IFC International Finance Corporation
World Bank Group

GSMA Green Power for Mobile

In partnership with the Netherlands

Bi-annual Report January 2014

Contents

Welcome Note

As 2013 drew to a close, the Green Power for Mobile team had a chance to look back at an exciting year of analysis and progress in green telecoms. This, the ninth Green Power for Mobile Bi-annual Report will look at the Programme's progress throughout the year, and highlight some of the market and trend analysis that was completed. Also, in this issue we'll hear from some of the industry players such as Telekom Networks Malawi and TowerXChange in collaboration with Eaton Towers.

Jointly with our partner, the International Finance Corporation (IFC), the GPM team has hosted six industry Working Groups and published twelve reports and cases studies to aid the industry. There has been great progress in the number of deployed renewable energy sites over the past couple years – we have seen the number of deployed sites grow from 10,233 in 2011 to more than 37,000 at the end of 2013. More details on the growth of renewable energy sites is available in Chapter 1 of this Bi-annual Report.

In this Bi-annual, we provide insight into a couple of the main challenges of deploying renewable energy sites: cost, operations and maintenance of the sites. An important factor in deployment of renewable energy systems over the years has been the cost and total cost of ownership (TCO). In Chapter 5, we look at the pricing trends of green power systems, especially solar and wind, to provide an understanding of how pricing dynamics have impacted CAPEX requirements of deployment.

As part of our series of Market Analysis and Best Practice reports, we recap the findings from our Afghanistan and Pakistan report – two markets that have shown a great deal of potential for renewable energy for telecom sites – as well as the best practices of deployment in Africa and Asia. More details and full reports can be found in the resources section of our website (http://www.gsma.com/mobilefordevelopment/programmes/green-power-for-mobile/resources).

This Bi-annual Report also has great industry contributions from Eaton Towers and Telekom Networks Malawi (TNM). Eaton Towers and TNM, representing tower companies and mobile network operators respectively, both give their insights on how their organisations' approach green power and energy efficiency.

The last section of this report will look at the Mobile Enabled Community Services programme, focusing on how mobile communications can be applied to providing improved energy and water access. You will find a synopsis of the eport, *Sizing the Opportunity of Mobile to Support Energy and Water Access*, that was released in December 2103 as well as insights on the MECS opportunity in Latin America and the challenges around financing the sector's projects.

We hope you will find this edition of the Bi-annual Report useful and informative. We look forward to working and collaborating with you in the year to come and hope to see you at Mobile World Congress.

Areef Kassam
GSMA Programme Director – Green Power for Mobile

GPM Working Groups: 2008-2013

Meet the Team

Who's who in GPM and MECS

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.

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.

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 Electronics Engineering from Simon Fraser University of British Columbia.

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.

Hélène Smertnik

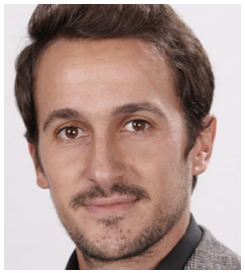
Market Intelligence Analyst

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. 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 Project Manager

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 Project Manager

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

Green Power Deployment Trends

By Ferdous Mottakin, GPM Programme Manager, and Satish Kumar, GPM Africa Project Manager

Extending mobile beyond the grid

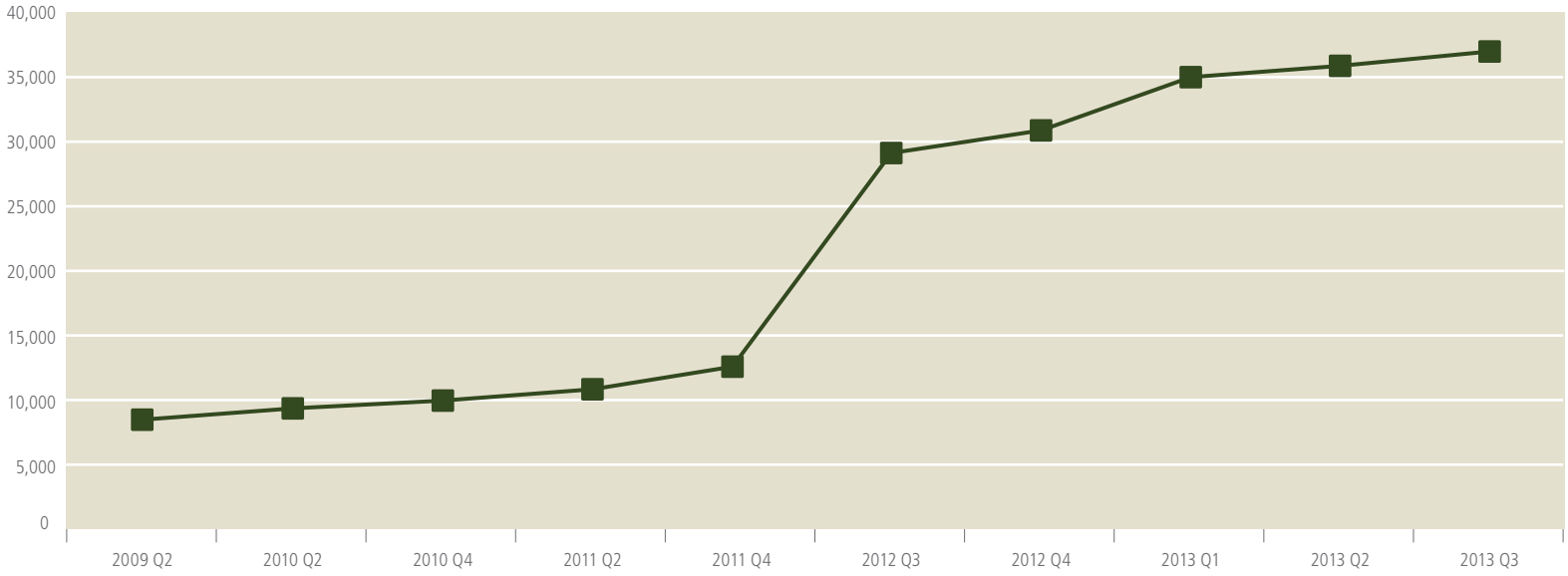
'Extending mobile beyond the grid' is the theme of GSMA's Green Power for Mobile (GPM) programme. At the beginning of the programme, we experienced a big gap between the growth of mobile coverage and the availability of grid electricity, which resulted in a massive energy OPEX burden for mobile operators in developing countries. With an ever-increasing diesel price, the mobile telecom industry had to look for means of financially viable and scalable alternative power generation at the site level. Though the adoption of alternative green solution was very slow at the beginning, over the last few years we have seen a tremendous growth of green deployment.

The GPM programme created a green deployment tracker to track all green telecom deployment globally. Currently it tracks more than 37,000 green sites wordwide.

Deployment growth

The adoption of green power alternatives for powering telecom base station sites has seen considerable growth, as illustrated in Figure 1 (below). The deployment had been very slow in the initial years of the launch of the GPM programme, between 2009 and the end of 2010. However, the green power deployments have risen tremendously during the period 2011-2013; the green deployments have grown by over 260%, from 10,233 green sites in 2011 to more than 37,000 sites in 2013. This has clearly shown the growing impact of GPM programme activities including Mobile Network Operator (MNO) feasibility studies, training and capacity building activities, publications and market insights, the promotion of green power feasibility and knowledge sharing by convening industry-wide working groups and through demonstrating a viable business case and technical feasibility.

Figure 1: Global green deployments in telecom, 2009-2013



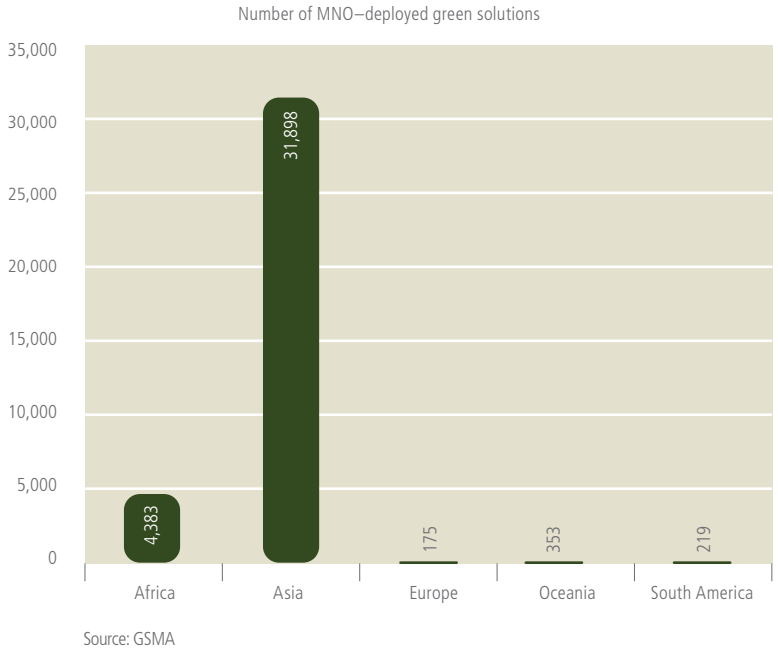
Source: GSMA

Regional comparison

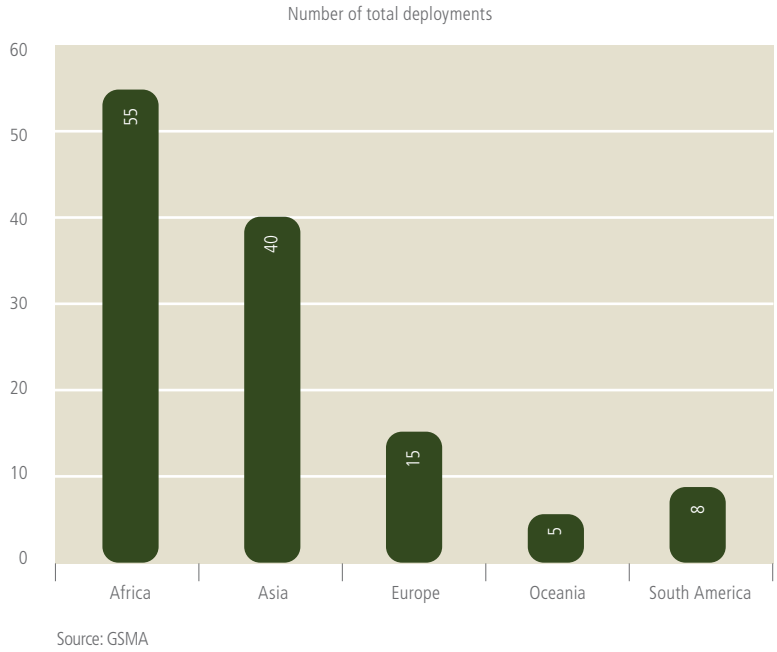
Figure 2, below, illustrates the regional deployments and comparisons in terms of the number of deployments by MNOs. As shown in the chart, the Asian region leads the pack with a total of nearly 32,000 sites, followed by the African region with more than 4,000 sites deployed with green power alternatives. In numerical terms:

- 40 MNOs in Asia deployed a total of 31,898 green sites;
- 55 MNOs in Africa deployed a total of 4,383 green sites;
- 8 MNOs in South America deployed a total of 219 green sites;
- 15 MNOs in Europe deployed a total of 175 green sites;
- 5 MNOs in Oceania deployed a total of 353 green sites.

Figure 2: Number of MNO-deployed green solutions and total deployments by region in 2013



Source: GSMA

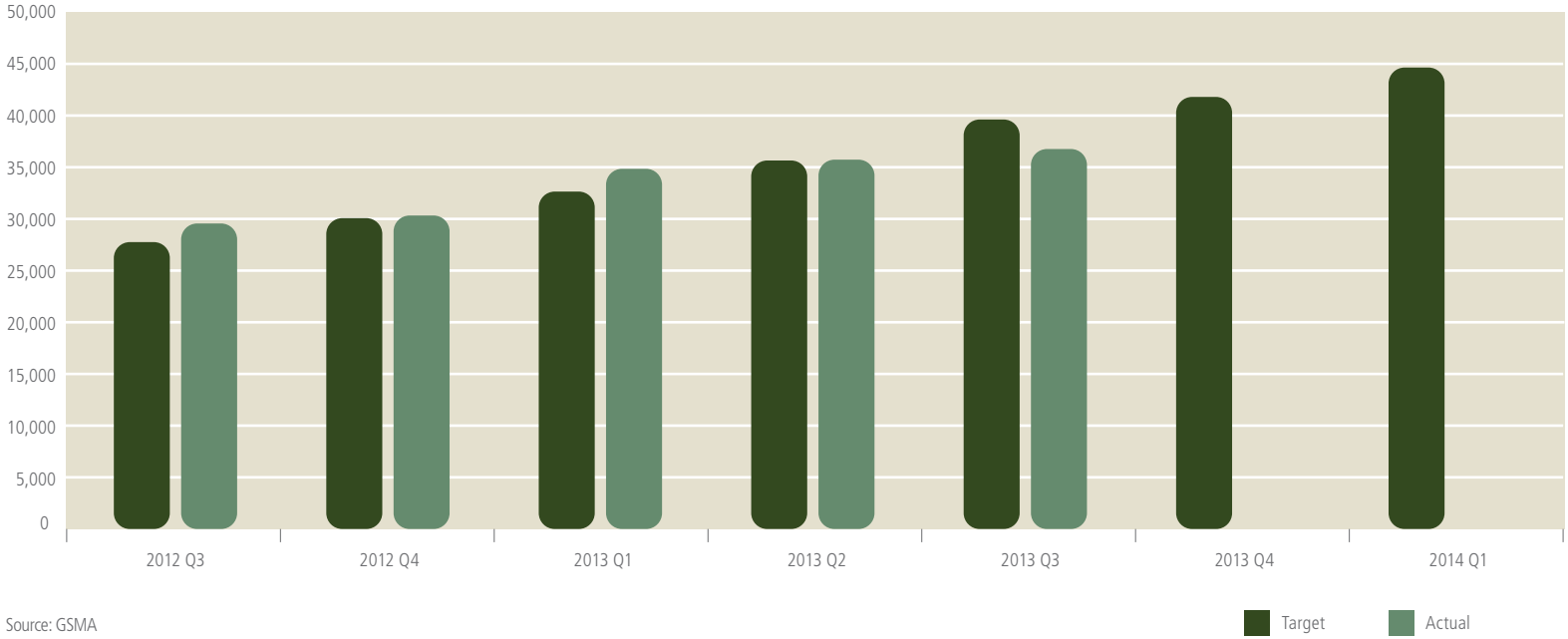


Source: GSMA

GPM's effort to get the growth

The GPM programme has greatly impacted the growth of deployment numbers by constantly engaging with mobile operators, tower companies, green solution vendors and other key stakeholders through its focused programme of activities, as well as its regional presence across developing regions. The impact is illustrated in Figure 3, by the green deployment targets set by the GPM programme, and the actual deployments, which have kept pace since 2012.

Figure 3: GPM's green deployment targets and global actuals, 2012-2014



Source: GSMA

The outcome of the GPM programme and its impact can be gauged from the below activities so far:

- it has published nine bi-annual reports highlighting success stories, MNO case studies and industry trends;
- it has conducted 23 working groups facilitating knowledge- and experience-sharing through focused discussions, case studies and new technology development;
- it has conducted green power feasibility studies with 27 operators in 23 countries, in order to demonstrate the technical and financial viability of green power alternatives as well as to impart training to MNOs on the right approach and methodology for green power deployments;
- it has provided training to more than 300 telecom professionals from 82 organisations globally;
- it has published more than 50 reports including case studies, vendor directories, best practices, market insights and technical white papers to build industry knowledge on green power for the telecom industry.

Challenges still exist

Global green power deployments are still far from reaching the potential opportunity available for MNOs and tower companies. There are various challenges hindering the scaled adoption of green power across regions and MNOs. Finance, the cost of solutions, local technical know-how and unfavourable regulatory policies are just some of the key reasons for the limited scale of adoption. For example, in Africa the lack of finance and limited technical know-how are among the many challenges that have limited the scale of deployments to just over 4,000 green sites. A lack of knowledge of the potential opportunities that exist in various markets has been another factor for the limited scale of deployment.

Besides the technical and financial challenges, there are many operational difficulties including theft and vandalism of equipment, and local technical support as well as friction with the existing diesel supply chain which has resulted in a larger perceived risk of investment by operators.

Mitigation plan

GPM has been in the forefront, catalysing and scaling the adoption of various green power alternatives across Asia and Africa with its focused programme of activities. In addition to building market knowledge through research and stakeholder engagement, GPM has been driving the development of technology and business models to address the technical and financial challenges faced by the industry. GPM believes that the energy outsourcing model driven by third-party energy service companies will immensely impact the scale of adoption across regions by bringing in a specific focus to energy as a service to the mobile operators and tower companies. With the support of International Finance Corporation (IFC), GPM aims to address the finance challenges by bringing in financial products that are suitable for investments in green telecoms across regions.

Recent developments in the industry, including the emergence of the tower outsourcing model in Africa, have greatly impacted the adoption of green power in the telecom industry. The future growth of green deployments will greatly depend upon the industry moving towards energy outsourcing business models with a key focus on energy as a service and OPEX-saving opportunities.

Chapter 2

Green Power Best Practice Guides:
Africa and Asia — Summary

By Satish Kumar, GPM Africa Project Manager

GPM recently published industry best practice guides focusing on key elements of procurement and operations associated with green power deployments across Africa and Asia. In this article we present a summary of highlights touching upon various aspects of sustainable procurement and operations, as well as business models in practice.

Best practice procurement guide

The best practice guide for procurement focuses on the sustainable procurement process as well as the procurement business models for green power deployments in the mobile telecom industry.

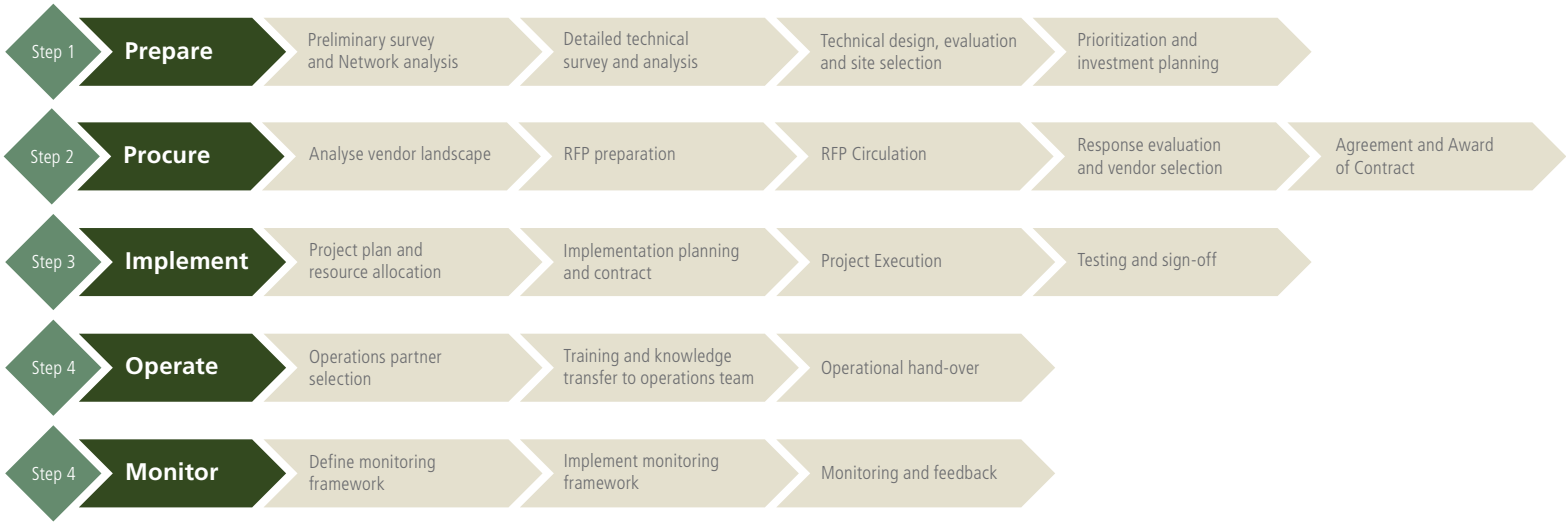
The sustainable procurement process describes a step-by-step approach to procurement, starting from the preparation phase through procurement to the implementation phase. The figure, below, highlights various phases and steps involved in a sustainable procurement process.[1]

The procurement guide also highlights key aspects of the post-deployment activities, including operations and monitoring. Operations and monitoring are examined further in the Best Practice Operations Guides for Africa and Asia, which are summarised later in this article.

The best practice procurement guide also looks into a detailed understanding and analysis of various business models in green power deployments, including the in-house CAPEX model and the outsourced OPEX model.

The document, through various examples, highlights the key elements and process steps for each of the business models in an attempt to provide the mobile operators, tower companies and other stakeholders with best practices for evaluating and adopting the business models. The examples of both CAPEX- and OPEX-based procurement models explain in detail the investment, net cash flows and the cumulative savings and benefits for the mobile network operator (MNO) as well as the third-party energy service company (ESCO).

Figure 4: Sustainable Procurement Process steps



Source: GPM Best Practice Procurement Guide – East Africa

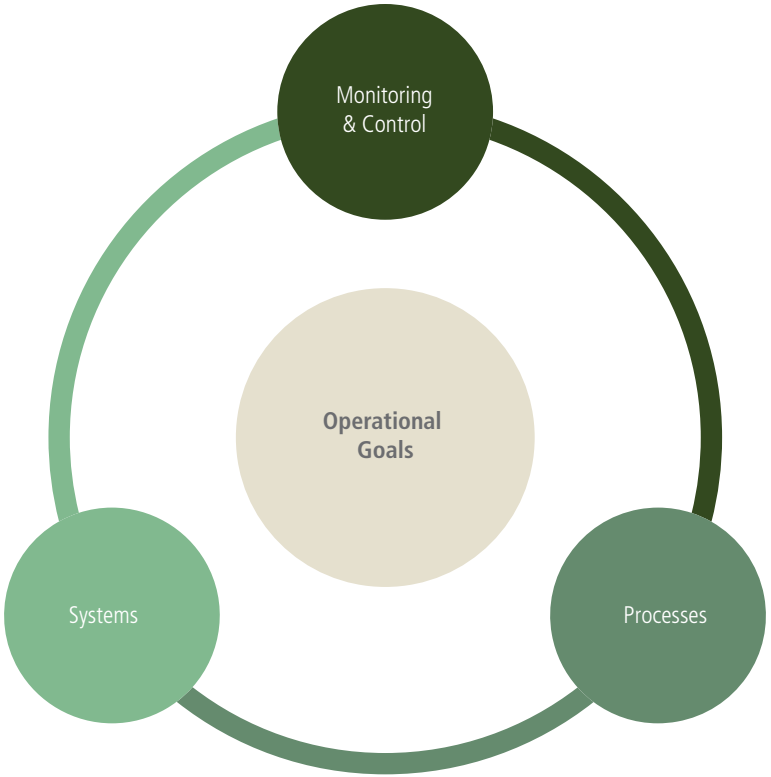
1. For a detailed understanding on each process and activities as well as business models, you can read the best practice guides published for Africa (East Africa) and Asia (Bangladesh).

In addition, the best practice procurement guide provides detailed process flows for both CAPEX and OPEX business models, and highlights various steps, activities and contractual elements required for a successful adoption of either CAPEX or OPEX business model.

Best practice operations guide

Network and site operations are the most critical operational elements of managing and running telecom networks and are at the backbone of a mobile telecommunications business. Energy provision comes as a major priority for network operators, and remains the most crucial part of network and site operations, impacting the availability of mobile network and services to end users.

Figure 5: Sustainable Operations Framework



Source: GPM Best Practice Operations Guide – West Africa

The best practice guide for operations focuses on a sustainable approach to network and energy operations, and analyses the key enabling factors for achieving the broad operational goals of network availability and OPEX efficiency. Figure 5 highlights the key elements of a sustainable operations framework in achieving the operational goals.

Systems, processes and a monitoring and control framework play a major role in defining the best practices for operations. Supporting systems, enabling processes and integrated monitoring and control mechanisms provide a strong platform for sustaining the operational goals of network availability and OPEX efficiency.

The best practice operations guide expands, in great detail, the various operational activities along with associated business models and activity ownership between MNOs and service providers.

In addition, the document provides detailed process flow for some of key operational activities and illustrates key operational steps in executing these activities in an efficient manner.[2]

The site operations of an MNO can be broadly divided into active and passive maintenance, field operations and monitoring and control operations. Some of the key operational activities are highlighted below:

- preventive and corrective maintenance of network equipment;
- monitoring and preventive, as well as corrective, maintenance of other active components including radio, transmission and antenna equipment;
- preventive, corrective, scheduled and breakdown maintenance of passive infrastructure elements including power systems, diesel generator (DG), batteries, air conditioners and other related power system components and green power systems;
- DG servicing and overhauling in accordance with the specification and guidelines;
- active monitoring and maintenance of alarms for site outages and link failures;
- diesel filling to ensure availability for uninterrupted back up (or primary) power supply.

2. For a detailed understanding on operational framework as well as business models, you can read the best practice guides published for Africa (West Africa) and Asia (Indonesia)

The key operations and responsibilities for each of the operational models are described in Table 1, below.

Table 1: Operational Models and Responsibility Matrix

Operations	In-house	Outsourced	Remarks
Maintenance	MNO (with support from MSP)	MSP	Maintenance in the in-house model is the responsibility of the MNO with support from vendors for planned and corrective equipment maintenance activities.
Field operations	MNO	MSP	Monitoring of field operations including equipment performance monitoring, diesel logistics, grid connection maintenance are the responsibility of MNO.
Site security	MNO	MSP	Site access and security remain critical aspects in the network operations in order to ensure predictability in site operations.
Monitoring and control	MNO	MNO	Monitoring and control of operations, maintenance and site access and security need to be the responsibility of the MNO in order to ensure network performance.

The best practice guide for Asia (Indonesia) also touches upon standardisation frameworks for sustainable operations using the eTOM (enhanced Telecom Operations Map) framework that is being using across the telecom industry in the region. The key elements of the eTOM framework are:

- strategy, infrastructure and product, covering planning and lifecycle management;
- operations module, covering the core operational processes and day-to-day operational management;
- enterprise management, covering corporate and business support management .

The best practice document for Indonesia focuses on aspects of the eTOM framework, which is the operations process framework. The operations process framework is necessary to provide guidelines for field operations to enable proactive and corrective maintenance of equipment and fault handling to achieve optimum network availability and OPEX efficiency.

Conclusion

Power provision has been an essential element of network operations and is a critical part of mobile network infrastructure, providing for 24x7 network uptime. The availability and reliability of a power supply, as well as the source of the power supply, has great implications on operations and associated costs impacting the overall OPEX performance of the network.

Unfortunately, the mobile industry faces many challenges due to the lack of reliable supporting infrastructure, such as power grid and roads, which tremendously impact mobile network operations. The limited reach of power infrastructure in Africa and poor accessibility to widely dispersed network of telecom sites has enormously impacted the operations and costs of running the network across the region.

It is crucial for mobile network operators to establish best operational practices to overcome the various operational challenges that are prevalent in network operations and achieve optimum network availability and OPEX efficiency across the network.

Chapter 3

The Regulatory Environment for Green Telecom in Asia and Africa

By Ali Imron, GPM Asia Project Manager

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

GPM was launched in September 2008 with the objective of aiding the mobile industry in deploying renewable energy technology. The programme is now in Phase Two, where it is focusing on 11 countries in Africa and Asia, namely Indonesia, Bangladesh, Pakistan, Afghanistan, Nigeria, Ghana, Kenya, Tanzania, Uganda, Senegal and Cameroon.

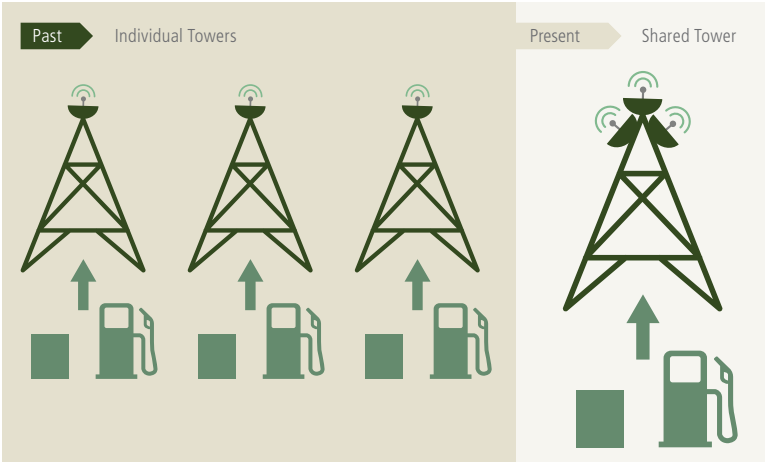
One of the key activities in Phase Two is studying and analysing the markets in these countries and examining their current approach to power management, the opportunities for deploying green technologies in the telecom industry, market size and any regulation of green telecom initiatives. The regulation of green telecom may vary from one country to another and it is an essential consideration for investors and industry stakeholders looking to implement such technology in the country.

Regulations have played a significant role in attracting both investors and mobile operators to implement green solutions, by offering some incentives such as tax exemption. This article presents a summary of green regulation, as well as other related regulations, in the Phase Two countries in both Asia and Africa.

Infrastructure Regulation

In emerging markets, mobile network operators (MNO) have shifted their paradigm on telecom infrastructure ownership. Now, MNOs will often choose a tower company to build and maintain site infrastructure and maintenance. This trend has reduced CAPEX significantly for MNOs and has also created a business opportunity for investors.

Figure 6: The current business model — site sharing



Source: GSMA

The tower company will provide a passive infrastructure for MNOs, and the tower company will receive a fee as a return. Site sharing or tower sharing has been implemented in many countries in the Asian and African regions.

Governments, as industry regulators, have encouraged and supported the telecom industry by issuing regulations that relate to infrastructure sharing. Table 2, on the following page, shows the regulations in place in the 11 countries as of June 2013.

Table 2: Site Sharing Regulation

Number	Region	Country	Regulation	Source
1	Asia	Indonesia	Act No. 02/PER/M.KOMINFO/03/2008 Guidance for Infrastructure Sharing Construction and Utilization from Ministry of CIT regulates the following: - Tower sharing deployment mechanism and implementation - Co-location regulation for MNO/Tower Company	www.kominfo.go.id
2	Asia	Bangladesh	Act No. BTRC/LL/INF-SHARING (304)/2008-447 - This act regulates on active and passive infrastructure sharing - All operators need to share detailed information of passive infrastructure on their website and the list shall be updated on monthly basis	www.btrc.gov.bd
3	Asia	Pakistan	The Mobile Cellular Policy date 28 January 2004, includes as part of its remit: - Regulate active infrastructure sharing - Regulate passive infrastructure sharing - And spectrum sharing	www.pta.gov.pk
4	Asia	Afghanistan	Economic Council Act #22 from Ministry of Economic about national infrastructure sharing policy: - In general the Act manages about integration on infrastructure sharing among ministries, government entities and municipalities - The infrastructure sharing includes tower sharing for base stations The Act just has been released on 11 April 2013	www.mcit.gov.af
5	Africa	Nigeria	Nigerian Communication Commission (NCC) has guided the infrastructure sharing mechanism. The objectives of the guidelines as follows: - Ensure that the incidence of unnecessary duplication of infrastructure is minimized and completely avoided. - Protect the environment by reducing the proliferation of infrastructure and facilities installations. - Promote fair competition through equal access being granted to installations and facilities of operators on mutually agreed terms.	www.ncc.gov.ng
5 (cont.)	Africa	Nigeria	- Ensure that the economic advantages derivable from sharing facilities are harnessed for the overall benefit of all telecommunication stakeholders. - Minimize capital expenditure on supporting infrastructures and to more funds for investment in core network equipment. - Encourage operators to pursue a cost-oriented policy with the added effect of a reduction in the tariffs chargeable to customers.	www.ncc.gov.ng
6	Africa	Ghana	National Communications Authority Act, 2008 This Act regulates on passive infrastructure sharing and license of tower company.	www.nca.org.gh
7	Africa	Kenya	Kenya Information and Communications Regulation, 2010 - The regulation manages the interaction between lessor and lessee with regulator - lessors and lessees shall submit a copy of a concluded access agreement to the Communications Commission of Kenya (CCK)within 30 days of the conclusion of the agreement - The Commission may authorize access to essential facility	www.cck.go.ke
8	Africa	Tanzania	There is no specific site sharing regulation in Tanzania	
9	Africa	Uganda	There is no specific site sharing regulation in Uganda	
10	Africa	Senegal	There is no specific site sharing regulation in Senegal	
11	Africa	Cameroon	There is no specific site sharing regulation in Cameroon	

These regulations have pushed MNOs to carry out site sharing of the most important infrastructure, which has reduced capital and operating expenses and in turn led to optimised investment for telecom industries.

Green Regulation

The relative lack of power generation has been a problem for the industry. Governments, as regulators, have approached the industry to work together to eliminate that issue by searching for an alternative energy source. Green energy is one alternative energy option that many countries have been looking at, because it offers an alternative energy source and at the same time has an environment impact by reducing CO_2 emission.

The governments have encouraged the industry to participate in the implementation of green solutions to their business by creating regulations and setting targets for the industry to achieve. Table 3, below, outlines the highlights from the policy framework and guideline for the 11 countries.

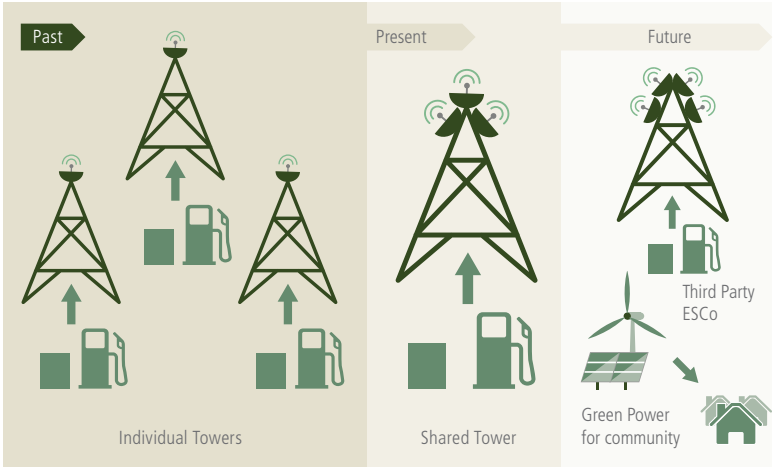
Table 3: Green Regulation

Number	Region	Country	Green Regulation	Source
1	Asia	Indonesia	- Presidential Regulation No 61/2011 has set a target of reducing greenhouse gas (GHG) emissions by 25%, or 767 million tonnes of oil equivalent (TOE) by its own efforts, and 41% with international support, by 2020	State Ministry for Development Planning
2	Asia	Bangladesh	- 5% of total power from the telecom sector is to be from renewable energy by 2015 - 10% of total power from telecom sector is to be from renewable energy by 2020	Bangladesh Power Division
3	Asia	Pakistan	- Alternative Energy Development Board (AEDB) has mandated that 10% of the country's total power generation capacity is to be from renewable energy sources by 2015	Ministry of Water and Power
4	Asia	Afghanistan	- As Energy sector strategy roadmap for 2008 – 2013, the country aims to deploy 10MW of wind power in the next five years and 50MW in the next 10 years	Ministry of Energy and Water
5	Africa	Nigeria	Renewable Energy Master Plan - The pursuit of enhanced solar energy integration into the national energy mix - The promotion of efficient biomass conversion technologies - The commercialization of national's wind resource	Federal Ministry of Power and Steel
6	Africa	Ghana	- Ghana's Renewable Energy Policy, as part of the National Energy Policy 2010, has targeted that 10% of electricity generation will be from renewable energy sources by 2020	Energy Commission
7	Africa	Kenya	- Kenya is still in the early stage of implementation, and the main focus is on creating a department that will create and manage renewable energy policy	
8	Africa	Tanzania	- the government is still developing the framework for renewable energy projects and tariff methodology	
9	Africa	Uganda	- the overall policy goal is to increase the use of modern renewable energy from 4% of the country's total energy consumption to 61% by 2017	Ministry for Energy, Minerals and Development (MEMD)
10	Africa	Senegal	- the target is to have a minimum share of 15% of electricity production by 2020	Ministry of Energy
11	Africa	Cameroon	- Cameroon has no policy on renewable energy yet	

From the data in Table 3, we can see that most of the countries are now focusing on renewable energy to mitigate their energy supply problems, by setting some targets for the industry. In telecom, energy is the main consideration in powering up the base stations to serve the customer.

The regulations have stimulated activity in developing novel renewable energy solution requirements. Vendor and tower companies have looked into was of developing a new business model to providing a power solution. Energy service companies (ESCOs) have started to meet the demand and as a result the business model has shifted, as shown in Figure 7, on the next page.

Figure 7: The future business model: shared sites and ESCOs



Source: GSMA

Tower companies or third-party ESCOs will offer green solutions to MNOs and they will bear the burden of investment costs as well as the maintenance, and in return, the tower company or third-party ESCO will receive a fee.

The energy outsourcing business model is growing rapidly in many countries, because it offers a mutual benefit for MNOs and ESCOs. The MNO makes a saving by engaging the ESCO and the ESCO will gain by providing its service to the MNO. As a result, the MNO will be more focused on product innovation and maintaining the customer.

Incentives to promote green technology

Regulation will not work properly without any benefit for the industry: there needs to be some incentivisation for the industry to accede to new operating practices. The incentives to promote green technology may vary from one country to another, and the approaches of the Phase Two countries are presented in Table 4.

Table 4: Incentives to promote green technology

Number	Region	Country	Incentives	Remark
1	Asia	Indonesia	Yes	The government, through the Ministry of Finance, has unveiled regulations and linked them to a tax holiday and import duty tax exemption for renewable industry player.
2	Asia	Bangladesh	Yes	To promote the use of renewable energy, the government gives a 15% tax exemption from Value Added Tax (VAT) for all renewable equipment and related raw material.
3	Asia	Pakistan	Yes	The government will give fiscal and financial support to independent power producers (IPP) in the renewable sector.
4	Asia	Afghanistan	No	There is no specific incentive programme from the government.
5	Africa	Nigeria	No	There is no specific incentive programme from the government.
6	Africa	Ghana	No	There is no specific incentive programme from the government.
7	Africa	Kenya	No	There is no specific incentive programme from the government.
8	Africa	Tanzania	No	There is no specific incentive programme from the government.
9	Africa	Uganda	Yes	The government has introduced a feed-in tariff structure and tax exemption for renewable energy material.
10	Africa	Senegal	Yes	Feed-in tariff structures were introduced in 2010; however the tariffs law has not yet come into effect.
11	Africa	Cameroon	No	There is no specific incentive programme for renewable energy players.

Moving forward

Just like Rome, the green telecom industry will not be built in a day, and nor will it happen without any support from regulators. Government plays an important role in the promotion of green initiatives in a country; it can legislate and regulate the telecom sector but it must also put in place an incentive system to encourage the industry to implement green technology solutions.

Table 5 outlines the support required from the regulator to promote green telecom in the Phase Two countries.

Conclusion

Power and infrastructure are the key points for MNOs to look to in expanding their network and capacity. Site sharing and energy alternative sources are solutions that can eliminate costs and lessen environmental impacts. The government, acting as a regulator, has to pay attention to providing the industry with some actual regulations and incentives to promote green telecom take-up; in several countries, regulations have been put into place to help the MNOs to penetrate the market more widely.

Table 5: Support requirements in Phased Two countries

Number	Region	Country	Remark
1	Asia	Indonesia	- A package of fiscal incentives for telecom sector - A raft of regulations to control the deployment of green telecom - A package of fiscal incentives for the telecom sector - A raft of regulations to control the deployment of green telecom solutions
2	Asia	Bangladesh	- Tax incentive for batteries as part of a green telecom solution - Fiscal incentives for MNOs to implement green site on their network
3	Asia	Pakistan	- Green telecom regulation to encourage the industry - Tax and fiscal incentives for green telecom player
4	Asia	Afghanistan	- An attractive incentive for ESCOs or MNOs that have implemented green telecom by giving tax exemption or tax holidays - The government needs to encourage MNOs to implement green base stations
5	Africa	Nigeria	- A financial incentive scheme needs to be put in place for green telecom regulation - The government needs to bring green awareness to the telecom industry
6	Africa	Ghana	- Specific targets need to be put in place for the telecom industry to bring in green telecom - An incentive scheme needs to be drawn up for green telecom players
7	Africa	Kenya	- A government body needs to be created to manage green telecom environment - Tax and fiscal incentives need to be developed to encourage the telecom sector to 'go green'
8	Africa	Tanzania	- The government needs to add tariff methodology to the existing renewable energy laws - It also needs to educate and encourage MNOs to go green
9	Africa	Uganda	- The government needs to set up a regulator for green telecom - It also needs to build an attractive incentive scheme for green telecom player
10	Africa	Senegal	- The government needs to promote the benefits of green telecom more widely - Tax and fiscal incentives need to be developed
11	Africa	Cameroon	- The government needs to create a green telecom policy for the industry - The government needs to prepare an incentive scheme for MNOs and ESCOs to promote green telecom

Chapter 4

Greening Telecoms: Pakistan and Afghanistan Market Analysis

By Ali Imron, GPM Asia Project Manager

The Pakistan and Afghanistan Market Analysis report was published in early November 2013. The report aimed to identify the potential opportunity for green deployment and its adoption. This market analysis presents infrastructure and power regulation, the potential resources for green deployment, the current deployment in the telecom sector, current approaches and the challenges faced by the power telecom network.

The report aims to enable the reader to understand the potential of green power in the telecom sector and its benefit in terms of OPEX savings as well as environmental benefits.

This article will present the highlights and a brief summary of the report.

About Pakistan and Afghanistan

Geographically, Pakistan occupies a greater area than Afghanistan, spanning 796,096km^2, with Afghanistan spanning 652,230 km^2. Both countries are located in the South Asia region and are members of SAARC (South Asian Association for Regional Cooperation).

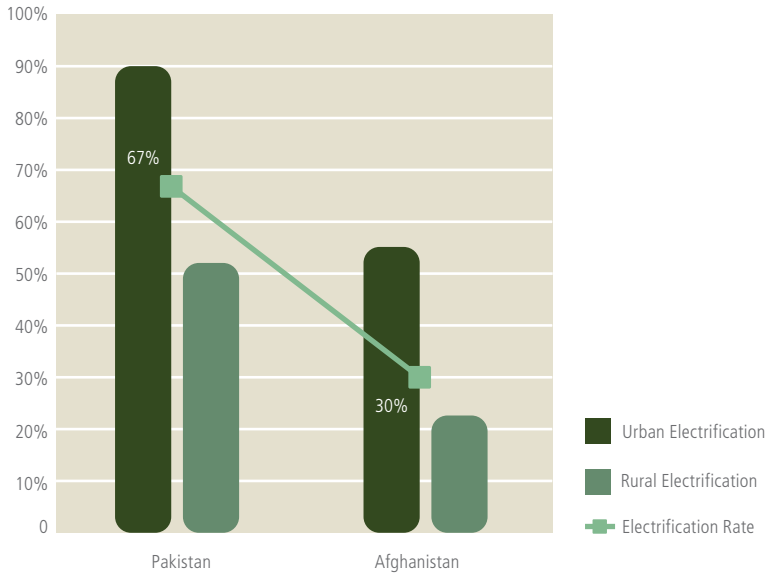
In fiscal terms, Pakistan has a better economic condition than Afghanistan; its GDP per capita is about US$1,189 whereas Afghanistan's GDP is only US$542 in 2011. Afghanistan's GDP has grown an average of 9.7%, compared with Pakistan's growth of 2.96% from the past 4 years.

Power and Energy

The electrification rate for both countries is shown below.

The electrification rate for Pakistan is better than that of Afghanistan, but appearances can be deceptive: in reality, Pakistan still suffers regular outages of 4-8 hours daily in urban areas.

Figure 8: Electrification rate in 2012



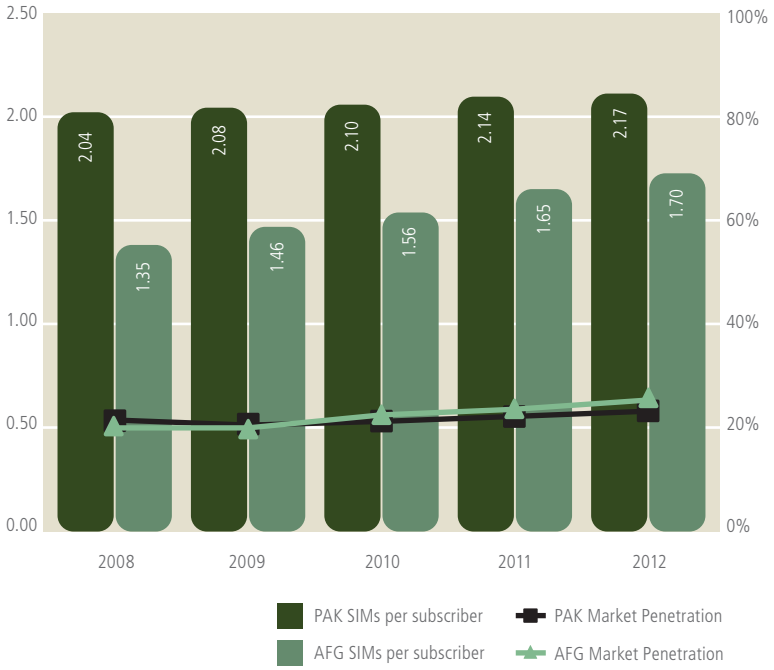
Source: IEA – www.worldenergyoutlook.org

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)

Telecoms

The telecom sector in Pakistan and Afghanistan is still growing. GSMA estimates that mobile penetration climbed up to 28.51 % for Pakistan and 33.92 % for Afghanistan by 2012, with the SIMs per subscriber reaching 2.17 for Pakistan and 1.70 for Afghanistan. The number of unique subscribers in each country has reached 51.7 million and 11.5 million respectively.

Figure 9: Market penetration, 2008-2012

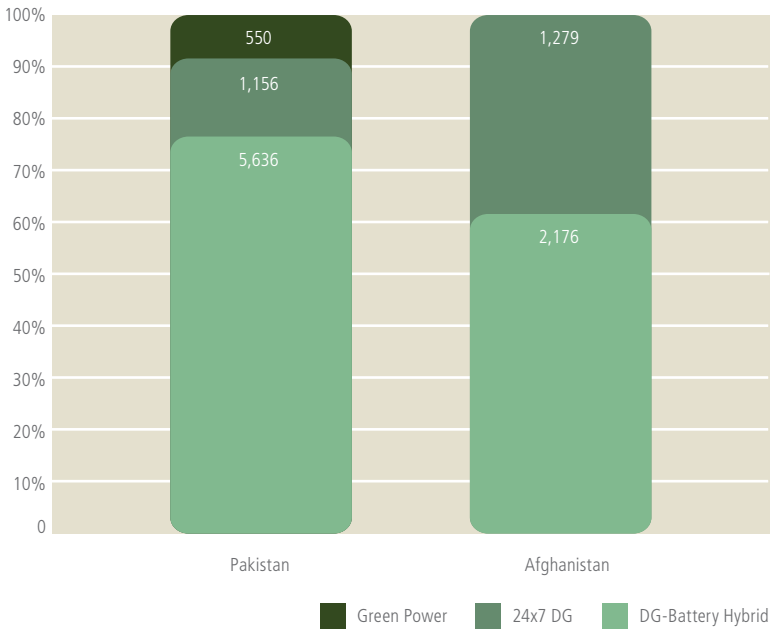


Source: GSMA Wireless Intelligence

Network size and current power approach

By Q2 2013, Pakistan had a total of 33,160 tower sites, while Afghanistan had 5,292 tower sites. The unreliable grid in both countries means that a total of 10,801 sites are problematic – with 7,812 problem sites in Pakistan and 2,989 in Afghanistan. Figure 10 shows, in detail, the nature and scale of these sites.

Figure 10: Problematic sites (Q2 2013)



Source: GPM research

Green technology choices

Geographically, Pakistan and Afghanistan have access to very good solar resources. They enjoy daily average insolation levels of about 4-5.3kWh/m² and the amount of sunshine can reach 8-8.5 hours daily. Other resources such as hydro, wind and fuel cells have the potential to be used as alternative energy sources for mass power generation in both countries.

GPM has analysed the opportunities for the adoption of green energy by Pakistan and Afghanistan's telecom industries, and its findings are tabulated below.

Table 6: Green Power Adoption in Pakistan

	Solar	Biomass/ Biogas	Wind	Fuel Cell	Pico Hydro
Solution availability	Very Good	Good	Good	Good	Good
Reliability	Good	Good	Good	Good	Good
Market acceptance	Good	Poor	Poor	Good	Poor
Supply chain readiness	Good	Poor	Poor	Poor	Poor
Stage of adoption	Commercial	N/A	N/A	Trial	N/A
Resource potential	Moderate	Good	Low	Good	Low
Barriers to adoption	- High initial CAPEX - Space requirement	- Supply chain challenges - Unproven operational trial in telecom field - Business model offering	- Low scalability limited to coastal and mountain area - High initial CAPEX	- Supply chain availability for hydrogen or methanol - Suitable only for unreliable sites	- Number of sites near the river flow location - High initial CAPEX - Operational challenges
Risks of adoption	- Reliability issues due to distance from the nearest O&M hub - Vandalism of battery and panel theft	- Biomass supply and sustainability - Scalability of solution for telecom load	- Operational risk due to wind speed availability - Unreliable power generation due to wind speed characteristic	- High replacement cost of fuel cell	- Operational risks associated with limited knowledge and readiness

Source: GPM research

Table 7: Green Power Adoption in Afghanistan

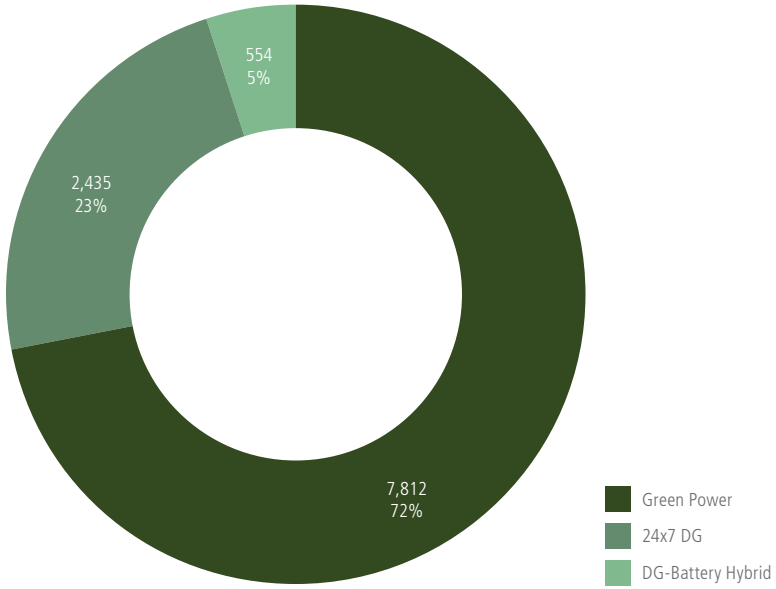
	Solar	Biomass/ Biogas	Wind	Fuel Cell	Pico Hydro
Solution availability	Very Good	Poor	Poor	Good	Good
Reliability	Good	Good	Good	Good	Good
Market acceptance	Poor	Poor	Poor	Good	Poor
Supply chain readiness	Good	Poor	Poor	Good	Poor
Stage of adoption	Trial	N/A	N/A	N/A	N/A
Resource potential	Moderate	Good	Low	Good	Low
Barriers to adoption	- High initial CAPEX - Space requirement	- Need supply chain for biogas based on animal waste - Vendor availability for biogas solution	- Low scalability, limited to coastal or mountain area - High initial CAPEX	- Supply chain and trial are needed in Afghanistan	- Number of sites near the river flow location - High initial CAPEX - Operational challenges
Risks of adoption	- Site security and distance challenges	- Continuity of supply chain - Scalability for telecom sector	- Wind speed data before adoption of solution - Security issue for remote area	- High replacement cost of fuel cell	- Operational risks associated with limited knowledge and readiness

Source: GPM research

The market for green deployments (short-term and long-term)

Out of the 10,801 problem sites identified, 10,247 – almost 95% – may possibly to be converted to green sites. Of these, 23% rely on 24x7 DG and 72% are running on DG-battery hybrid solutions.

Figure 11: Current power deployment for problematic sites



Source: GPM research

To convert the problematic sites, mobile network operators (MNOs) are able to choose a short-term or long-term strategy. Which one is chosen will depend on its alignment with the MNOs' objective of reducing their OPEX.

Short-term strategies

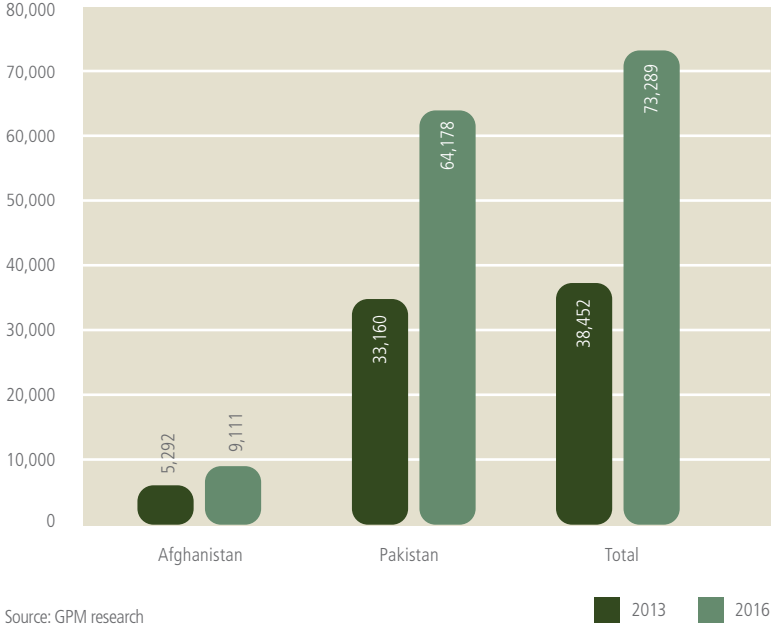
MNOs can impose a short-term solution to get immediate savings for their 24 DG sites by converting to a DG-battery hybrid solution. GSMA estimates that for the 2,435 sites, the potential OPEX saving represents about US$18.1 million per annum.

Other short-term solutions would involve power optimisation, using DC fan or free cooling units instead of normal air conditioning units, replacing outdoor-type Base Transceiver System (BTS) with indoor-type BTS and upgrading the base stations with low consumption BTS.

Long-term strategies

Long-term strategies are something that MNOs need to consider for green deployment in their networks. GSMA estimates the network will grow from 38,452 sites in 2013 to 73,289 sites by 2016, as shown in Figure 12, below.

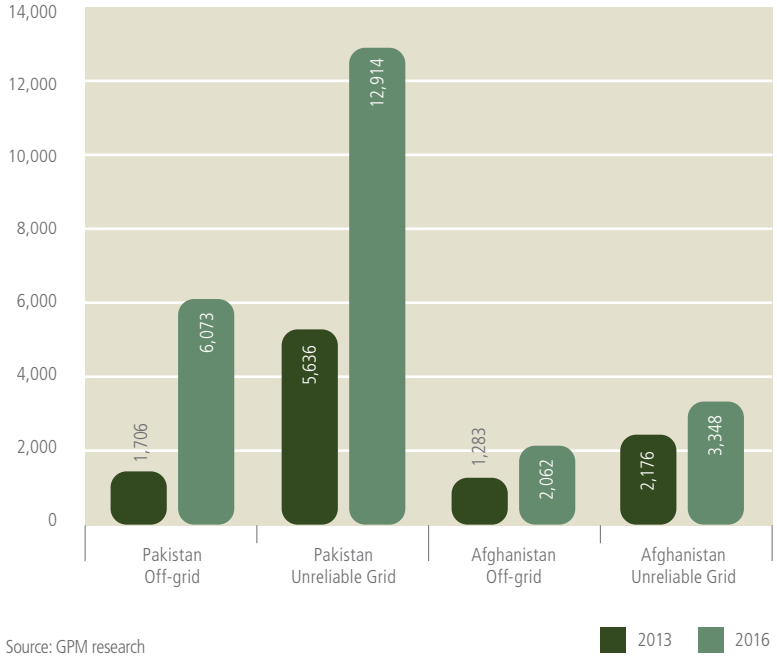
Figure 12: Site growth estimates, 2013-2016



Source: GPM research

The number of problematic sites will increase at the same time MNOs expand their network to rural areas and if there is no improvement in commercial grid connections in Pakistan and Afghanistan, then the potential growth in the number of estimated problematic sites is shown in the figure below.

Figure 13: Problematic Site Growth, 2013-2016



Source: GPM research

By converting all currently problematic sites to solar green sites, MNOs will save around US$127.7 million, with a CAPEX of US$394.5 million; by 2016 the investment will increase to US$939.3 million, with MNOs making estimated savings of around US$314.5 million.

Another way of achieving this is by shifting the investment responsibility to an energy service company (ESCO). The ESCO will bear all the investment and maintenance costs, and in return the ESCO will get a payment from MNOs. By adopting the ESCO model based on a power purchase agreement (PPA), it is estimated that MNOs will save an OPEX of around US$41.6 million in 2013, rising to US$104.3 million by 2016.

The market size for the ESCO model is US$141.9 million in 2013, rising to US$20.5 million by 2016.

Conclusion

There is an opportunity for MNOs in Pakistan and Afghanistan to make significant savings by going green. MNOs can choose a short-term or long-term strategy for green deployment in their network. And at the same time, there is an opportunity for ESCOs to offer their solution in the Pakistan and Afghanistan industries.

To view the full report, visit:
http://www.gsma.com/mobilefordevelopment/greening-telecoms-pakistan-and-afghanistan-market-analysis

Chapter 5

Pricing Trends in Green Power Systems for Telecom: Impact on CAPEX and TCO

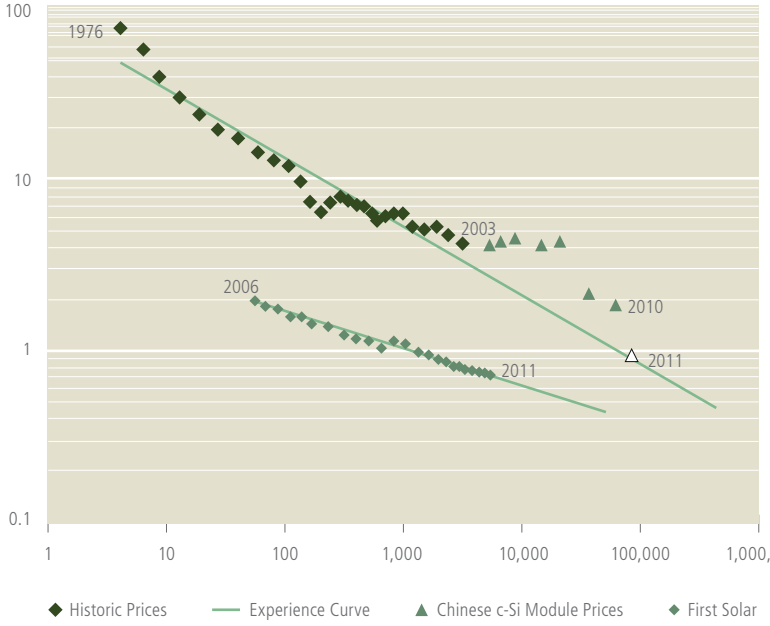
By Satish Kumar, GPM Africa Project Manager

This chapter looks at the major trends in pricing of green power systems, especially solar and wind, for telecom network deployments and provides a clear understanding of how the pricing dynamics has impacted CAPEX requirements and Total Cost of Ownership (TCO) of green power systems for telecom.

Global pricing trends in Solar PV

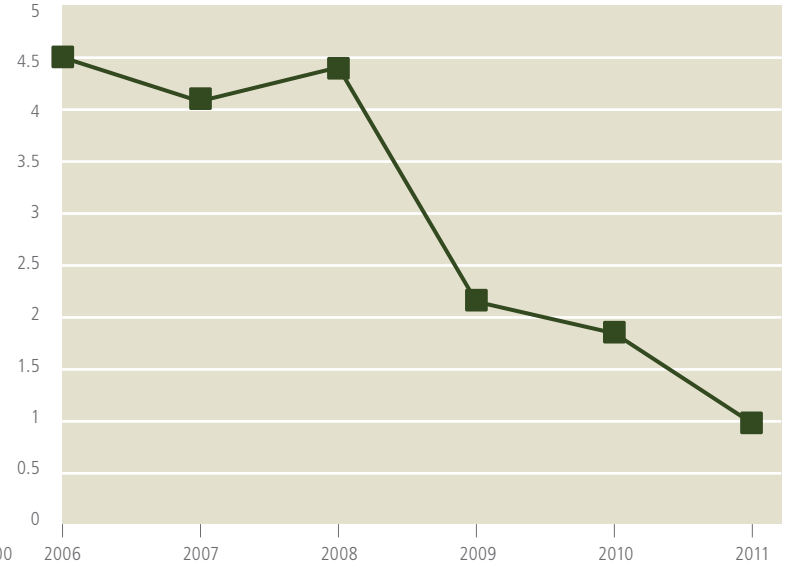
Historically, solar PV technology adoption has faced many barriers including high upfront capital costs of technology, limited manufacturing capacities, cost and reliability of balance of system (BOS) components such as batteries. However, in recent years, with increased manufacturing capacities at huge scales, the cost of solar PV modules has drastically decreased, strengthening its competitiveness with traditional power generation alternatives such as fossil fuel. As shown in Figures 14 and 15, the cost of solar PV modules has reached the below US$1 per Watt mark as of 2011. This can be attributed to improved supply of silicon in the industry and increased scale of manufacturing. As shown in the figures, we can observe that the module prices have remained almost constant during the period from 2003 until 2008 and then turned downwards from 2008, reducing the prices drastically.

Figure 14: Solar PV module cost curve, 1976-2011 ($/W)



Source: Bloomberg New Energy Finance (BNEF)

Figure 15: Chinese crystalline silicon PV module prices ($/W)



Source: Bloomberg New Energy Finance (BNEF)

The impact of price reductions in the global PV market can also be observed in small-scale solar PV applications such as telecom power systems. The following section analyses various elements of the telecom power system components and their relative share of costs in the entire system.

Pricing trends in green power systems for telecom sites

The upfront capital costs and limited availability of green power technology has long been a hindering factor in the adoption of green power alternatives for powering mobile telecom networks. However, recent cost reductions and reliable supply-side elements have improved the focus and adoption of green power alternatives such as solar and wind power systems in the mobile industry. However, despite cost reductions and eco-system development, the industry still considers CAPEX as a major challenge in scaling green telecoms adoption. We analyse the pricing trends and its impact on CAPEX and TCO reductions for green power deployments in telecom industry over the last five years.

A typical telecom power system consists of a power generation source, storage system, converter (rectifier), controller and monitoring systems. The relative cost of each component in the entire power system varies depending on generation technology and solution dimensioning. As an example to demonstrate the pricing trends, we consider a typical load of 1.5kW and green power systems as below:

1. Solar PV solution capacity of 5kW with 1,000Ah battery bank (approximate autonomy of 25 hours @80% DoD).

2. Solar-Wind hybrid solution with 3kW Solar PV, 3kW Wind turbine and 1,000Ah battery bank (approximate autonomy of 25 hours at 80% DoD)

Both the power systems above are 48V telecom power systems.

Solar PV solution – pricing trends

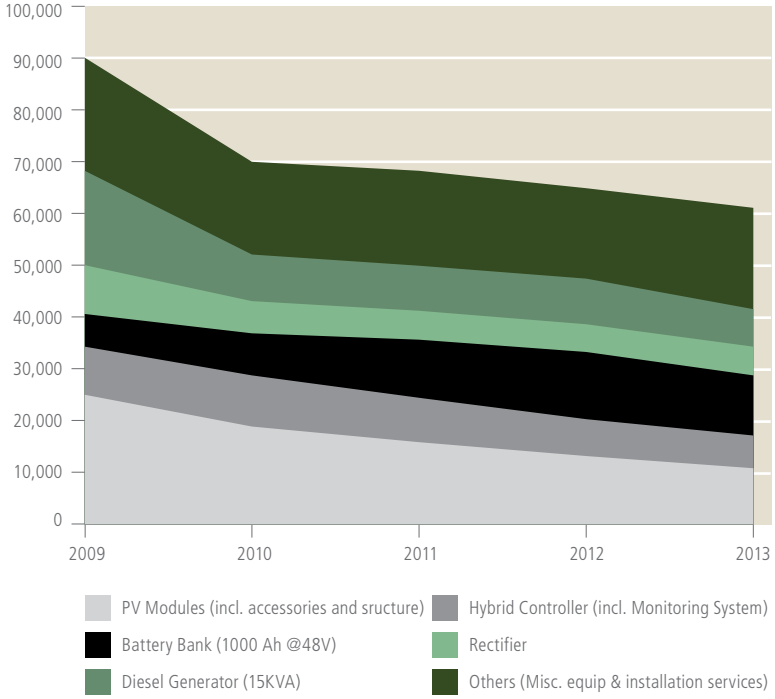
Figure 16 illustrates the relative cost share of each component of the power system and also shows the changing trend over the last five years.

As we can see from the graph, Solar PV constituted a majority 28% of the entire cost of green power system in 2009. However, the share of Solar PV in the total cost has decreased over the years, reaching 21% in 2013. This is majorly due to the global price reductions in Solar PV technology.

The other major cost component in the power system is the battery. The proportion of the battery cost in the cost of the entire system has increased from 11% in 2009 to 20% in 2013. This can be attributed to various technological developments in existing battery technology as well as new technology introductions over the years. While the cost of batteries has not decreased over the years, there has been a significant improvement in performance, specifications and cycle life of batteries.

The share of other components such as controllers, rectifiers and monitoring systems has remained almost constant. However, we need to make note of the increased importance of integrated controllers as well as remote monitoring systems and their performance improvements over the years, making them a crucial component of the power system.

Figure 16: Cost trend in Solar PV power system and components for powering telecom sites, 2009-2013

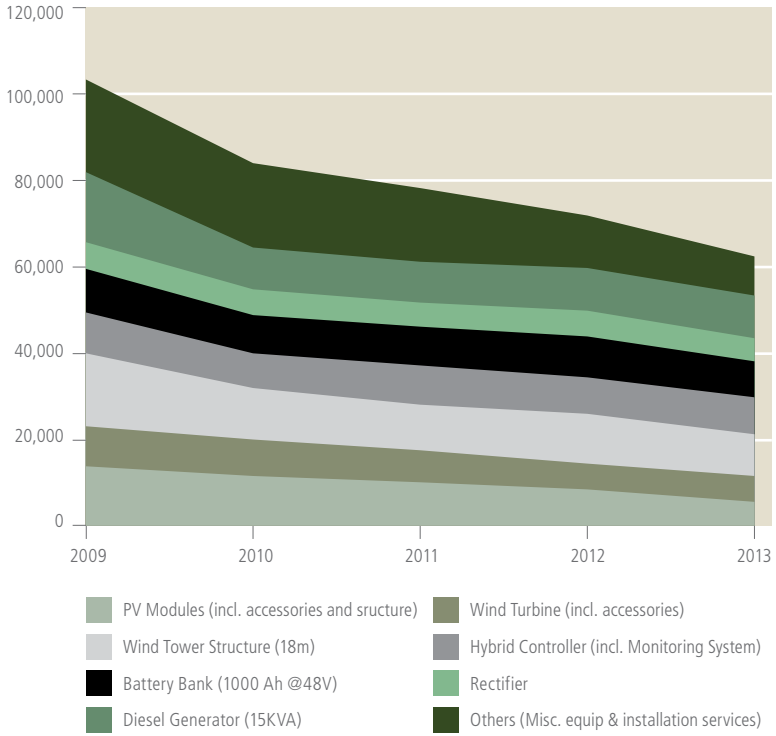


Source: GPM Research and Analysis

Wind turbine hybrid solution – pricing trends

The cost share of wind turbines has not seen a similar reduction as solar PV shown above, but there have been considerable improvements in performance as well as technology adoption for specific use cases such as the telecom industry. The figure below illustrates the relative cost share of components in wind turbine hybrid power solutions, and their trend over the years.

Figure 17: Cost trend in wind hybrid power system and components for powering telecom sites, 2009-2013



Source: GPM Research and Analysis

As can be seen from the graph, the share of wind turbine costs is almost constant over the years; however there has been a considerable price decrease in key components of wind power systems, such as wind tower structures.

Pricing trends in other renewable technologies and their adoption in telecom

It is worth noting that price reductions have also been observed in other green power technologies such as fuel cell and bio-mass for off-grid and on-grid telecom applications.

Despite cost reductions, the fuel cell technology has not reached the price competitiveness of other green technologies, for example Solar PV, and its adoption in telecoms has been hindered by the limited readiness of eco-systems for hydrogen fuel supply and handling. Nevertheless, the fuel cell technology is gaining ground for telecom applications owing to various technological developments as well as on-site hydrogen fuel generation from widely available alternative fuels and inputs such as water.

Though the cost of bio-mass technology is competitive enough, its adoption for powering telecom sites is still in the initial stages and necessitates the development of a sustainable operational model for bio-mass supply in order to establish reliability of power supply for telecom sites.

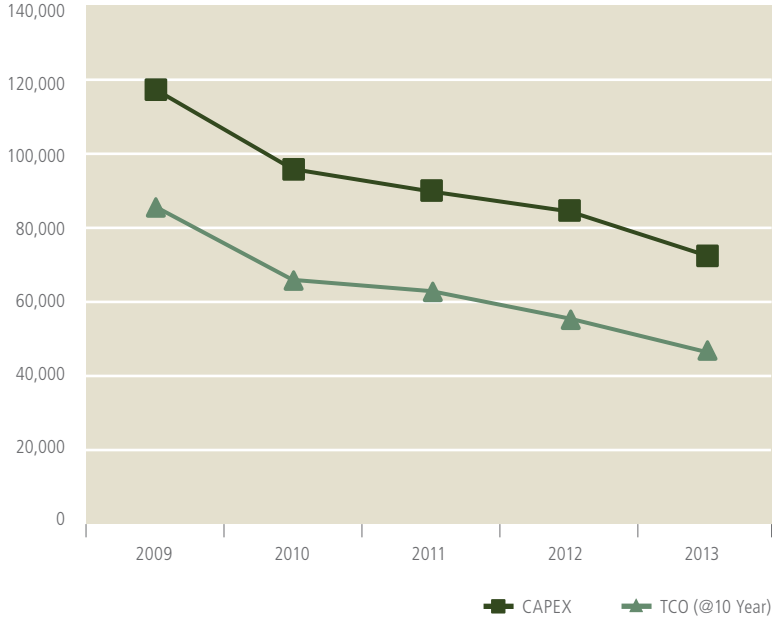
The impact on CAPEX and TCO

The impact of technology improvements and cost reductions on the overall CAPEX requirements and TCO of green power solutions has been tremendous over the years in driving the adoption amongst the mobile operators across countries and regions.

The below graph illustrates a typical solar PV power system, with its CAPEX and TCO for operators and its trend over the years.

As can be seen in Figure 18, operators have realized the benefits of cost reductions in the overall CAPEX which has reduced by over 40%, from nearly US$90,000 in 2009 to about US$52,000 in 2013 for a typical mobile telecom site of 1.5kW. The corresponding reduction in the TCO of green power system has been around 36%, from US$130,000 in 2009 to US$82,000 in 2013.

Figure 18: Green Power System - CAPEX and TCO trends, 2009-2013



Source: GPM Research and Analysis

Conclusion

The global price reductions in green power technologies have greatly impacted the adoption of green power in the mobile industry. As has been observed, the relative share of each component in the total cost of the system has been drifting from a high percentage share for green power technology in 2009, to an increased share of the balance of systems (especially battery bank) components in 2013. There is a need for performance improvement and cost reductions in the balance of system elements, especially the battery storage system, in order to increase green power deployments in the industry and reach a bigger scale, realizing the potential benefits of both commercial and environmental.

Chapter 6

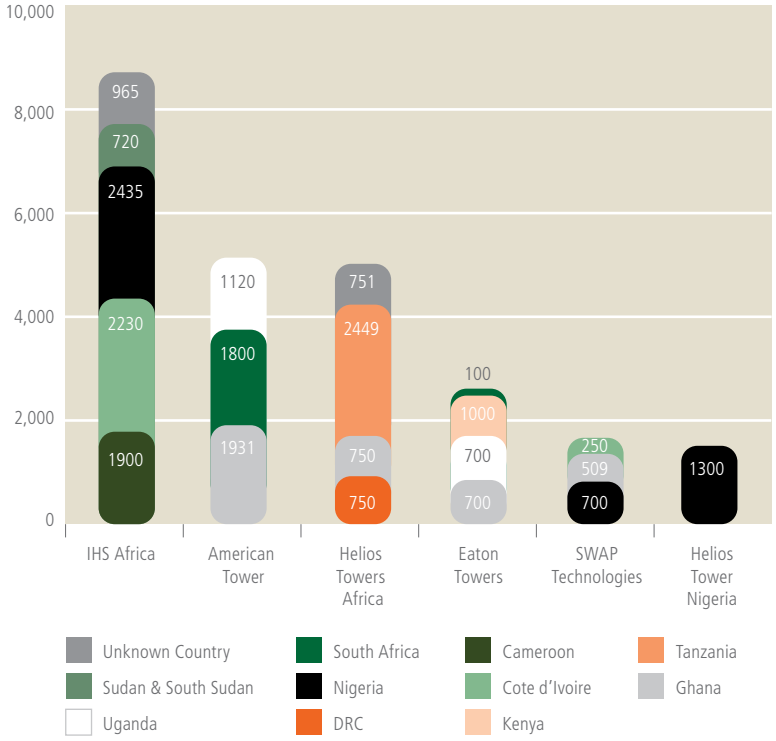
How and When do Tower Companies Invest in Green Power and Energy Efficiency?

Interview with Thomas Jonell of Eaton Towers, by TowerXChange

The increasing importance of independent tower companies in Africa

Fifteen percent of Africa's telecom towers (23,060) are owned or operated by independent tower companies (towercos). With substantial tower transactions imminent in several major markets, TowerXchange forecasts that the proportion of African towers in the hands of towercos will double to 30% (or 54,000 towers) by the end of 2014.

Figure 19: Tower Portfolio by Country



Source: TowerXChange Research

When a towerco enters a country, not only does it manage the acquired portfolio of legacy towers, but one often finds that a significant proportion of build to suit programmes is typically also managed by the towerco. With increasing responsibility for established and greenfield cell sites, towercos are having a transformational effect on the supply chain for passive infrastructure equipment and services. In this article, TowerXchange focuses on the investments towercos are making to improve energy efficiency and to decrease diesel consumption.

Towercos take a longer-term perspective on investments in energy efficiency

TowerXchange spoke to Thomas Jonell, CTO at Eaton Towers, which owns or manages and markets 2,500 towers across Ghana, Kenya, Uganda and South Africa.

"Towercos think about investing to reduce energy and O&M costs in a very different way from operators, as the focus is based on future tenant demand and timing," says Thomas Jonell. "Towercos work on a known margin, and therefore are more sensitive to increases in OPEX, including energy costs. At Eaton Towers, any investment towards greener / efficient solutions is based on positive return over 24 months with a hurdle rate of 25% IRR (Internal Rate of Return). We calculate total cost of ownership over five years."

Eaton Towers focuses on reducing diesel consumption by maximising use of the commercial grid

"For towercos, it's not about every site having solar panels – in an infrastructure-sharing environment we often don't have the space and the CAPEX can be four times' higher for sites with multiple tenants," says Jonell. "Our focus is on managing OPEX through solutions based on deploying deep-cycle batteries and / or PIUs (Power Interface Unit), including site hardening and access control actions to remove security personnel on site.

"We're increasing the use of the commercial grid by deploying PIUs or PMUs (Power Management Unit) with AVR (Automatic Voltage Regulator) functionality, line conditioning and best-phase selectors at bad / poor grid sites," he continues. "This can increase our use of grid power by as much as 40%, reducing the use of generators and diesel. Based on a capital outlay of less than US$10,000 per site, we can in most countries break even on investment in PIUs in less than one year.

"Another strategy we are now actively implementing is passive cooling including DC cooling and battery coolers, which can yield a total 20% reduction in energy consumption," adds Jonell. "The first thing we'll do is examine the equipment in a given shelter / indoor room and determine the maximum operating temperature based on equipment deployed – in all cases we can increase to the outdoor temperature.

"Often the only equipment that needs to be kept at 23-25°C are the batteries, so we deploy battery chillers. We may replace the conventional AC units with DC cooling and passive cooling systems. These 'smarter' systems deliver substantial savings by slow starting and only consuming the power they need for the load on the site. We've taken this approach at 300 sites in Ghana and achieved our targeted savings per year.

"We're also offloading diesel generator runtime by connecting many off-grid sites to the grid," he says. "There are thousands of sites in Africa running on diesel generators 24/7. Eaton Towers recently took over a portfolio of around 1,000 sites in Kenya, of which more than 70 sites were off-grid. In 2014 we will connect 36 of those sites to the grid. We've done a technical feasibility study which revealed that the grid is close enough (typically this means under 2km) and is reliable enough. In Africa connecting to the grid might cost US$15-30,000 per site, and we're forecasting payback in 16-24 months, while also delivering value through the replacement and maintenance value of generators.

"Connecting off-grid sites to the grid isn't an option in every market – there's an unusually high ratio of suitable sites in Kenya. The availability and quality of the grid has got to be good – it's less predictable in Uganda and Ghana for example."

The timeline for towercos to invest in green power

"Following a typical tower transaction, towercos' first priority is to understand and stabilise OPEX (through refurbishments, battery replacement and generator replacements or overhaul) before we try to improve it based on long-term tenancy build up," states Jonell. "We install a monitoring system immediately, then put in place a stringent operation and maintenance programme with a highly reliable O&M contractor. Next comes power and energy optimisation and co-location management, which is usually executed one year after a transaction, as by this time we will have reliable data collected through the site management system.

"We have to get to know the assets we're taking over before we invest, and everything we do is driven by tenancies and the behaviour and characteristics of each individual site. We need to know if a site has the possibility for co-location, and if so when. Capital deployment depends on tenancies – for example it would be a waste of money to deploy solar on a single tenant site if the addition of a second tenant meant we had to make substantial upgrades – it makes more sense to get more cycles out of batteries at first; then when the additional tenants are added, that is the time to optimise power."

Eaton Towers' view of renewable energy

"Any renewable energy solution needs to be deployed based on the need of the site and the state of existing equipment including AC and DC requirements," concludes Jonnell. "We take into consideration the capital and operating costs of renewable and hybrid solutions, including historical data on uptime, availability and any issues of theft. There is no single solution that fits all sites. It's critical we take the right actions at the right time to change."

About TowerXchange

TowerXchange is a boutique research firm, publisher and community host focusing on the emerging market telecom tower industry. We have a laser-beam focus on passive infrastructure; on towers, power and real estate. We track the transfer of assets from operators to towercos, and the engagement of investors and strategic advisers, while also examining the impact of these transactions on the supply chain. TowerXchange's research, including 100s of senior executive interviews like this, is available free of charge at www.towerxchange.com

Chapter 7

Mobile Network Operator Initiatives and Green Power Strategy: An Interview with Telekom Networks Malawi

Interview with Vishwajeet Deshmukh of Telekom Networks Malawi, by GPM

Mobile network operators (MNOs) in Africa have made significant investments in expanding mobile network coverage by investing in key network equipment as well as passive infrastructure such as telecom tower assets, power equipment and systems for powering the network. Unfortunately, the mobile industry in Africa faces many challenges due to a lack of reliable supporting infrastructure such as power grid and roads which tremendously impact mobile network operations. The limited reach of power infrastructure in Africa and poor accessibility to the widely-dispersed network of telecom sites has enormously impacted the operations and costs of running the network across the region.

In this interview, GPM talks to Vishwajeet Deshmukh, Head of Division – Radio Access Network (Planning, Projects and Energy Management) at Telekom Networks Malawi, a leading mobile operator in Malawi. The interview touches on various aspects of network power management and related initiatives in order to understand the operator focus and the outlook for green power adoption and the challenges associated with this.

Powering the network

GPM: How important is power provision in your network operations? How does green power fit into your overall sustainability strategy?

TNM: As you know, stable power is the backbone of telecom operations to ensure uninterrupted services at BTS sites and it is one of the major contributors to overall operational expenditure (OPEX) in TNM's networks.

Rapid developments in solar technology over the last few years have created opportunities for telecom operators to expand their coverage in those remote areas which would otherwise be challenging due to the high operating cost and low ARPU (Average Revenue per User).

Green power is very important in reducing operational cost and improving network availability. TNM has implemented DG-battery Hybrid systems for all of its off-grid sites and unstable grid sites, which has helped us to reduce the DG running hours by 50-60 %.

TNM is working on a deployment in first phase of 7 Solar-DG Hybrid solutions for difficult-to-maintain sites in remote rural areas.

GPM: What are the challenges in powering your network? Is it difficult to operate your network since the grid power availability and access is relatively low at your country / region of operation?

TNM: TNM has rolled out more than 200 sites in rural areas, which has had a very great impact on overall power management in the network due to poor or no-grid connectivity in rural areas.

One of the main challenges is the high operating cost for off-grid sites due to the high cost of fuel and maintenance. Also there are increasing numbers of cases of extremely low voltages which can cause damage to cooling systems, and DG run hours are increased exponentially so as to power the site during low voltages.

GPM: How important it is to improve energy efficiency at your network? Does green power come as a priority for you in powering the network? What other alternatives do you consider for reducing OPEX as well as CO_2 emissions?

TNM: Currently TNM enjoys 75% geographical coverage but mobile penetration is still low (< 30%) and TNM plans to add 180 additional sites in the next five years to improve coverage in the rural areas.

As the number of off-grid and unreliable grid sites continues to grow, the costs of powering those sites will increase. Therefore it is very important for TNM to have an adequate focus on energy efficiency, and we have created a separate section within RAN Projects to focus on energy management.

Cooling at telecom sites contributes 20-30% of total power consumption, due to the high energy usage of running air conditioners. TNM is implementing a free cooling solution at 10 hub sites to minimise energy usage as well as CO_2 emissions.

Green power adoption

GPM: How many green powered sites you have so far in your network? And what's your plan for further deployment in next few years?

TNM: We have currently implemented two solar solutions as part of a trial to evaluate solution and design issues in order to draft a future strategy. We are in the progress of implementing solar solutions for the seven most difficult-to-reach sites.

TNM is successfully implementing the DG-battery hybrid solution at all of its 45 off-grid sites and plans to implement a battery hybrid solution for all the remaining sites with unreliable grid power.

GPM: How do you describe your experience dealing with green power alternatives? Are they reliable? Does it make business sense?

TNM: In 2011, TNM had 65 off-grid sites running primarily on generator power and contributing 70% of the total network operating costs. In addition to the cost factor, it was a challenge to keep the availability of the network at industry benchmark levels as well as operating the network efficiently because of the high probability of faults occurring on generators when they are run continuously.

Hence TNM started exploring the business case and feasibility of green power solutions for off-grid sites, which can help to reduce OPEX.

A significant saving has been achieved in our network through the adoption of green power solutions, and we are planning to deploy more sites in 2014. Some of the sites achieved savings of US$15-18,000 in just one year and it makes perfect business case deploy more hybrids instead of running on generator power for 24x7.

GPM: Do you think the regional market has accepted green power at telecom the way it should have?

TNM: Green power represents a great opportunity for the telecom sector in Africa as the majority of the population lives in rural areas, and mobile penetration is less than 50% in many countries.

Adoption of green power in Africa is relatively slow compared to benefits it can confer. However there are different reasons for this slow adoption ranging from internal resistance to financing.

TNM has managed to overcome some of these issues through top-down management focus and effective governance.

Investment and business models

GPM: Does power management and green power come as a priority in overall network operations? How do you see investment as a challenge?

TNM: As was highlighted earlier, it is very important for telecom operators to improve operational efficiency through effective power management so as to provide more affordable services to the low ARPU segment.

Power management is a priority for TNM and we will be investing considerable amount of CAPEX to effectively address the power management challenges we currently face.

TNM has experienced very high growth in the number of subscribers in last three years and there is a need to expand capacity to support this growth. In addition, the mobile penetration in Malawi is presently low and it is an opportunity for the expansion of coverage in new, untapped market.

Therefore, we have a challenge to face in balancing CAPEX allocations to increase capacity and coverage to sustain the growth in subscribers and investing in green power to minimise operating costs.

GPM: There are a lot of discussions around energy outsourcing through independent energy service companies (ESCOs) in the Asian and African markets? How do you see that as a possible opportunity to scale green power adoption in the mobile telecom industry?

TNM: As highlighted earlier, there is huge scope for MNOs to expand their services in Africa as mobile penetration remain very low and telecom operators are facing challenges to balance budget allocations between new service rollouts and green power deployments.

Therefore, there is an opportunity for independent ESCOs to offer services to telecom operators as an OPEX model but adoption is still low due to the unproven business models and unattractive price points proposed by independent ESCOs.

GPM: Would you prefer energy outsourcing for your network power as against bringing your own CAPEX investments for green deployments? What is your reasoning?

TNM: Malawi has a fairly good transmission grid network but suffers high transmission losses. Currently there are not any attractive energy outsourcing models being offered by ESCOs in Malawi and therefore TNM is investing in green power through CAPEX model.

Definitely, there is an opportunity for MNOs to work with ESCOs on outsourcing models so that MNOs can focus on network quality and also improve energy efficiency through the speedy adoption of green power.

Industry and supply-side factors

GPM: What is the biggest challenge you face today in-terms of solutions or solution provider selection?

TNM: Solution providers are constantly improving their products and designs to suit telecom applications.

Solar energy efficiency is still low (<30%) and its solution are very bulky. The energy storage cost is high, which increases OPEX due to the need to replace batteries every four or five years.

Renewable energy solutions are still expensive, although we expect to see significant reductions in cost as solution providers will benefits from higher volumes.

GPM: Do you think tower sharing or tower outsourcing models may slow-down the pace of green telecom adoption? Or you think it will complement it?

TNM: Tower sharing has made a significant impact on the exponential growth in telecom by minimising the duplication of infrastructure and improving operational efficiency.

Tower sharing can complement the adoption of green power solutions as this will lead to a major cost reduction through green power adoption, and there will be multiple anchor tenants for tower companies to build the business case; there will be also improved efficiency due to shared infrastructure.

Conclusion

TNM Malawi has been actively pursuing energy efficiency and green power solutions as part of its overall OPEX reduction strategy. CAPEX is a big challenge and new business models, such as the third-party ESCO model, are yet to be proven in order to lead to their becoming a mainstream adoption.

Chapter 8

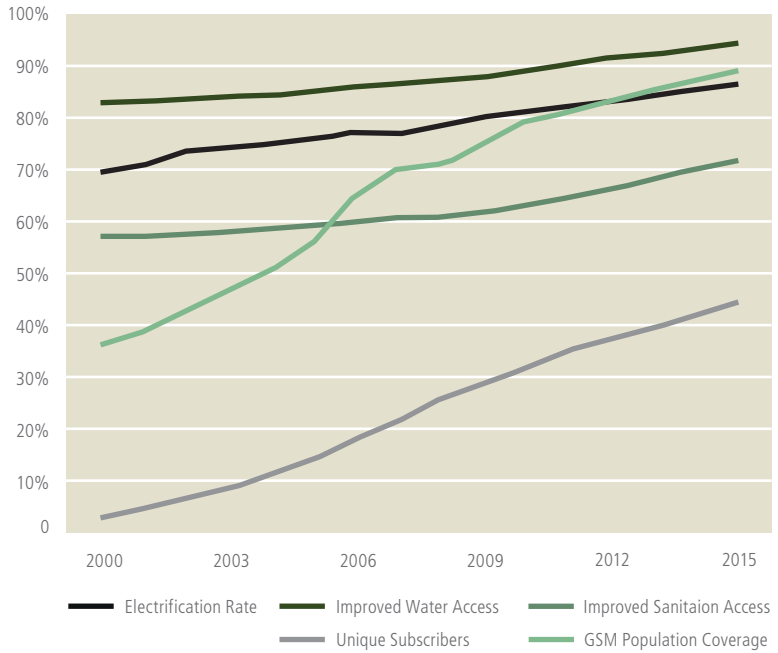
Mobile Networks can Make Water and Power more Accessible in Emerging Markets

Sizing the Opportunity of Mobile to Support Energy and Water Access

By Michael Nique, MECS Innovation Manager

Mobile connectivity has grown beyond the reach of the electricity grid and piped water networks in most emerging markets, widening the gap that exists between access to mobile and access to utility services – especially for underserved populations. With GSM coverage reaching up to 84% of the population living in developing countries, the size and the reach of the mobile industry's infrastructure, distribution channels, mobile payments and technologies offer innovative pathways to achieve reliable energy access and improved water access for underserved communities.

Figure 20: Growth of mobile indicators (GSM coverage and subscribers penetration) versus access to energy, water and sanitation, 2000-2015



Source: GSMA, IEA, UN data (with forcast up to 2015)

In the new report, *Sizing the Opportunity of Mobile to Support Energy and Water Access*, the Mobile Enabled Community Services team estimates that hundreds of millions of people living in emerging markets are currently covered by mobile networks but without access to electricity and/or clean water (See Table 8).

Table 8: Energy and Water Addressable Markets, 2013

Regions	Energy-addressable market (millions)	Population Without Access to Energy (millions)	Population Without Access to Water (millions)	Water-addressable market (2013)
Sub Saharan Africa	359	580	332	125
Middle East and North Africa	18	23	35	30
South Asia	175	416	158	50
East Asia & Pacific	80	170	199	44
Latin America	15	31	30	12

Source: GSMA

Findings include:

- Key building blocks to energy projects' sustainability could be based on mobile

The total addressable market for mobile-enabled energy access is more than 643 million people in 2013, or 53% of the global population without access to the electricity grid (~1.2 billion people); the largest addressable market is Sub Saharan Africa (359 million people) where the reach of electricity networks remains limited (~32% of the population) but where GSM networks cover more than 74% of the population.

Leveraging this increased mobile coverage and mobile penetration, the development of innovative mobile-enabled energy services such as Pay-As-You-Go (PAYG) is enabling low income customers to afford solar power thanks to innovative financing solution (Off Grid Electric (OGE) operating in Tanzania provides Pay As You Home Solar System under a Solar as A Service model - See Figure 21). In poor markets where the affordability barriers to clean energy solutions are high, this model could prove highly impactful.

1. i.e. how many people are currently living without access to electricity or clean water but within the range of GSM networks.
2. International Energy Agency
3. WHO/UNICEF JMP

Figure 21: Off Grid Electric's (OGE) Home Solar System installed in rural Tanzania

OGE provides solar home systems under a 'solar as a service' model – each unit embeds a GSM chipset and a SIM card, enabling remote monitoring; customers can use their Vodacom mobile money account to prepay for energy.

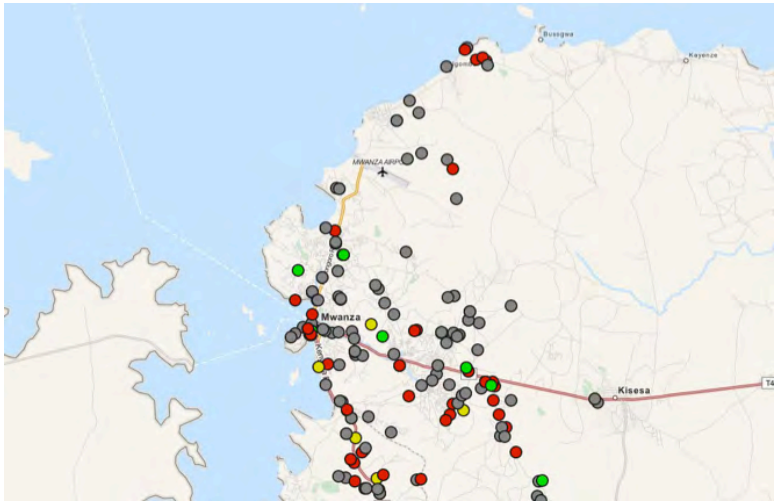
Source: GSMA

Access to information is key to water infrastructure sustainability

The total addressable market for mobile-enabled water access is estimated at approximately 262 million people in 2013 or 34% of the global population without access to improved water sources (~780 million people). In Sub Saharan Africa, where improved water access has reached 61% of the population in 2012 , we estimate a water-addressable market of 125 million people.

More than extending access to clean water, mobile has a strong and immediate role to play to support and improve current water services and infrastructure, which can be unreliable due to poor monitoring or poor payment collection. The current opportunity for mobile technologies to increase and improve water access is important in urban and peri-urban areas, as a large proportion of the population without or with difficult access to safe water lives in urban informal settlements where GSM coverage is extensive. Large and micro-utilities could leverage mobile monitoring of private water connections, mobile financial services for water payments or use mobile services to better collect and disseminate information to end users on water availability, in order to improve their overall operations. For example, mwater operating in Tanzania provides low cost water test kits coupled to a smartphone application to map out water points quality and reduce water contamination in underserved areas - (see Figure 22).

Figure 22: mWater maps out water quality in the Mwanza region (Tanzania)

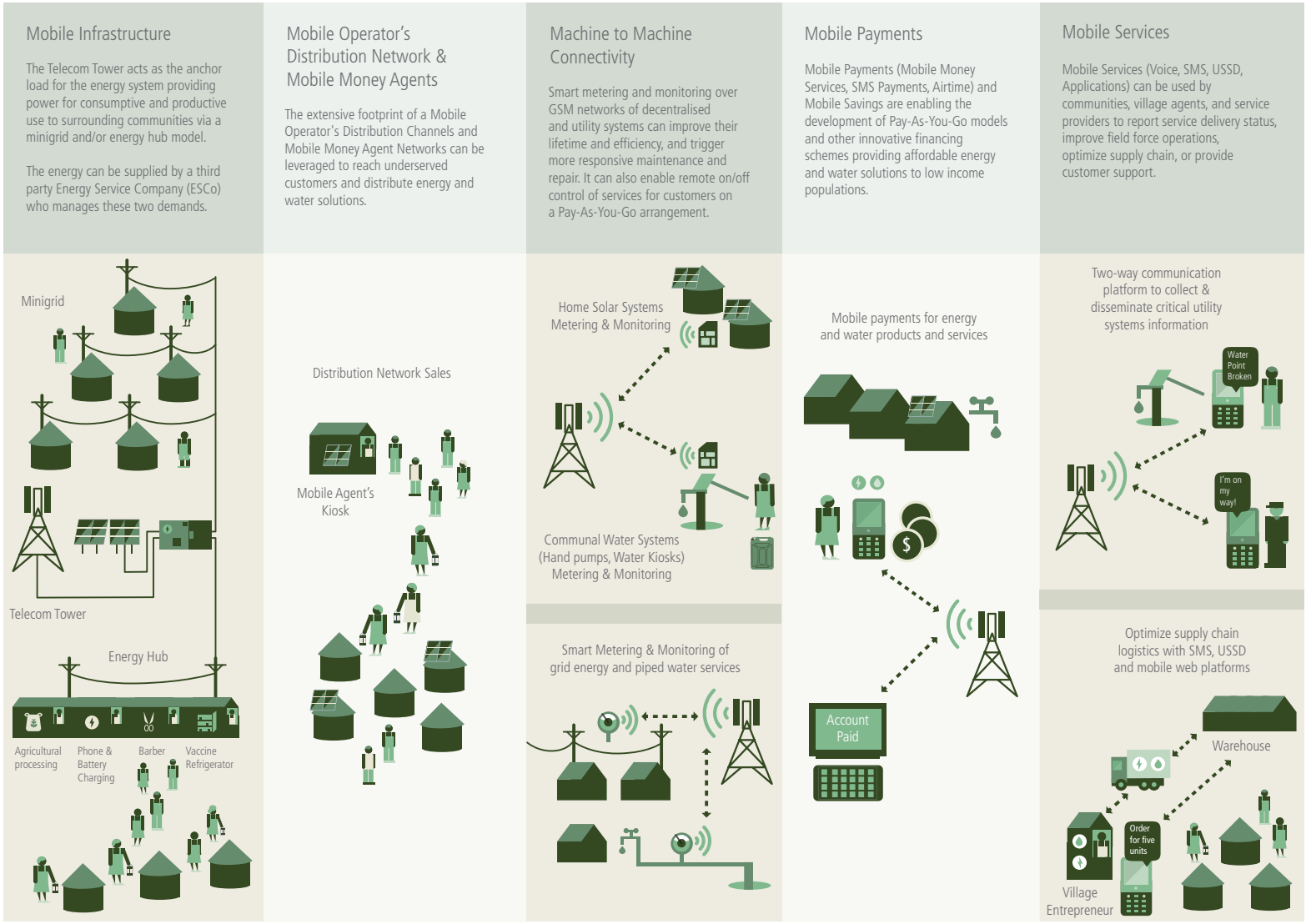


Agents are using low-cost test kits and smartphones to upload online information about water sources quality. This data is then openly available online for the use of practitioners and government.

Source: mWater

Based on the current footprint and maturity of the mobile industry, the GSMA Mobile Enabled Community Services programme envisions five channels to immediately increase and support access to energy and water if harnessed by public or private parties. The diagram on the following page (Figure 23) summarizes the role of these five channels.

Figure 23: Five Mobile Channels – How the Mobile Industry Can Enhance Access to Energy and Water



Early in 2014, the Mobile Enabled Community Services team will publish two other reports to provide complementary regional information on institutions and entrepreneurs leveraging mobile technologies in Africa and Asia for better energy and water service delivery (http://www.gsma.com/mobilefordevelopment/programmes/mobile-enabled-community-services/resources)

Chapter 9

Beyond Coverage: The Opportunity for Mobile Operators to Improve Access to Energy in Latin America

By Mary Roach, MECS Operations Manager

Movistar Nicaragua feasibility study — summary

(The full report can be found here).

In Latin America and the Caribbean, there are currently approximately 31 million people who live without access to the commercial electricity grid.[1] However, some 11 million people in the region live off-grid but have mobile phone subscriptions.[2] This means that many Latin Americans have a phone before they have somewhere to charge it.

In 2012, the Multilateral Investment Fund (MIF), a member of the Inter-American Development Bank (IDB) Group, and GSMA teamed up to explore examples of using innovative applications of mobile technology and infrastructure to deliver off-grid energy solutions in Latin America. The study focused on the network of Telefónica Movistar Nicaragua, a subsidiary of the global Spanish-based operator Telefónica.

Country background: Nicaragua

Nicaragua is the largest of the Central American countries, bordered by Honduras to the north and Costa Rica to the south. The Pacific Ocean lies to the west and the Caribbean Sea to the east. Geographically, Nicaragua has three major areas: the Pacific lowlands, the central highlands and the Caribbean lowlands. The country is divided into 17 departments and a total of 153 municipalities.[3]

Energy access and off-grid spending

Nicaragua has made great progress in the area of electrification. In 2001, just one in five extremely poor rural households had access to electricity, and only half of Nicaraguans had access to electricity in rural areas. It is now estimated that 72% of Nicaragua's population has access to electricity.

Telecoms networks

The Nicaraguan market is for the most part considered a two operator market with fierce competition existing between Claro (America Movil) and Movistar (Telefónica).

Table 9: Telecom networks in Nicaragua

	Amount
Mobile penetration %	71%
Mobile coverage % (population)	75%
Mobile coverage % (country)	21%
GSM base (connections)	5,778,781
Number of mobile operators in the market	2

Source: GSMA & Wireless Intelligence

Until 2012, Claro maintained market dominance due in large part to its broader mobile coverage. In 2011 Claro committed to expanding cellular coverage to reach 99% of all communities[4] with a population greater than 1,000 people, including those of the Atlantic departments and Movistar committed to investing USD 100 million in mobile towers, greatly expanding network coverage.

Energy and Mobile: the opportunity

At the time of the study, 28% of the population of Nicaragua lacked access to electricity and 25% of the population lacked access to mobile coverage, as the mobile network in Nicaragua is largely on-grid. As mobile operators seek to grow their customer base and increase coverage in increasingly rural areas, the opportunity and need exists to consider the way in which mobile towers will be powered and also how customers will keep their phones charged. The 1.45 million people without access to both electricity and mobile networks represent a significant opportunity that will require increasingly ingenious ways to serve.

1. The International Energy Agency (IEA) defines access to modern energy services as access to electricity and clean cooking facilities (i.e. clean cooking fuels and stoves and biogas systems). Source: "Energy Poverty: How to Make Energy Access Universal." Special Early Excerpt of the World Energy Outlook 2010 for the UN General Assembly on the Millennium Development Goals. International Energy Agency, 2010
2. GSMA MECS, "Sizing the Opportunity of Mobile to Support Energy and Water Access", December 2013
3. IEA WEO 2008-2009 https://mobiledevelopmentintelligence.com/metrics/38#
4. Revista IT Now

Key findings of the feasibility study

Mobile infrastructure

At the time of the study, there were approximately 1,500 mobile towers operated by Movistar Nicaragua and Claro, with both companies investing heavily in network expansion. Like many other Latin American countries, the vast majority of the mobile operators' towers are on-grid and thus there is no immediate opportunity for Movistar to extend energy services from its physical infrastructure.

There is a need to integrate the provision of basic energy services in future rollouts as Movistar begins to consider serving increasingly smaller communities in more remote areas like the interior of the Región Autónoma Atlántico Sur (RAAS) and Región Autónoma Atlántico Norte (RAAN) autonomous regions. Through the study, it was identified that over 700,000 people are currently not served by Movistar in their municipality and that over 90% of these unserved municipalities are in the departments of Jinotega and Matagalpa and RAAS and RAAN autonomous regions.

Distribution networks

An analysis was conducted to evaluate the potential for Movistar to use its distribution channels to improve access to lighting and phone charging products for its off-grid customers. More than 290,000 people live in municipalities with mobile coverage but where electrification rates are below 50% there is an opportunity for Movistar to partner with an energy product provider to support the sale of off-grid phone charging solutions.

Furthermore, it was found that, most on-grid communities on the edge of the mobile and electricity grids serve as central points for customers to charge their phones. Depending on the proximity of the off-grid communities to these central points, mobile phone subscribers would visit the nearby town to charge their phone from one to three times per week.

Mobile money and payment technology

Currently in Nicaragua only one mobile money product exists operated by an organisation independent of a mobile operator, and that is M-PESO. M-PESO customers can currently send person-to-person transfers, purchase airtime with Claro, pay bills and make merchant payments.

This opportunity is a longer-term opportunity for Movistar in Nicaragua as the mobile money ecosystem develops and grows in the country and more start-ups trial this solution.

Final remarks

Through their future network growth and existing sales and distribution channels, the mobile industry can play a critical role in bringing access to energy and other basic services to underserved communities. New business models will need to be developed and tried to road test both the technical solutions and the financial viability of the approach. Locally, there is already a rich ecosystem of energy product distribution companies in many Latin American and Caribbean countries that can be used to reach the far corners of the region and last-mile customers.

Chapter 10

Drawn to the Flame: A Brief Look at Investing in Off-grid Lighting

By Charlotte Ward, MECS Business Development Manager

Reflecting on 22 October 2013, also known as World Energy Day, let's take a brief look at what is attractive in improving energy access in developing markets, and then how the MECS Innovation Grant Fund will support early development and longer-term growth of mobile-enabled energy services, by helping to direct additional finance from donors and investors.

World Energy Day was established by the World Energy Forum with the goal of stimulating awareness of energy issues and the political will and passion to support universal energy access. It was marked by a conference at the United Nations. Discourse around the event has been closely linked to the latest report issued in September by the International Panel on Climate Change (IPCC), a scientific intergovernmental body set up in 1988 by the United Nations. This report states that humans are the "dominant cause" of "unequivocal evidence" of climate change. As would be expected. the report sparked debate with sceptics warning against alarmist use of poor science to promote disastrous policies. Mechanisms for change will be suggested by the IPCC in April 2014 and are anticipated to include the financial markets, following the declaration by the IPCC Chairman (R. K. Pachauri) that these have an impact by putting a price on carbon.

In bringing this discussion to focus on developing world markets, it is essential to consider that in achieving a reduction in carbon emissions the effects also contribute to improvements in health, the environment and livelihoods. So, can financial market mechanisms designed to reduce emissions also help to grow an off-grid energy market that improves social, economic and health standards in less developed nations? Or is it more realistic from an investor's perspective to prioritise other socio-economic impacts before carbon emission reductions, while seeking the best financial return? The replacement of fuel-based lighting by solar provides many such benefits, plus it can offer an attractive return to investors.

In 2013, the United Nations Environment Programme estimated that fuel-based lighting contributes 74 million tonnes of carbon emissions annually. This is equivalent to taking 18 million mid-size cars off the road, and is valued at US$32.5 billion per year. The IFC, using a slightly different approach in 2012, estimated a smaller but still significant value of US$18 billion for the cost of lighting and charging small appliances. Kerosene makes up over three-quarters of this valuation and the remainder is composed of candles and flashlight batteries.

The high running costs of fuel-based lighting systems, including the poverty penalty faced by those using them, creates an attractive payback period for investment. UNEP's en.lighten project calculated a payback period of seven months for solar-powered LED systems in Kenya, not including government subsidies, to light 7.8 million households and save each household US$105 per year.

Better lighting is a basic energy service but it also offers opportunities for productive services, such as improving health clinics and allowing retail and business services to operate longer hours. Using mobile technologies and infrastructure in solar lighting services can improve energy access with the right business model, through creating more affordable and better quality services.

The mobile-enabled energy and water sector is nascent and its growth is largely driven by start-ups and entrepreneurs. Occasionally the same mind-set sits within mobile operators that have the ability to innovate and incubate ideas, but largely the start-ups sit in small offices bolstered by other tech start-ups, or are out testing in off-grid communities. They see the potential in a large consumer base with low competition and are encouraged by the social impacts of their services.

As with all business that has yet to reach commercial viability, investment is needed to support business model development and attain a proof of concept which typically comes through grants and angel investors. Development finance in the form of well-targeted grants and concessional debt has a role and is critical to momentum, but a balance is needed. Companies must attract commercial finance in order to grow and maximise the potential to scale. This might include carbon pre-financing to form additional capital once sufficient proof of concept and scalability is created.

Reaching scale in underserved communities means thousands of local entrepreneurs with hundreds of companies. As Jigar Shah stated in the Mobile Enabled Community Services' 2013 Annual Report, local and increased competition means a healthy industry and the right structure of concessional and commercial investments is needed to ignite growth. Within the context of tackling climate change, Shah further argues in his book, Creating Climate Wealth, that while new technical innovation is valuable, deployment of existing technologies are the key to reaching near-term climate targets. This is an appropriate description also for the use of prevailing mobile telephony technologies and infrastructure, in combination with renewable energy technology, in improved energy services.

> "Rather than waiting for yet to be developed technology, business model innovation is the key to attract mainstream capital and unlock transformational change."
>
> ***Jigar Shah, Creating Climate Wealth***

MECS Innovation Grant Fund and identifying investment opportunities

In a sector using familiar technology but in new settings and with new business models, the period between raising initial awareness of investors and inking a deal can be longer and more painful to the working capital needs of the start-up. Access to a selection of potential deals is critical to an investment pipeline, and knowledge is also essential to constructing and conducting due diligence that will lead to investment decisions. Earlier this year, the GSMA's MECS Innovation Grant Fund was launched with the support of the UK Government. The first round recipients have been announced and second round awards will be publicised in early 2014. The goal of the fund is to award GBP2.4 million in grants to organisations trialling and developing innovations that improve access to energy and water to underserved communities by using mobile technology and infrastructure.

1. i.e. how many people are currently living without access to electricity or clean water but within the range of GSM networks.
2. International Energy Agency
3. WHO/UNICEF JMP

In addition we want to support early development and longer-term growth of mobile-enabled off-grid energy and water services, through helping direct additional finance from development and commercial investors into the sector. This will be achieved via two activities:

- **Investment pipeline:** We have been overwhelmed with the positive response to our calls for applications, receiving a total of 200 concept notes from across the globe. We can offer introductions to our grantees and applicants.
- **Trial data from grantee projects and MECS research:** The trials will operate for one year and address a series of questions and knowledge gaps related to whether the business models and technology can work in the field environment, carried out at the minimum scale required to answer a specific research question or to provide evidence that the solutions are viable. At the end, we will provide publicly available data following monitoring and evaluation. In the meantime, we will be publishing supportive data on general sector trends, case studies and addressable market sizes.

If you are an investor in the energy (and water) sectors, please get in touch to find out more about how the MECS Innovation Grant Fund could help create deal flow for your fund. And in return, we ask you to educate us on what you need to know to make investment decisions.

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

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

AVR – Automatic Voltage Regulator

BoP – Base of Pyramid

BOS – balance of system

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

eTom – enhanced Telecom Operations Map

GHG – Green House Gases

IDB – the Inter-American Development Bank

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

IPCC – the International Panel on Climate Change

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.

MIF – the Multilateral Investment Fund

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

PMU – Power Management Unit

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

ROI – Return on Investment

TCO – Total Cost of Ownership

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 July 2013

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/07/GPM-Bi-annual-Report_July13.pdf

Bi-annual Report January 2013

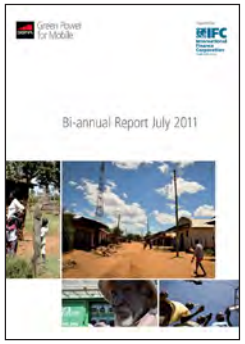
http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/01/GPM-Bi-Annual-Report-January-2013.pdf

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



Bi-annual Report July 2011

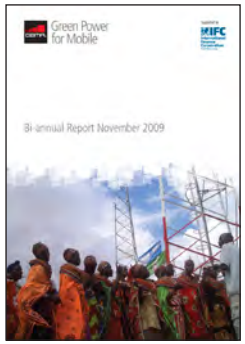
http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/biannual_report.pdf

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



Bi-annual Report November 2009

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/05/gpfm_report_09_annual_review.pdf

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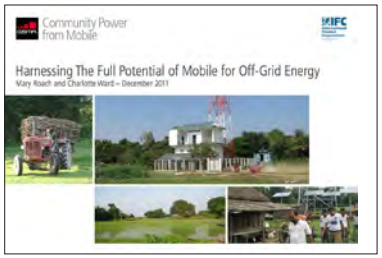
MECS Annual Reports

Mobile Enabled Community Services White Paper (January 2013)

http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2013/02/Service-over-Technology-CPM-White-Paper.pdf



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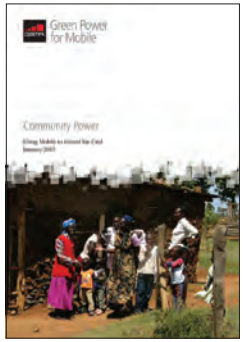

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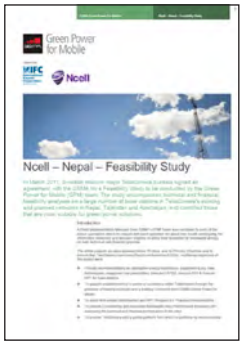

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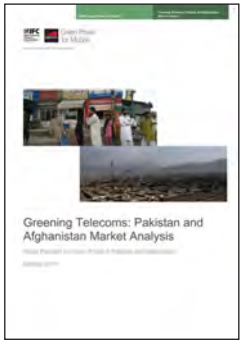

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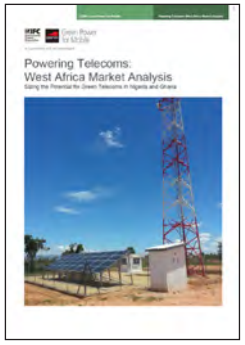

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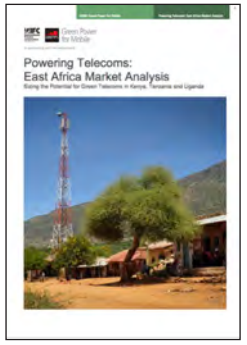

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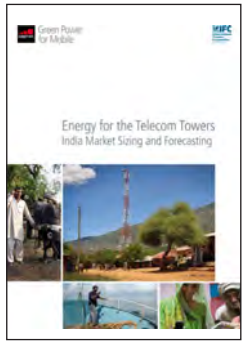

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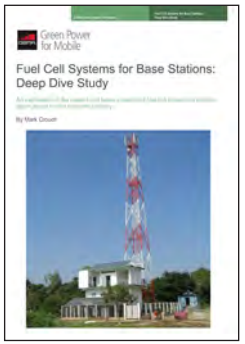

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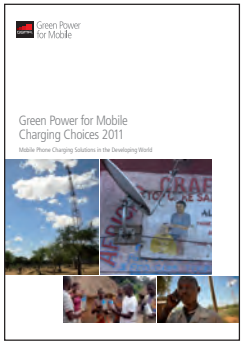

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Heliocentris

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CASCADIANT

http://www.cascadiant.com/

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