appears to be a visible penetration of mobile money payments or voucher billing models, for electricity provided through mini-grids. While in India, most collection is done door to door, in Bangladesh customers recharge their cards at local offices or kiosks, and some pay directly using mobile money.

Revenue collection via prepaid meters is mandated for all IDCOL mini grids in Bangladesh. The cards are charged through mobile money or local offices of operators.

Cost of Prepaid Meters

- Cost of a prepaid meter for **commercial enterprises** is BDT 15,000 **(GBP 130)**, while for **households** it is BDT 7,000-8,000 **(GBP 60-70).**
- **BDT 100 (GBP 0.8) is the monthly "line charge"** incurred by mini-grid customers, for maintenance of distribution lines. Typically, tariffs and line rates increase by 10% pa every 5 years.

Examples of Payment Mechanisms

- **Voucher billing model (Rahimafrooz Ltd.)**: The customers are supplied with a prepaid smartcard on installation of the meter. They are required to **purchase energy credit for at least one month**. Energy will be credited through smartcard from the **vending station located in the project office** and/or **vending kiosk at the local market**.
- **Recharging cards at local operator offices (Green Housing and Energy Ltd./Exelon Bangladesh Ltd.):** Majority of the mini-grid customers recharge the smart card at the **local operator office or collection point**. The card is recharged based on **units (kWh) of electricity purchased**. After recharging, the **card is displayed on the front panel** of the meter to enable the system.
- **Mobile money (Green Housing and Energy Ltd./Blue Marine Energy Ltd.):** The customers make an **advance payment** using **mobile money**. Once mobile money is received by the mini-grid company, a **unique code** is generated through a **software** that is shared with the customer **via SMS**. This **unique code is entered into the prepaid smart meter** to receive electricity.

Sources: Mini Grids In Bangladesh: A Case Study of An Incipient Market, 2017, World Bank; Solar Mini Grids, Investment Case, Bangladesh, Vivid Economics, 2019; Stakeholder interactions

PAYGO Model – Case Study of SolShare

SOLshare has created the world's first integrated peer-to-peer solar micro grid system. This allows trading of electricity among households with or without SHS; and enables PAYGO for individual SHS through mobile money (such as bKash).

Model

SOLshare has developed SOLbazaar, an **IoT-driven trading platform** which enables people to **trade the excess solar energy generated by SHS.** This consists of **SOLbox** (a DC bi-directional smart meter costing GBP 22), **SOLapp** (mobile application with customer portfolios and payment details) and **SOLweb** (data analytics platform). This enables peer-to-peer electricity trading, smart grid management, remote monitoring, mobile money payment and data analytics.

- It **installs the smart meter** and **solar charge controller** in the households/businesses with SHS/solar panels and connects them to other households with electrical cabling. The meter measures **energy inflows and outflows**, **optimises battery charging**, supports **grid control,** and allows users to **set buy or sell-only mode.**
- This creates a **network of localised grids (called SOLgrid)** allowing households to **sell surplus solar energy** to households/businesses with energy deficiency. The payments are made through **mobile money (such as bKash). The credit** can be either **cashed** or used for **purchase of goods** at local stores. SOLshare charges a **transaction fee for every unit of electricity traded** on SOLgrid.
- The **PAYGO enabled SHS** allows customers to **pay installments by mobile money/cash**. The customers receive a **code by SMS** which is entered through a **keypad to unlock the electronic battery lock**.

Impact

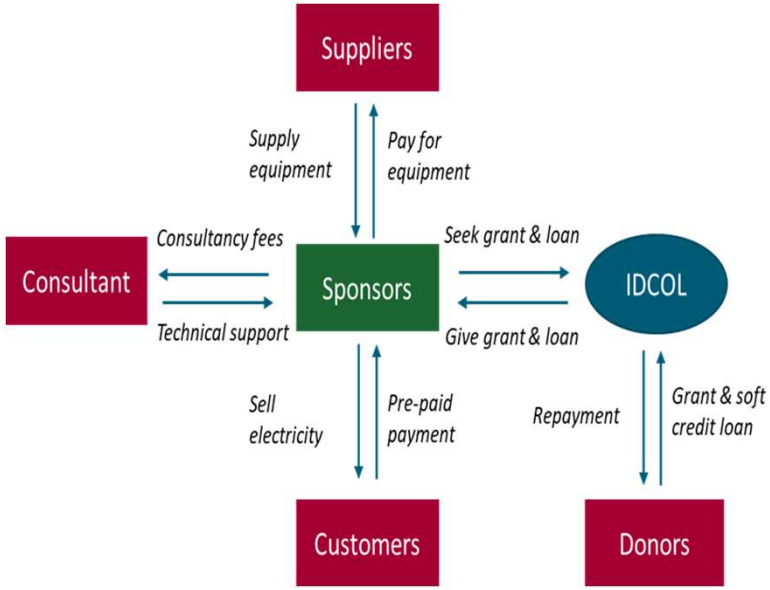
- **Increase the utility** of an individual SHS by **30%**
- **Reduction in** the **annual cost of energy** by **25%**

Sources: SOLshare, the StartUp for Solar Energy in Bangladesh, 2017 (Link); Effective Disruption: How Blockchain Technology can transfer the Energy Sector (Link); Bangladesh goes PAYG, GSMA (Link); UNFCCC SolShare (Link); SOLshare Mini Solar Power Grids Energy (Link)

Mini-Grid Financing Model of IDCOL in Bangladesh

IDCOL provides sponsors with the following: a) 50% grant b) 30% concessional loan at 6% annual interest rate for 10 years (2 years grace period) with 100% collateral in the form of bank guarantee or land mortgage covering the full loan c) 20% equity for implementation of mini-grids in Bangladesh

- **Sustainable and Renewable Energy Development Authority (SREDA) and Bangladesh Rural Regulation Electrification Board (BREB):** Established a list of **1,027 areas** where mini-grids are techno-economically optimal, where the grid cannot be expanded or where there are very few customers to justify grid expansion.
- **Sponsor:** Submits a proposal to IDCOL to set up mini grid. Owns and operates system for 20 yrs. Pays EPC contractor and technical consultant for their services.
- **IDCOL:** Finalises location with a no objection certificate (NOC) from the ministry, defines technical standards for equipment, enables financing etc.
- **Donors:** Loans from WB and JICA and grants from KfW, UKAid, GPOBA, and USAID
- **Technical Consultant:** Involved in the technical design of the mini grid system. Consultants are suggested by IDCOL.
- **Suppliers:** Provide equipment as per specific technical standards.
- **EPC contractors:** Apply for tenders floated by IDCOL and the project sponsor. The lowest bidder wins and buys equipment from IDCOL's preferred suppliers.



Sources: Solar Mini Grids Projects, IDCOL (Link)

Market Overview

Digital Payments in India and Bangladesh

Trends in Digital Payments in India

Government policies, Covid-19 and rising smartphone and internet penetration have boosted digital payments in India

- **India witnessed a 95-fold increase in number of registered mobile money accounts between 2014 and 2019** driven by factors such as the government's demonetisation policy of 2016 and increase in smartphone penetration (by 23% in rural and 17% in urban India between 2015-2019); and rise in internet penetration (35% y-o-y growth in rural India and 7% in urban India in 2018). It was further accelerated by the Covid-19 pandemic. As of 2014, there were about **13 such mobile money accounts per 1,000 adults** in the country and this number **rose to 1,265** in 2019.
- Indian market consists of **160 million unique mobile payment users** until 2020, **11.7%** of the population.
- No. of **cashless transactions per person in India** grew from **2.2** in 2014 to **18** in 2019.
- Mobile money transactions grew from **0.02% of GDP in 2015 to 0.9% in 2019**. These are **still far behind some of the African and Asian countries** such as **Ghana and Cambodia**, where the **value of mobile money transactions** was **70% and 90% of GDP** in 2019.

Users are shifting away from mobile wallets to UPI enabled transactions

- Users of one digital/mobile wallet cannot transact with users of another wallet. They don't earn interest on money kept in these accounts. But **United Payment Interface (UPI) enables account-to-account transfers, and customers get to keep the money in their bank accounts and earn interest.** As a result, mobile payment users are shifting away from wallets and towards UPI. By October 2020, **2.2 billion transactions** were executed via UPI. **207 Financial institutions** in India have enabled payments via UPI.
- **Google Pay and PhonePe lead the market** as the most popular UPI payment apps. **Amazon Pay** entered the UPI space in mid-2019.
- Other payment platforms like **AEPS have 120 FI members**, and there are **63 FIs registered as Customer Bharat Bill Pay Operating Units** (BBPOUs), enabling payments through BBPS.

Mobile payments are mostly used for P2P transactions

- A large number of transactions handled by payment apps include **peer-to-peer transactions, mobile phone account recharges and utility bills.** Mobile payments are also increasingly becoming a popular for **retail transactions at the point of sale and online.**

Sources: IJRAR , Digital Financial Services in India, 2019 (Link); The Economic Times, India to have 820 Smartphone Users by 2022, 2020 (Link); Bloomberg, India's mobile Banking Accounts Rise 95-Fold In Five Years: IMF, 2020 (Link); McKinsey Global Institute, Digital India: Technology to Transform a connected nation (Link); Digital Payments Grows At 55% Over Past Five Years, Inc42, 2020 (Link); NCPI Live UPI Members (Link); NCPI Live Customer BBPOUs, Oct 2020 (Link)

Trends in Digital Payments in Bangladesh

More than 100% mobile penetration in Bangladesh

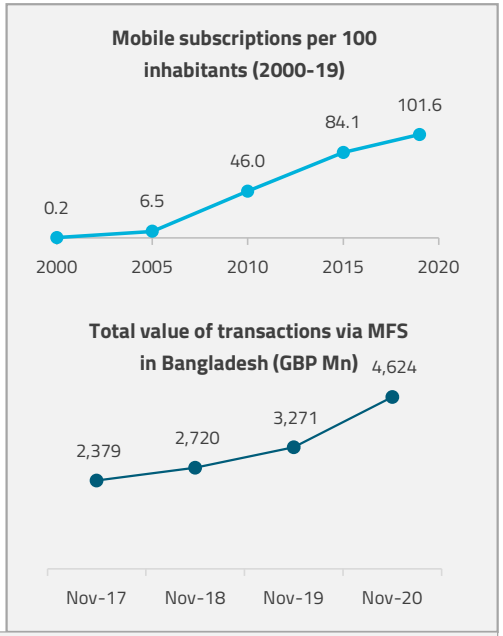
- Bangladesh achieved **101.6% mobile phone penetration** in 2019 and **41% internet penetration rate** by Jan 2020. There was a **4.5% increase** in the number of mobile connections between Jan 2019-20; and no. of internet users increased by 9.5% between 2019-20.

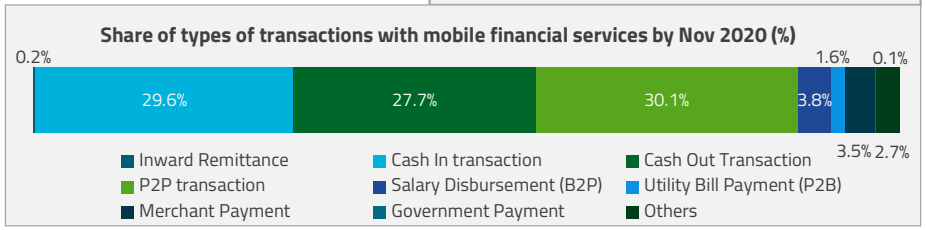
Strong uptake of mobile financial services (mostly P2P, cash-in and cash-out), especially in rural areas

- As of Nov 2020, the number of registered **MFS** users was **98 million** of which **32 million accounts were active** (as per transacting within 3 Months). The total **value of transactions** through these accounts was **GBP 4.6 Bn rapidly increasing from 2017.**
- **Majority of MFS transactions were for cash-out (28%), cash-in (29%) and peer-to-peer transfers (30%)** by Nov 2020. Usage rates for digital merchant payment services remain extremely low at only 3.5%.
- **There is higher prevalence of MFS in rural areas.** As of Aug 2020, **58.6 million users** of MFS in rural areas compared to 35.3 million users in urban areas. Most common form of transactions are peer-to-peer transfers and cash-in.

bKash is the leading market player for mobile payments in Bangladesh

- **bKash** is the leading player with 75% market share, followed by **Rocket and Nagad (service of Bangladesh postal department)** with 10-12% each.
- **15 private banks and one public sector dept.** provide MFS including UCBL, Mercantile Bank, Rupali Bank, Trust Bank, Islami Bank Bangladesh Ltd, BRAC Bank. Etc. MFIs using MFS include Buro and Sajida Foundation.





Sources: Digital Payments in Bangladesh: A road to stability and growth, Lightcastle Analytics, 2020 (Link); Digital 2020 Bangladesh (Link); Digital Bangladesh 2021 Payment Systems and Fintech, Daily Star, Oct 2020 (Link); Mobile Financial Services Data, Bangladesh Bank (Link); Mobile Penetration Data, Statista (Link); The Mobile Economy Asia Pacific 2020, GSMA (Link); Covid triggers rise in Mobile Financial Services (Link)