Community Power from Mobile

IFC International Finance Corporation World Bank Group

Harnessing The Full Potential of Mobile for Off-Grid Energy

Mary Roach and Charlotte Ward – December 2011

Contents

Welcome

At the Development Fund we are cautiously excited about Community Power from Mobile (CPM). Now more than ever we are confident that the mobile sector can deliver the scale required to disrupt the energy gap we see in the world and foster the development of a new set of enterprises delivering both good value to the mobile industry and underserved communities. We are also more aware of the challenges that the off-grid energy sector faces. We do not underestimate the size of the task at hand: to marry the expectations and speed of the mobile sector with the realities of pioneering entrepreneurs who are often underfunded and under resourced.

This report follows our first 12 months of operations and the numerous interactions we have had with our GSMA members, mobile tower companies, pioneering CPM entrepreneurs, impact investors and development organisations working across Africa and the Indian Sub-Continent.

On the eve of 2012, the UN's International Year of Sustainable Energy for All, we hope that our contribution (and those of our telecom and development partners) can provide new and exciting insights to the rural energy sector.

The Community Power from Mobile Programme would not be possible without the generous support of the IFC and that of the GSMA Development Fund.

We look forward to continuing the exchange with all interested parties that inspire and stimulate the programme in the pursuit to challenge and develop the application of "community power from mobile" as one solution for closing the energy divide and taking it beyond concept to mainstream operation.

Warm Regards

Charlotte Ward
Community Power from Mobile Programme Manager

Meet the Team

Who's who in GPM and CPM

Areef Kassam

Programme Manager

Areef is the Green Power for Mobile Programme Manager. In this role he is responsible for developing and delivering the programme products and services that are tailored to support operators in the decision-making process around deploying renewable energy. Areef also works directly with our vendor partners to understand their products, services and provide visibility to the mobile operators.

Abirami Birrell

Programme Coordinator

Abi is the Green Power for Mobile Programme Coordinator. She provides the team with ongoing project management support for all GPM work streams; Renewable Energy Networks, off-grid Handset Charging Initiative and Community Power from Mobile. Abi is particularly involved with organising the GPM Working Groups which are held quarterly around Asia and Africa.

Michael Nique

Strategy Analyst

Michael Nique joined the GSMA as a Strategy Analyst for the Green Power for Mobile programme. In this role, he is monitoring key innovations in renewable energy applied to the mobile market and provide insights on data analysis for the mobile and development markets. He is also closely following the development of Community Power solutions for off-grid subscribers.

Ferdous Mottakin

Field Implementation Consultant

Ferdous is the Field Implementation Consultant for the Green Power for Mobile Programme. Within GPM he is responsible for Green Power Feasibility Studies and the associated project management. Ferdous has completed successful projects in Burundi and Bangladesh.

Mina Zaki

Field Implementation Consultant

Mina Zaki is a Field Implementation Consultant for the Green Power for Mobile Programme. Mina has worked in Telecoms for many years in Africa, USA and the Middle East with both vendors and MNOs. Recently he has completed a multi-country Feasibility Study for a Central Asian Operator.

Mary Roach

Community Power from Mobile Business Development Manager

Mary Roach joined the GSMA in 2011 as an advisor for the Community Power from Mobile Programme. Prior to joining the GSMA she spent two years working on rural energy solutions in sub-Saharan Africa and five years working with GE Power Generation as a project and operations manager. She holds a MBA from Oxford University and a Bachelors in Chemical Engineering from McGill University.

Satish Kumar

Field Implementation Consultant

Satish is a Field Implementation Consultant for the Green Power for Mobile programme. Within GPM he is responsible for conducting Green Power Feasibility studies and is associated with Community Power from Mobile activities in the East African region. He has varied experience working with government bodies and organisations across telecoms, renewable energies and rural enterprises. He holds a Bachelors degree from IIT Kanpur and an MBA from IIM Bangalore.

Charlotte Ward

Community Power from Mobile Programme Manager

Charlotte is a financial consultant based in Nairobi working on the Community Power for Mobile program. She previously consulted government and corporates on carbon and energy projects in East Africa. She is a Masters in Applied Environmental Science from Sydney University. She has eight years investment banking experience with Deutsche Bank in Europe, Asia and Australia.

Executive Summary

In a time when one can make a mobile phone call from rural Kenya to the United Kingdom for less than US$0.04/minute there are over half a billion mobile subscribers worldwide living without grid-power and another three-quarters of a billion people struggling to gain access to electricity. While some progress has been made to meet the needs of the energy poor we are yet to see transformational change and identify a role for the mobile sector.

The first 12 months of the Community Power from Mobile Programme have highlighted both the opportunities and challenges in delivering access to energy through mobile. Through sharing knowledge gained from our work we hope to provide insights to our members and increase the conversations and collaborations we are having with organisations interested in how the advancement of the mobile sector can be best leveraged to develop the off-grid energy market. As we look to the future, we hope to build on the foundations of the programme to develop increasingly impactful workstreams and interventions.

The mobile industry's upside in bringing the best models to scale is massive. If customer phones can be more easily and affordably charged, they are almost certain to spend more money on airtime. Likewise, if incomes in off-grid areas can be increased through access to services like irrigation or lighting, mobile subscribers will be quite likely to increase their communications budget. Finally, mobile operators have the opportunity to create far deeper brand loyalty and equity by tangibly improving the lives of their customers beyond just communications. Winning the hearts and minds of customers is the best long-term strategy in any market, and community power provides an exciting way for mobile operators to do just that.

It follows that our analysis is organised into three sections:

- Lessons from our first year of operations
- Recommendations to increase the likelihood of CPM
- Engagement model to move the CPM concept forward.

The delivery of energy services to rural and off-grid communities is a hugely complex challenge, but it presents an equally huge opportunity. The combination of a social and environmental problem with an economic opportunity has attracted a wave of entrepreneurial energy and interest from impact investors. The most promising models are likely to come from small entrepreneurial teams. For the sector to flourish, these teams need technical assistance and access to the mobile industry, which the GSMA Development Fund is committed to providing. They need risk-taking pilot and seed funding (often in the form of grants or sympathetic debt). They also need the flexibility and cooperation of mobile network operators in commercial trials.

Community Power from Mobile White Paper – Synopsis

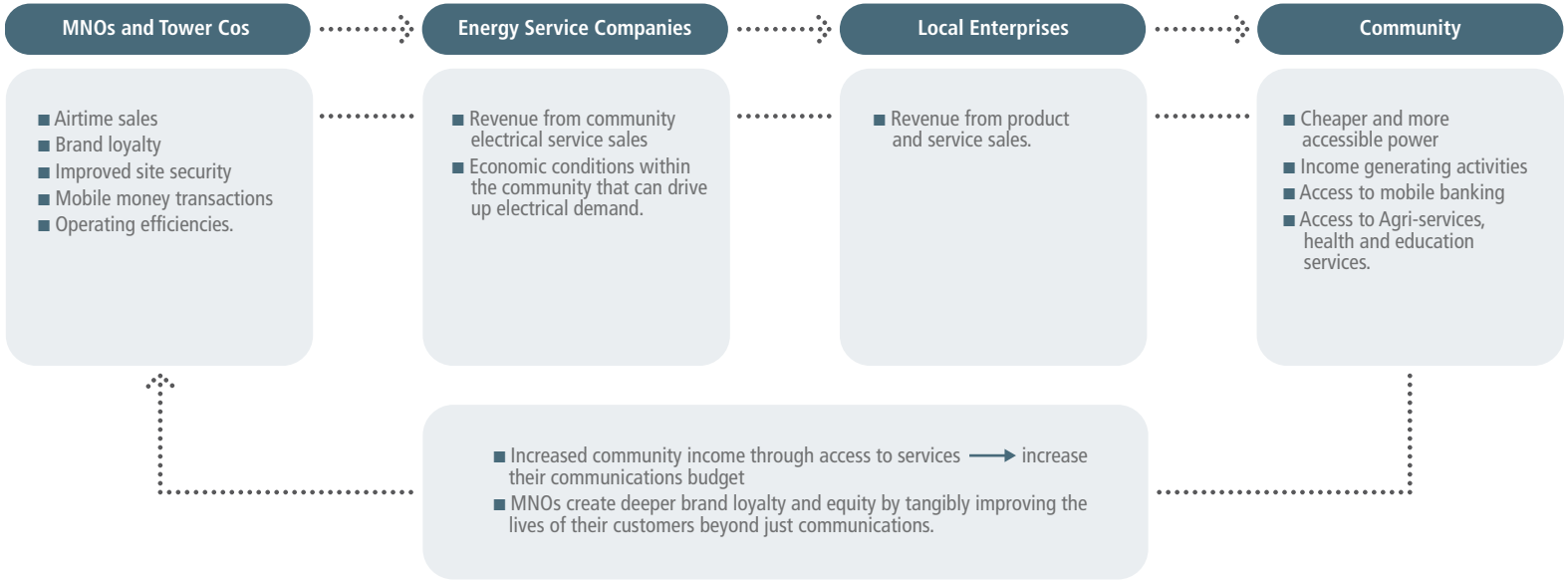
Lessons From the Last 12 Months

Excess Power is less of a reality	■ Understand site load requirements ■ Reducing dependency on diesel.
Off-grid market is complex and immature	■ Challenges in last mile delivery ■ Rural energy market remains immature ■ Lack of capital for the sector.
CPM: More than just infrastructure	■ Towers+ ■ Last mile delivery supply chains ■ Mobile payments and scratchcards.
More than pilots are required for large scale adoption	■ CPM delivers social value ■ Tie pilots to strategy of telecom player ■ 3rd party financing is required.

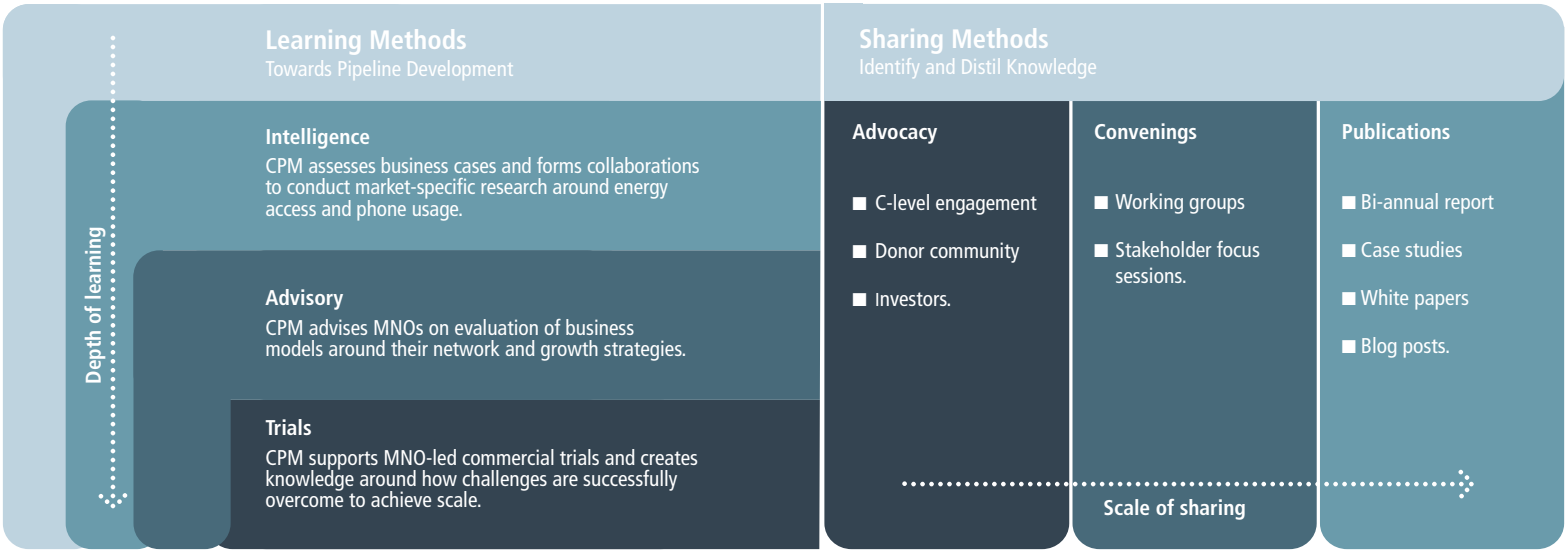
Recommendations to Improve CPM's Likelihood of Success

Develop rigorous models for Community Power from Mobile infrastructure	■ Collect and disseminate business models ■ Adapt models with changing tower infrastructure ownership.
Assist mobile network operators in developing CPM strategies	■ Identify ways to leverage telecom supply chain and human infrastructure ■ Map deployment opportunities ■ Correlate accessible and affordable energy access with phone usage.
Conduct research to inform innovative service providers	■ Understand demand for priority energy services and their impact on MNOs ■ Identify potential obstacles and opportunities posed by rural energy and communication policies.
Partner with the investor base to drive capital in to the sector	■ Engage, inform and learn from investors ■ Nurture a pipeline of opportunities.

Access to Community Power Reinforces Opportunity for Mobile Network Operators



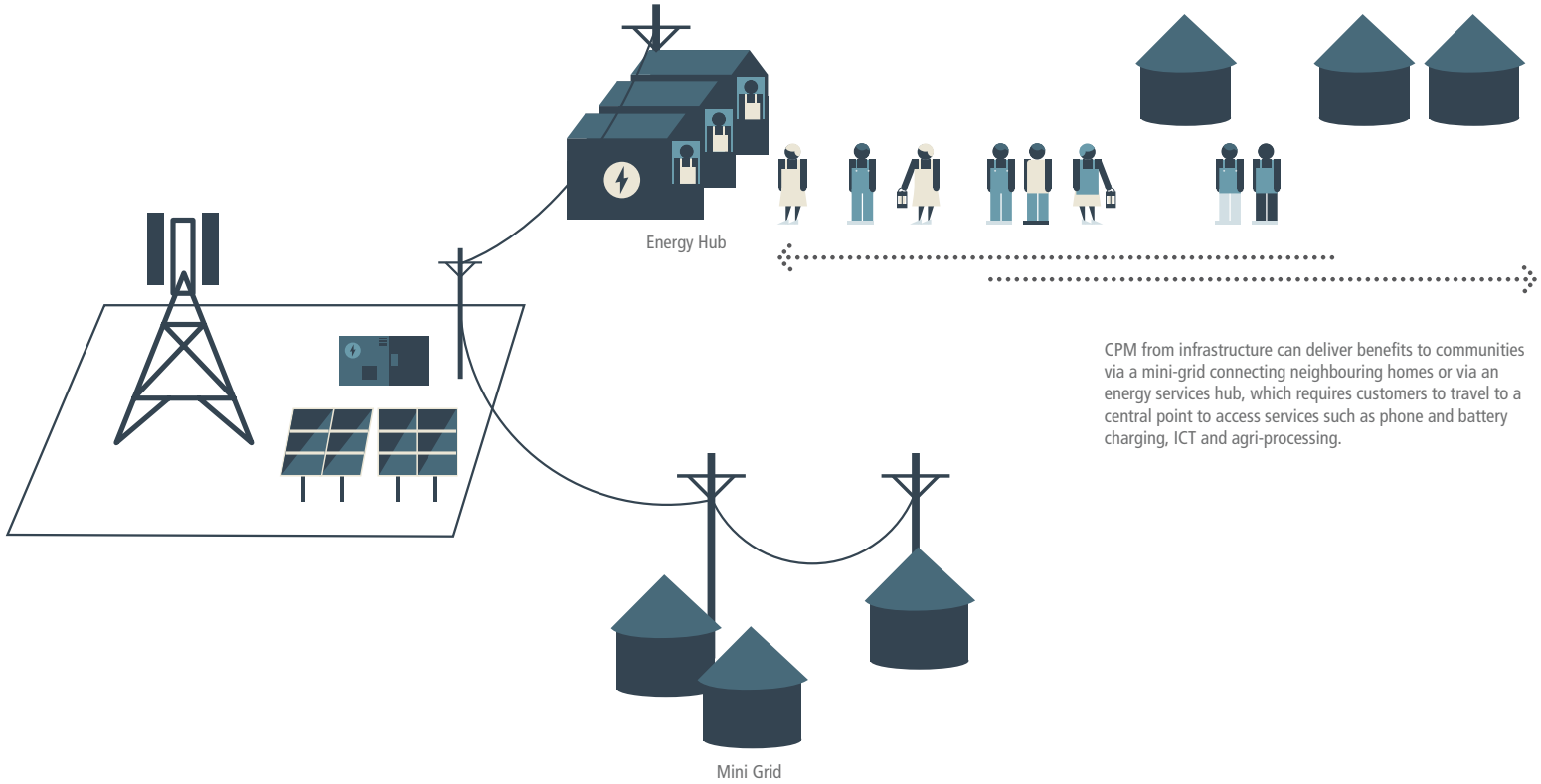
Framework for Engagement and Knowledge Sharing



About Community Power from Mobile

Over 1.4 billion people lack access to electricity.[1] In many emerging markets mobile network operators have become adept at generating their own off-grid power as mobile penetration has outpaced the growth of the electricity grid. Community Power from Mobile (CPM) works to leverage the scale of mobile technology and infrastructure to improve the case for off-grid telecoms and provide millions of underserved communities access to vital energy services.

The Community Power from Mobile Programme builds from the strong foundations of the Green Power for Mobile Programme (GPM). The CPM team leverages the technical strengths of the GPM team, relationships of the GSMA members and contacts within the social impact and entrepreneurship space to facilitate an ecosystem of innovators and trial deployments which will realise the potential of CPM.

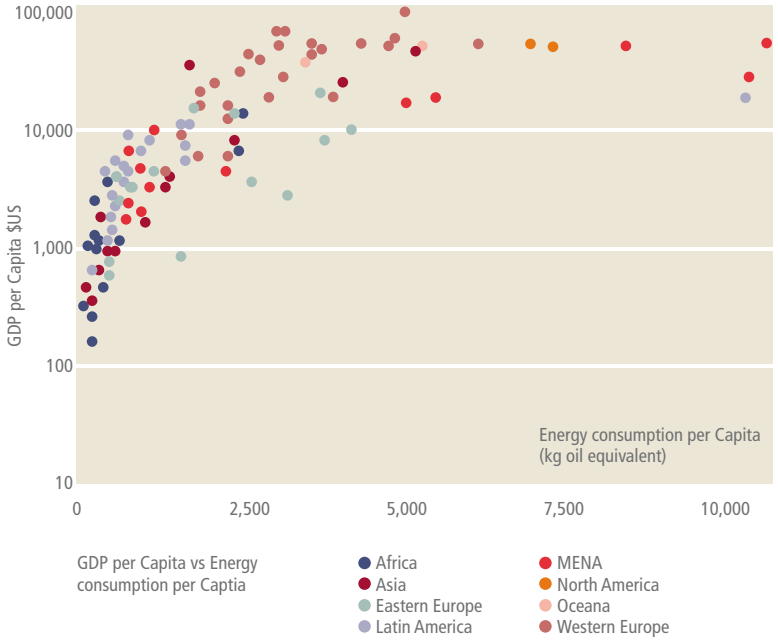


CPM from infrastructure can deliver benefits to communities via a mini-grid connecting neighbouring homes or via an energy services hub, which requires customers to travel to a central point to access services such as phone and battery charging, ICT and agri-processing.

1 http://www.worldenergyoutlook.org/development.asp

Why is Energy Important?

The links between energy access and poverty alleviation are well documented. Energy access improves quality of life and opportunities for economic growth.



Why Mobile?

Mobile penetration has quickly outpaced the growth of the electricity grid with 548 million mobile subscribers living beyond the grid.[1] The wide adoption of mobile services by underserved populations provides an opportunity to develop energy solutions at a scale never before seen, leveraging both human and physical infrastructure and innovative payment technologies.

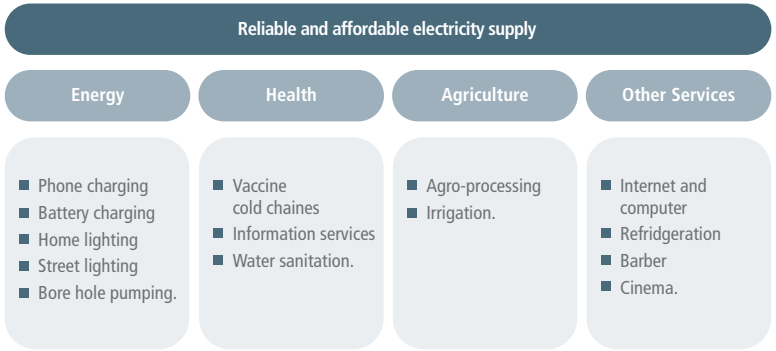
Community Power also improves the business case for off-grid telecoms by (a) growing revenue streams, (b) improving base station security, (c) charging mobile phones for increased usage, and (d) outsourcing power provision to third party companies to achieve lower cost of power.

What do CPM Trials Look Like?

Mobile network operators are trialling different approaches:

- Using their network of airtime vendors and partners to supply energy solutions to their customers
- Providing excess power from their towers to the community for small needs like charging up mobile handsets, large household batteries and rechargeable lanterns
- Committing to be a stable 'anchor' client to a third party energy service company powering both the base station and community.

The potential for rural service delivery has much greater magnitude with dedicated and affordable power supply:



What Does the CPM Programme Do?

The team aims to facilitate the development of Community Power from Mobile initiatives worldwide with an understanding of their geographic context. We seek to:

1. Raise awareness through knowledge sharing and convening, publication of case studies and business case development.

2. Partner with mobile network operators and tower companies to conduct feasibility studies and establish trials.

3. Develop relationships with private investors and provide technical assistance for due diligence in to the rural ESCO sector by interested investors with the aim to support longer term rural ESCO success.

1 GSMA-2010

Chapter 1

Evolving the Original Concepts Behind Community Power from Mobile

Since the launch of the Community Power from Mobile programme in November 2010, field work and exchanges with mobile network operators (MNO) and the energy and investment communities have enhanced our awareness of the changing landscape of energy and infrastructure services in the mobile sector as well as the challenges to rural energy delivery. There are four key lessons to be extracted which alter some of the original assumptions that determined the route to developing Community Power from Mobile. When considered these will hopefully benefit the progress of the model for the mobile sector and underserved communities.

Excess Power is less of a reality	■ Understand site load requirements ■ Reducing dependency on diesel.
Off-grid market is complex and immature	■ Challenges in last mile delivery ■ Rural energy market remains immature ■ Lack of capital for the sector.
CPM: More than just infrastructure	■ Towers+ ■ Last mile delivery supply chains ■ Mobile payments and scratchcards.
More than pilots are required for large scale adoption	■ CPM delivers social value ■ Tie pilots to strategy of telecom player ■ 3rd party financing is required.

Lesson #1: Excess Power is Less of a Reality.

The 2010 Community Power from Mobile White Paper suggested that two main models of Community Power from Mobile infrastructure were possible:

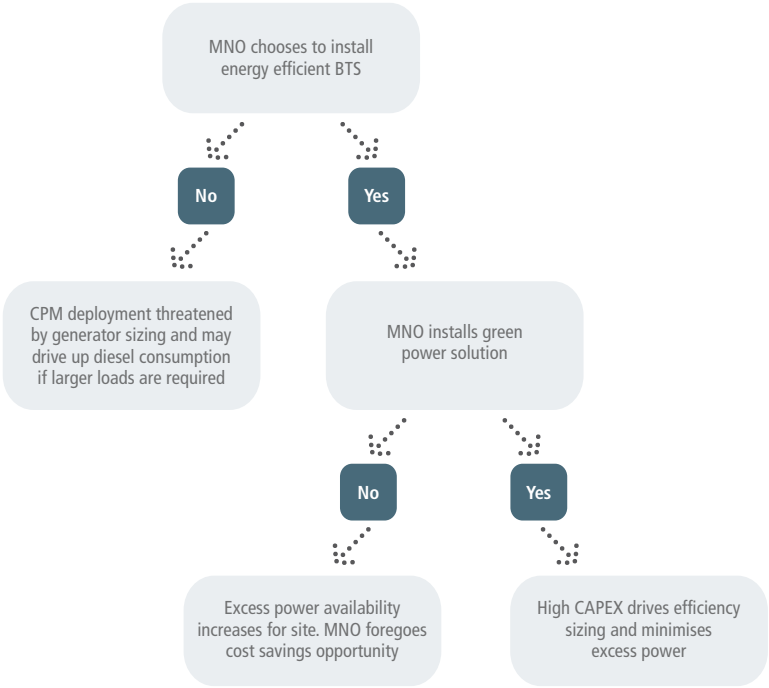
- Using excess power available from existing equipment: Operators can provide excess power at their base stations to the community for low power demand like charging mobile handsets, small household batteries and rechargeable lanterns. The excess power model is controlled by the energy solution at the base station
- Using 3rd party energy service companies (ESCOs) to deliver power to the mobile tower (as an anchor tenant) and the community. This first requires the operator to outsource the energy solution and its management.

The feedback received over the last 12 months is that the availability of "excess power" is challenged when considering the long term sustainability of CPM deployments. Simply put, all energy has a cost and the cost of this power needs to be accounted for when considering CPM from infrastructure deployments. This change is driven by the competitive dynamics of the industry reducing margins and the resulting additional internal focus on operational expenditures (OPEX). Estimates from mobile network operators both in India and sub-Saharan Africa suggest that energy represents approximately 40% of their monthly OPEX and the largest single line item.[1] Thus energy expenditure is increasingly becoming a topic of focus within the telecom industry.

As Mobile Network Operators work towards cutting their cost their strategies focus on:

- Reducing the load requirement of their network equipment
- Reducing their dependence on diesel.

Energy Solution Decision Tree for MNOs and its Impact on Excess Power



1 GSMA-From discussions with varying operators in Indian Subcontinent and Africa

Understanding Site Load Requirements

Since the uptake of mobile services occurred in most of sub-Saharan Africa at a rate greater than the Indian subcontinent, the network equipment installed by African mobile network operators are generally a generation behind that installed in India. As a result the majority of Base Transceiver Stations (BTS) deployed in Africa are largely inefficient when compared to newer technologies available on the market.

This case is best illustrated when comparing the energy requirements of single tenancy sites with varying load requirements for both older and newer generation BTS equipment. Newer generation equipment is up to 50% more efficient than older generation equipment. As is illustrated there is a large variance in the energy requirements of a single tenancy sites. Network operators can reach significant OPEX savings through proper sizing and installation of new generation equipment. The savings, when multiplied over networks of thousands of sites, represent a significant opportunity for the network operators and thus they prioritise energy efficiency over other energy initiatives.

Variations in Single Tenancy Energy Load

To better illustrate the energy requirements of single tenancy sites, generalised information was used for small, medium and large capacity BTS for both older and newer generation equipment.
To calculate the Annual Cost a constant price of US$0.7/kWh was used. This price stems from the Indian Market Sizing report and represents the price Indian Tower Companies would be willing to outsource energy production under a Power Purchase Agreement. These costs are rather conservative as they are less than current market prices in India, and the GSMA estimates the cost of power production to be higher in Africa due to initial cost of equipment and higher diesel prices.

Load of Older and Newer Generation BTS

	Older	Newer
Small Capacity BTS	1.6 kW	0.8 kW
Medium Capacity BTS	3.4 kW	1.3 kW
Large Capacity BTS	5.4 kW	3.2 kW

Annual Cost of Running one BTS at of US$0.7/kWh

	Older	Newer
Small Capacity BTS	US$9,811	US$4,906
Average Capacity BTS	US$20,849	US$7,972
Large Capacity BTS	US$33,113	US$19,622

Reducing Dependency on Diesel

A second development that threatens the viability of an excess power model is the increased focus across the industry to reduce dependency on diesel. As is discussed in the GSMA December 2011 **GPM Biannual Report**, 15 to 20% of all diesel consumed by the telecom industry in India and sub-Saharan Africa is pilfered.[1] Thus telecom players are actively seeking ways to introduce alternative energy solutions. The move to green power solutions does begin to challenge the availability of excess power as diesel engines are used a back-up power solution in a hybrid solution which prioritises renewable energy sources and battery power back-up.

As was mentioned in the **biannual report** unravelling the diesel theft issue is tricky and is still now the greatest challenge to green power deployments where site loads are appropriate. CPM is viewed as a potential solution to unblock the diesel theft issue by providing a benefit to the entire community and thus providing incentives to the community to look after the tower site.

Community power needs to be thus considered in a more holistic view of site operations and energy efficiency programs.

What Does This Mean for CPM?

As a result of these market changes, mobile network operators and tower companies are reluctant to consider CPM models which do not take into account the greater company strategy around energy reduction and do not factor in the costs of delivering energy to the community.

As such a more nuanced view of Community Power from Mobile needs to be integrated in which the costs of sustaining energy production at these sites is considered and passed on to the community. Energy service business models need to be developed that provide mutual benefits to the mobile network operator and the community and provide for the long term maintenance of the services.

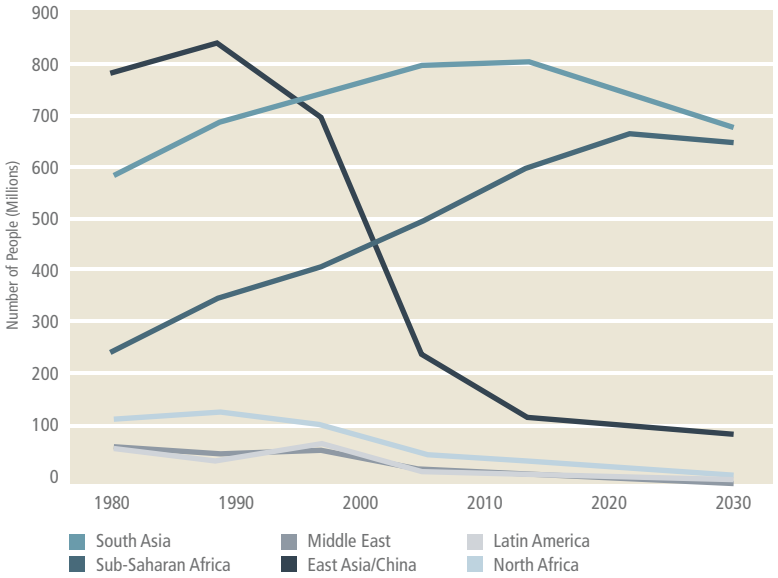
1 http://fuelcellsworks.com/news/2010/07/06/african-telecoms-begin-hydrogen-trials/
http://articles.timesofindia.indiatimes.com/2011-10-24/infrastructure/30315880_1_standalone-tower-tower-companies-telecom-tower-business

Lesson #2: Off-grid Electrification is a Complex and Immature Market.

While the mobile industry provides an attractive path to scale, the existing off-grid energy market remains relatively immature and requires significant support to capture the potential of the opportunity.

Governments across emerging markets, aware of the challenge of last mile electricity delivery, have created rural electrification agencies. Most offer a mix of incentives to attract private sector developers but still electrification rates have not increased significantly in most of South Asia and sub-Saharan Africa.

Number of People without Electricity, 1980-2030



Source: IEA World Energy Outlook 2002

Over the last year we have come to better understand the challenges of bringing together telecom giants and off-grid ESCOs in trialling the CPM concept. Small off-grid energy providers face significant challenges tied to serving the rural poor while delivering a viable business model. These challenges are rooted in the complexity of delivering last-mile energy services and a lack of risk capital to support the development of new innovations.

The Challenge of Last Mile Energy Delivery

Working with the most disadvantaged communities is difficult to say the least. Rural Energy Service Companies (rural ESCO) focussed on last-mile delivery of services to customers often get bogged down in day-to-day operations and fail to achieve the speed required to scale at a sufficient pace to create a viable business. The reasons for this are many:

The design is difficult to standardise: Off-grid communities vary significantly in geography, resources and energy demand. They often require technically different solutions which consumes considerable amount of time in the design of appropriate solutions.

Non-ideal Conditions to Run a Service Company:

- Customers: Most off-grid communities are rural with the majority of inhabitants being small holder farmers. They are generally less educated than their on-grid counterparts and their energy demands and access to cash can vary significantly depending on the farming seasons.
- Operational challenges: By working in remote communities rural ESCOs face obstacles that reduce their operational efficiency. Challenges include:
  - Finding and keeping qualified staff in rural areas
  - Access to spare parts and materials
  - Transporting equipment and distance from an easy to access city
  - Difficulty maintaining transparency without being physically present.

Lack scale to attract sufficient funding: Due to the challenges mentioned above rural ESCOs often lack the resources to build an effective strategy that allows them to scale to a size that is of interest to private investors. As a result they are often left looking for grant after grant to fund their growth which is a laborious process, acts as a distraction to their operations and slows down their growth. Furthermore the growing demand for electricity in electrified areas lends itself to more attractive returns for entrepreneurs and infrastructure investors.

The Rural Energy Market Remains Immature

The last ten years has seen an increase in enterprises offering village level energy services. For most of the past decade the success story of the off-grid energy market have been cook stoves as a means to deliver safer and cleaner cooking fuel reducing the incidence of respiratory disease. More recently, a fresh group of product companies offering solar lanterns, solar home systems (SHS) and high quality energy storage devices (batteries) have emerged. These companies have developed durable and efficient technologies which are both attractive to investors due to the clean energy lens but also due to the highly scalable nature of the product. On a per unit basis margins remain slim and hence their success depends on volume sales.

Case Study: Cook Stoves

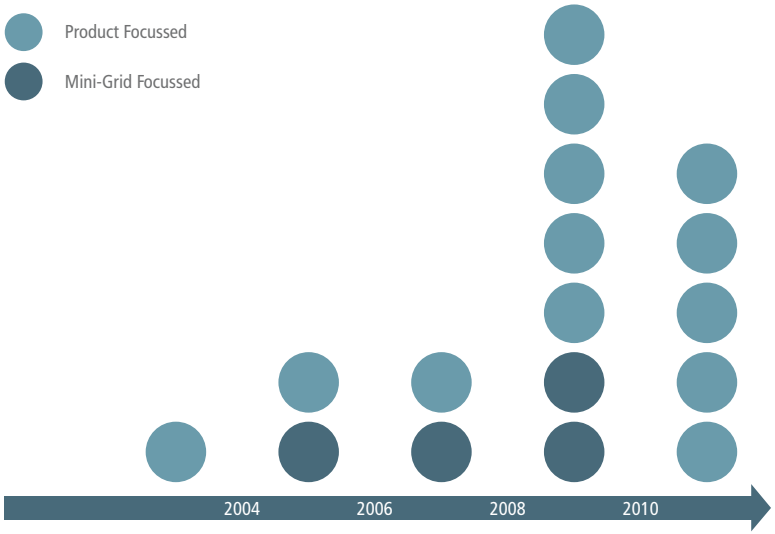
The Global Alliance for Clean Cookstoves[1] is a public/private partnership launched in September 2010 by the UN Foundation with the aims to "save lives, improve livelihoods, empower women and combat climate change by creating a thriving global market for clean and efficient household cooking solutions". The alliance has the goal of reaching 100 million users by 2020. Apart from the obvious social benefits, cook stoves more than any other BOP technology have the ability to draw in capital from the sale of carbon credits.

Our informal research suggests that good product is necessary but not enough to scale as companies quickly become hard pressed to establish intricate supply chains to fulfil the last-mile delivery to their customer. Moreover, low cost products still require financing and many product companies end up operating customer finance departments or partner with Micro Finance Institutions that can oversee loans.

Through this time a viable and highly scalable model for rural electrification has remained elusive with few players choosing to follow this impact path. These pioneers have had to develop the technology and the business model which has slowed their progress. To survive they have had to turn to the aid industry for grants further distracting them from operational efficiency. More recently a few social enterprises have emerged testing highly scalable business models offering varying levels of energy access.

In all, companies delivering energy products and services to off-grid customers still remain few and far between. Bigger players are defined by their ability to draw investments through their path to scale. In a market of this size there are still no clear winners and more importantly there is plenty of room for competition.

Growth in Enterprises That Provide Energy Services to Off-grid Communities in India/Africa



1 http://cleancookstoves.org

Lack of Capital for the Sector

Organisations improving energy access face significant challenges raising the funds for both proof of concept and growth. The principal reasons for the lack of investors in the space are:

Energy is Not Attractive

As energy is not considered a primary need there is a lack of easy to access grant funding for new entrants into the sector. Similarly, angel investors hesitate to invest in the sector as they deem it too risky and question the commercial scalability of the model.

Capital Intensive

Like the clean technology industry in developed markets, energy solutions for emerging markets require continual access to funding. The "valley of death" is often known as the gap in financing that start-ups face somewhere between grant funding and commercialisation. Two studies conducted last year suggested that the valley of death was particularly precarious for energy companies since:

- They maintain high variable costs even after proof of concept either in the form of building products (i.e. carrying inventory) or developing physical plants
- They take a long time to scale: in comparison to the IT companies, development of cleantech product and installations takes much longer
- Energy development must navigate a series of political, financial and regulatory issues specific to the geography they wish to operate in.

Sector Faces Structural Issues

While the reasons above highlight why the energy sector remains unattractive, the finance sector faces significant structural issues which make it difficult to invest in new energy companies.

- Investment in energy remains risky: without proof of commercial scalability, investments in energy companies are considered to have "technical risks"
- Longer term investments: the longer term investment requirements of energy companies make them less attractive to funders who seek high risk/high rewards such as the IT space
- Opportunity cost of early stage investment: donors who also have an interest in leveraging for longer-term returns are aware of giving away value to later stage more risk-averse investors.

As a result energy entrepreneurs face a tough sell to investors interested in the social enterprise sector, especially when they compete with other technologies with potentially lower development or on-going variable costs.

Lesson #3: The Mobile Sector Provides More Opportunities Than Just Their Infrastructure.

In conversations with mobile network operators and energy service and product providers we see increasing ways for the mobile industry to drive the growth of innovations in the off-grid energy sector. In the push to increase market share and mobile penetration, mobile network operators are unintentionally helping to lower the barriers to off-grid energy electrification.

At the heart of this opportunity is the realisation that a mobile customer is also an energy customer and without affordable energy cannot participate in the mobile economy.

Towers+

The original CPM from infrastructure concept underscored the geographic scale of the mobile industry and associated footprint of mobile towers. This cannot be denied. However, as important as the physical infrastructure are the business opportunities, systems and supply chains that can be developed to improve the case and the ease of off-grid energy service delivery.

Formalising the Industry and Developing Expertise

As mobile operators are concerned with their network uptime they have become effective at ensuring reliable power to their tower, whether that is in off-grid areas or in areas with unreliable grid (the reality for most emerging markets). As the mobile industry pushes for more efficient use of energy resources to operate their networks, specialised companies are being formed and attracting seasoned entrepreneurs.

How can companies delivering energy solutions to towers in densely populated areas be leveraged to provide communities access to energy services?

Service Supply Chains

Mobile network maintenance has led to the creation of specialised service delivery companies ensuring that trained technical staff are often visiting towers whether to perform routine maintenance or deliver diesel fuel. The development of these services helps to lower the cost per transaction of servicing remote areas and provide potential opportunities for synergies that support rural franchise business models.

Predictable Demand

Apart from scale the mobile industry provides stability and predictability of energy demand in a frontier market. While the energy demand of a mobile tower is relatively small their consistent demand can support the development of new business models.

Last Mile Delivery Supply Chains

Mobile network operators have extensive agent networks selling airtime sales and handsets. Leveraging this existing network of entrepreneurs to also deliver phone charging, battery charging and lighting solutions to rural customers is a natural progression.

Mobile Payment/Scratchcard Driven Solutions

In recent months an increasing number of organisations that are leveraging mobile payment technology, shortcodes and scratchcards to create pay-as-you-go energy products have emerged.

These innovations are helping to reduce one of the main barriers to off-grid energy products; affordability. Similar to the development of other mobile products (mobile money), energy service provision and more broadly utility-like services can build off customer's existing familiarity and trust with scratchcards.

Case Study: Dr. Vijay Modi and Shared Solar

Dr. Vijay Modi is the Director of the Modi Research Group and Professor of Mechanical Engineering at Columbia University. He is also the Director of Infrastructure Programs of the Earth Institute's Millennium Villages Project. Dr. Modi and the SharedSolar team are pioneering the development of local micro-grids that provide a grid-like service to the customer premises. The customer has the flexibility to purchase electricity in small incremental amounts, either from local entrepreneurs who can upload credit, or using scratch cards. SharedSolar has recently signed an agreement with Airtel to explore the use of mobile-money transactions. About a dozen pilot systems, benefiting a population of 1500 are now functioning in Mali and Uganda with some in place as long as one year.

Lesson #4: Pilots Prove Social Impact of CPM but do not Reduce the Barriers to Widespread Adoption.

The initial thesis of the CPM programme was that pilots would both prove the social impact and viability of the opportunity and hence lead to the broader adoption of Community Power deployments by the telecom industry.

Early Community Power from Mobile pilots have offered varying services ranging from phone charging and street lighting to ambitious electrification schemes for large rural markets. In July and August of 2011 the CPM team visited Kenya, India and Bangladesh to see first-hand the results of these early pilots. The demand for off-grid energy services is clear in all cases studied. What has been seen is that while pilots help to prove the social impact of CPM and the potential of a viable business model, several barriers still remain for the widespread adoption of CPM.

Lessons Learnt from Early CPM Pilots

Grameenphone

Lesson #1: Proof of concept may be required before a mobile company allows an organisation to tap into their energy supply.

Lesson #2: Mobile tower companies are looking for prices that bring costs, delivered to site, to below US$1/kWh.

Lesson #3: Customers are effectively paying above US$1/kWh for access to lighting service.

Lesson #4: Fixed monthly rates can simplify the bill collection system and allow for easier remote monitoring.

Safaricom

Lesson #1: In some geographies governments will want to be involved in an energy project that provides services to end user consumers.

Lesson #2: If the culture is to pay for things, don't give things away for free as you may alter the local business environment.

SPEED – DESI Power

Lesson #1: Bio-gasifiers pose a challenge in that they are sized to a particular load. If the main anchor tenant represents an overly large proportion of the energy demand then the ESCOs business model may be at risk.

Lesson #2: ESCOs must have back-up means of providing power to mobile operators if they want to be considered as the primary power producer.

Lesson #3: Running wiring underground reduces illegal taping

Lesson #4: Customers in areas with poor grid connectivity are willing to pay above Electricity Board prices for access to reliable power.

CPM Delivers Significant Social Value:

Across all the pilots visited, CPM was providing significant social value to communities. The pilots varied significantly in terms of power source, contracting relationship and scope of services delivered to the communities. But in all cases CPM pilots would not have been possible without the support of external actors:

- In Kenya, Safaricom started providing energy services after receiving requests from the community and pursued it as CSR initiative
- In Bangladesh, Grameenphone partnered with the University of Oslo to pilot the concept
- In India, DESI Power was able to connect to several tower companies through Rockefeller's SPEED Programme.

Case studies of the pilots are available in the Appendix but the synopsis of the pilots, business model and services delivered are summarised below.

Pilot organisation	Safaricom
Start date	Starting in 2005 with most deployments occurring in 2009/2010
CPM model	Excess Power-CSR Driven
Scale	25 deployments across Kenya
Services to community	Range of services from phone charging to street lighting to water pumping
Charges to the community	Designed to be free services. Some communities have elected to deploy a paid-for phone charging services to account for caretakers time
Main barrier to scale	The pilots have been mainly driven from a CSR perspective and do not have an annual budget allocation. Furthermore, no assessment has been made of their impact on subscriber loyalty and ARPU

Pilot organisation	DESI Power w/Support of SPEED and two mobile tower clients
Start date	November 2010
CPM model	Commercial ESCO with towers as anchor tenants
Scale	Currently operating a biogas plan at one site in Bihar, India providing 11 hours of continuous power to two mobile towers and 30 commercial clients. A second site is temporarily closed due to the loss of their main anchor client (a 60kW industrial rice mill)
Services to community	Power to SMEs who provide agro-processing, phone charging, entertainment (cinema), and small office services
Charges to the community	SME clients are charged on a per kWh basis. Customers pay approximately US$0.30/kWh
Main barrier to scale	Management of biogas technology (availability of feedstock, sizing of gasifiers), managing a 24/7 solution and managing contracting relationship between a large tower company and small ESCO

Pilot organisation	Grameenphone with support from the University of Oslo
Start date	October 2010
CPM model	CSR Driven with own power generation equipment
Scale	1 site in Paharpur, Bangladesh
Services to community	Night Lighting to the community
Charges to the community	Each household pays an equivalent of US$2/month
Main barrier to scale	Identification of suitable sites, integration of CPM mini-grid with the existing tower power generation equipment to reduce CAPEX

Tying Pilots to the Strategic Imperatives of Telecom Players

While pilots help to prove the potential positive impact of community power, they do not provide an immediate path to scale.

This exists for several reasons:

- Single pilots do not quantify the opportunity: A deeper understanding of a mobile players tower network needs to be conducted to understand the number of sites that are suitable for CPM from Infrastructure
- CPM requires coordination across multiple departments: Several departments within a Mobile or Tower company can be interested in CPM including the marketing department trying to increase rural subscribers' airtime usage or brand stickiness, operations team who are concerned with the energy solution and network uptime and the CSR team who works to deliver benefits to communities.

To move Community Power from one-off CSR activity to a viable opportunity to engage external organisations requires deeper interactions with telecom players.

Stuck in the Middle: A Third Party Financing Organisation is Required

Telecom players and ESCOs require financial support to capture the CPM opportunity.

Emerging ESCOs interested in leveraging the scale of the mobile industry are often caught between two challenges:

- Potential investors require the signed commitment of mobile network operators as a before they consider investment
- Potential MNO partners require proof of concept before they are willing to considering partnering with ESCOs.

This leads to a lose-lose-lose scenario with passionate ESCOs without funding or pilot sites, MNOs frustrated by socially leaning enterprises and investors, and social investors without deal flow.

If Community Power is to become a reality a risk ready environment needs to be created where good enterprises are mentored, nurtured and monitored, have access to the patient capital and test sites they require to gain proof of concept.

Chapter 2

Increasing the Likelihood of Community Power from Mobile

Drawing from the lessons learnt during the last 12 months, as covered in the previous section; four recommendations are offered to draw out the best opportunities for CPM to develop from concept to mainstream operations through research, advisory and commercial trials.

Develop rigorous models for Community Power from Mobile infrastructure	■ Collect and disseminate business models ■ Adapt models with changing tower infrastructure ownership.
Assist mobile network operators in developing CPM strategies	■ Identify ways to leverage telecom supply chain and human infrastructure ■ Map deployment opportunities ■ Correlate accessible and affordable energy access with phone usage.
Conduct research to inform innovative service providers	■ Understand demand for priority energy services and their impact on MNOs ■ Identify potential obstacles and opportunities posed by rural energy and communication policies.
Partner with the investor base to drive capital in to the sector	■ Engage, inform and learn from investors ■ Nurture a pipeline of opportunities.

Recommendation #1: Develop Rigorous Models for Community Power from Mobile Infrastructure.

To reach the full potential of Community Power from Mobile, viable business models need to be identified that take into consideration the strategic goals of telecom partners in rural expansion. Building off the lessons of pioneering organisations in the rural energy sector and the first generation of CPM trials, the programme will continue to explore the different paths to scale from Corporate Social Responsibility to purely commercial business models. Successful models will minimise the tension between capital expenditure and complexity versus service delivery to communities.

Collect and Disseminate Business Models

There is more than one business model that could successfully deliver community power from infrastructure and benefit multiple stakeholders when considering all the variations within markets, infrastructure models, community needs and technologies.

The challenge for any business model, whether CSR driven or purely commercial, is combining the services delivered to the community in a way that maximizes the revenue and minimises limited and intermittent power availability.

From our experience there are two main drivers that will determine the business models:

- Whether the venture will be run as a CSR, commercial or hybrid organisation
- The energy distribution model employed.

These factors combined will determine the level of service to the community and whether additional capital investment will be required for power generation. While any of the models can be managed within a mobile network operator the more complex models, which do more than use the excess power available at a particular site, will more than likely require the involvement of a rural ESCO to support the CPM initiative.

Energy Distribution

Two basic models of distribution to the community have emerged in the market; the energy hub and the mini-grid. The distance of the mini-grid is determined by costs and the community population density. The hub can be strategically placed close to the mobile network towers or at a distance and connected by underground cables (as implemented by DESI to eliminate cable theft and vandalism). Each of these distribution models can be leveraged to deliver single or multiple services to communities with revenue diversification being greatest in multiple service models. Defining the business case for each of the four business models outlined below will provide a significant portion of the foundation required to attract telecom and rural ESCO players.

Emerging Energy Business Models with Examples

	Mini-Grid Distribution	Energy Hub Distribution
Multi-Service	DESI Power (biomass micro-utility, US$0.26/kWh)	(Commercial models being developed in the market)
Single-Service	Grameenphone (home lighting, US$2/month)	Safaricom (phone charging, free)

Mini-Grid

The more capital-intensive approach is to build a community mini-grid. In countries with high population density such as India and Bangladesh the mini-grid model can be cost-effective, but it is more difficult in most of Africa without substantial subsidies. Mini-grids also have increased maintenance requirements and can be theft targets due to the use of copper wiring, unless wiring is put underground as has been witnessed in India.

3rd party Power (ESCO): Mini-grid	
Power available	Demand of tower and community
Power supply	Diesel GS, battery, solar, biogas
Capital cost items	Mini-grid, PV, Diesel GS, Battery
Operating cost items	Diesel, Salaries, Maintenance
Energy services supported	Home and commercial lighting; agro processing and irrigation; ICT centre
ESCO incentives	Increased revenue streams; multiple anchor clients
Revenue streams	Sale of power to MNO; Sale of power to communities via metering; Sale of power to commercial centres
Community impact	Home lighting and other services; More affordable power for commercial operations
Community involvement	Entrepreneurs caretaking and revenue streams
MNO incentives	Outsourced cheaper power and positive feedback to local economy increases ARPU; Reduction in diesel theft through community involvement
Challenges	Increased complexity of system; Community population density
Case studies	Grameenphone (Bangladesh); DESI Power (India)

Energy Hub

The less capital-intensive and scalable approach is to create an energy services hub. This requires the beneficiaries to travel to a central point. Depending on load requirements an energy hub can be built using the excess energy capacity of existing power generation equipment or may require additional capital expenditure. As was previously highlighted a pure CSR driven approach, in which customers do not pay for the energy services, may not be appropriate for all operators due to the real cost of power.

Audiencescapes reported in 2010 that at a national level in Zambia 16% of respondents gave lack of power the top reason for why they do not own a mobile phone (behind phones being too expensive). In a country where 61% of homes do not have electricity, this speaks volumes about the alternative methods of phone charging made available by local entrepreneurs but also the unmet demand for phone charging which if fulfilled would increase mobile phone penetration and usage.

Single Service:

There remains a business case for just providing basic charging solutions due to the clear existing market demand and the requirement for very small amounts of power. Mobile phone charging is a clear micro-business opportunity in most developing countries, even those within reach of the national electrical grid since many consumers can't afford grid connection fees (for example, from US$300 in Kenya). Research has shown that in East Africa the average unit cost per phone charge is US$0.20 and phones are charged twice a week. (In certain studies carried out by GVEP a greater proportion of monthly income is spent on charging than airtime.)

Excess Power:	
Power available	<0.5 kWh
Power supply	Diesel gen set or green power hybrid solution
Capital cost items	None
Operating cost items	Minimal unless draw on extra diesel or power demand above efficient requirement for the base station
Energy services supported	Phone charging; Lantern and small battery charging
Community impact	Reduced indirect costs of phone charging; Displaces expensive and dirty kerosene; Better lighting for students
Community involvement	Local entrepreneur(s) caretaking and earning income
MNO incentives	ARPU uplift; Branding loyalty; Potential for income for power supply to entrepreneur(s) if not CSR model; Reduction in diesel theft through community involvement
Challenges	Cash handling; Very small price per transaction; Competition
Case studies	Safaricom Kenya (CSR)

Multiple service:

Numerous attractive revenue streams are available where there is a potential of distributing multiple energy services from a central hub. These hubs can provide similar services to micro-grid schemes but with much smaller CAPEX expenditure. These hubs can provide charging of both mobile phones and batteries, lighting to shop keepers, agro processing and other services that require motive power. To date this model has not been tested in a CPM pilot. More rigorous research needs to be conducted to better communicate the opportunities and challenges of this business model.

Comprehensive commercial trials of the energy hub and mini-grid models have not yet happened at MNO/tower company sites largely because operators have not been able to evaluate their impact and benefits on broader strategy, sales and energy costs. Trials are critical across distinct markets assessing real network deployments, growth strategies and community impacts to improve understanding and awareness of the real commercial successes and challenges.

Adapt Models with Changing Tower Infrastructure Ownership

The operating infrastructure across the telecom grid determines largely the supply-side working model for Community Power. This is evolving across national and regional scales, at a varied pace and with either operator-led or independent tower companies taking ownership and maintenance of the infrastructure, but nevertheless in the same direction. A growing number of conversations with MNOs show that they would like to be able to engage an energy provider that can offer community power services. Community Power from Mobile business models will need to be adapted to take into consideration the ever changing landscape of players and better understand and articulate the opportunities for mobile tower companies.

Recommendation #2: Assist Mobile Network Operators in Developing CPM Strategies.

If implementations are going to have the chance to develop and be tested, deeper interactions with telecom operators to both educate and assist assessments of commercial opportunities and engagement with external organisations are necessary.

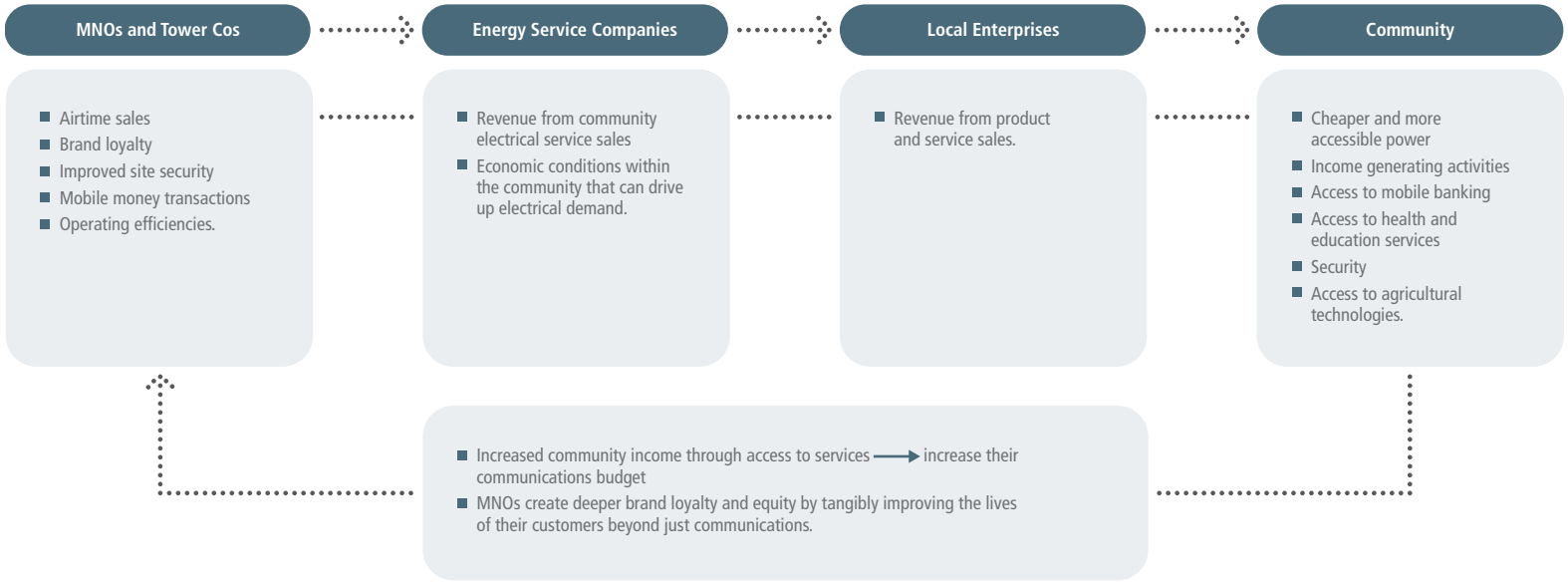
A mobile network operator committing to a third-party to manage and own their energy solutions is a step-change in itself. Adding to the model that the organisation provides energy services to an off-grid subscriber base (the 'base of the pyramid' community that will drive the future for mobile growth and innovation) is an interaction not previously on their radar. The adoption of 3rd party energy provision is still a nascent concept but it is evidently happening.

India's nascent ESCO market

India, considered a leader in evolving the tower ownership and energy provision model, currently counts less than 3000 towers of a total installed base of over 400,000 towers which use a 3rd party renewable ESCO. While the adoption of this model is gaining traction renewable ESCOs are relatively new players in the mobile industry.

Attracting the mobile network operators, and increasingly the tower companies, in to the mix to deliver rural power services at scale will require assessments that incorporate their strategic drivers and networks. There are several interventions and processes being developed by the GSMA to work directly with our members to make the decision on whether to, or how to, participate in and support a beneficial energy service for them and their customer-base.

Access to Community Power Reinforces Opportunity for Mobile Network Operators



Identify Ways to Leverage Telecom Supply Chain and Human Infrastructure

Realising the synergies between telecom and ESCO supply chains in rural and remote areas will enrich the service delivery of rural energy franchises and highlight opportunities for cross-selling airtime and mobile money. At an early stage in discussions the ESCO or local phone charging entrepreneur and mobile network operator need to ascertain the location and running of service supply chains and agent networks.

Map Deployment Opportunities

An integral technique for effective identification of the most apparent community power sites and most effective means of delivery is by combined spatial mapping of the operator's network and subscriber data with community profiling. Input data should include the following:

From the Mobile Network Operator:

- Current and planned mobile infrastructure deployment and energy solutions
- Location of mobile money agents
- ARPU and off-grid subscriber growth strategy.

Development Indicators:

- Population density across socio-economic groupings
- A comprehensive and detailed survey of basic community energy access.

Correlate Accessible and Affordable Energy Access with Phone Usage

There is reported evidence of the connection between better access to electricity and growing social and economic status, but insufficient quantitative examples that specifically relate to key aspects of interest to mobile network operators, within their networks or in target growth areas.

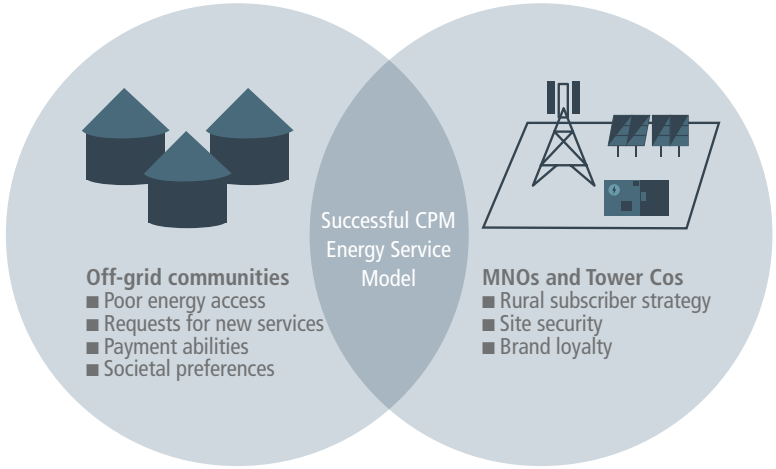
Research in to phone usage (voice, SMS, mobile money) and barriers to growth is needed in distinct markets in correlation with energy access data within the same communities. Once a benchmark is established on-going monitoring shall create impact statistics and real case examples for the mobile network operator and the industry at large.

Recommendation #3: Conduct Research to Inform Innovative Service Providers.

For CPM to succeed as a means for deploying scalable and sustainable rural electrification, the needs of the community must be aligned with the incentives of the MNOs and tower companies. The third-party energy company providing services to the telecom tower and the community plays a crucial role at the intersection of community needs and corporate motivation. The benefits of scale that equate from a mobile network operator anchor client are clear. Less clear is how to best leverage that by also understanding the social and economic impact of energy services on the community and the positive feedback to their own business and to the mobile network operator.

Is the problem not that the goals and drivers are misaligned but that the two parties don't understand that they are aligned?

Motivations of Off-grid Communities and Telecom Sector Convene in Order to Produce Good CPM Solutions



Understand Demand for Priority Energy Services and their Impact on MNOs

By the nature and number of stakeholders involved in CPM, a large amount of due diligence by energy service providers is required to provide a thorough and fundamental understanding of both the off-grid community and telecom energy solutions before the ESCO can confidently enter the marketplace. Reducing the effort needed to collate the data and improving its quality and reliability through independent market-specific research will reduce due diligence costs for all interested ESCOS and accelerate the development of successful business models to the benefit of the MNO and community. Further, it could drive the quality of value-added services that distinguish the market-leaders.

Example of Operator and Market Information Needed by the ESCO to Build their Business Model

From the Telecom Sector	From the Community
Power load requirements at off-grid base stations and market rates	Current fuels used for lighting and their cost
Cost and impact of energy efficiency measures	Current source of power for charging phones and cost
Capital expenditure on green power solutions	Frequency of phone charging
Operating expenditure losses from diesel theft	Indirect cost of phone charging and collecting lighting fuel
Management contracts with energy solution vendors	Current use and cost of power for other services in the community/household
Service supply chain network	Income vs. expenditure on fuel/power and sources of income (including regularity)
Agent network	Priority requests for new power sources and services

A ground-level survey of energy fuels, usage, expenditure and access points of communities and households where community power services could be implemented will be very powerful to stimulate the most successful and impactful business models for all stakeholders involved. To be utilised best this needs to be targeted at the sites and networks of the MNOs rather than broad-sweep studies or in areas where grid-access is an affordable option.

Identify Potential Obstacles and Opportunities Posed by Rural Energy and Communication Policies

In most countries regulations exists on who can and cannot produce power for use by the public. The use of sub-contractors and 3rd party ESCOs by the telecom industry has to-date not had to deal with attaining licenses for Independent Power Producers as the energy is used purely for their own use. Currently telecom players work hand-in-hand with ministries and regulators to roll out their mobile network extending where feasible the grid to their towers.

As the telecom industry moves to outsourcing power production, 3rd party companies will increasingly navigate the maze of local regulations to attain the right to operate. As these actors begin to consider also delivering community power services there will be a need to reduce the barriers to operation and make the most of local subsidies for household connections or other financial incentives.

Similarly additional work needs to be done to see how CPM can support the mandates of communications departments in emerging markets. In many countries Universal Service Obligation Funds have been created using a portion of the profits of telecom players to improve access to telecommunication and ICT services in rural areas. The link between access to energy and communication services can be leveraged to deliver increasing value to communities.

Recommendation #4: Partner with the Investor Base to Drive Capital in to the Sector.

GSMA has a role in helping to de-risk investment in rural energy providers by better supporting investment readiness and assisting in structuring mechanisms that better channel capital in to the rural energy sector that is innovating energy delivery through mobile. Such investors include donors, impact investors able to offer soft loans and attractive equity and more traditional venture capital funds with focus on rural energy in emerging markets.

GSMA works alongside key stakeholders to create CPM opportunities

Engage, Inform and Learn from Investors

The innovators and entrepreneurs that are filling up the fledgling rural energy market space are competing hard for seed and venture capital from donors and social impact investors. The opportunity driven by the growing energy divide plus development in technology has created an attractive business prospect with social and economic impacts. The hard sell that entrepreneurs face comes down to the capital intensive nature of operations, inherent risks in energy delivery, lack of awareness around the mobile sector and the often rigid structure of the finance sector.

To enable the investment sector to better assess opportunities, there is a need to engage with it to learn from past successful and unsuccessful business models for rural electrification and inform investors on the present opportunities and limitations within the mobile industry. Through both identifying the funding gaps that confine the new energy service companies' ability to participate in CPM and understanding what opportunities are of interest to investors, investments can be made? And simply by articulating the CPM 'story' in a way that lays out the prospects and risks more investors may be attracted to the sector.

Nurture a Pipeline of Opportunities

Patient capital will become more available in this sector as a result of greater awareness of the opportunities, the new innovative means of energy service delivery and access to better data to underpin due diligence. The mobile sector offers a new and unknown element to rural energy service delivery channels and a gateway to scale. GSMA's position in the centre of this network and our capacity to deeply engage with all the stakeholders means we have the ability (and a vested interest) to inform the investment community and help to create a pipeline through which to participate in the growth and impact of this sector.

M-PESA's funding story

M-PESA, Safaricom's mobile money product launched in 2007, is largely considered a runaway success reaching over 40% of adult Kenyans[1] and representing over 12% of Safaricom's revenues.[2] What is less talked about is that M-PESA would never have existed had it not been for a £1M challenge grant to Vodafone from DFID in 2003, an investment the envy of most Venture Capitalists.

Below are insights from Nick Hughes and Susie Lonie, the internal champions of M-PESA and winners of the The Economist's 2010 Social and Economic Innovation Award, on their experiences of creating M-PESA within Vodafone.

Nick Hughes, former Head of Global Payments at Vodafone and Director of Signal Point Partners

"Private sector organizations such as Vodafone are legally bound to use their shareholders capital to achieve the best returns. But many organizations use internal competition to allocate funds to their projects, and this competition is based on potential returns on investment. As a result, any initiatives that relate to the development agenda usually get squeezed out… How could firms raise executive-level interest and get funding to develop products that will be non core and long term but do have some sort of sustainable development theme?

One angle could be to position such projects in the Research and Development (R&D) department. This would work in many sectors where new products take a long time to reach market, but many technology-based companies—and Vodafone is no exception—tend to keep R&D focused on the technology rather than the marketplace... Enter the role of challenge funds. What if a firm could use somebody else's capital to overcome the internal competition (one hurdle down) and a compelling proposition could be shaped that would give the company some comfort that the project was addressing a market of potential future value?"[3]

Susie Lonie, Mobile Payments Specialist at Vodafone

"Money, that was the real determining factor for us. M-PESA would never have existed if it had not been that DFID put together a challenge fund for private industry to try out new things…. Because we had that money we could go away and try out some new things and be a little bit crazy. There is no way that Vodafone would have given us resource in amongst all of its higher priority, immediate innovation requirements."[4]

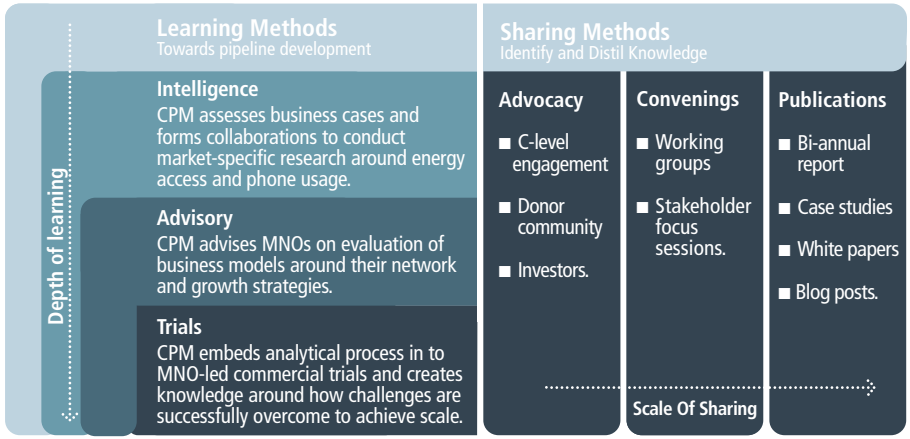
1 http://mmublog.org/wp-content/files_mf/mpesa.pdf
2 http://mmublog.org/blog/safaricom-56-growth-in-m-pesa-revenue/
3 http://www.mitpressjournals.org/doi/abs/10.1162/itgg.2007.2.1-2.63
4 http://www.economistconferences.co.uk/video/economists-innovation-award-winners-2010/4500)

Chapter 3

Moving Forward with a New Engagement Model

To move Community Power from Mobile forward a new engagement model is proposed that makes best use of the knowledge acquired and the opportunities identified.

Framework for Engagement and Knowledge Sharing



Appendix 1

Case Study: Grameenphone Energises Paharpur

By Xavier Helgesen and Charlotte Ward, GSMA

History

The remote village of Paharpur is located in a vast wetland area in the district of Hobiganj in Bangladesh; about one hour by boat from the nearest city. It is a quiet community of about 20,000 people and most income is generated by fishing and growing crops in the rich marshlands. The Bangladesh Energy Regulatory Committee advises that there are no plans for extending the national grid to this community within the next 20 years (Geirbo, 2011). In October 2010, over 100 houses turned on their lights thanks to an innovative collaboration between Grameenphone and the University of Oslo.

Current State

All households receive a seven watt compact fluorescent lightbulb (or two bulbs if they wish to pay) but they do not have a "mains" power outlet, so cannot plug in electrical appliances. Households receive power from the hours of 5pm to midnight, while the Community Information centre (CIC) and mobile phone charging booths receive it during the daytime.

The CIC provides basic information services to the village via the Internet. It does not function like a typical Internet café, as most villagers do not actually operate the computer directly; instead they ask an operator at the counter who looks for the information for them. The presence of the CIC in the village made the community power project much easier, as Grameenphone already had a trusted and technically savvy representative in the form of a CIC manager who they had trained.

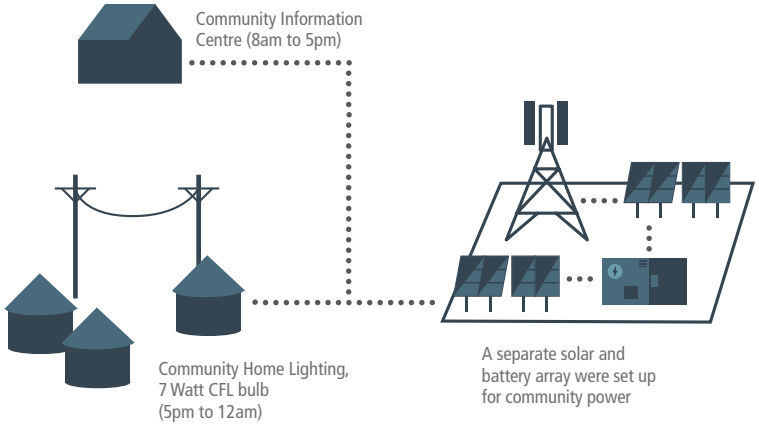
Getting access to mobile charging in the households was among the main requests that were received by the pilot team from villagers, ranking second after requests for lights in households (Geirbo, 2011).

Impact of Community Power Project (Mini-grid and Community Information Centre)

Services	Before Establishment of CIC (Jun-Dec '10)	After Establishment of CIC (Jan-Jul '11)	Growth
Internet	Service not available	US$65	
ERS (mobile recharge)	US$10,000	US$12,000	21%
GPPP (Public Phone)	Service not available	US$140	
New Connection sale	177	186	5%
Handset	19	23	21%
Data Card	Service not available	1	

ERS: Electronic Recharge System. Source: Grameenphone

Design and Technical Overview



The mobile tower that serves as the base of the project is one of Grameenphone's first solar base stations. It is powered primarily by an 8.5kW peak solar PV array connected to a 2200 Ah battery bank; it also has a backup diesel generator that seldom runs. In 2010 it only ran for about 20 hours in the year. For the community power project, the team decided to set up a separate 3.17 kW solar array with a 400Ah battery bank rather than sharing or expanding the main one.

The separation of systems was done to simplify the test phase and to minimize risks of tower downtime before the system was proven. In the future, Grameenphone would likely use a combined system for the tower and community rather than a separate system.

Lesson #1: Proof of concept may be required before a mobile company allows an organisation to tap into their energy supply.

This PV/battery system is much larger and more expensive than optimal for a solar base station. Grameenphone's current solar rollout is based around a 5.5 kW solar array with an 800 Ah battery and a backup generator. These serve an average load of 1.3-1.5 kW per tower. The generator is used for roughly two hours per day; the level that optimises the blend of OPEX and CAPEX.

Lesson #2: Mobile tower companies are looking for prices that bring costs, delivered to site, to below US$1/kWh.

Grameenphone in the Market

History
- First and largest MNO in Bangladesh
- Founded as joint venture between Grameen Bank and Telenor
- Long history of rural innovation.

Competitive Position
- 44% share by volume
- 52% share by revenue
- $3 ARPU, 35 million subscribers
- 6 operators. Intense price.

Leader in Green Power and Energy Efficiency
- Currently 37 solar base stations. Work in progress for another 72 by 2011
- OPEX model with ESCO partner: Less than $1/kWh off-grid
- Rolling out energy-efficient towers
- High-level climate executive: Md. Ariful Alam champions projects.

Branding and Marketing
- Premium position
- Wins hearts and minds with rural service delivery
- Widest rural coverage in Bangladesh
- Now rolling out wireless broadband.

Business Model and Economics

Business Model	Lighting Mini-Grid
Business Type	Corporate Social Responsibility – no return on capital expected
Capital Expense	$35,000 (granted by University of Oslo)
Operating Expense	Minimal. Caretaker takes 20% of revenue
Revenue Model	US$2 per household per month for lighting. Some free recipients
Monthly Revenue	US$272 gross, US$218 net

Lesson #3: Customers are effectively paying above US$1/kWh for access to lighting service.

Operations and Maintenance

The first level of support, bill collector, and on-the-ground manager of the project is the manager of the CIC. He is a dedicated and hard-working individual who wants to help his community and is broadly respected by the community.

To make certain that incentives are aligned, the CIC manager receives 20% of the expected amount receivable from electrical services. The funds are deposited in a local bank that maintains a dedicated account for the project, allowing Grameenphone's team in Dhaka to confirm that funds have been collected.

Lesson #4: Fixed monthly rates can simplify the bill collection system and allow for easier remote monitoring.

Challenges and Obstacles

- Agricultural cycles impact fee collection
- Prompt disconnect of non-payers is currently difficult
- Remote location makes innovation, maintenance and monitoring difficult.

Collection of payments has been very high (> 95%) until July 2011 when they dropped off sharply to 65%. Cash income is not regular all year round due to agricultural cycles, and there is also labour migration to cities in the summer which means that the cash earners in the household can be away for months at a time. In the original design of the system, the circuit breaker was inaccessible to the local operator. This meant that if the system was overloaded and a technician had to take a 10 hour trip to the site from the capital city to flip the breaker. The breaker has now been moved to be accessible, making it much easier for basic problems to be solved locally.

The remoteness of the location is also a serious challenge; a 10 hour journey by car and boat through very bad roads. It was chosen for the project because it was very unlikely to be connected to the national grid for decades to come. These same characteristic makes it very time-consuming and expensive for Grameenphone staff to visit the site and try out new ideas.

The Future

The team at Grameenphone and University of Oslo are continuing to think creatively about how to improve the model and provide a better service. In order to achieve a self-sustaining solution capacity will be expanded gradually in accordance with local conditions. The engineers are working on a small biogas plant that will use locally available animal waste to run a generator. This will substantially increase the capacity of the system and will bring down the per unit electricity cost. They also have many requests for connection from the local school, market shops, and other residents. The University of Oslo is also monitoring and evaluating the project on a regular basis to see the difference it has made to the lives of villagers.

Thanks are owed to Ariful Alam (head of the Climate Project for Grameenphone) and Dr Hanne Cecilie Geirbo of the University of Oslo for their assistance in organising and supporting Xavier's field visit to Pahapur and the community site.

Appendix 2

Case Study: Safaricom's Community Power Initiative in Kenya

By Erica Mackey, GSMA

History

Due to the slow pace of electricity infrastructure penetration in rural areas in Kenya, Safaricom began to receive requests to power certain projects within its off-grid stakeholder communities where the base stations were located. Given that Safaricom's mobile infrastructure were often producing excess power in order to provide coverage during peak demand, Safaricom decided to respond to these requests in two ways:

1. To provide electrical connections and ongoing power support for existing infrastructure that the community already owned like computers and water pumps.

2. To purchase infrastructure requested by the community, like street lighting, and provide electrical connections and ongoing power for this infrastructure.

In either case, the community itself was responsible for the maintenance and operating expenses outside of the power connection and provision.

Safaricom was motivated to respond to the communities' needs for a variety of reasons. First, as part of its Corporate Social Responsibility (CSR) programme, the Safaricom Foundation was able to build publicity around Safaricom's focus on empowering the community and its subscribers. Secondly, CPM deployments reduced its OPEX by creating community ownership over the BTS, which incentivised the community to increase local site security, reducing diesel theft by 10-20%. Finally, Safaricom believes that by increasing network access in off-grid rural sites, they will see an increase in the average revenue per user (ARPU).

Current State of Community Power

The initial Community Power deployment by Safaricom occurred in 2005 when the Kalama Community Wildlife Conservancy, which owned the land where the Archer's Post BTS[1] was to be built, asked Safaricom to provide power to pump water to fill a tank located within 200m of the BTS. The conservancy had previously purchased and installed the water pump and tank. Safaricom agreed to build the connection and provide ongoing power based on the fact that the CPM project would increase goodwill with its landlord and the community. This installation provided about 500 rural people with a place to water their livestock. The pump worked for about two years before Kalama built another water tank less than 1km from Archer's Post and connected it to the grid. Now this CPM installation is no longer required to power the water pump.

Since this initial deployment, Safaricom has spent a significant amount in capital and operating expenses to support over 30 CPM sites. While the vast majority of these sites host a mobile charging booth[2] at a minimum, Safaricom also supports water pumping, a community computer lab, street lighting, hospital lighting, sockets and lighting to community members (village chiefs and landlords) and a security surveillance radio.

Design Overview

The mobile towers that serve as the base of the Safaricom community power deployments are all off-grid and the power source is primarily a renewable hybrid of solar, wind and/or diesel. Safaricom currently has 115 green BTS and are now looking at outsourcing the financing and leasing of these green BTS on a lease to own model. They expect to have over 200 sites running off a green hybrid model within the next two years. Currently, the hybrid sites run the diesel generator for five hours a day on average and hold about three hours of back-up battery capacity. As these new, green hybrid sites rollout over the coming years in off-grid locations Safaricom may consider adding a mobile charging booth to each site. Each new CPM deployment design needs to be approved by Kenyan Lighting and Power.

1 See appendix for photos of Archer's Post BTS
2 See appendix for photos of Mobile Charging Booth

Lesson #1: In some geographies governments will want to be involved in an energy project that provides services to end user consumers.

In order to protect the energy provision for the base station (BTS) and ensure that the community does not syphon off a damaging amount of power, Safaricom has set up two circuit breakers designed to protect the BTS circuit from overloading. The breaker on the outside of the compound for the community power (outside tower) will switch at 40A and the breaker on the inside of the compound, designed for the BTS circuit, will switch at 63A. This way, the community power circuit will switch off before it draws a disruptive amount of power from the BTS.

In the past, Safaricom has considered any proposal for a CPM installation within 600 meters of the BTS. Most commonly, Safaricom would lay a limited mini-grid in response to these requests.

Business Model/Economics

As this program was developed as a CSR initiative for Safaricom, it currently does not directly charge for any of the electrical services for which they have installed.

Operations and Maintenance

No payment or metering systems are in place for the Safaricom deployments and the maintenance of the Community Power infrastructure has been completely turned over to the community after the initial installation knowing that people are happy with their service because they provide security for the generators and diesel.

The regional Safaricom engineers select one community member to man the charging booths and this person alone is given the key to the booth. This 'community volunteer' is often the landlord or a relative of the landlord and commonly begins to charge the market rate of 10-20 Ksh (US$0.10-0.20) per phone charge to compensate for his time of operating the booth. In informal interviews with community members, this resale market did not seem to impede on Safaricom's positive image created with the intention of free community services. In fact, it allowed other local charging businesses to compete as well.

Lesson #2: If the culture is to pay for things, don't give things away for free as you may alter the local business environment.

The BTS are maintained by sub-contractors which often selects one local Form four or Form six leaver (secondary school graduate) for BTS to act as a remote contact for emergency and security purposes. This remote contact visits the tower one time per month for regular surveillance and then is called to troubleshoot if there is a serious emergency.

Challenges and Obstacles

Safaricom's challenges are unique to the Community Power sector as it is purely providing services on a CSR basis. The technical team feels that the most prominent issue is that there is no official budget for these CPM deployments for CAPEX and OPEX investments. The Safaricom Foundation has been able to publicize the fruits of the efforts of the technical team, but there is some misalignment in incentives as the outputs of the deployments are not explicit.

Other challenges include:

- The incentives for Safaricom are not clearly defined without a clear revenue stream or measured impact on ARPU
- The national grid is expanding more rapidly than Safaricom expected
- More local stakeholders are involved than Safaricom is trained to deal with. The remoteness of their deployments means that there is very little monitoring that happens regularly. The sub-contractors do not always consider meeting community stakeholders when they arrive for routine maintenance.

The Future

Given that Safaricom has not monitored the impact of the CPM deployments very closely, there is no documentation linking a reduction in expenses or an increase in revenue to its outlay of capital expenditure. With more evaluation around the impact on revenue from the uplift in ARPU and increase in brand loyalty, the Safaricom may be able to leverage the innovative work they have done to date and expand their Community Power program.

Appendix 3

Case Study: SPEED – DESI Power in India

By Mary Roach, GSMA

History

DESI Power was founded in August 1996 by Dr. Hari Sharan, a seasoned professional in the energy sector, DASAG Seuzach, a Swiss energy technology company (reference Empowering Villages) and Dr. Ashok Khosla of Development Alternatives, New Delhi. Since its inception, DESI Power has built a total of 14 power plants. In the district of Araria in the state of Bihar, DESI Power has three power plants. Two of their power plants provide power to commercial customers and one of their plants is a community run power plant providing homes and markets with lighting and power for pumping and other microenterprises.

In late 2009, the Rockefeller Foundation launched the Smart Power for Environmentally-Sound Economic Development (SPPED) program jointly with DESI Power and other Indian partners with the aim of catalysing off-grid energy solutions in rural India via the support of the mobile sector. The first phase of the program was to test the use of mobile towers as anchor tenants to rural energy service companies who could benefit from their consistent and reliable demand for energy. In late 2010, SPEED partnered with DESI Power to validate the concept and inform the program structure.

DESI Power in the Market

DESI Power is a pioneer in the rural energy market. DESI Power commissioned their first 100kW plant in 1996 in Orchha, Madhya Pradesh which is still in operation as of August 2011. Since 1996 DESI Power has completed an additional 13 plants.

Since inception DESI Power has been focussed on trying to stimulate the growth of small and medium sized enterprises within underserved communities. As such, apart from providing power, DESI Power has been focussed on developing the right relationships with the villagers and management and financing tools which can make this model sustainable from the points of view of reliable and profitable operation as well climate change considerations. New entrants are continuing to emerge in the off-grid energy sector using a variety of energy resources but few have gotten beyond the pilot phase.

Current State of CPM

A total of three DESI Power plants are located in the Araria district with two of them being connected to towers.

In Jokihat, a roadside community connected to the grid with intermittent power, DESI Power operates a 50kW plant which provides 9-11 hours of electricity a day to a total of 32 commercial customers. Of these clients two are mobile tower consuming a combined load of 16kW.

The remaining 30 customers include a variety of local enterprises present and active in the market. Customers with low consumption rates use the access to electricity for lighting of their shops and operation of fans and computers. Customers with much large energy requirements include an agricultural processing plant which consumes approximately 8kW/hr.

In Gaiyari, DESI Power operates a 100kWe power plant which was designed around an industrial rice mill which required 60kW. The remaining 40kWe were to be consumed by other commercial clients including four mobile towers consuming a total of 22 kW. At the time of our visit in August 2011 the Gaiyari plant was closed as the rice mill had closed and it was decided by the local community, shareholders in the plant, and DESI Power to close the biomass plant temporarily to avoid operating at a loss. DESI Power is in the process of reconfiguring the plant and will have it up and running in the coming months.

Lesson #1: Bio-gasifiers pose a challenge in that they are sized to a particular load. If the main anchor tenant represents an overly large proportion of the energy demand then the ESCOs business model may be at risk.

Lesson #2: ESCOs must have back-up means of providing power to mobile operators if they want to be considered as the primary power producer.

Design Overview

The system developed by DESI Power has two main components: the power plant and the distribution and metering system.

The Power Plant

DESI Power's power plant includes a biomass gasification unit, control systems, and a gas engine. The bio-gasification unit uses heat and steam to convert biomass into gas that is then used to power the pure gas/diesel generator. The Jokihat power plant is equipped with two gasifiers (a 75kW gasifier and an 11kW back-up gasifier) and a gas engine. The gas engine runs only on gas while diesel engine can be run on a dual fuel system including "20 to 30% diesel fuel".[1]

Biomass Source

The Jokihat unit is primarily run on Dhaincha, corn cobs and firewood. The wood is locally sourced from entrepreneurs. DESI Power is starting its first 10 acre energy plantation in Baharbari and plans to include one in every village project for exclusive use by their power station.

Distribution and Metering

The distribution system that DESI Power has developed is remarkably simple and effective. DESI Power has chosen to run their power cables below ground to minimise damage to the network and illegal taping. They provide both three phase and single phase power as required by their clients. They place above ground metering boxes which are easily visible and easy to read by their commercial customers and DESI Power's staff but which are guarded against tampering. As the physical plant is located in proximity to the Jokihat market, it is quite easy for one of DESI's employees to conduct daily metering for their customers. Many of DESI's customers prefer to be billed daily to ensure that they are able to pay their electricity bills.

Lesson #3: Running wiring underground reduces illegal taping.

Business Model/Economics

DESI Power is currently in the process of reviewing their business model to incorporate the lessons learnt from SPEED Phase I such that they can become a financially successful organisation. The business model used at the time of our visit is below:

Business Model	Lighting Mini-Grid to commercial customers
Business Type	Quasi Commercial- pay back capital but not developed to provide large profits
Operating Expense	Feedstock + cost of two staff to manage the plant
Revenue Model	Approximately US$0.30/kWh
Monthly Revenue	Approximately $4,500 assuming 10 hrs/day of operation

Lesson #4: Customers in areas with poor grid connectivity are willing to pay above electricity board prices for access to reliable power.

Operations and Maintenance

The Jokihat plant is managed by two operators that ensure regular operation of plant including loading of biomass in the gasifier, regular maintenance, maintaining daily log book of the plant and collection of bills.

1 http://cdf.ifmr.ac.in/wp-content/uploads/2011/03/Empowering-Villages.pdf

Challenges and Obstacles

To date DESI Power's largest challenge has been to develop a model that allows them to achieve scale in a financially sustainable manner while also achieving their mandate to support rural entrepreneurship. As a pioneer, they have been heavily dependent on grant funding to develop both the technology and their concept but are now better positioned for commercial scaling.

The main challenges that DESI faces with their model include:

- Proper sizing of plants: While mobile towers provide a consistent demand for electricity they do not require large loads. The lessons from Gaiyari have shown DESI Power what happens when you build a large plant around the demands of one customer, and that customer folds
- 24hr reliable power: Tower operators are hoping to simplify their operations and looking for complete turn-key energy solutions with outsourced O&M. While the current system provides tower operators 10-11 hours of relief from diesel power generation it doesn't provide them complete relief from managing their energy requirements. For DESI Power to thrive as a vendor to Tower Companies they will need to develop a complete turn-key solution.

The Future

Going forward DESI Power is looking at ways to drive commercial activity and scale. Based off of their learning in Araria, they are planning to progress with three models:

1. Design of plants for 24 hr provision of electricity to mobile towers and small scale commercial tenants. DESI Power has been hard at work developing plans for 25 to 40 kW hybrid energy systems (biomass gasification, biogas, PV in Bihar and also wind and small hydro where available) along with a Power System Management Module to optimise load and generation to ensure financial viability and to be able to provide a turn-key energy solution to mobile tower operators.

2. Direct contracting with commercial clients: Working to build energy provision solution for exclusive use by commercial entities. DESI Power is willing to consider design to turn key and operation and maintenance contracts.

3. Village EmPower: Building off their success in the rural village of Baharbari, DESI Power is committed to work with off-grid communities on village managed energy systems. The aim is to work with like-minded partners who can facilitate the development of rural enterprises and help to grow demand for the energy produced. As part of this work, DESI Power is also working to promote cleaner cooking solutions.

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