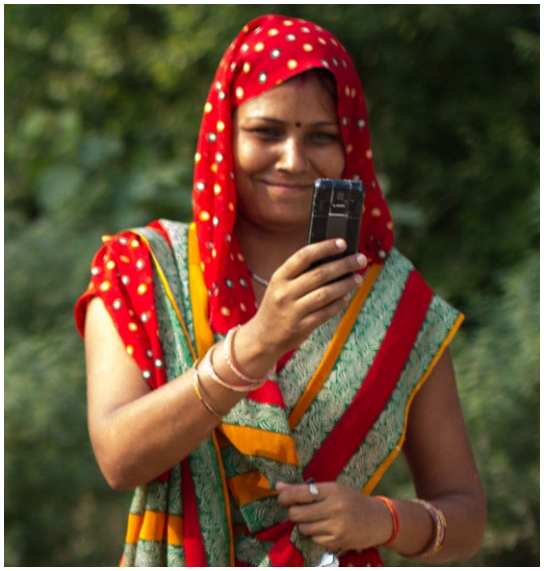
IFC International Finance Corporation
World Bank Group

GSMA Green Power for Mobile

In partnership with the Netherlands

Bi-annual Report July 2013



Contents

Welcome Note

This, the eighth Green Power for Mobile Bi-annual report, will capture all the main exciting activities that have happened over the past six months. It has been a frantic and immensely productive start to the New Year. Jointly with our partner, the International Finance Corporation (IFC), we have hosted four industry working groups, published 9 reports or case studies and seen the number of deployed renewable energy sites grow to reach over 35,000 to date.

To follow up on the Market Analysis reports previously published for GPM's focus countries, the team has now created Vendor Landscaping reports for each of those countries. The Vendor Landscaping reports aim to give the mobile operators a snapshot of the renewable energy vendors and service providers present within these countries. These Vendor Landscape documents have been completed for Kenya, Tanzania, Uganda, Nigeria, Ghana, Cameroon, Senegal, Indonesia and Bangladesh. All the reports are available on the Green Power for Mobile Website and summaries of the Bangladesh, Indonesia, Senegal and Cameroon Market Analyses are included in this Bi-annual report.

As Bharti Infratel's article on energy management illustrates, India continues to be a progressive market; deploying green technologies, suchas biomass and fuel cells, as well as green sites on an on-going basis.

The Green Power for Mobile team continues to host industry working groups. In the past six months four have been hosted – in Dhaka for the Bangladesh market, Kampala for the African Market, in Lagos for the Nigerian market and in Delhi for the Indian Market. Highlights of these are provided in Chapter 1 and detailed summaries can be found on our website. The strong and growing attendance at the GPM Working Groups is evidence of the hard work and commitment that the industry is showing towards energy efficiency and renewable energy for base station sites. We strive to continually improve and meet industry demand with the working groups by bringing out relevant discussion topics and presenting new trends in the sector.

The final section of this report will look at the Mobile Enabled Community Services programme, which builds from and is the successor of our IFC funded Community Power programme (CPM) which focussed on the role that the mobile industry can play in improving access to energy. The programme grew its scope of research to look at opportunities to leverage mobile telecommunications (infrastructure, technology or supply chain) to provide commercially sustainable energy, but also water, services to the surrounding underserved and isolated communities. The section will look at how mobile communications canbe applied to energy and water services and look at examples from the Feasibility Studies conducted with Safaricom in Kenya, TNM in Malawi and the M-Kopa product.

I trust you will find this edition of the Bi-annual Report educational and informative. We look forward to working with you on the issues raised in this report and establishing a work plan for the programme's next phase.

Areef Kassam
GSMA Programme Director – Green Power for Mobile

Meet the Team

Who's who in GPM and MECS

Ferdous Mottakin

GPM Programme Manager

Ferdous is the Green Power for Mobile Programme Manager. Within GSMA Mobile for Development, he is responsible for leading and managing the programme globally. Additionally, his role involves creating industry collaborations and enhancing mobile for development outreach. Prior to his role as Programme Manager, Ferdous successful completed the India-specific GPM project for 18 months. Before joining the GSMA, Ferdous spent much of his career working across the globe in different areas of the telecom industry. Ferdous holds a Bachelor degree of Electrical Engineering from Simon Fraser University of British Columbia.

Satish Kumar

GPM Africa Project Manager

As the Africa Project Manager, Satish leads the focus and activities of the Green Power for Mobile (GPM) programme for the African region and is responsible for the overall programme focus and deliverables for Africa. Within GPM, he has previously conducted several Green Power Feasibility studies across countries in Africa and Asia, and contributed to the knowledge base through case studies and publications. Prior to GSMA, Satish has worked in various roles engaging with government bodies and organizations across telecoms, renewable energies and rural enterprises. He holds a Bachelor's degree in Electrical Engineering from IIT Kanpur and an MBA from IIM Bangalore.

Ali Imron

GPM Asia Project Manager

In his role, he is responsible for conduction Green Power market analysis, feasibility studies and vendor landscaping deliverable in Asia Region. Ali has varied experience working with operator on O&M field and vendor as well. Ali holds degree from STT Telkom Bandung.

Areef Kassam

GPM Programme Director

Areef is the Green Power for Mobile Programme Director. In this role he is responsible for Managing the development and delivery the programme products and services that are tailored to support operators in the decision-making process around deploying renewable energy for base station power.

Hélène Smertnik

MECS Market Intelligence Analyst

Hélène is the Market Intelligence Analyst for the MECS Programme. She manages the programme's marketing and convening activities and supports regional and industry research (OR ANALYSIS) Hélène also supports the Green Power from Mobile Programme's marketing activities. She manages the organisation of both programmes' Working Groups. Hélène joined the GSMA following her master's dissertation on "The use of mobile as a tool for development in Kenya" during which she developed a strong interest in business-led development, using telecommunication technology and infrastructure to create socio-economic impact.

Mary Roach

MECS Operations Manager

Mary is the Programme Operations Manager for the MECS Programme. She is responsible for the overall management of the MECS Innovation Fund and leads the team delivering advisory services to mobile operators and support to the MECS ecosystem of organisations. Prior to joining the GSMA in 2011, she spent two years working on rural energy solutions in sub-Saharan Africa, including an early trial of pay-as-you-go access to energy using mobile money. Mary's interest in the role that energy can play in development emerged from the combined experiences of her 5 years working with GE Power Generation in project and operations management and decade of involvement with Engineers without Borders Canada at home and abroad . She holds a MBA from Oxford University and a Bachelors in Chemical Engineering from McGill University.

Michael Nique

MECS Innovation Manager

Michael joined GSMA Mobile for Development in June 2010 and now leads Innovation and Research Activities for the MECS programme. This includes monitoring and disseminating content related to technological and business model innovations affecting the energy, water and sanitation sectors; spending time on the field meeting innovators and communities to uncover insights on the usage and impact of mobile technologies. A strong focus of his work is related to the opportunity of using smart solutions, i.e. Machine to Machine modules, for decentralized access to energy & water services. Prior to the GSMA, Michael has been involved in various roles related to Innovation & Technology in France and the United States. Michael is originally from France and has a degree in Microelectronics from Université Joseph Fourier in Grenoble.

Charlotte Ward

MECS Business Development Manager

Charlotte brings over 12 years of experience in investment banking, carbon finance, renewable energy and telecom to her role in GSMA Mobile for Development, leading development of the Mobile Enabled Community Services programme. Charlotte lives in Nairobi. Prior to joining the GSMA in 2011, Charlotte consulted government and corporates on carbon and energy projects in East Africa, following 8 years with Deutsche Bank in global capital markets in business development, sales and trading. Charlotte has a Master's Degree in Applied Environmental Science from Sydney University and a Bachelor's Degree in Geography from Bristol University.

Rahul Shah

MECS Asia Technical Analyst

Rahul Shah is the Asia Project Manager for the MECS Programme. He is responsible for supporting the MECS Innovation Grant Fund in Asia through advisory to applicants and grantees, and for building relationships with the MECS ecosystem comprising MNOs, tower companies, ESCOs, WSPs, academics, NGOs, etc.; Rahul has a varied professional background ranging from engineering of wireless communications systems to general management in solar energy, media & entertainment and children's activities. He has an MSEE with a major in digital signal processing from the University of Missouri-Rolla and an MBA in general management from IIM-Ahmedabad.

Ilana Cohen

MECS Africa Technical Analyst

Ilana Cohen is the Africa Project Manager for the MECS Programme. She is responsible for supporting the MECS Innovation Grant Fund in Africa through advisory to applicants and grantees, and for building relationships with the MECS ecosystem comprising MNOs, tower companies, ESCOs, WSPs, academics, NGOs, etc. Prior to joining the GSMA she spent 2 years as a consultant in water and sanitation services, including the application of mobile tools. She was involved in research and organisation of the World Bank led Water and Sanitation Hackathons in London. Prior to this she worked as an environmental consultant carrying out environmental impact assessments. Ilana holds an MSc from Oxford University in Water Science, Policy and Management and a Bachelors in Biology from Brandeis University.

Chapter 1

Overview of Green Power for Mobile Programme activities

By Hélène Smertnik, GSMA

Following our welcome note, this chapter will provide an overview of GPM's programme activities for the last 6 months in both the Africa and Asia region. These activities and tools include the Green Deployment Tracker, regional and country-focussed market analyses, feasibility studies, vendor directories, procurement guides, working groups and bi-annual reports. All aim at demonstrating the potential of green power to reduce telecom operators and tower companies' dependency on diesel power.

The Green Deployment Tracker

Since its creation in 2010, the Green Deployment tracker figures – i.e. the number of green deployments installed – are constantly growing, especially in Asia and illustrate the operators' willingness to invest in green power technologies. Globally, green deployments have increased from 9000 in 2010 to over 35,000 this year. GPM estimates that there will be more than 40,000 installed green sites in the coming year.

The Green Deployment Tracker is publically accessible online through Mobile for Development Intelligence plateform [click here]. The data-driven portal for our member operators and wider vendor community is a fantastic resource providing information on organisations' energy portfolios (their green products or initiatives) as well as data analytics and metrics.

Market Analyses

GPM's market analysis reports lay out the opportunity that powering telecom networks through green energy alternatives holds in any given country. After assessing the current state of telecom and power infrastructure, the regulatory environment and the current approach to powering telecoms in the selected country, the report evaluates the availability of green power resources and the opportunity for OPEX savings in that market.

In the last 6 months, GPM has produced four market analysis reports, identifying focus countries for each region. The Africa Market Analyses looked at West and Francophone Africa, in line with GPM's new scope of work in that region. The Asia Market Analyses covered the Southern region looked at Indonesia and Bangladesh.

Feasibility Studies

Up to now, GPM has successfully conducted more than 27 feasibility studies for mobile operators worldwide. Through data collection, model design, financial analysis and business case development among others, GPM Feasibility Studies explore and prove the viability of alternative energy options to power the network of telecom sites.

GPM's latest feasibility study which will be detailed in Chapter 4 analysed Airtel Madagascar's entire network of sites.

Homer Software –Renewable Energy Design Tool
In the elaboration of a feasibility study, one of GPM's tools for designing and analysing the feasibility of renewable energy for telecom sites is the Homer Software. GPM has made a video training available on line (to understand the key design elements to optimize green power and optimize CAPEX required for deploying green power on MNOs' networks.

Vendor Landscapes

Vendor landscapes are an important part of GPM's efforts to grow the Green Power community and no less than four country-specific and one general GPM vendor landscapes have been published since January. Vendor landscapes aim at supporting mobile operators in their green power initiatives by providing them with a profile directory of green power vendors and service providers operating in or focusing on the targeted market.

GPM Resources are all available to download here.

Working Groups

Bangladesh Working Group, 11 May 2013

The last three Working Group organised by the GPM team, in partnership with the IFC, have been great successes. Despite the political unrest Bangladesh has been experiencing, the Working Group, which took place in Dhaka in May, reunited more than 35 industry stakeholders. The day-long event, co-hosted by Robi, showcased the industry's effort to deploy green power for their networks, in light of the country's target to achieve 5% green sites by 2015.

Mobile Network Operators Robi and Airtel presented their green roadmap, introducing their energy efficiency strategies for the upcoming years. The participants heard about the industry's new technology developments and business innovation models in the green space. The government also contributed to the discussion, highlighting the need to continue the dialogue with MNOs and encourage them to convert to renewable energy sources.

Overall, the tone of the Working Group was positive, as MNOs are interested to invest in green solutions inasmuch as they lead to OPEX savings and help acheive the 5% target set by the government for 2015. Challenges remain, such as the lack of sustainable green solutions offered by vendors or taxes on batteries, which will require a concerted effort from the industry and the government to overcome.

Africa Regional Working Group, 28-29 May 2013

The Africa Regional Working Group was a great opportunity to assess the current appetite for green power in the region, focusing on East Africa as the Working Group took place in Kampala, Uganda. Green Networks, the event's co-host, described the company's overall strategy to address the energy challenges they face in their unique markets, which include Uganda, Sierra Leone, and South Sudan. Uganda Telecom presented their green initiatives, including improved network energy costs and optimized power purchase. Then vendors SunPower and Ballard introduced their renewable energy solutions, highlighting the opportunities and the challenges that these solutions present. Later in the day, NorthStar Battery described storage techniques in telecoms highlighting the importance of efficient and long lasting batteries for stable power generation systems. Huawei then gave an overview of the different off-grid scenarios for the emerging markets. The second day of the Working Group, Orun Energy and Pamoja Cleantech presented their new business models for green power deployments.

India Working Group, 4-5 June 2013

Following the Africa Regional Working Group in Kampala, GPM organised its 5th India Working Group in Delhi on June 4-5, in partnership with the IFC. The event was co-hosted by Vodafone and successfully convened over 50 delegates from across the industry spectrum – from MNOs to Community Service Providers, including the main Tower Companies. The Working Group triggered interesting conversations on green power deployments and its impact on the telecoms sector in India. The first panel reunited the CEOs of three major tower companies: Bharti Infratel, Indus Towers and ATC India, to discuss in detail their green strategies. The operators Idea Cellular and Vodafone then shared their experiences and presented their strategies to successfully deploy green solutions. Vendors, Intelligent Energy, KMRI and Applied Solar Technologies also provided their respective approaches to green deployments in India, leading to a debate on the level of engagement required from the industry stakeholders. The Working Group concluded on one of the biggest remaining challenge to overcome: bridging the financing gap to bring green deployments to scale.

India article: Bharti Infratel's Green Initiative

As mentioned in the welcome note and the latest Working Group illustrates, India is an crucial market for Green Power for Mobile, repetitively proving its forward thinking strategies and taking the lead on greening the telecom network. As one of GPM's strongest supporters, Bharti Infratel, in chapter 5, presents their GreenTowers P7 Program, their path breaking initiative towards adopting cleaner technologies for power generation and energy efficiency for telecom towers.

MECS Programme

Building on GPM's research and expertise, the Mobile Enabled Community Services (MECS) Programme looks at the use of mobile technology and infrastructure to provide access to basic energy and water services to underserved communities. The bi-annual report dedicates a section to presenting some of the programme's activities and research. MECS's Energy Access Deployment tracker [click here] provides a landscape of the deployment of Community Power Services in emerging markets.

Similar to GPM, MECS conducted Feasibility studies evaluating Safaricom and TNM's opportunity to improve community services from mobile for their customers while improving the business case to serve off-grid areas.

MECS succeeds to the Community Power from Mobile programme, including water access to underserved communities as one of the Programme's priorities. Chapter 8 introduces the "Sustainable Energy and Water Access through M2M Connectivity"[1] report and explains how the water segment fits into the programme.

Following the publication, we asked Nick Hughes, co-founder at M-KOPA, to give his perspective on how mobile innovation is impacting the population his company is serving, what key challenges lay ahead and what should be done to overcome these challenges.

To conclude, Chapter 10 presents the new MECS Innovation Fund, which aims at providing focussed resources to accelerate the development and trial of products and services improving access to basic energy and water services to underserved communities using the mobile channel. Beyond this goal, MECS wishes, through this fund, to spark the conversation and support the creation of new ideas, that explore the use of mobile in the delivery of other community services.

1. http://www.gsma.com/mobilefordevelopment/sustainable-energy-water-access-through-m2m-connectivity

Chapter 2

Powering Telecoms: Green Power for Mobile Market Analysis – West and Francophone Africa

By Satish Kumar, GSMA

The Green Power for Mobile (GPM) programme, in its latest market analysis reports for West Africa and Francophone Africa, assess the potential opportunity for adopting green power alternatives to power the telecom networks. In order to do so, GPM chose two key focus countries in each region - Nigeria and Ghana in West Africa and Cameroon and Senegal in Francophone Africa.

The reports look at different key aspects across thesemarkets, including the current state of telecoms and power infrastructure, the regulatory environment, the current approach to powering telecoms, the analysis of green power resources and the potential opportunity for OPEX savings.

The market analysis reports broadly cover the following topics and facilitate the understanding of the overall market and the potential for OPEX savings going forward:

- The telecoms' current growth context
- Powering infrastructure and its impact on this growth
- Current approaches to powering telecoms networks and the challenges faced by telecom operators when powering their networks
- The green choices, their fit and challenges to adoption
- The market potential for green alternatives to power the network and the way forward for addressing OPEX challenges

In this article, we briefly present the key analysis and findings from the Green Power Market Analysis reports published for West Africa and Francophone Africa.

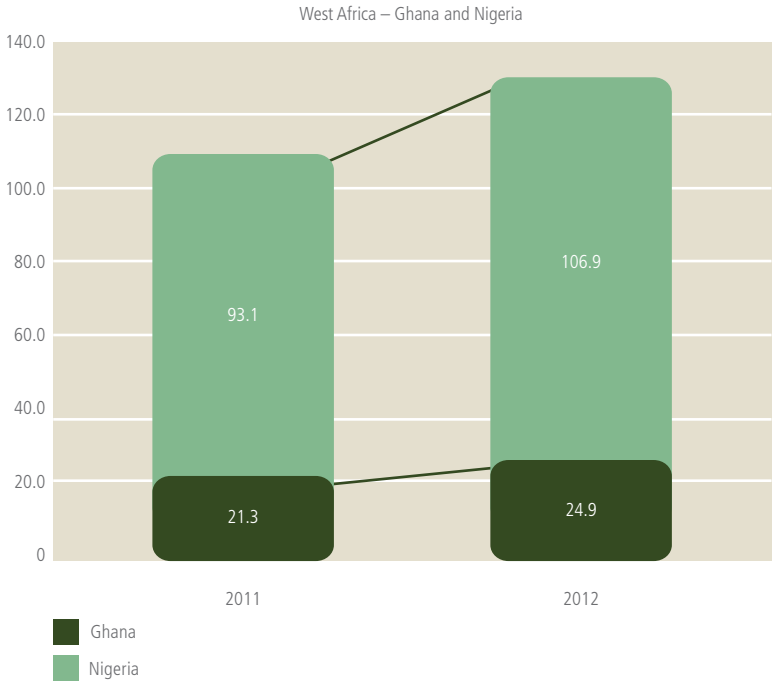
1 GSMA GPM Research and Analysis (source: published reports from Communications Commission of Kenya (CCK) – www.cck.go.ke, Tanzania Communications Regulatory Authority (TCRA) – www.tcra.go.tz, Uganda Communications Commission (UCC) – www.ucc.co.ug)

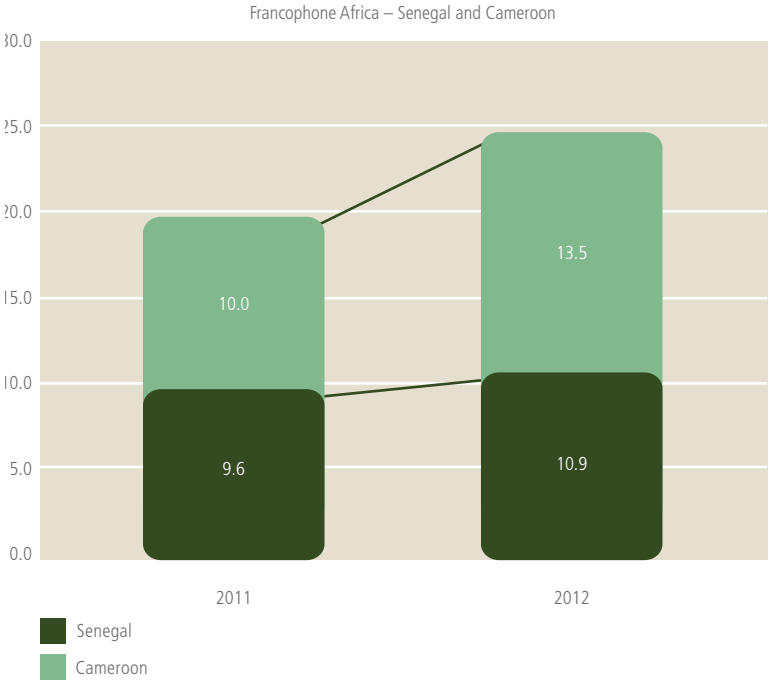
Overview and the Network Size

In the West African region, Ghana and Nigeria have recorded a significant growth reaching a subscriber base of 25 and 107 million respectively. Despite an impressive growth and good penetration levels, at 99.7% and 85% respectively, nearly 20% of the population is yet to be covered by mobile network signals.

In Francophone Africa, Cameroon and Senegal have recorded a subscriber base of 11 and 13.5 million, growing at over 13% and 35% respectively over the last year. At a mobile penetration levels of 67.3% and 85.3% respectively, 85% of the Cameroonians and 87% of the Senegalese are covered by mobile network signals.

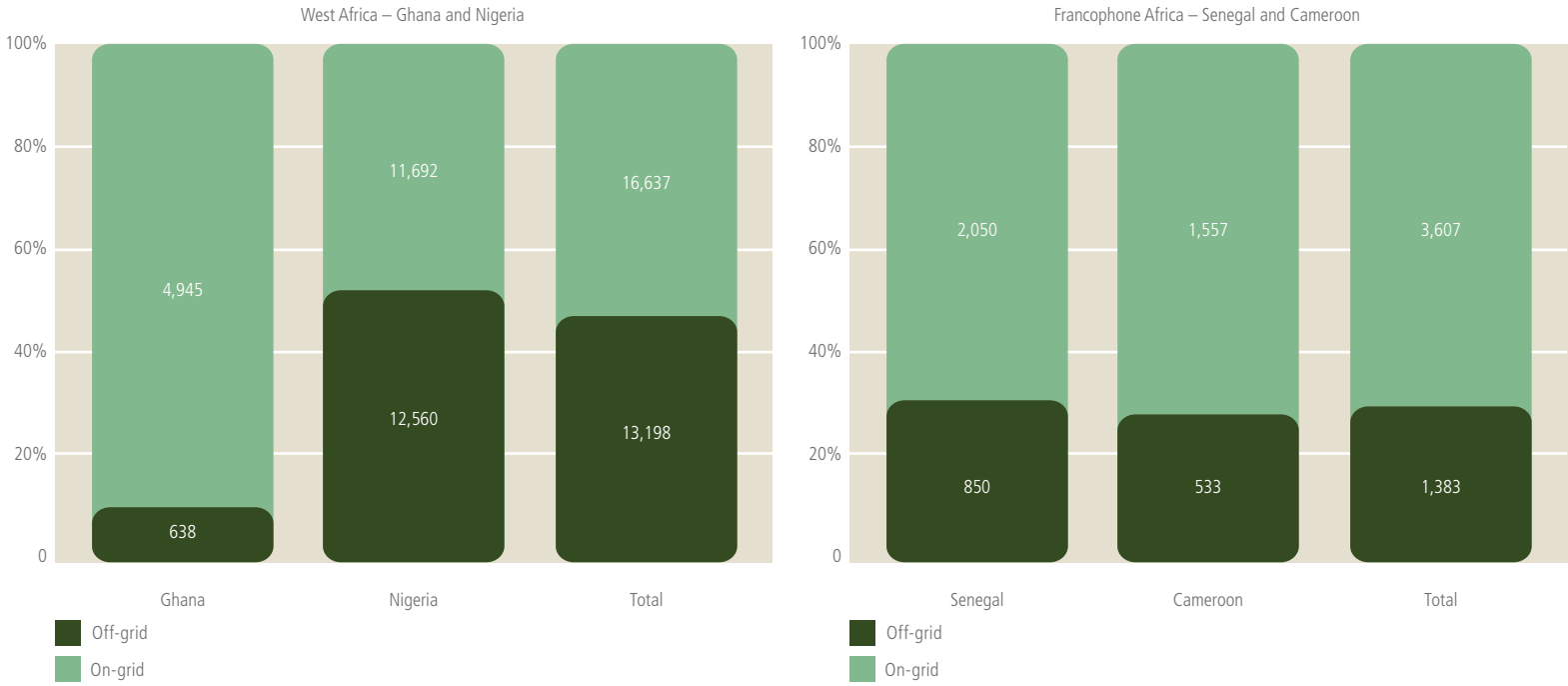
Figure 1: Subscriber base (numbers and growth)





Most of the uncovered population lives in rural and remote areas, far from access to any modern infrastructure such as electricity or roads. This presents challenges for future growth of the networks due to higher investment costs and lower returns, with higher operations and maintenance costs of the network.

Figure 2: Network Size (number of sites by On/Off-grid)



Ghana and Nigeria together have a total of 29,835 sites, of which 16,637 are connected to commercial power grid, and a remaining 13,198 are off-grid sites. Out of the total 24,252 telecom sites in Nigeria, around 52% of the sites are off-grid, i.e. located in places without access to grid power supply, against only 11% of in Ghana. In addition, due to Nigeria's poor grid power supply, over 81% of its on-grid sites suffer from power outages for up to 6 hours a day.

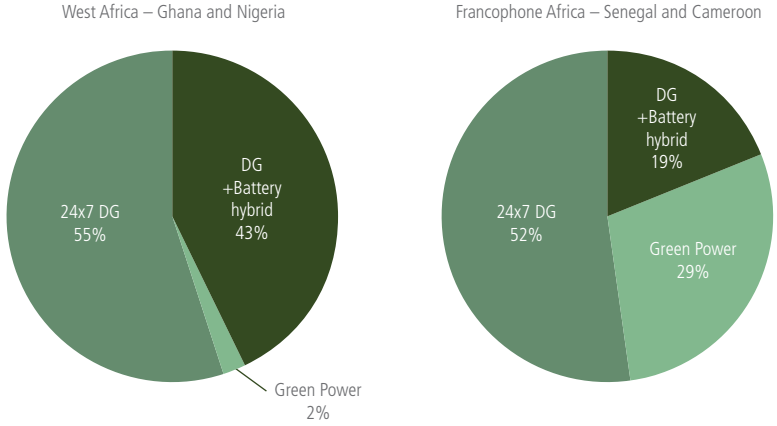
On the contrary, the number of off-grid sites in Cameroon and Senegal stands at 533 and 850 sites respectively, nearly 28% of the total 4,990 sites in both the countries. The remaining 3,607 sites are on-grid sites and have grid power supply with variable quality and reliability.

The Current Powering Scenario

More than 99% of the on-grid sites in the two West African countries have diesel generator as backup source against around 76% in the Francophone countries. Nearly 23% of on-grid sites in the Francophone countries use on-grid power as the only primary power source. Green power deployments at on-grid sites represent less than 1% in both the regions.

More than 50% of off-grid sites in both Francophone and West African countries are powered by 24x7 DG power solution. The two countries in the Francophone region have been encouraging green power deployments, which stands at 29% of the total off-grid sites against only 2% in Nigeria and Ghana. On the contrary, Nigeria and Ghana have around 43% DG-battery hybrid deployments against only 19% in Cameroon and Senegal.

Figure 3: Current Power Solutions deployed (Off-grid sites)



Green Choices: Potential and Adoption

The availability of green power alternatives in both regions and their fit for adoption in the telecom industry are presented below. The below table also identifies the barriers to adoption and the risks associated with each of them.

Green Choices: Potential Choice for Telecoms vs. Adoption

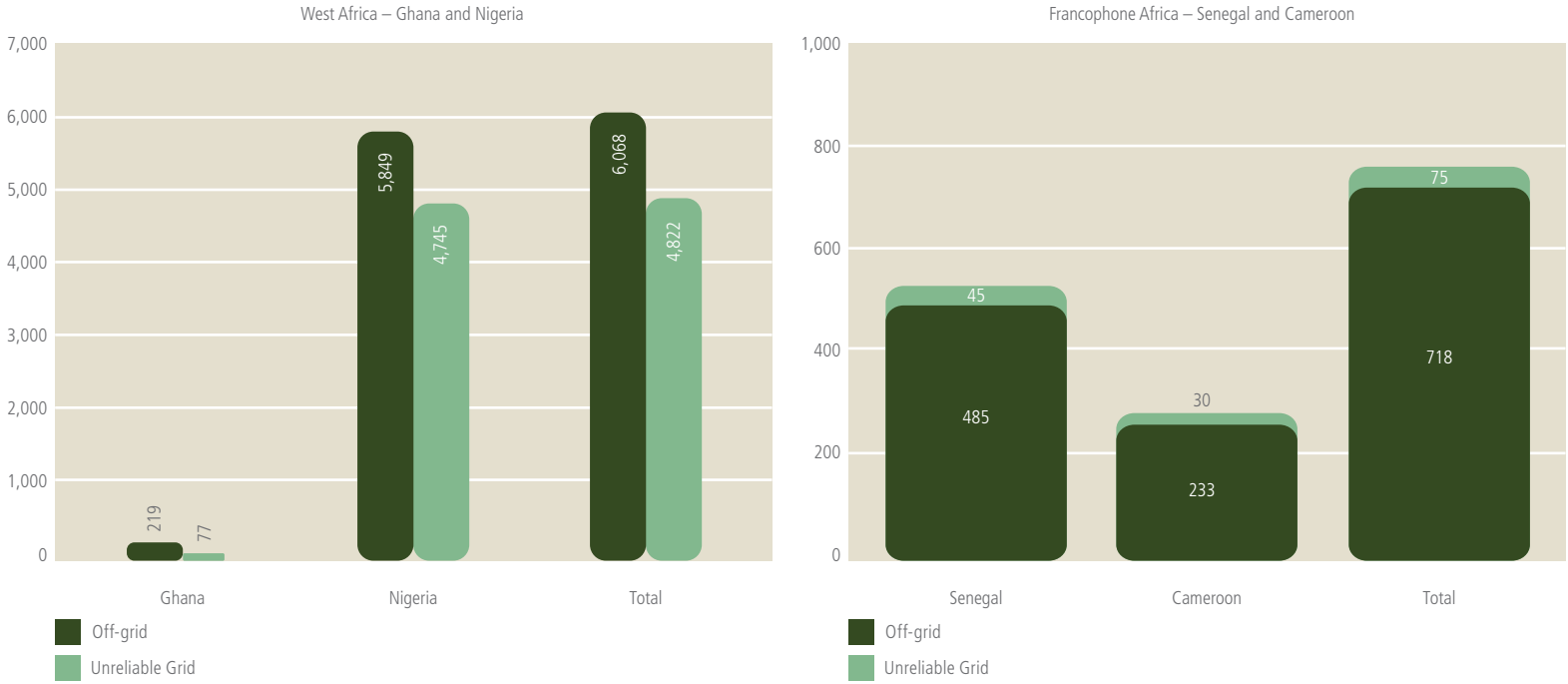
	Solar	Wind	Biomass	Fuel Cell	Pico-Hydro
Ghana	High	Medium to Low	Low	Medium to Low	Low
Nigeria	High	Medium	Low	Medium to Low	Low
Senegal	High	Low	Low	Low	Low
Cameroon	High	Low	Medium	Low	Medium to Low
Stage of Adoption	Commercial	Pre-pilot to Pilot	Pre-pilot	Pre-pilot	Pre-pilot
Barriers to Adoption	Higher pricing of solar power systems leading to large CAPEX requirement High load in multi-tenant scenario for tower companies Availability of local support for spare parts and Support from O&M partners for maintenance Lack of regulatory support and clear guidelines for green power adoption	Reliability of power generation Low scalability and high investment No satisfactory pilot results	Unavailability of vendors and technology adoption Operational complexity and Supply challenges Pre-pilot stage and unproven operational feasibility	Inhibition from using hydrogen fuel tanks in the premises due to perceived safety issues High initial CAPEX and Fuel supply challenges OPEX Savings not yet established	Low market awareness Availability of water body close to tower locations Cost of technology Regulatory clearance
Risks of Adoption	Operational risk in terms of local challenges in theft and breaking of solar panels Local support and availability of spares	Low energy resource Unreliable wind speeds and change of wind direction by season	Biomass supply and sustainability Reliability issues due to breakage in supply links	High replacement cost of fuel cells Reliability of fuel supply	Operational risks associated with limited knowledge and readiness

The Green Power Market Size and OPEX Saving Potential

Based on the current network characteristics and the powering supply scenario, a total of 11,683 sites (10,890 sites in West Africa and 793 sites in Francophone region) are estimated to offer an opportunity for deployment of green power alternatives. Nearly 60% of these sites are off-grid sites currently powered by diesel based power solutions and the remaining are unreliable-grid sites.

Based on current OPEX and diesel consumption, GPM estimates that a total OPEX savings of over US$ 200 million per annum and reduction in diesel consumption by over 70% from current levels can be achieved by deploying green alternatives at the above potential sites.

Figure 4: Green Power potential (No. of sites)

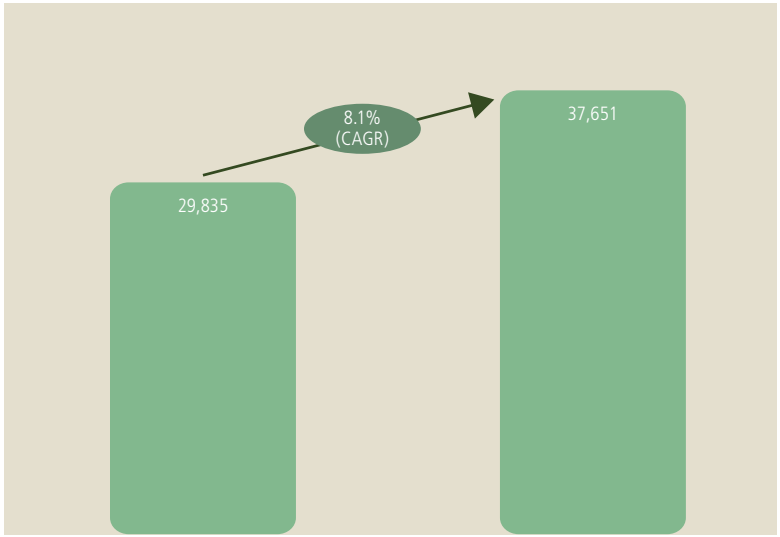


Long Term Growth Outlook

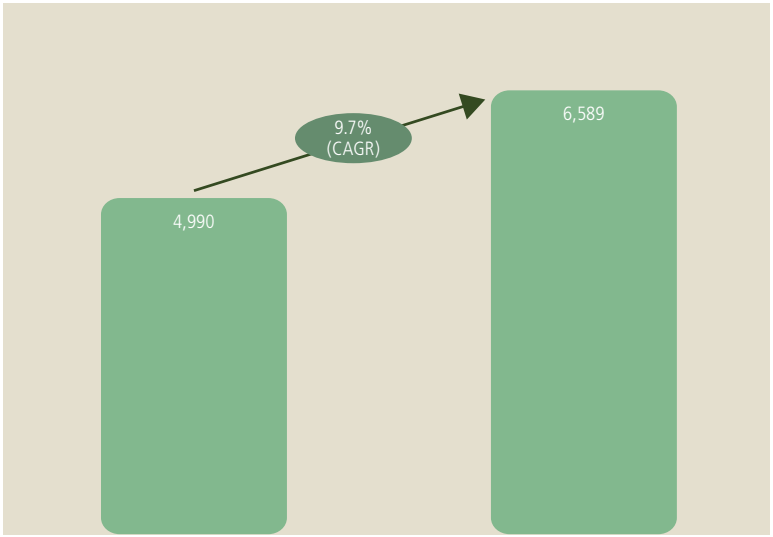
The long term growth outlook for both Francophone and West African countries is illustrated below. GPM estimates that the total number telecom tower sites in Ghana and Nigeria would reach to 37,651 sites by 2015 at a CAGR (cumulative annual growth rate) of around 8%. The estimated number of sites for Cameroon and Senegal is 6,589 sites by 2015 at a CAGR of close to 10%. These estimates are based on the market growth outlook taking into consideration the current levels of penetration, network coverage, and network capacity and associated demographic parameters including population density and growth.

Figure 5: Network Growth (No. of sites)

West Africa – Ghana and Nigeria



Francophone Africa – Senegal and Cameroon



Conclusion

The current state of power infrastructure and the cost of powering telecom sites in both West and Francophone Africa have led the operators to adopt various OPEX saving solutions including green power.

However, the adoption of green power as an OPEX saving alternative has not reached the potential scale and hence, presents an untapped opportunity for operators.

Chapter 3

Greening the Network: Bangladesh and Indonesia Market Analyses

By Ali Imron, GSMA

The Green Power for Mobile (GPM) programme has recently published two market analysis reports for Bangladesh and Indonesia. The reports present the power situation in the telecom network and the adoption of green technology in both these countries.

The reports focus on the power situation and the challenges it presents for the telecom industry in Bangladesh and Indonesia. The market analysis reports forecast the telecom towers' growth and the potential opportunity of green deployments, including the current state of power and infrastructure deployment. They also look at the energy regulation for telecom sector, the potential green resources, the investment for green technology telecom industry and the potential OPEX saving for MNOs.

The market analysis reports broadly cover the following topics and facilitate the understanding of the overall market and the potential for OPEX savings going forward:

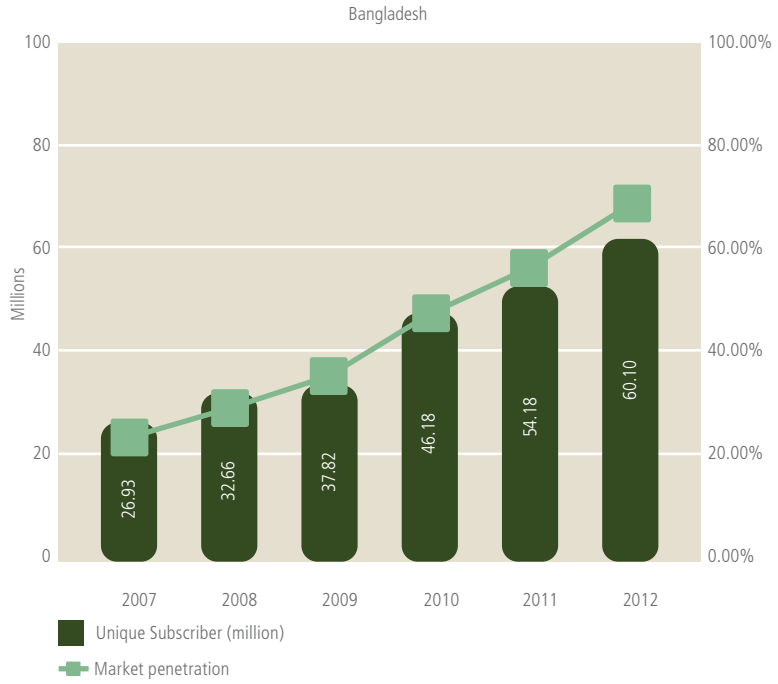
- The energy situation and energy regulation in both countries
- The telecommunication market
- The energy eco-system
- The current approach of power solution deployment in MNOs
- The potential of green telecom and market sizing
- The way forward for addressing power challenges

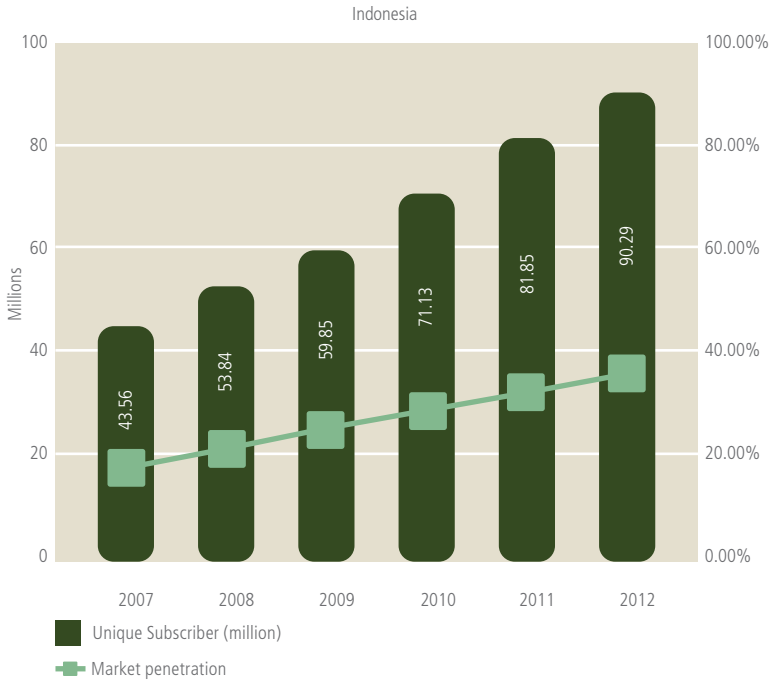
In this article, GSMA summarizes the key findings of the Bangladesh and Indonesia Market Analyses that are published and available on the GSMA website. [click here]

Telecom Sector

The telecom industry is one of the key driving forces for the socio-economic development of Bangladesh and Indonesia. Indonesia, with a population of 242.32 million, is leading in terms of unique mobile subscriber with 90.29 million in comparison to Bangladesh with a total number of unique subscriber of 60.1 million. However, in terms of market penetration, Bangladesh's market has reached around 70% whereas Indonesia has only reached 36%.

Figure 1. Market Penetration





In Bangladesh, most mobile network operators (MNOs) operate in 2G and 2.5G technology. 3G services were launched in October 2012 by the government-owned operator, which may lead to opening of 3G licenses for private operators. Indonesia is more advance in terms of implementing GSM technology and MNOs are running 2G, and up to 3.5G, technology across the country.

Green Technology Adoption in Telecom

Green technology options available vary between Bangladesh and Indonesia and the level of adoption is also different. The table below presents the green technology options for the telecom industry.

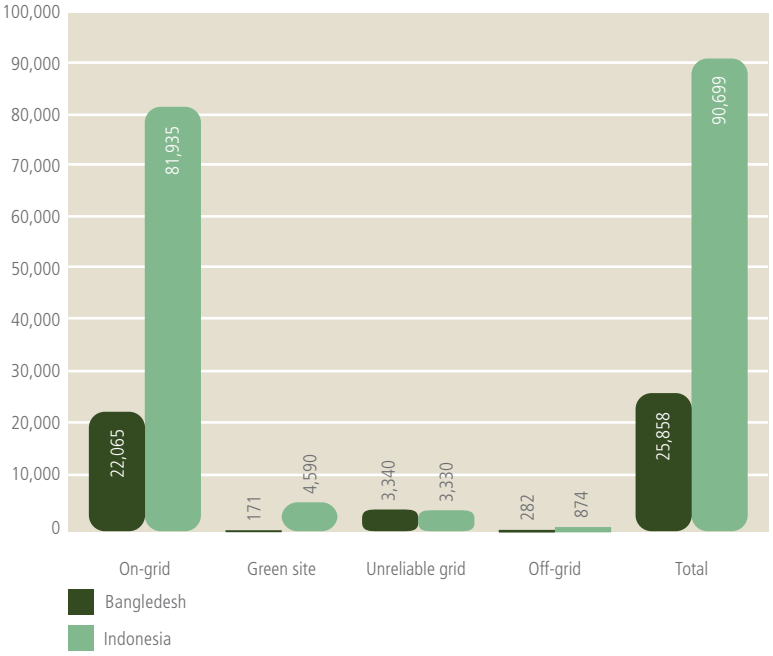
Green Technology Choices vs. Adoption

	Solar	Biomass	Wind	Fuel Cell	Pico Hydro
Bangladesh	Good	Poor	Poor	Poor	Poor
Indonesia	Good	Good	Good	Good	Good
Stage of Adoption in Bangladesh	Commercial	N/A	N/A	N/A	N/A
Stage of Adoption in Indonesia	Commercial	N/A	Commercial	Commercial	Commercial
Resource Potential	Moderate	Good	Low	Low-Moderate	Low
Barriers to Adopt	High CAPEX on initial stage Space requirement	Supply chain challenges Unproven operational trial in telecom field Business model offering	Low scalability only limited on coastal area High initial CAPEX No wind mapping data in the country	High initial CAPEX Supply chain hydrogen or methanol Suitable only for unreliable sites	Number of sites near the river flow location High initial CAPEX Operational challenges
Risks to Adopts	Reliability issues due to distance from the nearest O&M based Vandalism of battery and panel theft	Biomass supply and sustainability Scalability of solution for telecom	Operational risk due to wind speed availability Unreliable power generation due to wind speed characteristic	High replacement cost of fuel cell Reliability of supply chain	Operational risks associated with limited knowledge and readiness

Network Size and Current Deployment

In 2012, GPM identified that Indonesia had 90,699 tower sites across the country and Bangladesh had 25,858 tower sites. Indonesia has 874 sites operating in off grid areas whereas Bangladesh has only 282 off-grid sites. Around 14% of Bangladesh's sites regularly suffer from power outage for up to 8 hours a day.

Figure 2. Network Size with Power Situation



On green deployments, Indonesia has about 5% of its 90,699 sites converted to renewable energy whilethe number of green sites in Bangladesh has reached less than 1%, or 171 green sites, of the network. The current deployment is shown on the figure below.

Figure 3. Current Deployment in Bangladesh

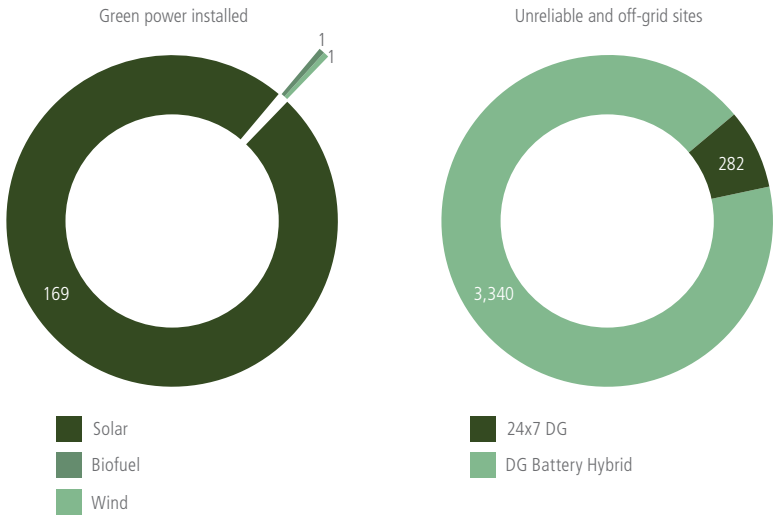
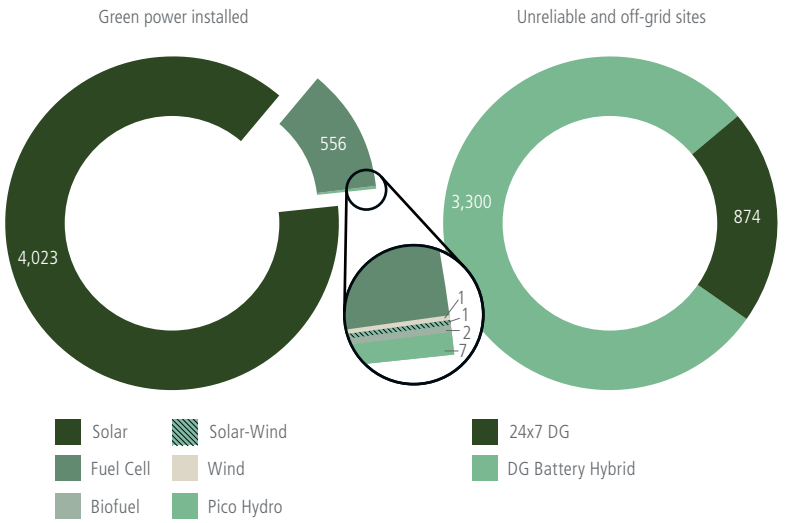


Figure 4. Current Deployment in Indonesia



Potential OPEX Saving

GSMA estimates that MNOs' potential saving for of implementing green technology to 3,622 of their problematic sites, is around US$41 million per year. It will require an investment of about US$100 million.

For Indonesia's MNOs, the potential saving is US$56.4 million per year by converting all 4,174 problematic sites to green technology choices. It will require an investment of about US$148 million.

Powering Telecom: The Way Forward

In the long term, GSMA analysed the tower growth for the next 3 years, keeping in mind the 10%-20% market penetration, the land coverage and the 2% network blocking rate. GSMA estimates that the number of tower sites will grow about 41% for Bangladesh and 48% for Indonesia by 2015.

The number of problematic sites for Bangladesh will increase from 3,622 sites to 6,660 sites by 2015. It will create a saving opportunity for MNOs of about US$90 million; with a total investment of US$184 million by 2015.

Similarly, GSMA also estimates that the number of problematic sites in Indonesia will grow from 4,174 sites in 2012 to 14,854 sites by 2015. MNOs' saving opportunity will equal US$151.5 million, with a total investment of about US$526.6 million by 2015.

Figure 5. Tower Growth

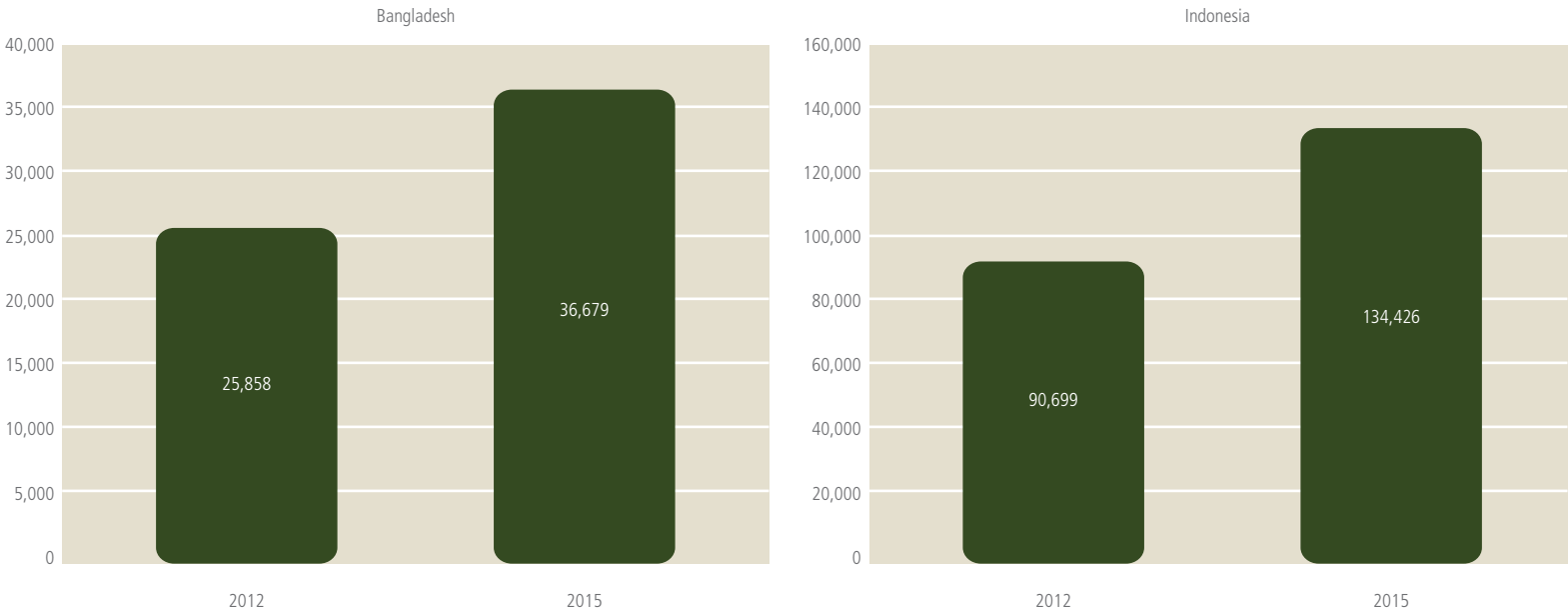
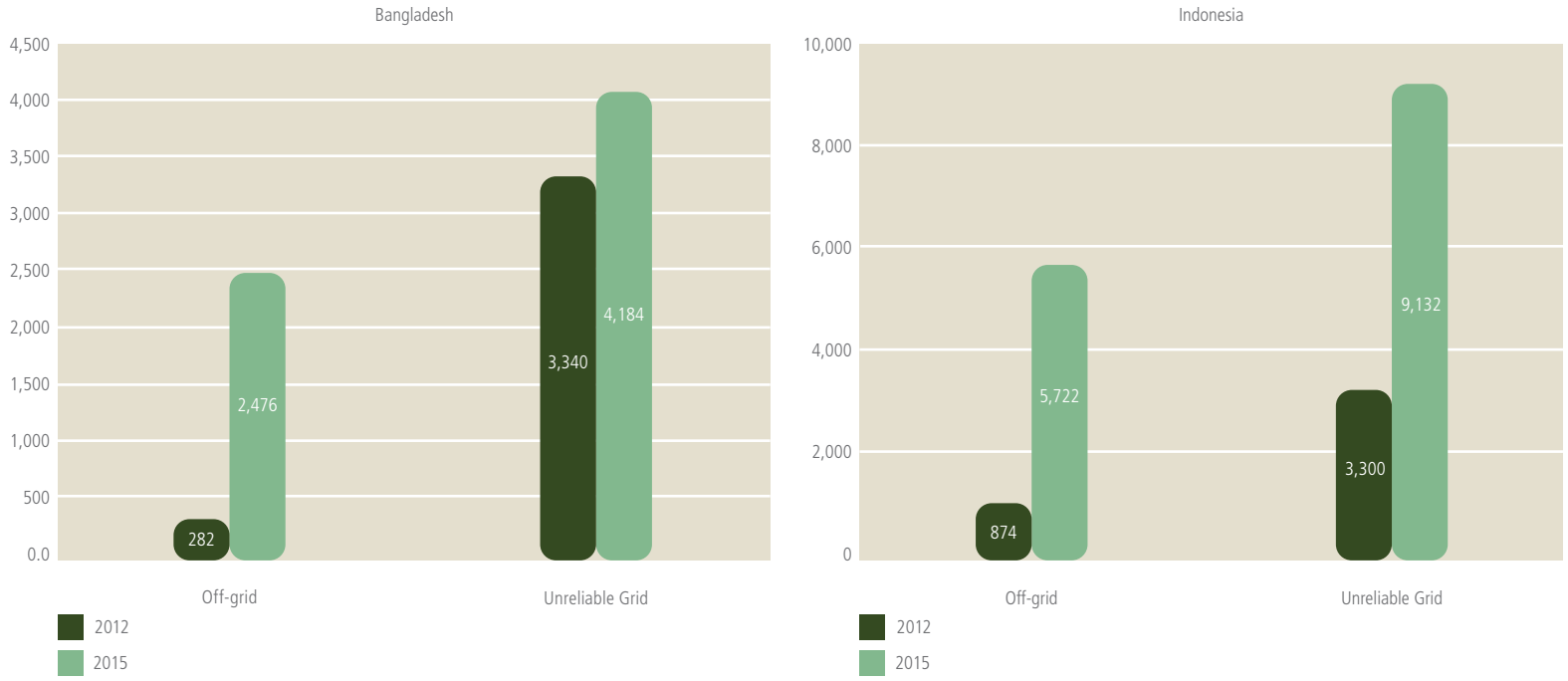


Figure 6. Unreliable and Off-grid Site Growth



Conclusion

Lack of electricity forces MNOs to find other resources to power their base stations and renewable energy is one solution. However availability of these green power alternatives might be a challenge, and some trials will be needed to ensure that the chosen green technology will fit with the telecom industry.

By shifting to green power solutions, MNOs will have an opportunity to not only make cost savings but also have a positive socio-economical and environmental impact.

For detail reports, please follow these links:

- Bangladesh: [click here]
- Indonesia: [click here]

Chapter 4

Green Power Feasibility Study – Airtel, Madagascar

By Satish Kumar, GSMA

1 http://en.wikipedia.org/wiki/Madagascar
2 CIA – The World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/ma.html)
3 GSMA Wireless Intelligence
4 http://www.reegle.info/policy-and-regulatory-overviews/MG
5 https://energypedia.info/index.php/Madagascar_Country_Situation

Background

Country – Madagascar
With a population of 22 million (2012 estimate) , Madagascar is the world's fourth largest island and is home to unique wildlife and diverse ecosystems. Madagascar's economy is driven by agriculture and ecotourism. Agriculture contributes to over 29% of the national GDP in 2011[1] and employs over 80% of the country's population.[2]

Madagascar's landscape is characterized by a central highland region at altitudes ranging from 750 to 1500 meters above sea level, sloping down to low land forest escarpments along the east coast and highly arid terrains in the west leading to the Mozambique Channel. The hot rainy season lasts from November to April and the cooler dry season runs from May to October.

Operator – Airtel
With over 2.5 million mobile connections and a market share of over 40%[3], Airtel is a leading GSM mobile operator in Madagascar. The operations started under the brand name of Airtel post-acquisition by Zain in 2010. Historically the operations started in 1997 under the name of Madacom until 2006, followed later by Celtel from 2006 to 2008. Madagascar is one of the 17 countries in Africa where Airtel operates and Airtel Madagascar is part of the global Bharti Airtel Group.

Industry – Telecommunications
With 6.4 million mobile connections, the mobile telecoms market in Madagascar is represented by three major mobile operators including Airtel, Orange and Telma. Madagascar has a mobile penetration level of 29%.

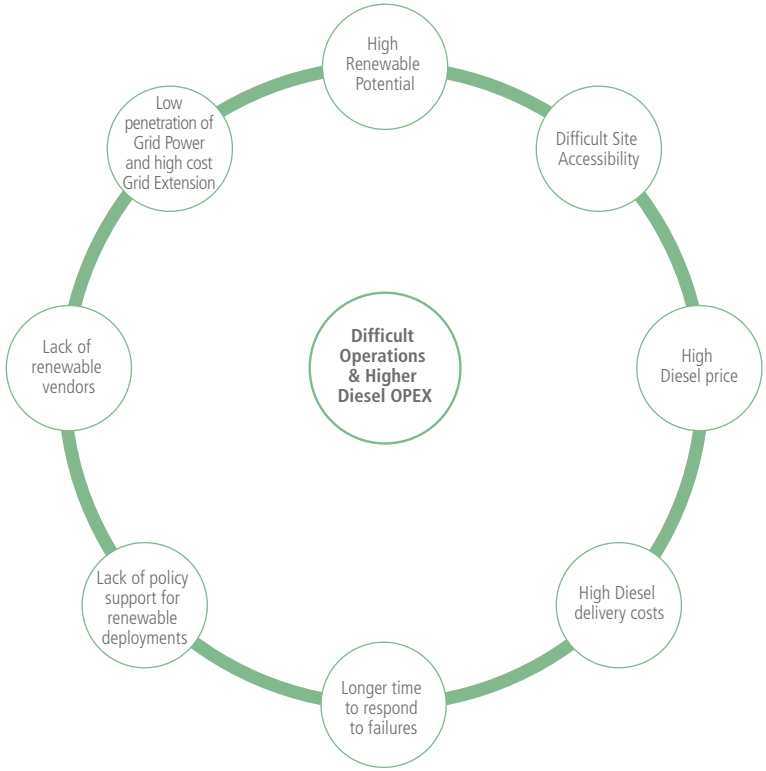
Context – Power and Telecoms

Madagascar's power supply sector is characterized by low generation capacities and limited grid infrastructure. Madagascar has three main grids namely Antananarivo grid, Toamasina grid and Fianarantsoa grid, operated and administered by the national utility JIRAMA.

Madagascar has 114 centers of power generation facilities of which close to 100 plants are diesel based and the remaining are hydroelectric generation plants. Electricity generation only covers 15% of the national needs.[4] Access to electricity remains as low as 20% and only 5% of the rural population have access to electricity[5]. The national electricity grid is limited to the major cities and the rest of the electrified regions and communities rely on isolated mini grids. The reliability and availability of the grid power supply has improved over the years, however the low generation capacities fall short of meeting the demand.

The limited reach of grid power infrastructure has led MNOs to rely on diesel generators to power the growing network of telecom sites in Madagascar. Airtel has implemented battery hybrid solutions at all of their off-grid sites in order to reduce the dependence on diesel power thereby reducing energy OPEX. However, the costs of powering the off-grid sites still remain high, owing to high diesel costs, operational difficulties and regular maintenance of diesel generators. Airtel is also presented with a major challenge in terms of site accessibility increasing the cost of operations and maintenance.

The overall context in which Airtel operates is presented below:



Objectives

- To explore alternative energy options to power the network of telecom sites
- To demonstrate technical feasibility and financial viability of green power alternatives compared to existing power approach and solutions
- To reduce energy OPEX and promote green power for telecoms
- To reduce dependence on diesel generators and hence reduce CO2 emissions
- To enable capacity building through training and knowledge transfer

Within the context and background presented above, GPM has set forward to analyse the entire network of sites to understand the current scenario in terms of site operations, power provision and the respective costs associated with them and came up with feasible recommendations for alternative power solutions including green power.

Key Highlights and Approach

The feasibility study was carried out using the GPM methodology involving detailed data collection, data analysis, model design, business case development, implementation prioritization and financial analysis followed by recommendations.

A preliminary analysis was conducted on a network of 492 sites in Airtel's network in Madagascar. Based on the preliminary analysis, GPM concluded that the 234 on-grid sites are not suitable for green power design and analysis because the average daily grid power availability to these sites is 17 hours. Therefore, the green power feasibility analysis was carried out for the remaining 258 off-grid sites in Airtel's network.

The key highlights of the Airtel's off-grid network in Madagascar are outlined below.

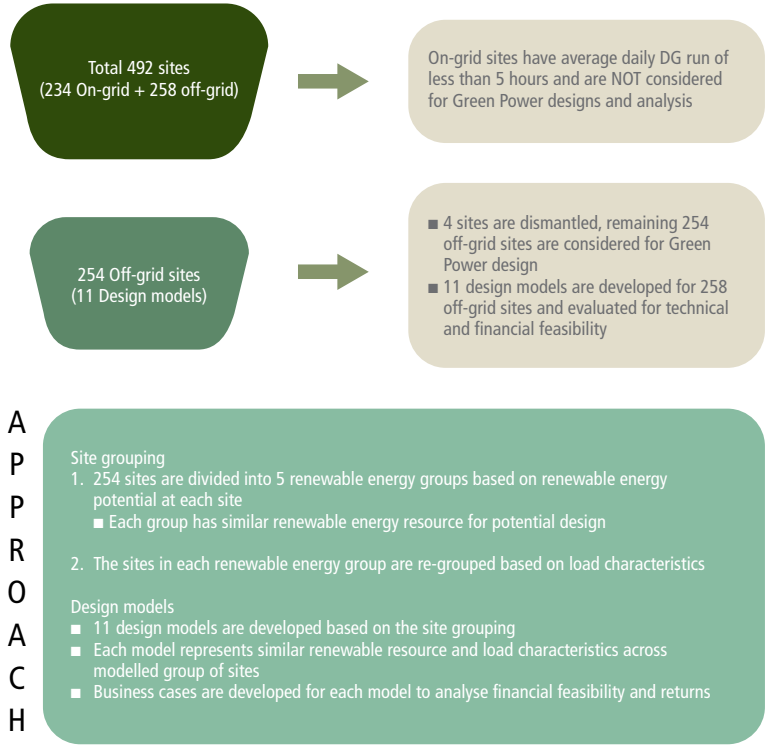
Network Highlights: Off-grid sites

	Network	Load	Power Source
Characteristics	35 indoor, remaining are outdoor sites 10 are Platinum sites, 7 are Gold, and remaining are Silver sites in terms importance; Only 10 are 3G sites 19 sites are currently deployed with Green Power Majority of the sites are greenfield sites	Overall average site load of 0.77 kW Overall Daily power requirement of 4,674 kWh	Daily DG run : 10.3 hours (avg. per site) Battery backup planned: 13.7 hours (avg. per site) Approx. 5,565 L of diesel consumed daily
Observations	Accessibility: Only 11% of the sites have Easy Accessibility More than 68% are moderate and 20% are difficult in accessibility	The average load per site is relatively low as majority of the sites are remote low traffic sites and are out-door sites.	Daily diesel OPEX of ~ US$ 7,847 Approx. 5,565 L of diesel consumed daily Daily DG run of 2,650 hours (Overall network) Daily CO2 emission of 15 Tons

Solution Design & Approach

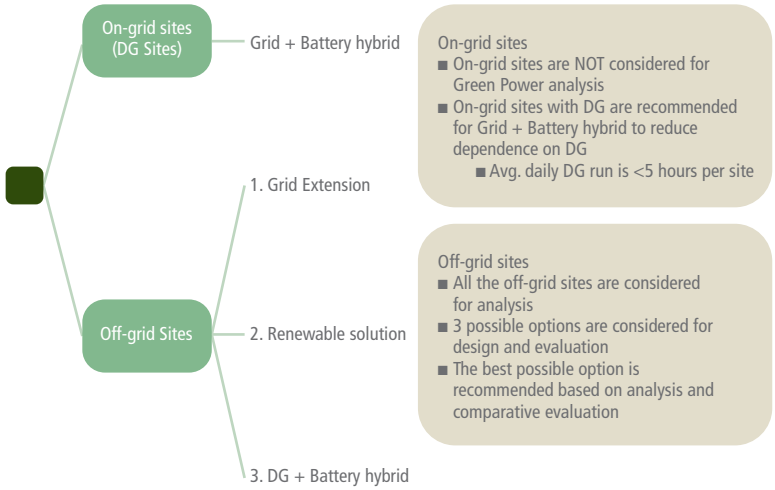
The overall design approach and key highlights are illustrated in the below figure.

Figure 1: Design Approach



As a first step, a renewable resource analysis is carried out for the 254 off-grid sites to evaluate the potential and availability of the renewable resources. The site grouping methodology and design models based on the renewable resource analysis is presented in Figure 1. Two renewable options including solar and wind have been considered (based on the available resources) for design and financial feasibility.
Each design model thus developed is evaluated against the other possible alternative power solutions and the most feasible option is chosen and recommended for implementation.

Figure 2: Evaluation Approach



Recommendations & Outcome

GPM's energy solution recommendations are based on comprehensive technical analysis, design and financial evaluation, while the energy efficiency recommendations are based on qualitative analysis through site surveys and discussions with the stakeholder teams.

Energy solution recommendations

Based on the technical design, financial analysis and comparative evaluation of the 11 design models, 147 sites are recommended for green power deployment, while 48 sites are recommended for grid power extension and 21 sites will remain on the DG + battery hybrid power solution.

Model	Grid Extension	Green Power	DG + Battery hybrid
IN1_S	0	0	4
IN1_SW	3	0	6
IN2_S	1	0	7
IN2_SW	2	0	4
OD1_S	18	50	0
OD1_SW_I	8	25	0
OD1_SW_II	0	22	0
OD2_S	6	35	0
OD2_SW_I	2	8	0
OD2_SW_II	2	5	0
OD3_S	6	2	0
Total	**48**	**147**	**21**

All the above recommended sites are prioritized for implementation and investment planning, based on financial and technical parameters. Considerable savings in OPEX can be achieved by implementing GPM's recommendations for the above sites. Key highlights of operational, financial and environmental benefits demonstrated are presented below:

- Dependence on DG reduced to less than 25%
- Savings in diesel consumption of 1.12 million L/year
- OPEX savings of over 90%
- Average pay back period of ~ 2.25 years
- Green Power generation of ~978,876 kWh/yr
- CO2 Emission reduction of ~3,120 Tons/yr

Energy efficiency recommendations

For overall energy optimisation, GPM came-up with a list of recommendations which could help the operators reduce their energy requirement at every site.

Existing Network

- Implement smart energy monitoring and site equipment control mechanism to control site operations
- Implement smart power source control mechanism to intelligently select between various power sources including Renewables, Grid power, Batteries and DG
- Energy Optimization and Efficiency
  - Upgrade or swap indoor equipment to outdoor equipment for Off-grid sites
    - Reduce overall site load and optimize energy requirements
    - Improve equipment performance for extreme weather conditions
  - Replace old diesel generators for improved performance and reduced O&M costs
    - Reduce fuel consumption
    - Reduce number of site visits and reduce operational expenses
    - Improve performance during extreme weather conditions especially during winter

Future Network

- Consider Light Rural site solutions for extending network to remote, low ARPU, low traffic regions
  - Feasibility of renewable alternatives to power
  - Less or zero dependence on diesel power
- Deploy outdoor equipment for upcoming network rollout for better network energy efficiency

As a first step, the above recommendations would considerably reduce the energy requirement of the network and pave the way for green adoption.

Chapter 5

Bharti Infratel's GreenTowers P7 Program:

Towards adopting cleaner technologies for power generation and energy efficiency

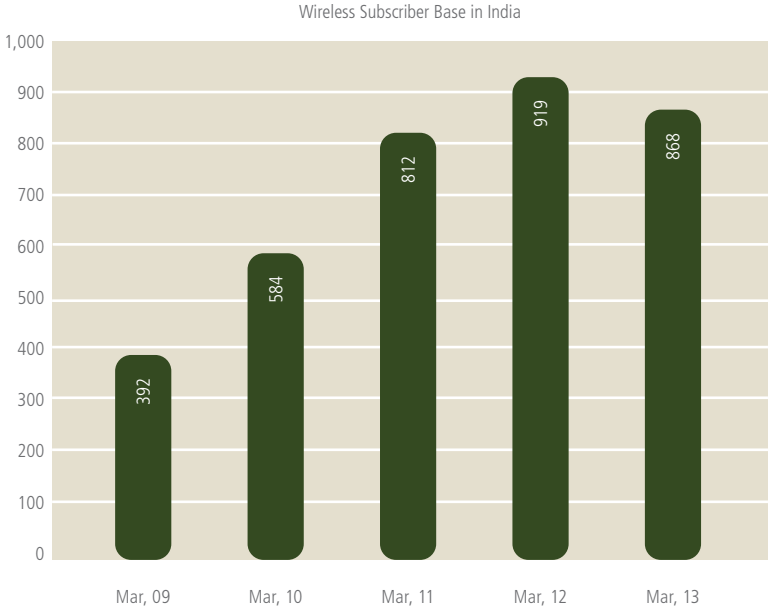
By Sachin Gupta, Bharti Infratel Limited

Additional Notes:
1. Globe's total no. of wireless sites is 6,200++
2. Part of our plan also include
   a. BTS change out and provision of high efficiency power systems for 1,400 sites that are already outdoor
   b. Some 2,000++ indoor sites are in close proximity to salt water will remain as indoor
   c. The rest of Globe's indoor sites houses critical nodes that will remain indoor too but resilient and redundant in power and facility design

Bharti Infratel has over 34,000+ towers, across 18 states, and 11 Telecom circles in some of the toughest terrains in the country where telecom penetration has far exceeded electrification reach. The Company also has a 42% stake in Indus Towers, which was created as a Joint Venture between Bharti Infratel, Vodafone and Aditya Birla Telecom to hive off the Towers business in 15 telecom circles.

Bharti Infratel's core mission is in line with the Bharti Group's philosophy of building businesses, which positively impact the society we live in. As one of the pioneers of Shared Tower Telecom Infrastructure services, Bharti Infratel has helped Telecom operators maximize their reach in a short period of time – by providing them compelling capex and opex saving opportunities, and as a result making them focus their investments in reaching out to more and more communities across the country, and contributing in offering highly affordable telecom services which helps integrate more subscribers into the mainstream, and connect them to the rest of the world. In the long run, this helps change their socio-economic status, and improve their 'quality of life'.

Sustainable energy has become a necessity in today's world and finding solutions to power industries with sustainable and eco friendly energy is a mammoth challenge. This is especially true in developing countries, where the growth of industries is faster than the nation's infrastructure.

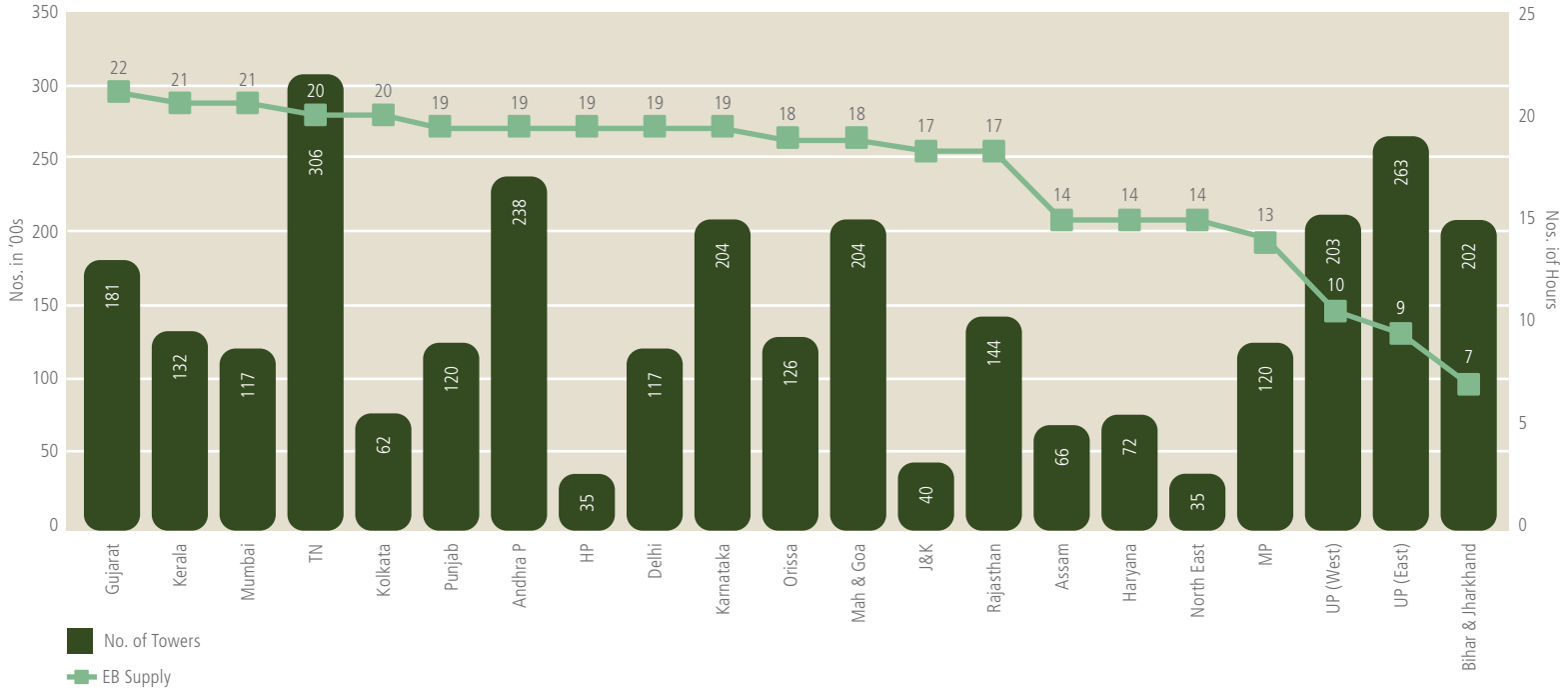


Over the last decade the need for mobile phones has increased exponentially, so much so that it is now considered to be the fourth basic need after food, clothing and shelter. Today, the wireless subscriber base in India is around 868 millions. This has not only helped in developing other industries, but has also empowered rural India with more than 90% of villages having access to improved telecommunication facilities.

The telecommunications industry in India has been a key contributor to the country's successful growth story. In a developing country like India, the geographical reach of the power sector is not nearly as widespread as that of the telecom industry. As a result, telecom tower companies need to overcome the obstacle of providing 100% uptime in areas with no, very low or unreliable grid power supply. While the conventional solution involves the use of a diesel generator, it is neither the most eco friendly option nor a cost effective solution for powering sites. Hence the challenge faced was to find sustainable, less expensive and environmental friendly energy resources to power the telecom tower infrastructure, which is essentially the backbone of the telecom industry.

It is vital for companies to find alternative sources of energy to reduce the usage of diesel. It is not enough to find an alternate energy source and expect that to solve all existing problems. The key to this being a successful aspect of the green revolution is to make it easy to implement, sustainable and replicable on a larger scale. In the face of these problems, hybrid energy solutions are emerging as an answer.

Grid electricity availability per day in key telecom circles

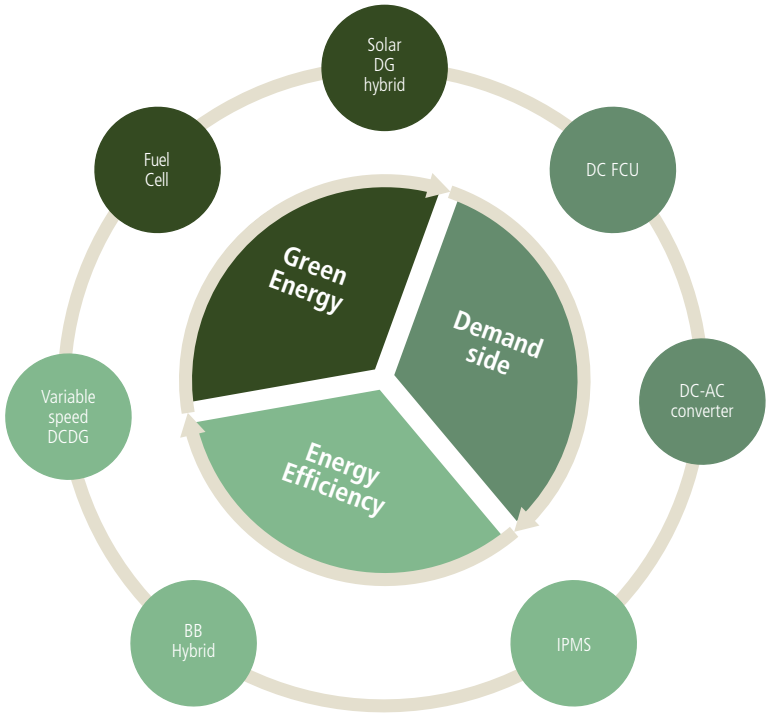


Source: TRAI consultation paper on green telecommunications, KPMG analysis.

Solution To The Problem:

Bharti Infratel's GreenTowers P7 Program is an earnest, conscientious and path-breaking initiative towards the goal of adopting cleaner technologies for power generation and energy efficiency to mitigate green house gas emissions. It is the association of 7 sub-projects, aimed at a common set of objectives:

(a) Improving energy efficiency of tower infrastructure equipment
(b) Use of renewable energy resources
(c) Reduction of equipment load on tower infrastructure equipment



GreenTowers P7 Program covers all the three aspects of energy management such as Alternate Energy, Energy Efficiency and Demand Side Management. This program has been developed in collaboration with our solution partners and help from GSMA in developing the site selection criterion and business model.

Alternate Energy Resource

Solar Hybrid DG (Diesel Generator)

This project targets non-electrified or poor grid sites in our circles. Bharti Infratel innovated a Solar – DG hybrid model in which solar energy is used along with diesel and battery. This makes solar solution economically more viable for telecom infrastructure companies. This solar solution has been implemented at more than 1200 sites with installed capacity of approximately 6 MW and generates approximately 8 million units of energy on an annualized basis. The project aims at reducing DG run time from 20 hrs to 5 hrs a day, thus accruing a 60% diesel saving at sites and will thus reduce CO2 emissions by approximately 21,000 MT per year.

Fuel Cell

It converts chemical energy of hydrogen into electricity through a chemical reaction with oxygen or another oxidizing agent with water as a by-product. This initiative aims to replace the diesel generator and thereby reduce significant diesel consumption. Also this is very silent and hence can be used at sound restricted areas Successful trials of the same have been conducted at Bharti Infratel sites and we are now planning to scale it up.

Energy Efficiency

Direct Current Diesel Generator (DCDG)

DCDG is a variable speed engine, which directly generates DC power that can be fed directly to the equipment without any conversion. It also regulates its speed depending upon required load and thus results into lower diesel consumption at low loads. This project targets sites with poor availability of grid power where generators run for more than 12 hours a day. The pilot of this initiative has been successfully implemented across 500 sites.

Integrated Power Management System (IPMS)

IPMS provides complete AC and DC power management of a BTS cell site in one single rack, and communicates all critical alarms & energy parameters to the Tower Operating Centre (A centralized Control Room that functions as a single point of contact for flashing and reporting all site-downtime alerts, which are routed to the concerned service technician, and "feet on street" who manage the Towers). IPMS is designed to seamlessly switch between different sources of power intelligently and also protect equipment from unwanted electrical disturbances. IPMS aims at maximizing grid power utilization during single phasing and under voltage supply which reduces the number of hours a DG is run. It also helps improve the combined efficiency of PIU and SMPS by about 3-5% that reduces the grid power cost by 3%.

Battery Hybrid

Capacity of the existing battery bank is increased coupled with charging batteries at higher current resulting into higher load which helps in running the Diesel Generator in a more efficient zone with improved load factor, this initiative is planned at 8000 sites and has already been executed at more than 5000 sites.

Demand Side Management

Direct Current Free Cooling Unit (DCFCU)

Free Cooling Unit utilizes the outside ambient cold airstream, which is supplied into the shelter and hot air which is at top of the shelter is evacuated into the ambient with the exhaust unit, cooling the shelter without using air conditioners. DCFCU operates from a DC source whereas an air conditioner requires 230 V AC supply. Thus in the case of grid power failure, DCFCU can reduce the run hours of a diesel generator by maintaining shelter temperature using the available battery. An air conditioner can be replaced with DCFCU in areas where the ambient temperature is less than 25° C throughout the year. A DCFCU has about 25% lower maintenance cost in comparison to air conditioner. It has already been implemented at around 6000 sites

DC to AC Converter

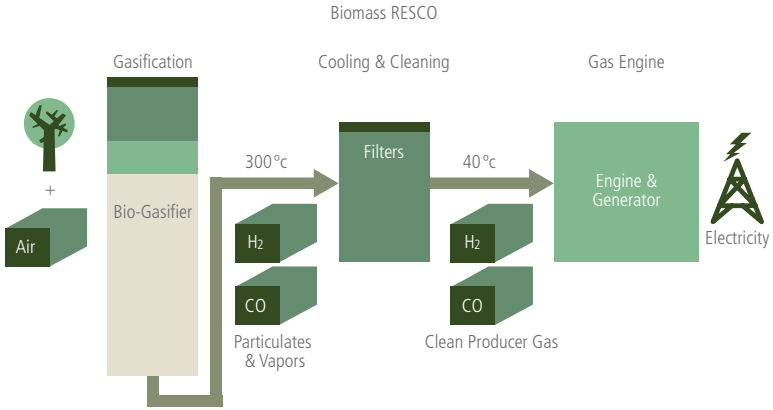
It is a soft start invertor which converts DC Energy stored in a battery into AC power to run an air conditioner without any starting current in case of grid power failure. It saves the consumption of diesel delaying the DG.

Way Forward

Other than the GreenTowers P7 Program that was launched in 2009 and has been implemented at about 70% of the Bharti Infratel sites, we are exploring other initiatives, which can help us in reducing our carbon footprint. RESCO is one such solution.

Solar RESCO
Renewable Energy Service Company sets up a green energy based power plant near to telecom site (outside the telecom site boundaries) and will supply metered 230V AC power to telecom sites under (pay per use)RESCO Model. In addition to powering mobile networks, RESCO supplies energy to neighboring and previously un-powered communities at subsidized rates, shifting their spend from fossil fuels to electricity generated renewably. This model is already been trialed at Bharti Infratel sites for last one year and is planned to scale up this year.

Biomass RESCO
Biomass technology is a small-scale biomass gasification system that is customized to meet telecom needs. The gasification engine uses a series of pyrolysis, reduction and combustion processes to create producer gas (combination of carbon monoxide and hydrogen). The gas then goes through extensive filtration process to eliminate all particulate matter and is used to run a gas engine to produce electricity. This technology is being trialed at Bharti Infratel site under on site Biomass RESCO.



Advanced Batteries
More efficient and fast charging batteries are also being explored to be used at telecom sites. Different technologies are under study, trial or pilot phase currently. Successful battery technology will be further scaled up in coming years.

The implementation of these initiatives have substantially reduced Bharti Infratel's operational costs and carbon footprint, and at the same time, increased the energy efficiency of operations. Renewable energy solutions are in existence for many years, but they were not being used extensively at a large scale due to the lack of sustainable business models. Our energy models however, are economically self-sustaining and are highly replicable and scalable. So far, investments of Rs 200 crore have been deployed towards these initiatives and payback is expected in the next 2 to 6 years, depending upon the solution. We strongly believe that encouraging and developing these models will help us in making our networks more greener while meeting our energy needs in the absence of reliable grid power in remote areas.

Chapter 6

Safaricom, Kenya: Feasibility Study - Summary

By Charlotte Ward, GSMA

Additional Notes:
1. http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
2. Kenya National Bureau of Statistics http://www.knbs.or.ke/Percentage%20Urban%20Households%20by%20main%20type%20of%20Lighting%20Fuel.phpstudy
3. Idem http://www.knbs.or.ke/Percentage%20Rural%20Households%20by%20main%20type%20of%20Lighting%20Fuel.php

Introduction

In June 2012, the GSMA, with the support of the International Finance Corporation (IFC), began working with Safaricom to evaluate the opportunity for the mobile operator to improve access to energy services for their customers while improving the business case to serve off-grid areas.

The study first sets the context, looking at Kenya's socio-economic background, its level of energy access and the telecoms market. The Key findings and recommendations are then presented.

Kenya's context

Kenya's context is unique as the country has the highest GDP per capita across East Africa (US$ 808[1]) while most of its population (78%) lives in rural areas.

Energy Access and off-grid energy spending

Kenya's electricity access rates are some of the lowest in Sub Saharan Africa (SSA). In 2012, only 23% of Kenyan households had access to electricity, with a 51.2% access rate[2] for urban households and a 5.2% access rate[3] for rural households.

Kenyans living off-grid spend a significant portion of their household budget on energy services including lighting and phone charging:

- Studies show that on average, off-grid, rural households spend between US$10.00 and US$14.12 per month (KES 850 – 1200) on lighting alone[4]
- An off-grid mobile subscriber in Kenya is spending between $2 and $3 per month on phone charging assuming an off-grid customer charges their phone 2 to 3 times per week at the going market rate of US$0.25[5]

In sum, Safaricom's subscribers living off-grid could be spending as much on charging their phones as they are on air time. This presents a huge opportunity to convert this expenditure on phone charging into spending on actual phone usage (or other productive activities) with cheaper phone charging facilities.

4. http://www.businessweek.com/news/2012-10-14/kenya-energy-regulator-raises-gasoline-diesel-kerosene-prices
5. http://www.gvepinternational.org/sites/default/files/phone_charging_businesses_report_with_gsma_final_for_web_0.pdf
6. Wireless Intelligence, Q2 2012
7. Wireless Intelligence, 2012
8. Wireless Intelligence, 2012
9. http://www.iea.org/papers/2011/weo2011_energy_for_all.pdf

Telecom background

In Kenya, mobile penetration (by connection) has reached over 69%, with 95% of the population living with GSM network coverage.[6]

As of 2012, there were four mobile network operators in the country. The market is characterised by intense competition: at the time of the study, Safaricom was the clear market leader with 64% market share, followed by Airtel (16%), Orange (11%) and Yu (9%)[7].

Airtel Africa acquired Zain Kenya in 2010, sparking high competition and driving down cost per minute. Safaricom's mobile money service, M-PESA, launched in 2007 and currently has the largest user base and rural reach in Kenya compared to other mobile wallets.

Key findings of the Feasibility Study

Opportunity for Safaricom's Network

While 95% of Kenyans have mobile coverage[8], up to 84% of the population[9] is without formal grid electricity. In other words, many Kenyans have a phone, before they have a place to charge it.

Safaricom's reach across Kenya through its extensive distribution and infrastructure network, the ubiquity of M-PESA, their mobile money product, and their brand recognition provide them a platform from which to support access to energy.

Mobile infrastructure

In June 2012, Safaricom had a total of 2,500 towers and 10% of these towers were off-grid. From previous efforts, Safaricom has an existing 28 towers that provide free community energy services including phone charging, lighting, street lighting and water pumping.

Ranking off-grid tower locations by district level household electrification rates (2009 Census data) and by density of rooftops/households within a 2km radius of mobile towers using satellite imagery, a further 47 off-grid tower sites were identified as suitable locations where community power services could be provided through partnerships with 3rd party ESCOs.

Safaricom could experience significant cost savings by entering into a relationship with a 3rd party ESCO that would manage their towers' power services using an OPEX model while benefiting from the additional revenue streams of providing community energy services.

Distribution Network

There is a sizeable opportunity to leverage Safaricom's extensive rural dealer and retail network for the distribution of energy products and services to regions which lack electricity.

A pilot using Fenix International's Ready Set was conducted to evaluate the opportunity for Safaricom's retail outlets to sell phone charging services. The pilot highlighted an unmet demand for phone charging services in Kenya as well as other energy services which have the potential to drive economic activity within rural and semi-rural areas. A revenue opportunity also exists for the community if site kiosks are operated by an agent entrepreneur.

Four regions, Kakamega, Meru, Bungoma and Kisii, where grid electrification is very low and community power demand is high, were identified as presenting an addressable market large enough to make a significant impact on monthly ARPU.

Mobile Payments for Energy Services

There is a huge opportunity in leveraging mobile payment technology as a channel to provide energy access to underserved communities - an opportunity that Safaricom has seized with their mobile payment service M-PESA.

The operator's leading position in this space is not, however, exclusively due to M-PESA; Safaricom's willingness to partner with new energy service companies, taking into account the risk it entails, also plays a significant role. In October 2012, Safaricom announced a commercial partnership with M-KOPA[10], a Nairobi-based company making clean energy affordable to customers across Kenya by combining machine-to-machine technology and mobile payments to offer customers the chance to purchase solar energy lighting and mobile charging equipment on a pay-as-you-go basis.

Recommendations

From the study, 2 key recommendations are made:

- Issue a tender to evaluate ESCOs' services, based on organisational and technological strengths, to power the 47 existing off grid sites in order to provide cost savings and deliver energy services to surrounding communities.
- Continue to assess commercial and social impact matrices to track the impact of all community energy services models in order to drive growth and build a strategy around multiple technologies and delivery models.

Equipped with nationwide mobile infrastructure, distribution network and mobile payment service, Safaricom is ideally placed to leverage these channels to provide community energy services to its customers living in rural, off-grid areas and help answer Kenya's energy access gap.

To read the full Feasibility Study [click here]

Additional Notes:
10. http://www.m-kopa.com/

Chapter 7

TNM Malawi: Feasibility Study - Summary

By Charlotte Ward, GSMA

Additional Notes:
1. World Bank, 2012
2. Mulanje Renewable Energy Agency (MuREA) 2012
3. Exchange rate for Malawian Kwacha: US Dollars = 360:1 (http://www.xe.com/currency/mwk-malawian-kwacha)
4. Energy Access in the Southern Region of Malawi' (MuREA)
5. GSMA Field Research, 2012

In April 2012, the GSMA, with the support of the International Finance Corporation (IFC), began working with TNM (Telekom Network Malawi) to evaluate the opportunity to improve access to basic energy services for their customers, while improving the business case to serve off-grid areas.

The study highlights the potential benefits of leveraging the operator's infrastructure, distribution and mobile payment networks to fill Malawi's energy access gap:

- Save costs: through an Energy Service Company (ESCO) model, provide power to towers and deliver community energy via a mini-grid or an energy hub
- Develop partnerships with household and kiosk-based solar services companies: through TNM's existing and new distribution channels
- Increase the volume of micro-payments: through the operator's payment technology

Country background: Malawi

Malawi is geographically small, with an estimated population of about 15.4 million and is among the world's least-developed countries. The country's economy is mostly agriculture-based with a largely rural population (80.2%)[1].

Energy Access and off-grid spending

Although electrification rates have been low in Malawi, particularly in rural households (1% in 2009), it is estimated that, due to grid expansion, electrification is now up to 20%[2] though it is seldom affordable or reliable. In off-grid locations, the primary source of energy for cooking is firewood/charcoal and paraffin for lighting (kerosene is used less as there are few distribution points and the income is much lower in comparison to selling other fuels). Malawians spend an important amount of their revenue on energy services such as lighting and phone charging:

- Families often spend around 6,000MWK (US$18[3])/month on batteries and lighting (candles, kerosene and paraffin) and 70% of them need to walk for up to 1km to buy their lighting sources. As a result, most families only light their homes for 2-3 hours a day.[4]
- The average cost of charging a phone in off-grid Malawi is 800 MWK/month (about US$0.3 per charge), with additional spend on time and travel. Phone charging businesses make on average 35,000 MWK (US$106.5)/month.

6. Mulanje Renewable Energy Agency (MuREA), "Total Energy Access Survey", November 2011
7. TNM Corporate Annual Report, June 2012
8. Wireless Intelligence, 2012

Telecoms networks

There are two GSM mobile network operators in Malawi: Airtel and TNM, which owns 38%[6] of the market share. MTL is a CDMA network operator and a shareholder in TNM. Together, TNM and MTL provide 80% mobile coverage to the whole country but still only 30.5% of the population has a mobile connection. Although mobile penetration is still limited, especially in rural areas, this figure is expected to grow, with TNM reporting a 32% increase in subscriber growth from 2011-2012.[7]

TNM and Airtel share 25 Base Station Towers and TNM alone has 65 off-grid towers (4 of which are expecting grid connection).

In terms of mobile payment services, Airtel launched Airtel Money, in February 2012. Following the study, TNM launched its Mpamba mobile money service.

Key Findings of the Feasibility Study

The objective of the feasibility study was to assess TNM's infrastructure, retail & distribution and payment networks in order to evaluate the opportunity to offer commercially-viable community energy services to off-grid areas.

As TNM's network provides mobile coverage to 80% of the population[8], while only 20% has access to the electricity grid, leveraging these channels presents a clear opportunity.

Mobile infrastructure

At the time of this study, TNM had 365 towers, 65 off-grid and 300 on-grid. The 65 off-grid sites are being considered for green power analysis. TNM's off-grid presence provides an opportunity to extend community power from the tower infrastructure to an outsourced power solution, such as a mini-grid or a centralised energy hub. Three factors were taken into consideration to identify the green power sites which could incorporate community power requirements:

- Sites staying off-grid in 2012 (49)
- Sites within 1-2km from an off-grid community (39)
- Sites off-grid (65)

The study found that 16 sites were suitable for community power either via an energy hub or a mini-grid model. These sites were then ranked in accordance to the potential impact of community power and to the priority for green power. The top 5 sites identified were within Nkhota Kota, Salima and Mzimba districts and several others were clustered in the Ntcheu district.

Distribution networks

In addition to its mobile infrastructure, TNM's rural dealer and retail network can be leveraged for the distribution of energy products and services to regions which lack electricity. Being a trusted brand is also a tremendous asset for TNM which will help in their provision of co-branded products and extended services to off-grid subscribers. The criteria used to assess possible community power markets included:

- Districts currently served by TNM
- Size of the addressable market
- Population density (2008 Census[9])

Analysis highlighted four regions that, together, represent an addressable market of 1.9 million people, which equates to an estimated annual ARPU of US$6.6 million. 10 regions have population densities of less than 100 people per km² and will therefore require more innovative business models to serve these communities.

Mobile Money and e-payments

Since the time of the study, TNM launched its mobile money services, Mpamba. By lowering the upfront cost barrier for energy services for off-grid communities, the operator mobile payment service can help tackle the energy access gap in Malawi.
The study encourages TNM to partner with local distributors and trial technologies that have already been developed for other African Markets.

Recommendations

From the study, three recommendations have been made:

- Issue a tender for ESCO's to power 16 current BTS sites predominantly in Nkhota Kota, Salima, Ntcheu and Mzimba districts, and for future expansion of the network in Mangochi, Mzimba, Kasungu, Dedza and Mulanje. The goal will be for the ESCO to provide complete site energy, security services and community energy services for phone charging, lighting and other productive uses.
- Explore distribution and marketing partnerships with providers of kiosk and household solar devices and solar home systems, focusing in the districts of Mangochi, Mzimba, Kasungu and Dedza.
- Use commercial and social impact matrices to track the effects of community energy services in order to drive growth and to subsequently build strategy around various technologies and delivery models.

Additional Notes:
9. National Statistics Office of Malawi

Chapter 8

Enhanced Utility Update: How Mobile is Applied to Energy and Water Services

By Michael Nique, GSMA

Solar Panels (240W) installed by Mera Gao Power for a microgrid deployment in the Sitapur district - Uttar Pradesh, India.

Additional Notes:
1. The term **enhanced utility access** refers to the use of mobile technologies, either through Machine to Machine (M2M) usage and/or mobile services, i.e. SMS/USSD and mobile payments, to enhance the access to energy and water for the population who lacks access to a formal utility connection

In January of this year, we published the report entitled "Sustainable Energy and Water Access through M2M Connectivity". The goal of this report was to outline the role of Machine to Machine components in adding a "smart functionality" to utility infrastructures, which can be plagued by poor maintenance or unaffordability by poor populations.

Some of the take-aways from this report were:

- Mobile networks have become the predominant infrastructure in many emerging markets. An estimated 411 million people are today without access to energy but covered by GSM networks, and 165 million people are without access to clean water but covered by GSM networks.
- The development of "Pay As You Go" solutions combining the use of M2M technology to mobile money services, provides a microfinance element where the credit on a user's account can be checked remotely, enabling low income consumers access what would have been normally prohibitively expensive goods/services.
- Embedding GSM connectivity in smart meters connected to a solar system or a water pump, enables the acquisition of real time information about the operations and usage of these systems, and can shorten the time to maintenance if any fault is detected.

Building on the information collected last year for this report, we are actively pursuing our role as GSMA to research the impact of technology innovation in energy and water service delivery. We are listing below some key ideas currently defining this sector.

Pay As You Go becomes a key feature for energy products and services

From the days when off grid energy access was only a matter of products (solar lanterns, solar home systems, ...), we are seeing today an increased traction of Energy Service Companies providing Solar as A Service. The service in this case is enabling off grid, and often low income, customers to afford high-priced solar systems through flexible financing schemes. This Pay As You Go model is coming to an age of more widespread availability and today most of the Energy Service Companies providing energy products are looking at developing their own Pay As You Go schemes.

M-KOPA is a successful example of this model in Kenya, where customers can acquire solar home systems for a small deposit and then repay by low monthly payments through Safaricom's M-PESA. As M-KOPA celebrated its 15,000th customer at the end of May, around 8 months after its commercial launch, sales are ramping up with units available in more than 600 Safaricom's shops across Kenya. The combination of a valuable service proposition adapted to low income consumers cash availability, distribution partnership and joint marketing campaign with the incumbent mobile operator Safaricom, mainly explained this path to scale.

The use of GSM connectivity in the M-KOPA system is also enhancing the depth of the proposed solar solutions as it gives entrepreneurs the ability to remotely controlled the unit without any operation from the end users (except for topping up their energy account using their mobile phone). Enabling real time information acquisition, entrepreneurs are also building up a wealth of information on energy usage and payments. However this GSM integration is also a premium as it increases the price of small solar systems that are often sub US$150 – as of June 2013, minimum prices of M2M GSM modules for low quantity order (below 10k units) is still above US$10 per module.

Several other RF technologies are being used and trialled by Energy Service Companies eager to develop Pay As You Go model in the most simple and cost efficient ways: for example, using infra-red for short range direct line of sight information transfer; Zigbee low energy wider range technology, RFID smart cards for short range low data transfer. Angaza Design, operating in East Africa, is leveraging another technology based on audio channels and sound modulation to transfer information (related to payment and energy system usage) between users mobile phone and the energy unit (through an embedded microphone). The advantage of such solution is its ultra low cost (~ US$2 for adding a microphone in the smart unit).

Mobile For Water – Mobile Payments and GSM Connectivity

As for energy, some key areas of focus for the use of mobile in the water sector, are related to GSM technology for water systems remote monitoring and mobile payments for increased payment efficiency and transparency. Published in April 2013, an Oxford University study[2] shows how mobile technology in Africa has dramatically increased the amount of payments water companies actually receive from the customers they bill. The study focuses on the Tanzanian water utility in Dar Es Salaam, which introduced mobile payments in 2009. This study showed that the amount paid by customers rose by 5% to 69% in 2011, after mobile money services were introduced.

From a rural perspective, there is also an increased traction today on the role smart meters could play to increase operations management and maintenance of decentralized water systems. Several entrepreneurs and experts are experimenting with GSM enabled water pumps that would transfer regular information to local water service providers. At an early stage of development, more results should be published by the end of this year to outline successes and challenges faced by these water entrepreneurs.

Next Steps – MECS financial support to innovate

For most of the energy and water entrepreneurs willing to leverage mobile technologies part of their operations and business models, the main question to ask is what role technology is playing to support their product or service delivery. Adding electronics to energy and water systems is also adding an extra layer of risk failure , beyond the short term benefits it might deliver. To support the innovative use of mobile technologies in this sector, the MECS team is opening its Innovation Grants Fund to entrepreneurs, academics, NGOs,... (read Chapter 10) to try and assess the impact such solutions might have on their customers and how sustainable is the use of mobile in low income, high risk environments.

Additional Notes:
2. http://oxwater.co.uk/#/wireless-water-dar-es-salaam/4575214770

Chapter 9

Unlocking a New Market: Ultra-Low-Cost M2M Opportunities and Barriers to a New Mobile Frontier - An Excerpt

By Nick Hughes, M-KOPA

Nick Hughes, co-founder of the company M-KOPA, shared with us some of his perspectives on mobile innovation in emerging markets and how the core concept of their mobile financial platform behind the M-KOPA business model is impacting the population his company is serving. His vision was summarized in the article "Unlocking a New Market: Ultra-Low-Cost M2M Opportunities and Barriers to a New Mobile Frontier".

We are providing a short extract of this article below.

Introduction

Edith Chelangat is one of M-KOPA customers. She represents a vast pool of potential customers in sub Saharan Africa who are off the power grid but have a mobile phone. Her profile is quite typical; she runs a small farm with relatively low income (about US$800 per year), with access to cash being variable, depending on how well her crops have sold. Before M-KOPA, Edith would spend around 50 Kenyan Shillings (KES) (or US$ 0.4) on kerosene each day and would spend KES20 three times a week to charge her phone at a local hardware store. Now, with M-KOPA, she pays KES40 per day for all her lighting and charging needs, topping up her lighting system credit whenever she wants using her Safaricom M-PESA account.

The idea behind M-KOPA is simple: helping customers save money by enabling micro-asset financing and allowing them access to previously unaffordable energy products. In the case of Edith, her payments are flexible, adapted to her income, and after she has paid down the balance, she owns the system outright.

The M-KOPA model

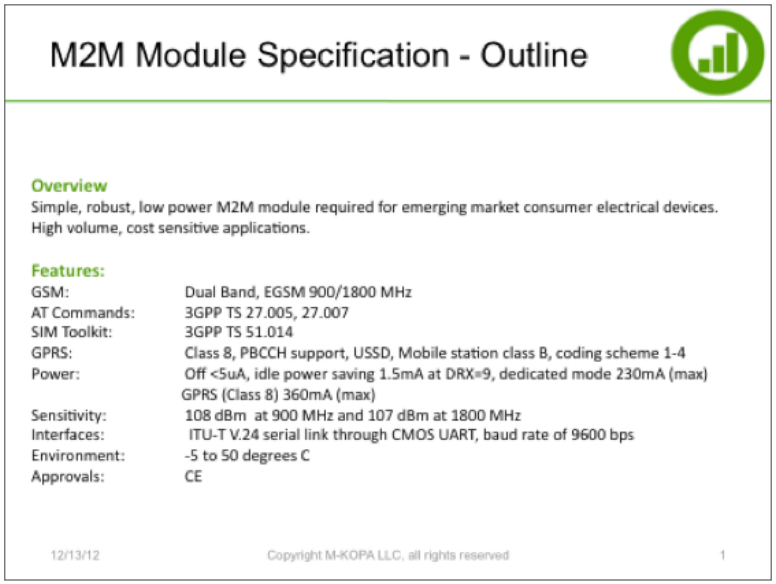
The core technology behind the M-KOPA model is the innovative use of Machine to Machine (M2M) technology for smart monitoring of the end user assets. M-KOPA believes that M2M services for customers like Edith represent a new frontier. If a device has an 'on/off' function, then an embedded M2M system can be built to allow remote management and micro-asset financing. Under this model, M-KOPA is currently assessing different opportunities in a range of verticals across energy, agriculture, health and information-management services - for example, water pumps for irrigation or potable supply, chaff cutters for preparing animal feed, egg incubators to drive up productivity, grain driers that can improve storage and retention.

Challenges and Solutions

Nick identifies several challenges impacting the availability and scalability of such micro-financed assets. Principal amongst them is the need to simplify the core M2M technology and reduce its costs to allow it to be used in a wide range of applications. Current 3G modules are in a price range close to US$40 and even the simplest 2G models range between US$13 and US$15 for low Multiple Order Quantity. That is almost as much as a basic phone. This price point of the simplest M2M modules prohibits their potential application in many smaller electronic items. The implementation of new Ultra Low Cost M2M specifications could unlock a very large potential market.

As with GSM mobile communications generally, the basic cost of M2M hardware is the biggest barrier to market change. For M-KOPA, the requirements for a M2M-enabled solar system are simple: 2G data only (no voice required), capable of processing small amounts of data, reliably and at low cost. The amount of data required to be sent over time is also low, typically a few kilobytes at periodic intervals.

The box below presents the specification of an M2M unit that would suit the consumer applications that M-KOPA provides:



M2M Module Specification - Outline

Overview
Simple, robust, low power M2M module required for emerging market consumer electrical devices.
High volume, cost sensitive applications.

Features:

GSM:	Dual Band, EGSM 900/1800 MHz
AT Commands:	3GPP TS 27.005, 27.007
SIM Toolkit:	3GPP TS 51.014
GPRS:	Class 8, PBCCH support, USSD, Mobile station class B, coding scheme 1-4
Power:	Off <5uA, idle power saving 1.5mA at DRX=9, dedicated mode 230mA (max) GPRS (Class 8) 360mA (max)
Sensitivity:	108 dBm at 900 MHz and 107 dBm at 1800 MHz
Interfaces:	ITU-T V.24 serial link through CMOS UART, baud rate of 9600 bps
Environment:	-5 to 50 degrees C
Approvals:	CE

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Chapter 10

Creating an Idea Factory for Community Services

By Mary Roach, GSMA

Our experiences with CPM

Earlier this year the GSMA, with the support of the UK Government, announced the launch of the Mobile Enabled Community Services (MECS) programme which leverages mobile technology and infrastructure to help improve access to basic energy and water services in underserved communities in emerging markets.

The programme builds from and is the successor of our IFC-funded Community Power from Mobile programme (CPM), which focussed on the role that the mobile industry can play in improving access to energy.

To design the new programme we spent time reflecting on our experiences with CPM, drawing out the lessons that would influence our strategy.

Our experiences with CPM taught us that single trials, under the umbrella of mobile operators CSR departments, did not do enough to quantify the opportunity and test the business case. One-off trials often failed to move beyond the scope of the CSR department into the strategic imperatives and day-to-day operations of the company.

Similarly we learnt that telecom players and Energy Service Companies (ESCOs) alike 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.[1]

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."

We concluded that for the "CPM opportunity to become a reality a risk ready environment needed 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."[2]

Creating an Idea Factory

With a blank canvas in hand we began to research organisations that had a track record of innovating and incubating ideas which, at the time of development, had an unclear business proposition. The hope was that we could learn something from the inventors of yester year to inform and influence the approach of the MECS programme.

We quickly realised that some of the most innovative companies were often government backed or monopolistic in nature, where large dedicated Research and Development budgets could be ring-fenced and protected from shareholders value extracting agenda, allowing scientists the runway to develop technologies over years if not decades, and bringing them to the market under the right conditions.

Bell Laboratories, the current research arm of Alcatel Lucent, stood out as prime example of the level of innovation that can occur when the research agenda is protected. In his book "the Idea Factory" chronicling the history of Bell Labs the 1920's through 80's, John Gertner argues " it was where the future was invented".[3]

If you are unsure of Bell Labs contribution here is a shortlist of some of their inventions: "Bell Labs was behind many of the innovations that have come to define modern life, including the transistor (the building block of all digital products), the laser, the silicon solar cell and the computer operating system called Unix (which would serve as the basis for a host of other computer languages). Bell Labs developed the first communications satellites, the first cellular telephone systems and the first fiber-optic cable systems."[4]

MECS Innovation Fund

While our ambitions are smaller in scope and shorter in timescale, the MECS programme is certainly focussed on the "future": the 20% of the world's population without access to energy and 10% of the world's population without access to water, increasingly living with access to the GSM network. Today, this customer bases is often considered a low value segment for mobile operators but represent one of the greatest growth opportunities for the industry.

To achieve our goals, the MECS programme has launched a £2.4M Innovation Grants Fund to provide focussed resources to accelerate the development and trial of products and services improving access to energy and water services in underserved communities using the mobile channel. The MECS Innovation Fund is divided into two tranches to provide support to concepts at different stages of maturity:

Additional Notes:
1. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/04/cpwhitepaper161211interactive2.pdf p 20
2. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/04/cpwhitepaper161211interactive2.pdf p 20
3. http://www.nytimes.com/
4. http://www.nytimes.com/

Seed grants are aimed at funding R&D of early stage innovations using mobile to support access to sustainable energy and water provision Market Validation grants are aimed at funding promising business models that support improved access to energy and water services at scale.

As the challenges of finding financial resources to support products and services geared to the BOP can be challenging before a business model has been proven, the MECS Innovation Fund supports applications from organisations large and small with good ideas and the commitment to see them to fruition.

The MECS Programme and Fund seek to address the following questions:

- What types of mobile technologies can support community services?
- For a solution to be adopted at scale what building blocks would be needed?
- What is the social and commercial impact of delivering community services to rural mobile subscribers?

But building an Idea Factory requires more than just funding good ideas: To put our research into practice we have chosen to adopt a structure that allows the MECS Team to act facilitators providing on-going support to innovators, advising potential applicants during idea generation and development, and providing on-going support to the sector (grantees or not) during project implementation. The decision to fund will be taken by a fund panel including an external fund manager and industry experts across the mobile, energy, water and development sectors.

Like all good research groups, the findings from the grants will be compiled, analysed and shared broadly to facilitate the cycle of adoption and adaptation. The targeted investment of the MECS Innovation Fund aims to not only deliver increased access to energy and water during the life of the programme but support the creation of new ideas that explore the use of mobile in the delivery of other community services including services such as sanitation and transportation.

Glossary

2G/3G – Second-generation and third-generation mobile telephone technology

AC/Alternating Current – An electrical current or voltage with a changeable direction (polarity) with respect to a fixed reference

Ah/Ampere-hour – Unit of electric charge, the electric charge transferred by a steady current of one ampere for one hour

ARPU – Average Revenue per User

BoP – Base of Pyramid

BTS/Base Transceiver Station – The name for the antenna and radio equipment necessary to provide mobile service in an area

CAPEX – Capital Expenditure

CO_2e/Carbon dioxide equivalency – A quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential when measured over a specified timescale.

COAI – Cellular Operators Association of India

CPM – Community Power from Mobile, GPM project

DC/Direct Current – An electrical current or voltage with a constant direction (polarity) with respect to a fixed reference

GHG – Green House Gases

IFC – International Finance Corporation – a member of the World Bank Group

IRR – Internal Rate of Return

kg/kilogram – A kilogram is a unit of mass

km/kilometre – A kilometre is a measure of distance

KPI – Key Performance Indicator

kVA/Kilovolt-Ampere – The unit of apparent power. KVA is used for measuring the power consumption of non-resistive equipments such as generators

kW/kilowatt – A kilowatt is a unit of power (see watt)

GDP – Gross Domestic Product

GPM – Green Power for Mobile Programme

GPRS – General Packet Radio Service

GSM – Global System for Mobile communications

GSMA – GSM Association

M2M – Machine to Machine

MECS – Mobile Enabled Community Services

MEE – Mobile Energy Efficiency, GSMA Initiative

MHz/megahertz – The hertz is a unit of frequency. It is defined as the number of complete cycles per second.

MSC/Mobile Switching Centre – Interface between the base station system, ie the BTS and the switching subsystem of the mobile phone network

Operator – Mobile Network Operator

NGO – Non Governmental Organisation

NPV – Net Present Value

OPEX – Operating Expenditure

PV/Photovoltaic – In this instance refers to PV cells which convert visible light into direct current

ROI – Return on Investment

V/volt – The value of the voltage equal to one ampere at one watt of power

W/watt – A unit of electrical power equal to one ampere under a pressure of one volt

Resources

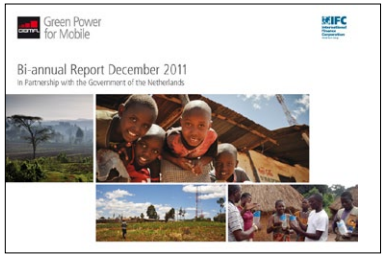
Bi-annual Reports

Bi-annual Report January 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/01/GPM-Bi-Annual-Report-January-2013.pdf

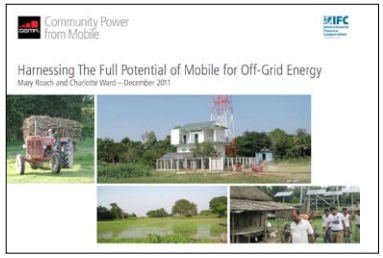
Bi-annual Report July 2012

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/GPM-Bi-annual-Report_Jul-2012_Final.pdf



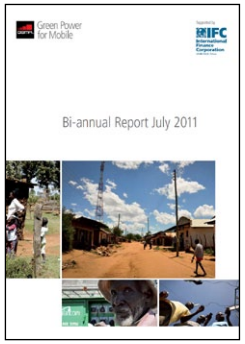
Bi-annual Report December 2011

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/GPM_Bi-annual_Report_Dec-2011.pdf



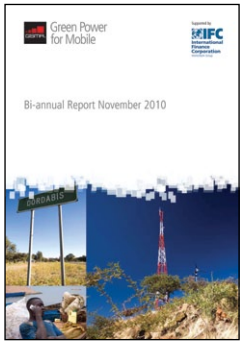
Community Power from Mobile White Paper (December 2011)

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/Community-Power-Using-Mobile-to-Extend-the-Grid-January-2010.pdf



Bi-annual Report July 2011

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/biannual_report.pdf

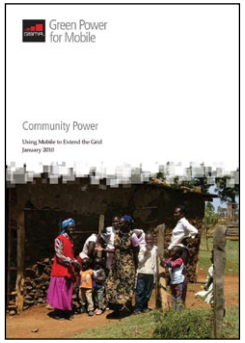


Bi-annual Report November 2010

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/GPM_Bi-Annual_Report_Nov10.pdf

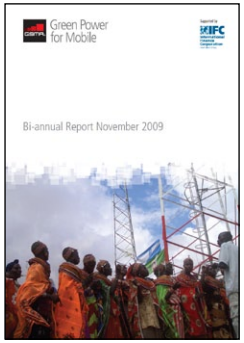
Bi-annual Report June 2010

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/GPM_Bi-Annual_Report_June_10.pdf



Community Power – Using Mobile to Extend the Grid

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/Community-Power-Using-Mobile-to-Extend-the-Grid-January-2010.pdf



Bi-annual Report November 2009

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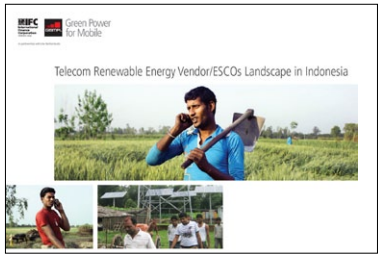
Vendor Landscapes and Directories

GPM Vendor Landscape – West and Francophone Africa – June 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/06/GPM_Vendor_Landscape_WestAfrica.pdf

Telecoms Renewable Energy Vendors/ ESCOs Landscape in Bangladesh - April 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/04/GSM_Vendor_040413_Bangladesh.pdf



Telecom Renewable Energy Vendor/ ESCOs Landscape in Indonesia - May 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/05/GSM_Indonesia-Vendor-Landscape_V4.pdf

Green Power for Mobile Vendor Directory - February 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/02/GPM-Vendor-Directory-February-2013.pdf

GPM Vendor Landscape – East Africa - May 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/05/GSM_Vendor_Landscape_EastAfrica_V5.pdf

Telecoms Renewable Energy Vendors/ ESCOs Landscape in India - April 2012

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/04/GSMA_Vendor_Landscape_India_v3_030412_Interactive1.pdf

Resources

Feasibility Studies

Airtel - Madagascar - Feasibility Study

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/04/GPM_AirtelCaseStudy190413.pdf

Ucell – Uzbekistan – Feasibility Study

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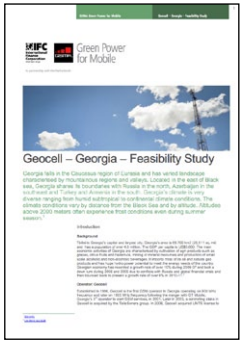

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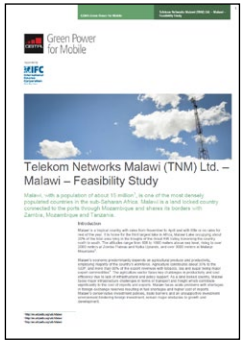

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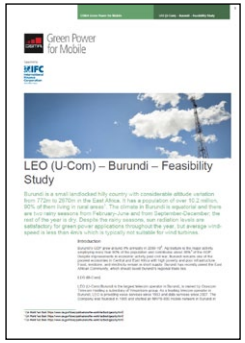

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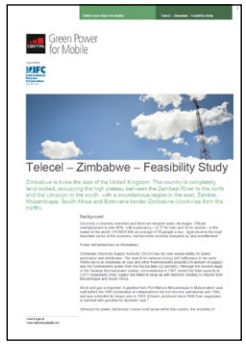

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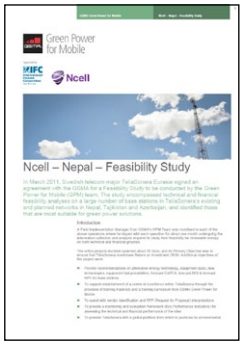

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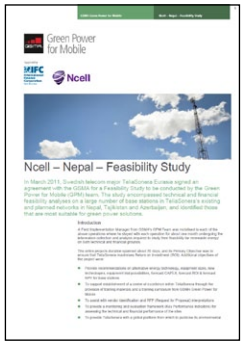

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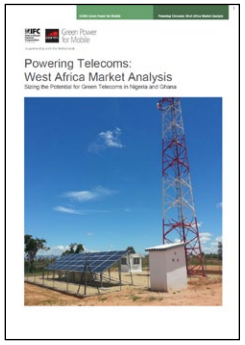

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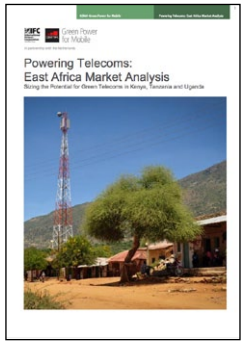

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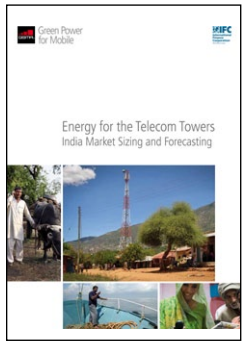

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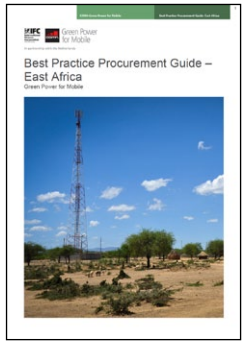

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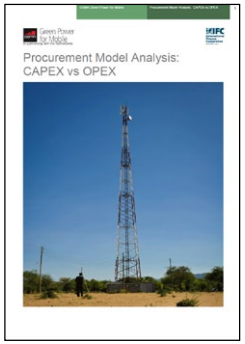

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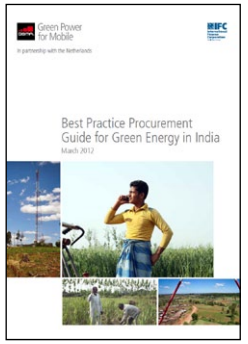

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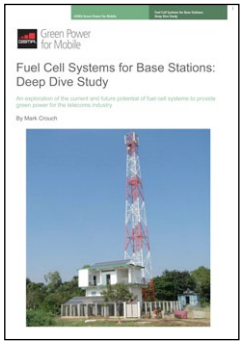

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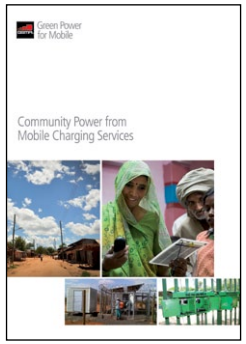

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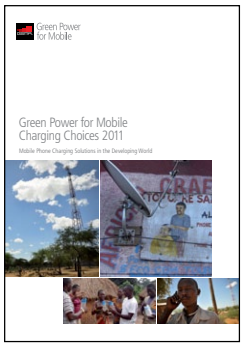

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