Mobile for Development Utilities

MOBILE FOR SMART SOLUTIONS:

How Mobile can Improve Energy Access in Sub-Saharan Africa

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UKaid
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Executive Summary

"Energy is the life-blood of economic development"[1], however, 1.2 billion people around the world lack access to electricity, representing 17% of the global population[2], and an additional 1 billion of those connected still face unreliable electricity[3]. A significant portion of the un-electrified are in Sub-Saharan Africa: 599 million people lack access to electricity[4], representing over 60% of the total 936 million regional population[5]. The majority of Sub-Saharan Africa's un-electrified populations live in rural areas: 82% of people lack access to electricity[6]. In turn, chronic power shortages, due to insufficient electricity generation capacity, heavily impact the region's economy, restraining growth by approximately US$33.6 billion annually.[7]

> *"Sub-Saharan Africa lags far behind developed regions in access to electricity, but the market for electricity meters is growing fast as national utility companies seek to deploy prepayment and smart meters."*
>
> **The Africa Report, May 2013**

In contrast, mobile networks have become the predominant infrastructure in emerging markets and more people are now covered by mobile networks than have access to energy. In 2013, more than one in three Africans had at least one mobile subscription[8] and GSM coverage was estimated to reach 76% of the African population. As a result, the gap between access to mobile and electricity services has widened from 2000 to 2012 to the point where, today, we estimate that more than 358 million people in Sub-Saharan Africa are covered by mobile networks but do not have access to electricity.

The ubiquity of mobile services presents a growing opportunity for energy service providers – national utilities in urban areas and energy service companies in rural areas - as well as governments, to leverage GSM networks and technologies to dramatically improve and expand energy services to new scales. The deployment of smart solutions can provide energy providers with improved management of connections, remote monitoring and more efficient billing processes, thereby reducing losses so they can recover costs they need to ensure reliable services and connect more customers. Therefore, mobile technology and mobile network operators can provide a range of smart solutions for energy services, from basic connectivity, and machine-to-machine communication, to platforms for mobile payments and data management services.

In this light, at the end of 2013, the GSMA Mobile for Development Utilities programme (M4D Utilities), with the support of the UK Department for International Development (DFID), began working with Orange to explore the opportunity for mobile operators to partner with energy service providers in the deployment of smart solutions to improve energy access in Sub-Saharan Africa. This research included desk-based and field-based research in three selected countries- Botswana, Senegal and Côte d'Ivoire- as well as inputs from African Utility Week 2014, and discussions with early adopters of smart energy solutions. The findings demonstrate the opportunity for smart solutions to support and improve energy access in Sub-Saharan Africa. To unlock the opportunity the following recommendations are made to the actors that can deliver this change: mobile operators, energy service providers, and the funders in the energy access sector.

1. Frans Vreeswijk, the Secretary General of the International Electrotechnical Commission (IEC) highlighted at the African Utility Week 2014, in Cape Town, South Africa
2. International Energy Agency, 2013
3. United Nations Development Programme, 2014, http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/sustainable-energy/universal-access.html
4. International Energy Agency, 2013
5. World Bank, http://data.worldbank.org/region/sub-saharan-africa
6. International Energy Agency, 2013
7. Frost & Sullivan, African Utility Market Intelligence Report, May 2014
8. GSMA Intelligence data on Unique Subscriber penetration in 2013 in Sub-Saharan Africa; the proportion will be higher in the more mature North African mobile markets.

Recommendations for Mobile Operators

There is an opportunity for Mobile Networks Operators (MNOs) to partner with utilities and energy service companies (ESCOs) to support the development of smart solutions for energy services. Our recommendations to mobile operators are two-fold:

- Mobile operators can develop a suite of enabling services targeted at utilities and ESCOs to support their smart solution deployments in urban on-grid as well as rural off-grid markets. These services include machine-to-machine connectivity for meters, the IT infrastructure to support data management and analytics, service delivery platforms to support customer management, mobile billing and payment, and customer interface services to support improved communication with end customers. Of these services, those with the greatest potential to provide immediate benefits to energy service providers includes customer service support and leveraging mobile money to support pre-paid bill payment services.
- Mobile operators should work with energy providers to clarify the business case for the deployment of smart meters and smart solutions by supporting pilots that focus on demonstrating their commercial viability, while sharing the risk.

Recommendations for Utilities and ESCOs

From rural to urban markets, ESCOs and utilities are increasingly aware of the role that mobile technology and smart solutions can play to support their business models but more needs to be done to quantify the benefits and accelerate uptake. Energy service providers should also seek partnerships with mobile operators to trial the deployment of smart meters with customer segments with high potential for success. For example, a trial of smart solutions with larger power consumers, who have the ability to pay present a significant portion of the utilities' revenue, provides the right conditions to test the business case. ESCOs should focus their business models and trials to prove customer uptake and their customer's payment ability. Both utilities and ESCOs should work with MNOs to define the enabling services required to support their business models.

Recommendations for Funders

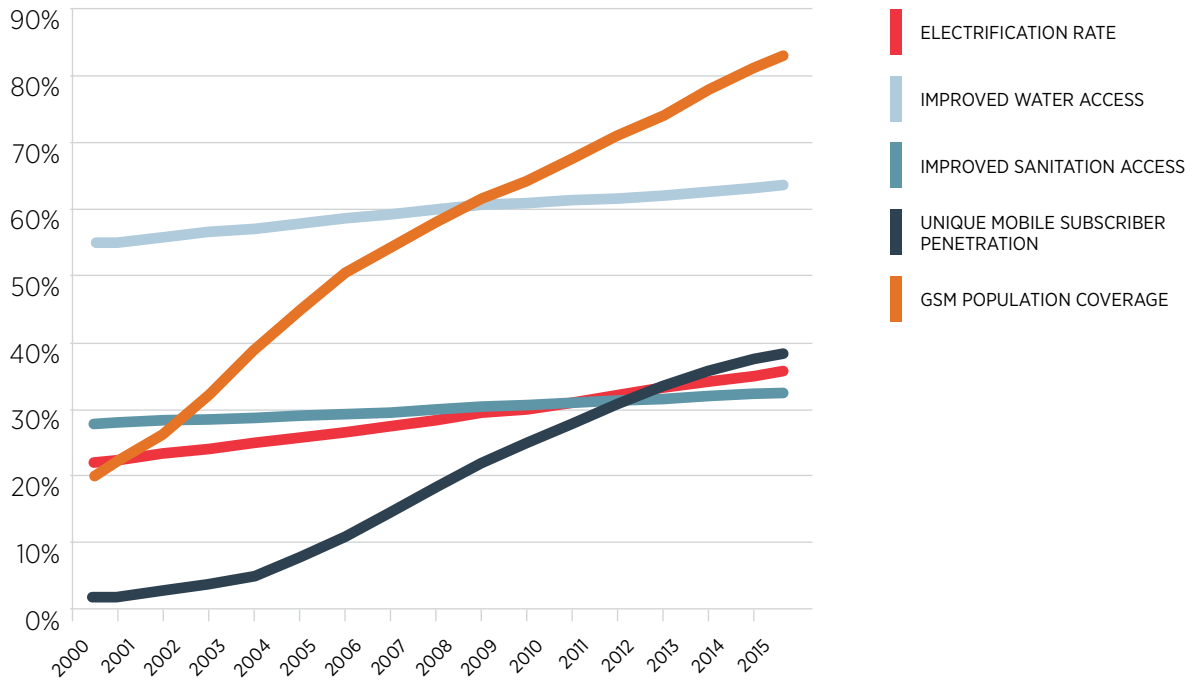
Our research shows that the results of smart, and even pre-paid non-smart, meter deployments depend often on the execution and processes used during the trial. While smart solutions can provide significant benefits to energy service providers, they are hesitating to raise, or invest, the capital required to trial these solutions at scale. As the commercial model is still unproven, donor agencies should step in to support the early stage trials with the goal of improving the understanding of commercial viability.

2

The Ubiquity of Mobile Networks

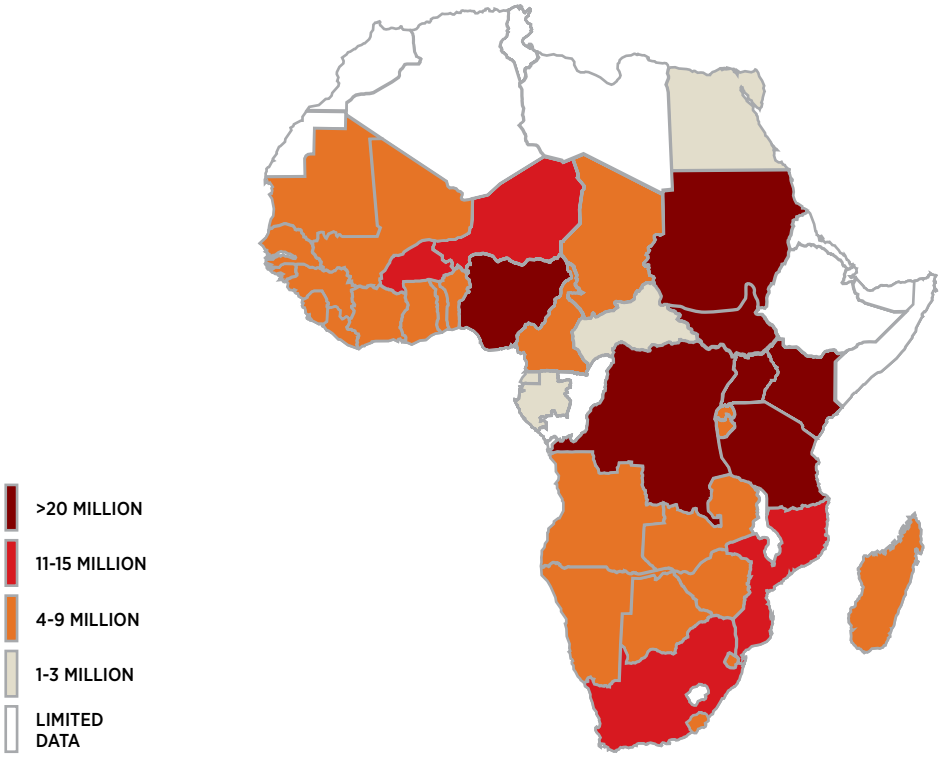
From urban to rural areas, mobile networks have become the predominant infrastructure in emerging markets and more people are now covered by mobile networks than have access to energy. In 2013, more than one in three Africans had at least one mobile subscription[9] and GSM coverage was estimated to reach 76% of the African population (a total of more than 700 million people)[10]. The boom in mobile adoption contrasts with the lack of access to basic infrastructure: the electrification rate is estimated at 32% of the overall population, leaving almost 600 million people without electricity.[11] As presented in Figure 1, the gap between access to mobile and electricity services has widened from 2000 to 2012 to the point where, today, we estimate that more than 358 million people in Sub-Sarahan Africa are covered by mobile networks but do not have access to electricity (this represents 59% of the off-grid population).

FIGURE 1
MOBILE ACCESS VERSUS ELECTRICITY, WATER AND SANITATION ACCESS IN SUB-SAHARAN AFRICA (2000-2015)[12]



9. GSMA Intelligence data on Unique Subscriber penetration in 2013 in Sub-Saharan Africa; the proportion will be higher in the more mature North African mobile markets.
10. GSMA, The Synergies between Mobile, Energy and Water Access: Africa, 2014
11. International Energy Agency, 2013
12. Source GSMA, IEA, UN data (with forecast up to 2015)

FIGURE 2
AFRICA'S MOBILE-ENERGY ADDRESSABLE MARKET (2013)[13]



Increased mobile connectivity has also led to the development of a range of mobile enabling services, with mobile financial services being one of the most lucrative. In 2013, there were approximately 114 mobile money offerings across Sub-Saharan Africa, with 98 million registered users, making financial services available to those who cannot access formal banking.[13]

Another key service enabled by mobile networks is machine-to-machine technology (M2M). This technology solution, "enabling mobile data transmission between two or more machines"[14] (such as meters), is developing and becoming more readily available at lower costs. Bringing together the ubiquity of mobile networks, the growth of mobile money services, and the availability of M2M has created new opportunities to leverage mobile services and technology in smart solutions to improve energy access in Sub-Saharan Africa. The experiences of pioneering utilities and off-grid ESCOs provide a positive outlook for the role that mobile technologies can play in energy access:

- UMEME, the national utility of Uganda, in 2012 was able to use GSM-enabled data concentrators (feeders) to identify where it was incurring its highest losses, leading to the recovery of US$1.5M in revenues within a year.
- Innovative companies such as Mobisol, M-Kopa, Fenix International and Off.Grid:Electric are using a combination of decentralised home solar systems, mobile payments and in some case GSM-enabled meters to serve over 140,000 customers across East Africa.

13. GSMA, 2013. "State of the Industry. Mobile Financial Services for the Unbanked, 2013" http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/02/SOTIR_2013.pdf
14. GSMA intelligence, "Cellular M2M forecasts and assumptions: 2010-2020" 2014, https://gsmaintelligence.com/files/analysis-subscription/?file=140922-m2m.pdf

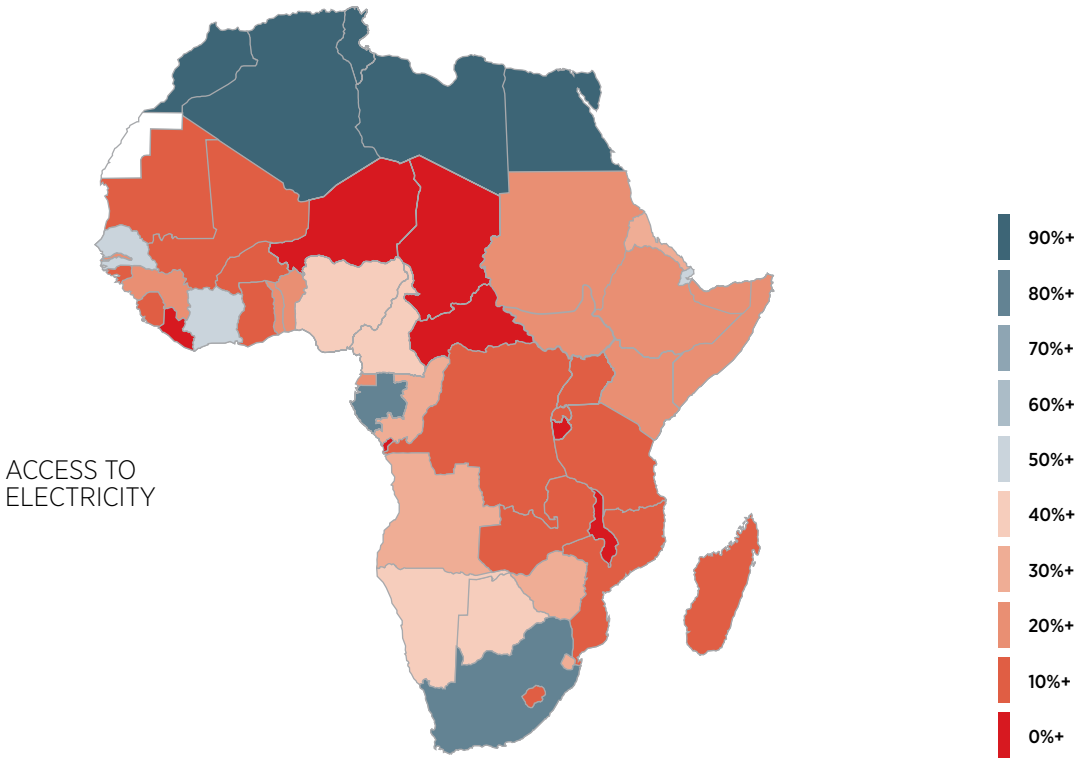
3

Energy Access Challenges in Sub-Saharan Africa

3.1 The energy gap across rural and urban settings

According to the World Bank's 2013 Sustainable Energy for All (SE4All)[15] Global Tracking Framework, 1.2 billion people lack access to electricity around the world and an additional 1 billion people are connected to unreliable grids.[16] In Sub-Saharan Africa, more than 60% of the population does not have access to electricity"[17], amounting to over approximately 600 million people without access (Figure 3). The majority of this population lives in rural areas, where 82%[18] of the population is not electrified.

FIGURE 3
AFRICA'S ENERGY ACCESS MARKET[19]



15. Sustainable Energy for All is a multi-stakeholder initiative launched by United Nations Secretary-General Ban Ki-moon in order to drive actions and mobilise commitments to positively transform the world's energy systems.
16. United Nations Development Programme, Facts on Universal Energy Access, http://www.undp.org/content/dam/undp/library/corporate/fast-facts/english/FF-Universal-Energy-Access.pdf
17. International Energy Agency, 2013
18. International Energy Agency, 2013
19. The total population covered by GSM networks without access to electricity

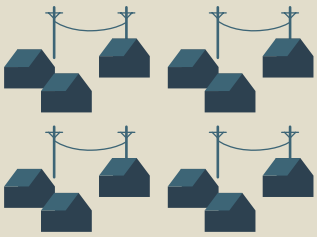
3.2 Energy service models from rural to urban settings

Incumbent energy and electricity models vary across urban, peri-urban and rural areas, dependent on factors such as population density, economic activity and availability of energy resources. Currently, most urban populations are connected through the main electricity grid operated by national utilities. In rural off-grid areas, where the population density is low and the grid does not reach, the main energy sources are traditional fossil fuels or batteries. Between these two extremes, there lie high-density off-grid urban (i.e. slums) and rural areas, which also generally rely on traditional fuels and batteries (but can also gain access to electricity through illegal connections to the electricity grid) or decentralized solutions such as diesel generators and home solar systems.

Closing the energy access gap will more than likely rely on three distinct energy delivery models, as illustrated in Figure 4 below:

- New utility connections in areas of high-population density or where the business case to extend the grid makes strategic or financial sense
- Mini-grid systems to support high-population density, off-grid areas
- Household level solutions including home solar systems whether sold to customers or provided as a utility-like service

FIGURE 4
FROM RURAL TO URBAN: ENERGY SERVICE MODELS

	RURAL OFF-GRID (LOW DENSITY)	URBAN AND RURAL OFF-GRID (HIGH DENSITY)	URBAN AND RURAL ON-GRID
SETTING			
DESCRIPTION	• Households are dispersed, community density is low • **Energy:** Households rely on traditional fossil fuels and batteries • **Poverty level:** High to medium	• Households are densely organised with business activities, schools, health centres • **Energy:** Households rely on traditional fossil fuels, own a home solar system, or are connected to a locally managed mini-grid • **Poverty level:** High to low	• Households are densely organised, with high business activities, schools, health centres • **Energy:** Households are connected to the national electricity grid • **Poverty level:** Medium to low
TYPE OF ENERGY MODEL	Household solutions (e.g solar home systems)	Mini-grid solutions or household solutions	Centralised grid energy

3.3 Energy service providers

National utilities, energy service companies and governments are the key actors responsible for provision of services within these models. The following responsibilities and mandates frame their roles in closing the energy gap:

National utilities in urban and peri-urban settings

Depending on a country's regulatory framework, utilities may be responsible for all, or part of, the generation, transmission and distribution of electricity. In Sub-Saharan Africa, most energy utilities are still owned and operated as part of national government, although some are moving towards a privatized model.

The utility's mandate is often limited to urban and peri-urban areas, which has in part led to low electrification rates, particularly for those in rural areas. Furthermore, electrification rates reflect national incomes: in Sub-Saharan Africa's middle income countries, only 32% of households have access to the electricity grid while this figure goes down to 16% in the region's low-income countries.[20]

Energy service companies in rural settings

In rural areas, as national utilities have limited reach, energy access is the responsibility of governments' Rural Electrification Programmes or a business opportunity for Energy Service Companies (ESCOs). An ESCO is an organization that can be for- or non-profit, working to expand energy access where national grids do not reach. They may generate and distribute their own decentralized energy, or they may distribute portable energy products to end users, providing varying models of ownership.

3.4 Energy service delivery challenges

Energy service providers, whether utilities or ESCOs, face significant challenges in delivering reliable services to their customers and in recovering revenue that supports commercial viability. The key challenges of utilities and rural ESCOs are discussed in more detail below, followed by an analysis of how they can be addressed through smart solutions.

3.4.1 Utilities' key challenges

"Some 40% of people connected to infrastructure services do not pay for them, including 20% of the most affluent customers".[21] This lack of revenue recovery illustrates just one of the major challenges which utilities face in terms of losses. Other major challenges include poor infrastructure management and operational efficiency, lack of sector investment, and inefficient governance.

Infrastructure: Ageing equipment and poor maintenance

In Sub-Saharan Africa, as much as 25% of installed capacity is not operational for various reasons, including ageing plants and lack of maintenance. Utilities' poor network maintenance, leading to physical leakage, represents a large part of distribution losses, which costs the Sub-Sahara African region US$1.8 billion a year.[22]

Operational efficiency: Non-technical losses and inefficient billing

Non-technical losses (e.g. meter failure, meter tampering or fraud, un-metered or illegal connections, or data tampering in billing) represent approximately 20-30% of revenue losses for utilities across the continent, and in some cases this reaches 50%.[23] Additionally, power utilities' inefficient billing systems are one of the main reasons behind non-technical losses. They often rely on outdated and manual modes of billing and payment collection (e.g. post and in-person office payments), and face a culture of non-payment fostered by social and political impediments to disconnecting services.[24]

20. The World Bank, Monitoring Performance of Electric Utilities http://www.esmap.org/sites/esmap.org/files/P099234_AFR_Monitoring%20Performance%20of%20Electric%20Utilities_Tallapragada_0.pdf
21. African Development Bank, http://www.infrastructureafrica.org/key-msg/theme/although-nonpayment-rampant-costs-utility-services-do-appear-be-affordable-relatively-
22. African Development Bank, http://www.infrastructureafrica.org/key-msg/theme/africa%E2%80%99s-infrastructure-providers-waste-8-billion-year-inefficiencies-such-overstaffin
23. The World Bank, Monitoring Performance of Electric Utilities http://www.esmap.org/sites/esmap.org/files/P099234_AFR_Monitoring%20Performance%20of%20Electric%20Utilities_Tallapragada_0.pdf
24. African Development Bank, http://www.infrastructureafrica.org/key-msg/theme/africa%E2%80%99s-infrastructure-providers-waste-8-billion-year-inefficiencies-such-overstaffin

Financial: Non cost-reflective tariffs and heavy subsidies discourage investment

The limited financial capacity of national utilities has been a key impediment to increasing generation capacity across the region[25]. The World Bank "Monitoring of Electricity Utilities" report found more than half of Sub-Saharan countries use electricity tariffs that do not cover costs[26]. While private investment commitments in the Sub-Saharan Africa power sector have increased somewhat, access to private funding remains a challenge due to perceived risks including "instability within countries, poor regulatory regimes, and lack of infrastructure".[27]

Governance: Weak governance, regulation and policies

Challenges related to weak governance are well described by the World Bank report on Africa's Power Infrastructure: "Governments can interfere with management decisions … [pressuring] utilities to electrify certain areas, ignore illegal connections and non- payment, or maintain excessively low prices."[28] "These non- transparent pressures on the management of the utility can impact the implementation of new technology such as smart meter systems, as utilities and equipment suppliers await policy clarity".[29]

3.4.2 ESCOs' key challenges

Energy service companies serving off-grid customers (or those with unreliable grid service) face similar challenges, especially related to financing and the impact of weak governance, yet face other challenges more distinct to their market segment.

Remote, hard to reach customers

Off-grid energy customers often live in remote and hard to reach communities due to poor or underdeveloped road infrastructure. ESCOs serving these segments struggle to provide a significant presence in rural areas and deliver adequate levels of customer after sales services.

Customers are skeptical of poor quality products and services

Rural off-grid customers have limited risk appetite due to their lower incomes and limited knowledge of grid or solar services. Customers seek additional assurance that products and services will be reliable and address their needs.

Affordability

Rural underserved communities generally lack access to safe, affordable, convenient energy sources, and often pay a high price to buy small quantities of energy. With product costs that can rapidly reach over US$200 for ~10W systems, solar home systems companies typically need to offer financing solutions for their low-income customers[30] to grow the market demand.

25. Frost and Sullivan, African Utility Market Intelligence Report, May 2014
26. The World Bank, Monitoring Performance of Electric Utilities http://www.esmap.org/sites/esmap.org/files/P099234_AFR_Monitoring%20Performance%20of%20Electric%20Utilities_Tallapragada_0.pdf
27. Ibid
28. The World bank, "Africa's Power Infrastructure: Investment, Integration, Efficiency", 2011, p 140
29. d.light report, "Power for All, The Energy Access Imperative", June 2014
30. Ibid

4

Smart Solutions to Support Energy Providers' Challenges

Smart communication technology can help improve energy access by addressing energy providers' main challenges through remote monitoring and control of devices, and new channels for payment and customer engagement.

We use the term "smart solutions" to refer to the suite of information communication technologies, including GSM, which can be used to more rapidly and accurately send information between service providers, devices, and customers. This includes one-or two-way smart-meters, as well as the enabling services, which support customer engagement, such as remote payments and billing reminders. The specific functionality and technology for these smart solutions will vary between utility and ESCO services spanning the three energy service models from rural to urban contexts as illustrated in figure 4.

The most promising benefits that smart solutions offer to address energy service challenges can be generalized into 1) increased knowledge of energy flows and consumption through remote monitoring and control, and 2) improved billing efficiency through mobile enabling services.

1. Improved energy usage data through remote monitoring and control

Service providers' key challenges relate to operational inefficiencies, including losses and the inability to see energy flows in real-time. Remote monitoring and control of infrastructure via a smart meter improves clarity on customer usage and allows for easier detection of illegal connections or early warning systems for technical issues and for the remote shut-off of customers. A range of smart solution options exists, providing varying levels of information exchange (i.e. one or two-way communication, as described in section 5).

2. Improved billing efficiency through mobile payments and other enabling services

Inefficient billing and revenue losses, and their impact on governance and investment is another main challenge for energy providers. Smart billing and payment solutions allow the energy provider to monitor payments and ensure repayments while offering customers an efficient payment method. Other enabling services could include using mobile (SMS or Interactive Voice Response [IVR]) to alert customers of service notices, or payments due.

The potential for these solutions to address the identified challenges faced by utilities and their customers is as follows, whereas those for ESCOs are similar, but considered separately.

4.1 Smart solutions for utilities and their customers

Smart metering solutions provide more rapid access to detailed information about energy flows and consumption. This is particularly key to firstly addressing operational efficiency challenges, and subsequently the challenges around infrastructure maintenance, financial capacity and governance.

Improved access to data via remote monitoring and control can address these challenges as follows:

- Reduce technical and non-technical losses by more quickly detecting theft, losses, or a service problem to a particular area;
- Eliminate the need for costly and time-consuming manual meter reading which is also prone to error and corruption, therefore making billing and cost recovery more efficient;
- Make available reliable and regular consumption information for consumers to help them better manage usage and pave the way for pre-paid services which can dramatically reduce non-payment;
- Enable remote control of consumption for improved utility demand management;
- Increase data on energy flows and service levels to provide transparency and accountability for improved governance and demonstrate the need for greater investment;
- Improve accounting of energy flows and consumption, which, accompanied by customer payment data can help utilities attract more investment.

Mobile billing and enabling services provide solutions to utilities' challenges.
Mobile and digital payments can address operational inefficiencies related to revenue recovery:

- Improve customer repayment behaviour by eliminating customer travel to and queuing at payment offices, and speeding up the billing cycle for improve cost recovery;
- Reduce the risk of theft and costs associated with cash-handling;
- Support flexible tariff structures to enable incremental and smaller payments for lower income customers thereby increasing their ability to pay.

Mobile communication can be used to:

- Provide advance billing notification and billing reminders to reduce non-payment;
- Provide service updates, such as planned service work or peak demand constraints to improve customer behaviour in terms of usage and possibly lead to an increased willingness to pay.

Combining smart solutions for metering with mobile enabling services such as billing can jointly provide a more powerful solution to operational efficiency issues, particularly around losses and non-payment. Furthermore these combined services should provide the increased level of data on performance and consumer behaviour that can be used to demonstrate revenue recovery and the business principles needed to attract investment.

4.2 Smart solutions for ESCOs and their customers

Smart solutions address the challenges faced by ESCOs and their customers in a similar manner as for utilities. However, as ESCOs face challenges related to serving dispersed and remote populations with limited familiarity with technology and variable incomes, remote monitoring and mobile enabling services can play an even more crucial role.

Improved access to data via remote monitoring and control solutions can enable ESCOs to:

- Remotely monitor performance of products/services and pro-actively support hard to reach customers to ensure quality and maintenance of assets despite remoteness;
- Protect their investment in assets by remotely stopping service in the case of non-payment.

Mobile billing and enabling services can address ESCO challenges in the following key ways:

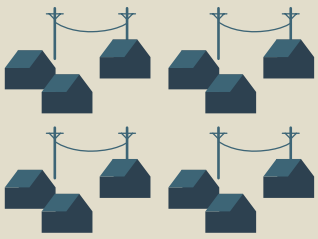
- Mobile payments enable innovative financing and flexible payments for users with low and variable incomes;
- Mobile payments eliminate risks associated with cash handling in remote areas where access to banking is limited;
- Smartphone applications and other functionality can be used by entrepreneurs to manage supply chains in remote areas where limited infrastructure makes distribution challenging.

Through these mechanisms, smart metering and support services, such as mobile payments, can address some of the key challenges that utilities and ESCOs face in delivering good quality service to their customers. However, there are many variations on the specific smart solutions that can be deployed, and the roles of mobile operators in each of these, which are considered in the following sections.

4.3 Examples of smart solutions for energy access

There is increasing optimism and evidence that smart solutions can support improved energy access in Sub-Saharan Africa. Figure 5 below introduces smart solutions that can be applied across the spectrum of energy models from rural to urban.

FIGURE 5
SMART SOLUTIONS FROM RURAL TO URBAN SETTINGS

	RURAL OFF-GRID (LOW DENSITY)	URBAN AND RURAL OFF-GRID (HIGH DENSITY)	URBAN AND RURAL ON-GRID
SETTING			
TYPE OF ENERGY MODEL	Household Solutions (ex. solar home systems)	Micro-grid solutions or solar home systems	Centralized Grid Electricity
TYPE OF METER	Meter integrated into home solar system installed in the household	Meter can be installed in the household or upstream	Meter can be installed in the household or upstream
GSM COVERAGE	Strong but some areas are uncovered	Mostly covered	Mostly covered
TYPE OF COMMUNICATION PATH	GSM is the main technology used to connect the meters, enabling remote monitoring and payment (Pay-as-you-go)	At the household level GSM directly competes with shorter range wireless technologies (ex. Zigbee). GSM is more likely to be used at the mini-grid level	GSM directly competes with technologies such as Power Lines Communication, Ethernet or other Radio Frequencies

The potential of smart solutions across the service delivery models for utilities, mini-grids, and decentralised solutions is presented in the case studies below.

CASE STUDY

UMEME, UGANDA'S UTILITY, TRIAL OF GSM-ENABLED PRE-PAID CUSTOMER METERS

In 2012, UMEME, the national electricity utility of Uganda sought to make significant improvements to their energy service following the government mandated 2018 target to improve revenue collection rates from 75% to 99%, and reduce losses (technical and non-technical) by 14%. A key first step was installing GSM-enabled meters at network nodes to determine the branches of greatest losses. Losses reflected technical losses due to the poor network, poor supply and an inefficient post-paid billing system, which included 900 non-billed connections. To address this, UMEME retrofitted 8,600 households with pre-paid split meters (these meters have separate keypad, installed outside the household, for entering a voucher code received upon payment). The cost of the 12-month pilot amounted to US$2.3M, yet within one year UMEME recovered US$1.5M, and an additional US$387,000 by imposing penalties for late payments. Also, the average energy consumption of customers decreased by 30% as customers had more visibility on their usage, while the utility's overall revenues increased because it became more difficult to tamper with meters and have illegal connections go undetected. UMEME has been encouraged by the results and is now looking at tackling theft by large power users through an Advanced Metering Infrastructure system. (The full UMEME case study is presented in the Annex 1)

CASE STUDY

DEVERGY'S M2M SMART METERS FOR MANAGING CONSUMPTION IN MINI-GRIDS

Devergy is setting up smart mini-grids, based on small solar towers (<100W per tower), in rural Tanzania; households and businesses are connected through power lines to these small solar towers. Applications include lighting, phone charging, TVs, fridges and entertainment centres. As of September 2014, Devergy had approximately 800 customers.[31] Solar towers and households are equipped with Zigbee-enabled meters allowing real-time monitoring of usage and credits by the household. Load monitoring is also enabling dynamic power allocation according to demand. In each village, a centralised GSM unit communicates information through GPRS about the mini-grid operations to a central server. Devergy also leverages mobile money for payment collection.

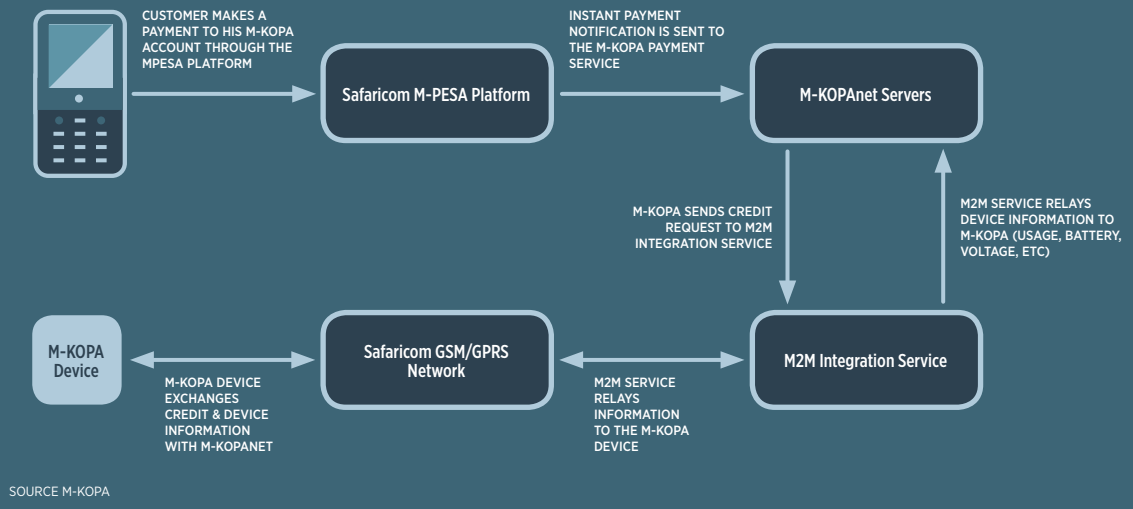
HTTP://WWW.DEVERGY.COM/

31. http://www.huffingtonpost.com/justin-guay/are-mini-grids-the-next-b_b_5766876.html

CASE STUDY

ASSET FINANCING FOR SOLAR HOME SYSTEMS USING MOBILE PAYMENTS AND M2M

M-KOPA provides micro-financed energy products in Kenya, Uganda and recently started operations in Tanzania. As of September 2014, M-KOPA provides an 8W solar system including two lights, phone charger, portable lamp and radio. The company has sold more than 100,000 units, with recent sales trend of 2,500 units per week. Each M-KOPA unit embeds a GSM module enabling the real time monitoring and connection/disconnection of the unit according to customer credit. M-KOPA has partnered with M2M specialist Eseye to manage the M2M communication system (see diagram below). Having received a DFID GSMA Mobile for Development Utilities Programme grant at the end of 2013, M-KOPA will also pilot larger systems with more appliances in 2014 in Kenya, targeting entrepreneurs and productive use of power. Results and lessons from this pilot will be shared publicly, providing a better understanding of the potential of such mobile-enabled PAYG solutions and the key building blocks to scale. HTTP://WWW.M-KOPA.COM/



SOURCE M-KOPA

These examples demonstrate that improved cost recovery and remote monitoring with flexible payments via smart solutions are addressing key challenges to improving and increasing energy access.

5

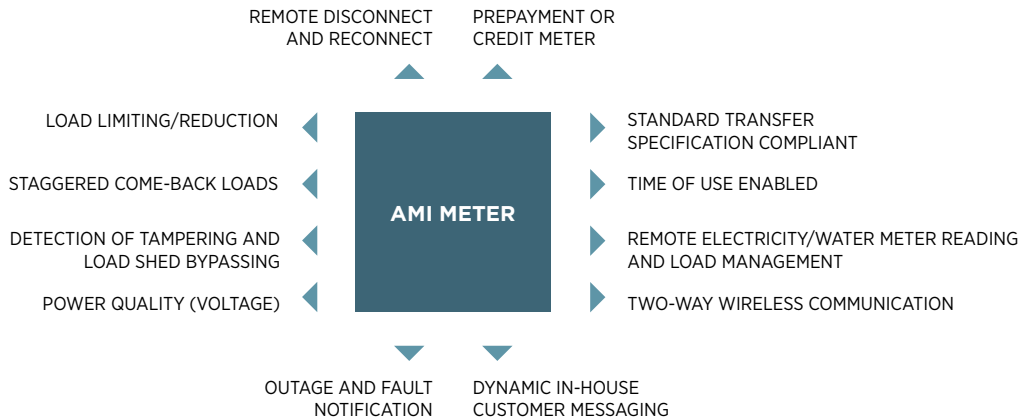
Smart Meter Technologies and Communication Pathways

Central to smart solutions are smart meters. Smart meters may utilise different types of metering and communication technologies, and the costs and benefits of each model must be considered in selection of the most appropriate solution.

Types of Smart Meters

A smart meter is an electronic device that can remotely monitor and control electricity consumption and that can communicate this information back to the energy service provider. There are two main types of smart meter solutions that can provide one-way communication and two-way communication about energy usage. The basic Automated Meter Reading (AMR) primarily offers basic one-way communication. A data-concentrator receives information from meters and sends it to service providers. In an advanced configuration, the data concentrator can poll AMR devices for information and send this to service providers. Advanced Meter Infrastructure (AMI) is more specifically designed for real-time or near-real time, two-way communication between the meter and the service provider (Figure 6). With this comes a wider range of benefits, including more detailed electricity consumption pattern information, remote monitoring and control, load management and tampering detection, to name a few.

FIGURE 6
ADVANCED METER INFRASTRUCTURE: BASIC FUNCTIONALITIES



5.1 The choice of communication pathway: PLC, Mesh or GSM?

Smart meters, AMR or AMI, can use several communication channels to transfer data from the meters to data concentrators including Power Line Communication (PLC), GSM networks, Radio Frequencies (RF) or a combination of these channels. Table 2 presents the pros and cons of using each of these communication channels for smart communication.

TABLE 2
COMMUNICATION CHANNELS FOR SMART METERS: PROS & CONS[32]

COMMUNICATION PATH	DESCRIPTION	PROS	CONS
Power-line Communication (wired)	Power-line Communication (PLC) requires a point-to-multipoint network, whereby a single transmitter is sending data to multiple receivers	PLC is convenient as it uses existing AC power lines and is well adapted for areas where there is a high density of meters per power substation	As PLC lines are not configured for the transmission of data, interference can occur
GSM networks (wireless)	GSM networks use a point-to-point connection	GSM is the most efficient technology for deployments in areas with low density of meters as there is no need for multipoint infrastructure. It is also a highly robust network (e.g. high interference management)	GSM communication remains more expensive than PLC or wireless mesh networks
Radio frequencies (RF), including mesh networks (e.g. Zigbee, Z-wave), unlicensed spectrum solutions	Mesh networks require a point-to-multipoint connection: data must be aggregated at central points and redirected to a backhaul network – frequently mobile data network	RF is highly robust as it can operate even if a node breaks down	The usage of radio frequencies is limited as the frequencies are reserved for specific purposes and are not readily available in every market (mostly concentrated in the USA)

While energy service providers can choose to transmit data between the meter and the data concentrator using one of the communication channels mentioned above, most often GSM networks are used to transmit data between the concentrator and the utility's database.

32. Berg Report, "Smart Meter in Europe", M2M Research Series 2013, www.berginsight.com

Costs of meters vary by communication pathway and impact adoption

The price of smart meters varies depending on the communication path utilised. According to an Ernst & Young study[33] a basic meter with GPRS communication will cost US$121, while one using Radio Frequency communication will cost US$100 and PLC communication US$83. PLC is often deemed to be the most appropriate, cost-effective solution when the infrastructure exists, while using GSM networks has an on-going cost for data connection.

For decentralised rural ESCOs, GSM M2M module installed onto home solar systems or mini-grids currently cost from US$8 to US$10, while 3G M2M modules vary from US$38 to US$45 for low volume orders (~ 10,000 units). This addition is therefore not viable for low cost infrastructure (such as solar lanterns) retailing from US$20 to US$50. However, for larger pieces of equipment such as home solar systems (>US$100) or mini-grids, long-range cellular connectivity, representing a small fraction of the total price, adds substantial value to these products and creates new opportunities from a business model perspective.[34]

Overcoming costs of smart solutions through mobile payment, pre-payment and innovative tariffs

The functionality of smart meters, when combined with a smart solution for payment, allows for more efficient billing and payment, thereby helping to recover both consumption charges and the costs of the smart-meters (see the UMEME case study). For example, GSM-enabled home solar systems may be more costly, but by enabling mobile payment, they also make multiple payments over long periods more efficient, thereby stretching out the costs to make the utilities more affordable. For utilities, smart meters can allow for differential tariffs that charge higher rates for peak demand, thereby helping utilities recover the added costs of peak supply while also encouraging customers to spread out their usage.

In cases where GSM-enabled two-way smart-meters are too costly, one-way digital meters, or even analog meters can provide an efficient solution to non-technical losses. This may be in cases where customers' electricity usage is so low that the commercial value of smart-meters is unclear, yet service providers and customer still require more clarity on usage and losses. Key to these meters having the greatest impact is a pre-paid model, in which customers can conveniently purchase electricity credit in order to use electricity.

5.2 Why energy service providers should partner with Mobile Operators

Amidst the range of communication pathways, GSM networks and the MNOs that operate them, are particularly well positioned to be the technology and partner of choice to utilities and energy service companies adopting smart solutions. Firstly, GSM network technology is compelling due to its ubiquity and security. In addition, mobile network operators have experience supporting smart services and have a range of value added services that can be leveraged to enable smart solutions delivery.

The ubiquity of GSM Networks

The wide presence of GSM networks makes them the most available and established communication pathway spanning both urban and rural areas. As a Berg Insight Report highlights, "The GSM standards are the main contender technology for Wide Area Networks (WAN) [telecommunication networks that provide communication between many users over broad areas, such as rural, low density areas. The WAN element of smart metering should start with GPRS, supported in 2G, and evolve to 3G, 4G and 5G when commercially viable and when more capacity and richer services are needed to be supported in the smart metering system."[35] To support this, "the mobile industry has the most extensive experience in deploying [these] diverse networks into a cost effective and reliable fabric." [36]

In urban contexts, the most affordable communication pathway may be PLC to GSM-enabled data concentrators, given the more densely packed houses that lend themselves to a more aggregated model of communication. However for remotely managing rural connections, GSM-enabled smart meters may be necessary where distances are too far to make PLC or RF networks viable. The ubiquity of GSM networks has been particularly important to enabling smart-metered home solar systems which can be installed without the need for fixed lines or proximity to RF data concentrators.

33. Ernst & Young, "Cost-benefit analysis of the roll-out of smart electricity metering grid in Lithuania. Cost-benefit analysis of the smart metering roll-out scenarios", September 2012 (Note: Costs originally in Lithuanian Litas. Exchange rate to convert to USD is USD/Lithuanian Litas 0.362433 (source: xe.com for September 2012)
34. GSMA, Sizing the Opportunity of Mobile to support energy and water access, 2013 http://www.gsma.com/mobilefordevelopment/sizing-the-opportunity-of-mobile-to-support-energy-and-water-access
35. Berg Report, "Smart Metering in Western Europe", M2M Research Series 2010
36. KEMA, GSMA, "Why Mobile for Smart Utilities? Assessing Service Opportunities in the Utility Sector for the Mobile Network Industry." pg 3

The security of GSM Networks

The security of GSM, compared to other communication pathways is a key reason for using GSM smart solutions. "Utilities are reluctant to depend on the unlicensed bands to carry operations traffic. This offers MNOs an opportunity to leverage their established and private networks to provide AMI services." In contrast, mesh networks may be un-licensed and subject to in-network and out-of-network interferences.[37]

Mobile Network Operators have existing smart solutions experience

Mobile network operators have stable and mature networks and can "quickly deploy reliable and secure machine to machine (M2M) communications and backhaul facilities, with guaranteed capacity/throughput performance and managed quality of service".

For example, the partnership between AT&T (a US MNO), and meter manufacturer SmartSynch illustrate the impact of partnerships on the deployment of smart energy solutions. By leveraging their respective strengths, the companies created a new range of end-to-end solutions for smart grids. "While the majority of cellular-based projects are today for advanced metering infrastructure projects, the same cellular networks will be able to support future applications such as Time-Of-Use tariff demand response, and home energy management." [38]

Mobile Network Operators are experienced partners

As mentioned previously, mobile operators have continued to innovate and expand the functionality of GSM networks. Smart solutions can therefore leverage mobile operators' value-added services to improve their operations:

- **Mobile Money:** In Sub-Saharan Africa, integration with mobile money is an increasingly valuable proposition to enable customers to make remote payments without queuing at pay point or banks and to support pre-paid business models as well as flexible tariff structures. These bill-pay platforms can be integrated with utilities' existing payment systems. Furthermore, "Mobile service providers can leverage years of experience in billing for prepaid services and dynamic tariffing, to assist utilities companies in launching innovative payment options"[39]
- **Core mobile services:** Voice, SMS and data can also become an integrated part of a smart solution. For example, energy service providers can work with operators to provide service information to customers' phones, such as an SMS to alert them to consumption rates or low energy credit (in the case of pre-paid meters). "Mobile service providers can be instrumental to generating consumer awareness and acceptance of smart energy services. By leveraging existing customer segmentation systems, MNOs can create highly customized customer campaigns and joint affinity marketing programs with utility partners."[40]
- **Energy Data Management Platforms:** Mobile operators have experience offering other business solutions which can be part of smart solution packages. For example, mobile or web-based energy information platforms allow both energy service providers and customers to know, in real time, how much energy is being consumed at the household / enterprise level, get alerts and alarms if their usage exceeds pre-set levels, as well as access data analysis and reports that enable control and demand management capabilities.

Through these service offerings, MNOs are positioned to bring energy service providers far more than GSM communications; they stand to be partners that bring secure, integrated services and large-scale network experience that match the needs of utilities or ESCOs.

37. Ibid pg 34,35
38. GSMA, SmartSynch and AT&T: End-to-end cellular-based advanced metering infrastructure, 2012 http://www.gsma.com/connectedliving/wp-content/uploads/2012/04/mutilitiessmartsynchlores.pdf
39. KEMA, GSMA "Why Mobile for Smart Utilities. Assessing Service Opportunities in the Utility Sector for the Mobile Network Industry." 2011, p30.
40. KEMA, GSMA "Why Mobile for Smart Utilities. Assessing Service Opportunities in the Utility Sector for the Mobile Network Industry." 2011. p31

6

The Opportunity for MNOs in deploying Smart Solutions

The benefits of GSM technology suggest a strong opportunity for MNOs to support energy providers to deploy smart solutions. MNOs can provide an array of key services such as basic connectivity to more sophisticated customer interfaces. These service offerings fall across a spectrum of investment levels and benefits for the MNOs.

6.1 Beyond connectivity: mobile services for smart solutions

Providing connectivity services (i.e. SIM cards, voice, SMS and data) is the core of what MNOs can offer to support the deployment of smart solutions, but their value is magnified by providing additional enabling services. MNOs can make the decision to broaden their offering, providing a full suite of services targeted at smart and non-smart meter deployments that can be leveraged by utilities and ESCOs.

The four key services MNOs can offer to support smart solutions, include:

- Connectivity/managed connectivity – connecting infrastructure and individuals' handsets to central servers and databases;
- Data aggregation/analysis – providing data about the status of connected smart meters and smart grid assets; combining data from multiple sources to produce new insights;
- Service delivery – delivering real-time consumption information to people and machines that will enable them to adapt and respond to events; the use of mobile money to support pre- and post-payments;
- Customer interface - providing customer support operations, such as call centers and web portals, as well as delivering messages to subscribers.[41]

These MNO services can be bundled into three levels of business offerings: access, enabling services and full service delivery (see Figure 8). The varying benefits and market opportunities of each package of services are listed in table 3.

41. GSMA, Guide to Smart Cities The Opportunity for Mobile Operators, 2013 http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/cl_sc_guide_wp_02_13.pdf

One key benefit is increased customer retention and the growth in connections for MNOs from providing M2M services. This is particularly true for MNOs that offer combined M2M and mobile payment services- for example for ESCOs that want to provide remotely-monitored and controlled, pay-as-you-go home solar systems. The M2M market has considerably matured over the years through the development of innovative business models in several vertical industries (automotive, utility and consumer products), while the costs of the M2M hardware have reduced.[42] GSM-enabled smart meter technology constitutes a significant part of this growing M2M market and they could become central to the access and sustainability of services by addressing some of the key challenges faced by energy service providers.[43]

FIGURE 8
MNO SMART SOLUTION BUSINESS OFFERING

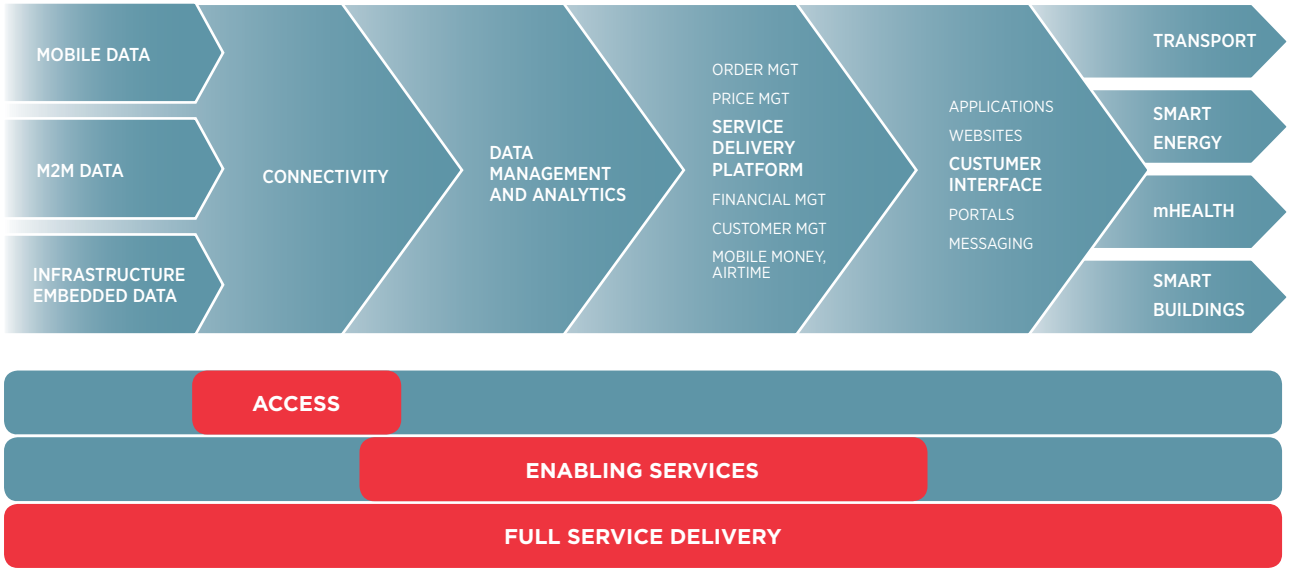


TABLE 3
MNO SMART SOLUTION BUSINESS OFFERING

MNO BUSINESS OFFERING	WHAT IS INVOLVED?	BENEFITS	MARKET OPPORTUNITY
Access	Providing SIMs, managing data traffic	Increases data traffic and number of connections	Limited
Enabling/Value Added Services	Managing data traffic, hosting and managing service delivery platform, CRM system and billing	Increases data traffic and the use of mobile money platform, leverages customer history information and reduces customer churn	**Strong:** Leverages existing assets and provides a platform for other energy service providers to innovate
Full Service Delivery	Turnkey service where MNOs provide: SIMs, smart meters (software and/or hardware), data platform, technical expertise	Develops loyalty of customer, embeds mobile technologies in utilities' business model, reduces customer churn	**Strong but more risky:** Places MNOs at the heart of operations

42. GSMA, From concept to delivery: the M2M market today, 2014 https://gsmaintelligence.com/files/analysis/?file=140217-m2m.pdf
43. GSMA, Sizing the Opportunity of Mobile to support energy and water access, 2013 http://www.gsma.com/mobilefordevelopment/sizing-the-opportunity-of-mobile-to-support-energy-and-water-access

In Sub-Saharan Africa, where the market for advanced smart solutions and vendors is less crowded and considering the rapid growth of mobile services over the last decade making mobile networks the predominant infrastructure in most Sub-Saharan African countries, mobile operators are well positioned to act as an enabler and strong partners for utilities and ESCOs to increase connections.

BOX 1

The experiences of utilities and ESCOs provide valuable lessons that demonstrate the complexity and challenges of supporting the roll-out of smart solutions.

LESSONS FROM UTILITIES: AFRICAN UTILITY WEEK

African Utility Week 2014 highlighted several key points that are limiting the uptake of smart meters for utilities in Africa. They include:

- Utilities are faced with many metering options and have a hard time identifying the right technology for the right customer segment. The right technology may not be smart;
- The cost of GSM meters and connectivity to support point-to-point communication is considered expensive limiting the uptake of solutions solely dependent on GSM from the utility to the household;
- Dependence on a mobile operator's network is seen as a risk to the utility. Although some concerns were raised regarding the phasing out of 2G technologies, these remain suitable choices for Africa's utilities, as they will remain in place for another decade in some areas. By about 2017/2018, a new host of Low Power Wide Area technologies, e.g. cellular Internet of Things, are also expected to become available and provide complimentary capabilities to 2G/3G;
- As the commercial benefits of smart meters is still unproven, there is a debate on whom should pay for meter upgrades (the utility, the government or the customer) and utilities often require funding to support these initiatives.

LESSONS FROM ESCOS IN OFF-GRID AREAS

Feedback from ESCOs using smart solutions to support energy access across Africa and Asia demonstrate that many, if not most, mobile operators in emerging markets are just beginning to translate the opportunity that the machine-to-machine (M2M) presents into tangible services. Some of the challenges that ESCOs raised[44] include:

- Paying roaming fees as embedded SIMs are often installed in the country of manufacture and lack the capability for remote provisioning;
- Having to hire people to manually top-up local pre-paid SIMs as it can difficult to get post-paid SIMs, let alone M2M specific SIMs, for deployments;
- Mobile network stability issues impacting meter functionality;
- The lack of APIs for Mobile Money Bill-Pay integration and the high costs for customised integration;
- Mobile money bill-payment fees that are too high to support small payments limit the use of mobile money services by low-value customers;
- The lack of flexible and accessible enterprise solutions to support communication with customers. Bulk SMS, IVRs, call-centre lines are negotiated separately and often require piecing together solutions from various providers.

44. GSMA Mobile for Development Utilities Programme research

7

The Market Opportunity by Customer Segments

As part of our research, the GSMA's Mobile for Development Utilities Programme examine the potential addressable markets for deploying smart solutions of three Sub-Saharan African countries: Botswana, Senegal and Cote d'Ivoire. The market size for smart solutions was assessed across different customer segments in both rural and urban areas. Where possible, further information from participating utilities provides line of sight to other specific segments such as large power users. For further details on the country specific results, please refer to the country specific reports published in conjunction with this report.

The potential market for smart meters and insights for each country are provided below. The key insights include:

- Off-grid rural households present the largest addressable market potential in terms of volume of smart meters.
- Off-grid urban households present an interesting opportunity as they may not be connected to the grid due to cost of a connection and may particularly benefit from innovative payments and flexible tariffs enabled by smart solutions.
- There is significant opportunity in on-grid areas to convert existing connections although the business case to convert to smart meters needs to be clarified before adopting large scale roll-outs.
- Large power users and public lighting initiatives present an opportunity to road test smart meters and the services required to support smart solutions.

Botswana

There is an opportunity for the Botswana Power Corporation to expand the current smart metering programme particularly for rural households- both on and off-grid. Table 4 indicates that of the 87,400 urban on-grid households, nearly 74,000 have smart meters. Yet of the nearly 300,000 rural households that are on-grid, the majority have digital pre-paid meters which are not smart. For rural off-grid households, there is a high potential for ESCOs to provide decentralized energy solutions (e.g. home solar systems or mini grid systems) where the grid is not viable. However, previous efforts at this faced challenges in utilizing smart solutions due to limited reach of mobile money networks and small economies of scale due to very low income rural populations.

TABLE 4
BOTSWANA MARKET OPPORTUNITY FOR SMART SOLUTIONS

	OFF-GRID		ON-GRID		
USER TYPE	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**LARGE POWER USERS**
NUMBER OF USERS (HOUSEHOLDS)[45]	124,488	24,410	299,799	87,408	Unknown
COMMENT ON THE MARKET	High potential for decentralised solar systems where the grid is not economically viable, but unexploited due to political focus on on-grid households and limited scale for smart solutions to enable remote monitoring and payments	Potential to increase connections and pre-paid smart metering	Majority of on-grid rural households have Budget Energy Controller meters	Of which 73,923 have pre-paid smart meters. Remainder have postpaid smart meters for government	5% of Large Power Users' connections are assumed to be government and businesses

Senegal

In Senegal, the biggest addressable market in terms of new smart meter connections lies in the rural off-grid areas, where more than 930,000 households live without access to electricity but are likely to have GSM network coverage, as presented in Table 5 below. Thus there is a high opportunity to leverage GSM for smart solutions that can improve energy access. As pre-paid meters are being deployed for the nearly 670,000 urban on-grid households, efforts should be made to extend pre-paid meters for the 300,000 rural on-grid households. Finally, there is an opportunity for utilities to trial smart solutions for large power users which represent a small portion of their customer base yet most of their revenues and which have the ability to afford trialling these solutions to improve their energy supply.

TABLE 5
SENEGAL MARKET OPPORTUNITY FOR SMART SOLUTIONS

	OFF-GRID		ON-GRID		
USER TYPE	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**LARGE POWER USERS**
NUMBER OF USERS (HOUSEHOLDS)	933,015	92,612	302,111	667,889	30,000
COMMENT ON THE MARKET	Almost one million households do not have access to electricity in rural areas but have GSM coverage, presenting the largest market potential, in terms of volume, of smart solutions in the form of GSM-enabled decentralised energy solutions	Possibly illegally connected	Senelec implements load limitations on on-grid rural households and is considering the implementation a tariff system to improve payment flexibility	Of which only 200,000 households are currently being installed with pre-paid meters	Of which half are being installed with smart meters

45. Based on Botswana Power Corporations's (BPC) reported number of connections and rates of electrification. BPC may consider "rural" connections to include those in small towns and large villages. See the Botswana specific report for more information about how these numbers compare to other estimates of electrification.

Côte d'Ivoire

Côte d'Ivoire's largest addressable market in terms of new smart meter connections lies in the rural off-grid areas, where more than 1.2 million households live without access to electricity but are likely to have GSM network coverage. As shown in Table 6, an equally sized opportunity exists in on-grid areas with over 1,700,000 households connected to the grid, of which 120,000 are already equipped with pre-paid meters. The CIE, the electrical utility of Cote d'Ivoire, is currently considering the further deployment of pre-paid meters for new connections as well as retrofitting existing connections with these meters. There is an opportunity to advocate for solutions that take into account smart components including pre-paid bill pay via mobile money, improved communication with end customers, and the use of GSM enabled data concentrators to control demand and measure non-technical losses.

TABLE 6
CÔTE D'IVOIRE MARKET OPPORTUNITY FOR SMART SOLUTIONS

	OFF-GRID		ON-GRID			
USER TYPE	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**RURAL HOUSEHOLDS**	**URBAN HOUSEHOLDS**	**PUBLIC LIGHTING**	**HIGH VOLTAGE CLIENTS**
NUMBER OF USERS (HOUSEHOLDS)	1,260,000	Unknown	540,000	1,200,000	8,000	4,000
COMMENT ON THE MARKET	The CIE aims to connect over 600,000 currently off-grid rural households by 2020, possibly deploying pre-paid meters	Unknown	Possibility to implement load management on on-grid rural households	All on-grid urban households are equipped with analog electromecanic meters (120,000 of which are pre-paid)	Possibility to trial smart meters	The CIE is planning to trial smart meters for Large Power Users

8

Recommendations & Conclusion

Our research shows that the use of smart solutions to support utilities in Sub-Saharan Africa is still nascent, although early trials of smart solutions show promise delivering tangible benefits to decrease non-technical losses for utilities and support new customer acquisition and service quality for ESCOs. To exploit the full benefits of smart solutions for the Sub-Saharan Africa's energy sector, mobile operators, energy service providers and the donor community need to work together to develop the opportunity.

8.1 Recommendations for Mobile Network Operators

Experience from developed country markets shows that the benefits for mobile operators to support smart solutions lies beyond connectivity, and requires mobile operators to develop and target the enabling services required for energy service providers. As the market is nascent across Sub-Saharan Africa, there is an opportunity for mobile networks operators to partner with utilities and ESCOs to develop the enabling services required to support the roll-out of smart solutions.

Our recommendations are two-fold:

1. Develop a suite of MNO services for smart solutions

Currently, early adopters of smart solutions in Sub-Saharan Africa must negotiate customised deals with mobile operators to support smart solutions. Building on the mobile industry's experience in developed markets, with higher M2M penetration, mobile operators should focus on developing a suite of services targeted at enterprises that are trying to leverage smart solutions. The services identified include connectivity bundles for meters, the IT infrastructure to support data management and analytics, service delivery platforms to support customer management, tariffs and billing, and customer interface services to support improved communication with end-customers.

Of these services, those with the greatest potential to provide immediate benefits to energy service providers (both utilities and ESCOs) include:

- **Customer service and communication support:** Energy providers require support to better communicate and interact with their customers. IVR, SMS, customer call centres and mobile applications can be used to communicate billing reminders, load shedding, demand control and field customer complaints.
- **Leveraging mobile money to support billing services:** Pre-payment has been identified as a key tool for utilities and off-grid ESCOs to support the delivery of reliable services to customer and considerably improve revenue collection. Mobile operators should consider how bill-pay functions for utilities can also be extended, with limited bespoke integration, to ESCOs who are seeking to serve a segment of the population who can afford small and relative frequent payments.

2. Create long-term partnership strategies

Mobile operators should work with energy providers to clarify the business case for smart meter and smart solutions deployment. One of the main challenges limiting the uptake of smart meters in Sub-Saharan Africa is the high capital investment required to install and support the meters when weighted against the benefits. Working in partnership, mobile operators can help energy providers, utilities and ESCOs alike, in clarifying the long-term business case for smart solutions by supporting smart meter pilots that focus on demonstrating these solutions' commercial viability, while sharing the risks. Furthermore, mobile operators' experience in developing innovative, rapidly expanding services across emerging markets make strong partners for utilities and ESCOs that can benefit from smart solutions.

8.2 Recommendations for Utilities and ESCOs

As 560 million people in Sub-Saharan Africa lack access to power and utilities are in a difficult financial position with approximately 50% of power generated unaccounted for[46], the need to find new and innovative solutions is clear and pressing.

From rural to urban markets, off-grid ESCOs and utilities are aware of the role that mobile technology and smart solutions can play to support their business models but more needs to be done to quantify the benefits and accelerate uptake.

Energy service providers should seek and develop partnership with mobile operators to trial the deployment of smart meters with customer segments with high potential for success:

- Utilities working with larger power consumers, who have the ability to pay and present a significant portion of the utilities revenues, provides the rights conditions to test the business case. Through these trials both the utility and mobile operator can better understand what services are required for small solutions and they can adapt the model for household and increased connections.
- ESCOs should focus their business models and trials to prove customer uptake and their customer's payment ability. Providing hard data to mobile operators on customer acquisition, transaction values and volumes, and the viability of the business model will help to inform mobile operators of the potential opportunity from both a customer retention perspective and commercial opportunity.
- Both utilities and ESCOs should work to define the enabling services required to support their business model. They can take this one step further by having the utility and off-grid energy communities respectively agree on the minimum set of requirements for smart solution integration, from communication protocols with customers to bill pay integration and customer accounts support.

8.3 Recommendations for funders

Our research shows that the success of smart, and even pre-paid non-smart, meter deployments depend often on the execution and processes used during the trial. While smart solutions can provide significant benefits to energy service providers, both utilities and ESCOs are hesitating to raise, or invest, the CAPEX required to trial these solutions at scale.

As the commercial model is still unproven, donor agencies should step in to support early stage trials with the hope of improving the understanding of commercial viability. The donor community can play a critical role by supporting additional trials by utilities and ESCOs to define and test a roll-out process and quantify the benefits to the energy providers and their customers. Trials with different customer segments will disclose different insights on the do's and don'ts of smart solution roll-outs and also allow energy providers to iterate and learn from their mistakes.

Conclusion

The business case for smart metering in Sub-Saharan Africa is still being fully grasped by the utilities, government and third party stakeholders. A transition approach could prove the best way to allow the region to successfully adopt and upgrade to smart solutions for energy access, giving it the necessary time to identify the right business model for the region, taking into account the populations' purchasing power and available infrastructure, varying from urban to rural areas. Where smart technology does not yet make commercial sense, traditional pre-paid meters coupled with smart enabling services (payments and customer service) could adequately answer the pressing need to improve energy access, as well as in the medium - longer term, increase the number of connections. MNOs have a role to play as one of the best allies for energy providers in bridging the gap that currently exist with the customer by improving the delivery of electricity through a suite of services, from connectivity to customer interface.

46. World Bank, 2009 http://siteresources.worldbank.org/EXTESC/Resources/Background_paper_Reducing_losses_in_the_power_sector.pdf

Annex 1 Lessons from Uganda's Meter Roll-Out

In 2012, UMEME, the national electricity utility of Uganda, conducted a 12 month pilot of pre-paid split smart meters in Natete, following the government mandated target to improve collection rates from 75% to 99% and reduce losses (technical and non-technical) from 27% in 2012 by 14% by 2018. The pilot provides valuable insights and a methodology that other utilities can use to derive commercial benefits of new metering initiatives. The core lessons from the pilot include:

- Utilities need to be clear on the reasons to drive a metering infrastructure upgrade as these initiative requires stamina
- Following a methodological process to segment customers and identify high potential opportunities is required to derive benefits

Before embarking on the infrastructure upgrade UMEME spent considerable time discussing the potential pros and cons of a smart meter roll-out carefully defining the motivations of the utility, and the long term benefits to customers and the utilities growth potential to roll out pre-paid meters for the region.

Identifying the highest losses upstream of the household

UMEME decided to first tackle the issue of non-technical losses as it represents a sizeable problem and also because tacking technical losses would be counterproductive without first addressing these losses. In order to identify the best areas to reduce losses, UMEME focused their technology upgrade investment upstream from the household, installing GSM enabled meters at the level of the power line feeders.

In 2007, UMEME installed 360 GSM-enabler meters to identify branches of the network with the greatest losses. Nineteen feeders were identified as the worst culprits, losing the most power due to a poor network, poor supply, an inefficient post-pay billing system. In addition to singling out the most inefficient feeders, UMEME was able to pick out 900 non-billed customers (~0.14% of the current customer base).

Results

In 2012, UMEME began retrofitting 8,600 households with pre-paid split meters. The cost of the 12-month pilot amounted to US$2.3M.

Over the course of one-year, US$1.5M was recovered by UMEME, and an additional US$387,000 was collected in arrears by imposing penalties for late payment. Also, the average energy consumption of customers decreased by 30% as customers had more visibility on their usage, while the utility's overall revenues increased because it became more difficult to tamper with meters and have illegal connections go undetected. Moreover, unless new non-technical losses appear (new ways of stealing for electricity), it is estimated that cost recovery will continue to grow.

UMEME have been encouraged by the results and is now looking at tackling theft by large power users through an Advanced Metering Infrastructure system (two-way communication).

Lessons

By having a clear strategy and process to tackle energy losses, and taking the necessary time to execute the two-step strategy, UMEME was able to recover more than half of their infrastructure upgrade costs within the year of implementation. Pre-paid meters for households, combined with GSM-enabled feeder meters were found to be an adequate first step to tackle the country's non-technical energy losses. While using GSM communication for their meters, the utility believes it is important to keep agents to collect data.

About the GSM Association

The GSMA represents the interests of mobile operators worldwide. Spanning more than 220 countries, the GSMA unites nearly 800 of the world's mobile operators with 250 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organisations in industry sectors such as financial services, healthcare, media, transport and utilities. The GSMA also produces industry-leading events such as Mobile World Congress and Mobile Asia Expo.

For more information, please visit the GSMA corporate website at WWW.GSMA.COM. Follow the GSMA on Twitter: @GSMAM4D.

About Mobile for Development - Serving the underserved through mobile

Mobile for Development brings together our mobile operator members, the wider mobile industry and the development community to drive commercial mobile services for underserved people in emerging markets. We identify opportunities for social, economic impact and stimulate the development of scalable, life-enhancing mobile services

About the GSMA Mobile for Development Utilities Programme

Mobile for Development Utilities Programme improves access to basic energy, water and sanitation services in underserved communities using mobile technology and infrastructure.

Our work encompasses any energy, water and sanitation service provided to a community which includes a mobile component, whether it is voice, SMS, USSD, Machine2Machine, NFC, a mobile operator's agent network or tower infrastructure.

We aim to seize the opportunity, leveraging mobile technology and infrastructure to enhance access to affordable and reliable energy, clean and safe water and sanitation services in underserved communities.

About Orange

Orange is one of the world's leading telecommunications operators with sales of 41 billion euros in 2013 and has 161,000 employees worldwide at 30 June 2014, including 101,000 employees in France. Present in 30 countries, the Group has a total customer base of more than 236 million customers at 30 June 2014, including 179 million mobile customers and 16 million fixed broadband customers worldwide. Orange is also a leading provider of global IT and telecommunication services to multinational companies, under the brand Orange Business Services.

For more information on the GSMA's Mobile for Development Utilities programme, please email: m4dutilities@gsma.com