Green Power for Mobile

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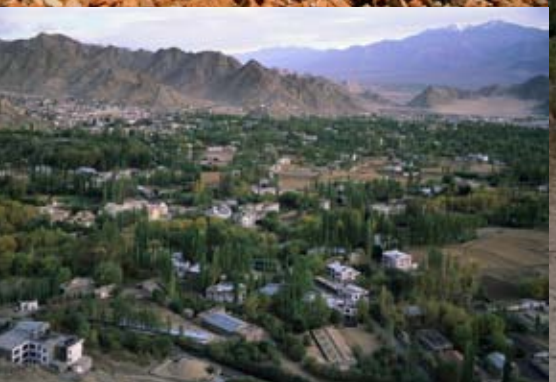


Table of Contents

Welcome

The GSMA Green Power for Mobile (GPM) programme was launched in September 2008 to 'extend mobile beyond the grid', with two parallel objectives:

1. To systematically reduce diesel consumption by mobile operators through the promotion of renewable energy technologies and energy efficient base stations,
2. To remove the barriers to handset charging in off-grid regions.

The first bi-annual report in November 2009 provided a high level view of the GPM programme, the key challenges facing the sector and case studies from operators and vendors. This second edition will focus on a specific topic **'Growth from Innovation'**.

A key trend emerging from the 6th GPM Working Group meeting held in Cairo in March was the number of operators moving from single site pilots to multi-site implementations. This trend is also highlighted by the GPM Green Deployments Tracker which is currently monitoring over 9000 live deployments.

The growth being witnessed in the sector is driven by the many facets of innovation that this report will highlight. In addition to technological innovation, we will describe advances in knowledge sharing, technical assistance & financing. We also look at innovation beyond the base station, where operators are piloting new business models to provide energy to local off-grid communities.

For this report we have focused the content into two sections – current innovation and future innovation:

Current Innovation

Central to the strategy of GPM is the sharing of knowledge, case studies and learnings between operators collaboratively solving the challenge of rising energy costs. We provide an overview of the evolution of the GPM Working Group over the last 2 years, a key forum for this collaborative approach. Bringing further innovation to knowledge sharing we introduce a new tool, the Green Deployments Tracker, providing a global, centralised database of green deployments. We also overview the technical assistance service that GPM provides to operators, highlighting a Feasibility Study that GSMA completed for Zantel Tanzania.

GPM is partnered with the International Finance Corporation (World Bank Group), and they provide an overview of the financial products available to operators to support the capital expenditure of implementations. Bharti Infratel provides a case study of its groundbreaking 2000 site solar deployment at its shared towers in India. Vihaan Networks Limited (VNL) introduces a step-change in base station efficiency with its solar powered, 100 watt 'WorldGSM™' solution, specifically designed to target markets where Average Revenue per User (ARPU) is less than US$2 per month.

Operators are also innovating beyond the boundary fence of the base station, by trialling new business models to provide electricity beyond the base station and into local communities, a phenomenon which GPM calls 'Community Power'.

Future Innovation

For the second section of the report we look ahead to the major technological innovations that will affect the sector in the next 5 years in a special report 'Mobile Operators take the Long View on Energy Innovation'. Through interviews with thought-leaders across the sector these emerging technologies are identified and their impact upon both the telecom and energy sectors is described.

The GPM team looks forward to continued collaboration with our Working Group members and the industry in general to ensure that our work is relevant to stakeholder requirements, actionable and aids advancing this emerging sector within the telecommunications industry. The next Working Group meeting will be in Asia in September 2010. I trust you will find the second edition of our bi-annual report educational and informative and we look forward to seeing many of you over the next six months to work on the issues raised in this report, as well as establish the work plan for us all over the next period.

David Taverner
Green Power for Mobile Senior Programme Manager

1. The Evolution of the Green Power for Mobile Working Group

By Lauren Dawes

The Green Power for Mobile (GPM) Working Group first met in September 2008 with the objective of consolidating industry insight and experience of green power in order to catalyse deployment across the industry. This first session was attended by 13 different operators and since then, more than 40 have attended the six sessions that have been held.

The first session at Lake Nakuru, Kenya saw the launch of the GPM programme. This was a visionary session that identified the few pilot case studies available and the emerging vendor solutions, to accelerate market awareness. The first session showcased a presentation on the GPM Toolkit. Over the past 2 years this has evolved into a rigorous methodology, for prioritising, designing and costing green base stations, that are available to operators via the GPM Feasibility Study service. Also in this first session the International Finance Corporation (IFC), conducted a workshop on the financing challenges for green networks, which led to the GPM partnership. The supporting role of the Working Group members was crucial in facilitating and encouraging this agreement.

The next session of the Working Group took place in Macau at Mobile Asia Congress in November 2008. With an open session format, there was just standing room only, a testament to how quickly interest in the programme was growing.

When the third session drew in the likes of Bharti Airtel, Telenor, Ericsson, Nokia Siemens Networks and Alcatel-Lucent, it was clear that the industry was really moving forward with its green agenda.

The fourth session, a video conference hosted in London, was pivotal in broadening the scope of the GPM programme to also address barriers to handset charging.

The last Working Group session was held in Cairo, in March 2010, and was kindly hosted by Orascom and Mobinil. The session introduced a new programme area for GPM called Community Power, as detailed in Section 7 of this report.

In addition to providing a forum for knowledge sharing and networking, the Working Group is used to actively plan new strategies, approaches and deliverables for the GPM programme. The GPM team looks forward to continued collaboration with our Working Group members and the industry in general to ensure that our work is relevant to stakeholder requirements, actionable and aids advancing this emerging sector within the telecommunications industry.

Green Power for Mobile Working Group

2. Green Power for Mobile: Green Deployments Tracker

By Danielle Pellikaan

The GSMA Green Power for Mobile (GPM) programme was launched in September 2008 to advance the use of renewable energy sources by the mobile industry to power 118,000 new and existing off-grid base stations in developing countries by 2012.

To monitor the progress the industry is making, GPM has launched a Google Earth database of green deployments worldwide, showcasing the progress on a country to country level and highlighting individual site case studies.

A major actor in the deployment of green base stations is Telefonica, with 225 renewable energy sites worldwide. This is part of Telefonica's energy reduction strategy, which targets a 30% reduction in energy consumption from 2007 to 2015.

Telefonica's energy reduction strategy focuses on three areas:

1. Cost reduction
2. Quality of the network
3. CO_2 reduction

According to Gabriel Bonilha (Network Transformation Manager at Telefonica Group) all three factors point in the same direction: power reduction directly means cost reduction; more efficient network equipment improves the network quality and is more energy efficient; and CO_2 reduction is achieved through energy efficiency and with that, reduction of power consumption.

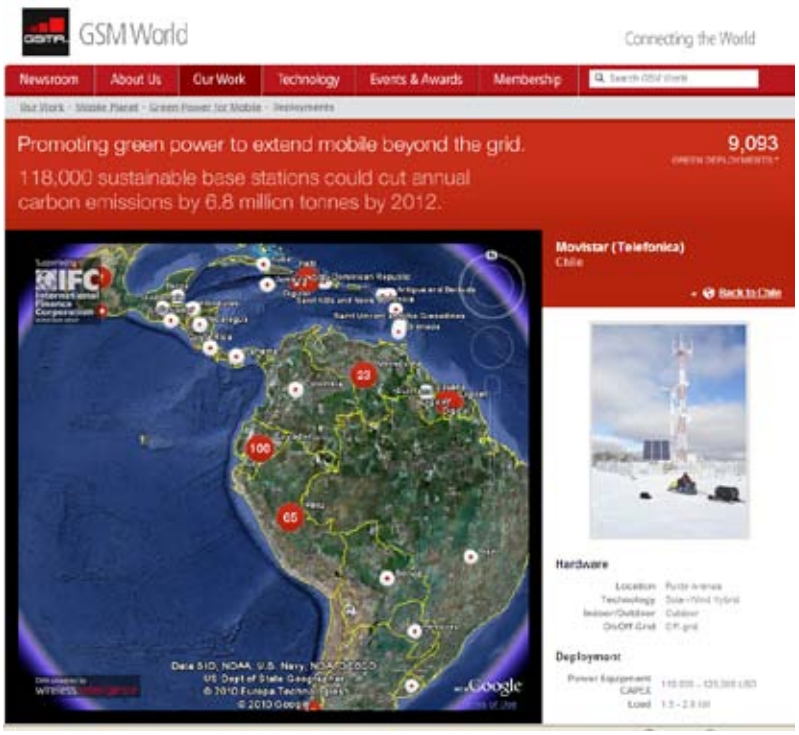
Over the year 2007 – 2008 Telefonica has already achieved a 6% reduction in energy consumption and with the progress made in 2009 are on track to meet their 30% reduction target from 2007 to 2015.

For their future green network plans Telefonica is focusing on four big areas; cooling optimisation, power saving features in network equipment, smart metering and technology modernisation (replacing old technology with new more efficient equipment). As Gabriel explains: *"We are using the CO_2 reduction and energy efficiency argument as a driver to accelerate the technology renovation in our business case"*.

On the Green Deployments Tracker, Gabriel Bonilha is very positive:

> *"It is a great tool, because it is an interactive inventory. I use it a lot; because it is based on Google Earth and has the visual features, it is a very attractive way of showing what we are doing in this area.*
>
> *Benchmarking is key to allow comparison with peers, but also as a comparison with your own past performance over time, to help all operators improve. Therefore I plan to keep updating the database from a Telefonica perspective."*

Figure 1 – Green Deployment Tracker



www.wirelessintelligence.com/green-power

3. Green Power Feasibility Study – Zantel, Tanzania

By Areef Kassam

Background

Key Facts – Tanzania

- Population = 41 million[1]
- GDP Per Capita = US$442[2]
- Mobile Penetration = 23%[3]
- Internet Penetration = 1.3%[4]
- Grid Penetration = 11%[5]

Power Infrastructure in Tanzania

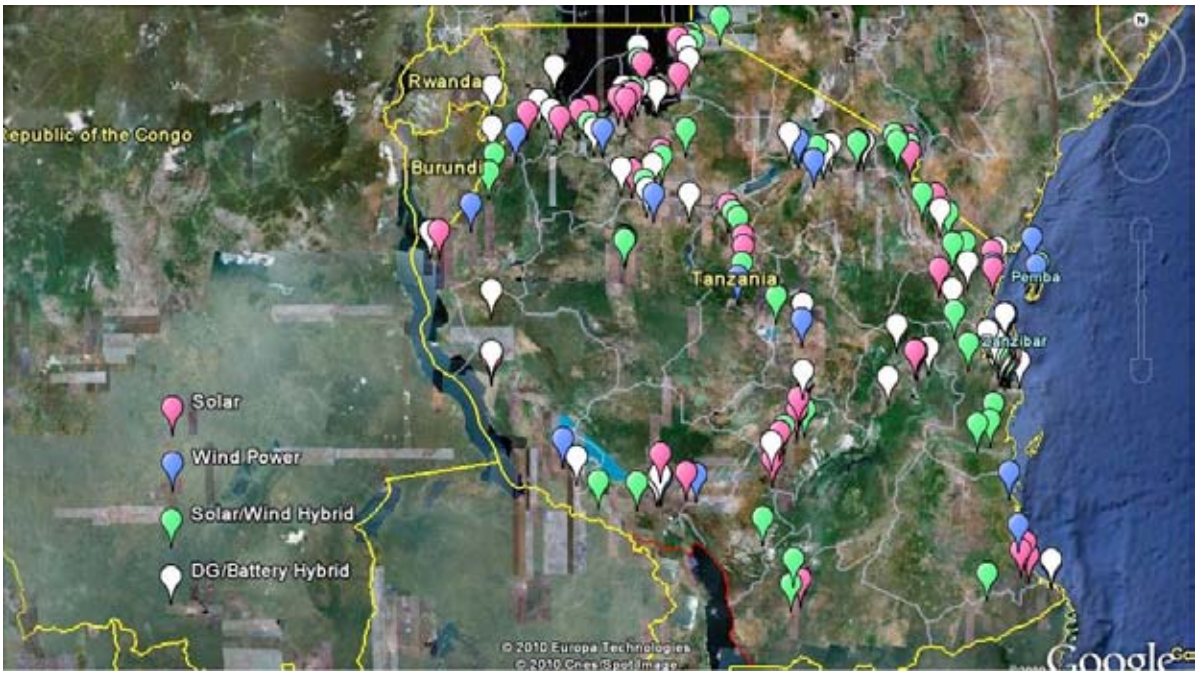
Tanzania, like many other developing countries, has a very limited power infrastructure. This has not prevented the mobile operators of Tanzania from rolling out telecoms infrastructure aggressively; achieving mobile penetration of 23%.

The lack of power infrastructure in rural areas and high demand for mobile communications has created a challenge for operators on how to rollout telecoms infrastructure to these areas. To solve this problem, telecom operators have relied heavily on diesel generators to provide power to the telecoms equipment and this has created an environment of high operating costs, increased environmental pollution and the logistical challenges of diesel delivery. Taking these factors into consideration, it makes it tougher for telecom operators to justify expanding their service to rural areas without existing power infrastructure. The challenge is to come up with an easier, more cost effective and environmentally friendly way to expand network coverage in rural Tanzania.

Suggested Solution

Through a Feasibility Study funded by the GSMA and International Finance Corporation (IFC), the Green Power for Mobile programme (GPM) and Zantel investigated the opportunity to deploy solar or wind power generation equipment onsite to replace the existing diesel generator sets. The combined GSMA and Zantel team studied 231 existing base station sites, analysed the power requirements for the sites and designed optimal solar power, wind power, hybrid or battery solutions.

Figure 2 – Recommended Solutions for Base Stations Analysed in the Feasibility Study



[1] US Department of State
[2] US Department of State
[3] Wireless Intelligence
[4] Internet World Stats
[5] United Nations

The key findings from the analysis are:

- The financial results showed a payback period ranging from 1.75 years to 5.6 years
- 115 of the sites analysed were able to achieve a payback period of less than 3 years, based on a delivered to site diesel price of US$1.20
- The Capital Expenditure (CAPEX) range for the green power solutions is US$40,048 to US$100,983 per site, with an average of US$75,832
- The GSMA Development Fund recommended that Zantel implement a 10 site trial before full scale deployment of 115 sites, to test multiple vendor solutions

Projected Results

The recommended implementation plan from GSMA of 115 sites would amount to an additional CAPEX spend of approximately US$8.74 million, but would result in a substantial savings in fuel expenditure, operations and maintenance (O&M) costs and carbon emissions. The projected results for these 115 sites would be a savings of approximately:

- 2.4 million litres of diesel per year
- US$3.1 million per year in total O&M costs (including fuel)
- Reduction in CO_2 emissions of 14,720 tonnes per year

Feasibility Study Offering

GPM is now offering a Feasibility Study service for operators. This service analyses an operator's entire country network of base stations, identifies those that are most suitable for green power solutions, assesses the dimensions of the equipment required and forecasts CAPEX. Our primary goal is to maximise the Return on Investment (ROI) for operators and provide training on the GPM Methodology. The service also assists operators with a Request for Proposal (RFP) design and interpretation of responses from vendors specific to the use of alternative energy.

If operators are interested in finding out more about this service please contact:

greenpower@gsm.org

Table 1 – Example of Key Financial and Technical Indicators for 5 Sites

Site	Total Power (watts)	ROI	Payback Period (years)	Net Present Value (NPV) (US$)	CAPEX (US$)	Renewable Vs. DG Contribution	Battery Backup (hours)
Site xxx	1550	36%	2.74	67,433	85,838	81%/19%	24
Site xxx	1650	34%	2.95	62,076	93,148	87%/13%	29
Site xxx	1650	36%	2.82	60,063	85,017	83%/17%	24
Site xxx	2800	31%	3.25	50,122	97,227	52%/48%	22
Site xxx	2800	36%	2.97	57,705	92,140	56%/44%	22

4. IFC Financial Products for Green Power

By Ian Larsen, International Finance Corporation (IFC)

In the longer term, green power has significant potential to reduce a Mobile Network Operator's (MNO) carbon footprint and slow energy consumption growth. A reliable green power source at a Base Transceiver Station (BTS) can be a very practical component of any MNO's current effort to expand its network into those remote areas that lack reliable grid power provision. Moreover, it is expected that future growth of the mobile industry will be highly dependent on expansion in remote parts of the world, many of which lie beyond the grid, reinforcing the critical role of green power alternatives.

However, one of the key limitations to the quick adoption of renewable solutions to BTS's is high upfront Capital Expenditure (CAPEX), in addition to potential limitations posed by the availability and capacity of renewable energy equipment.

In an effort to speed industry adoption of green power solution, the International Finance Corporation (IFC) is supporting the Green Power for Mobile (GPM) programme and is working to provide financing to support the operators' CAPEX budget for roll-out. IFC is a member of the World Bank Group that supports private sector development in developing countries and seeks to expand access to mobile technology and ICTs in poor and unconnected areas. As part of this effort, IFC has made a number of financial products available to provide financing for GPM projects. A selected list of these products is described below.

Loans

IFC offers fixed and variable rate "A-loans" from its own account to private sector projects in developing countries. Generally, these loans range from US$5 million to US$100 million. The loans typically have maturities of 7 to 12 years at origination, with grace periods and repayment schedules determined on a case-by-case basis. If warranted by the project, IFC can provide longer-term loans and longer grace periods. IFC can also provide US dollar and Euro financing as well as local currency debt financing in 3 different ways: (i) loans from IFC denominated in local currency; (ii) risk management swaps which allow clients to hedge existing or new foreign currency denominated liabilities back into local currency; and (iii) structured finance which enable clients to borrow in local currency from other sources.

IFC loans can finance both greenfield companies and expansion projects in developing countries. The Corporation also makes loans to intermediary banks, leasing companies, and other financial institutions through credit lines.

To ensure the participation of other private investors, A-loans are usually limited to 25% of the total estimated project costs for greenfield projects. In exceptional circumstances, loans totalling 35% of total project costs may be available. For expansion projects, IFC may provide up to 50% of the project cost, provided its investments do not exceed 25% of the total capitalisation of the project company.

Equity Finance

IFC could take equity stakes in private sector companies. As a long-term investor, IFC usually maintains equity investments for a period of 8 to 15 years. The Corporation does not take an active role in company management. It risks its own capital and does not accept government guarantees. To ensure the participation of other private investors, The Corporation generally subscribes to between 5% and 15% of a project's equity. IFC is never the largest shareholder in a project and will normally not hold more than a 35% stake.

IFC usually exits its investment through a sale of its shares on the domestic stock market in a way that will benefit the enterprise, often in a public offering.

Quasi-Equity Finance

IFC also offers a full range of C-loans – quasi-equity products with both debt and equity characteristics to private sector projects in developing countries. Among other instruments, The Corporation provides convertible debt and subordinated loan investments, which impose a fixed repayment schedule. It also offers preferred stock and income note investments, which require less rigid repayment schedules. Quasi-equity investments are made available whenever necessary, to ensure that a project is soundly funded.

Through its programme of syndicated B-loans, IFC offers commercial banks and other financial institutions the chance to lend to IFC-financed projects that they might not otherwise consider. These loans serve to broaden IFC's development impact by mobilising additional private sector financing in developing countries. Through this mechanism, financial institutions share fully in the commercial credit risk of projects and share the advantages that IFC derives as a multilateral development institution, while IFC remains the lender of record.

Structured Finance

IFC also provide clients with a series of cost-effective financing products that may not otherwise be available to them. Such products include credit enhancement structures for bonds and loans through partial credit guarantees or risk-sharing facilities.

Partial credit guarantees allow IFC to use its international triple-A credit rating to help clients diversify their funding sources, extend maturities, and obtain financing in their currency of choice. Partial loan and bond guarantees also help broaden clients' access to international and local capital markets. Credit enhancement structures help clients attract new sources of financing in their currency of choice, reduce borrowing costs, and extend maturities beyond what private investors would otherwise provide.

Risk-sharing facilities allow clients to transfer credit risk to IFC from their own portfolio or from a new portfolio they originate. The assets typically remain on the clients' balance sheet, and the risk transfer comes from a partial guarantee provided by IFC. In general, clients will enter into such a facility with IFC because it helps them increase their capacity to originate new assets within an asset class whilst IFC seeks to increase its own exposure.

Together with the GSMA, IFC believes strongly in speeding adoption of green power sources for mobile applications, and it is uniquely positioned to facilitate this transformation through financing solutions not available through other institutions.

MNOs interested in learning more about IFC's financing options for green power are invited to contact **greenpower@gsm.org** for more information.

5. 2000 Solar Powered Shared Sites from Bharti Infratel

By Areef Kassam

In an era of diminishing returns on capital invested, operators across the world are reviewing their costs. For a mobile operator, infrastructure Capital Expenditure (CAPEX) and network Operating Expenditure (OPEX) represent significant portions of spending, and with the lower Average Revenue per User (ARPU) being available in more remote and rural areas, operators have been looking for ways to minimise these costs.

To reduce infrastructure CAPEX operators have been sharing sites with other operators to reduce if not eliminate the CAPEX spending on infrastructure.

Energy expenditure represents a significant portion of network OPEX costs (approximately 40%) and with the emergence of renewable energy solutions for powering base station sites, operators have been able to cut their network OPEX spending by implementing these solutions.

These two cost savings methods have independently been effective in reducing the CAPEX and OPEX expenditure respectively, but in the past have not been able to be used together to maximise cost reductions. This is because at shared sites the cumulative power requirement of multiple operators reduces the financial viability of renewable energy solutions. In the past it may not have been possible, but Bharti Infratel has found a way to take advantage of both savings techniques simultaneously.

Through an interview conducted with the Bharti Infratel team, they explained how they were able to make this achievement.

With a site that can be used for a single operator or by multiple operators, the power load of the site is variable and as such Bharti Infratel needed to devise a system that was highly scalable, adaptable, and standardised to be able to work in a site sharing environment and on a large scale rollout. Given the regional climate conditions in India, Bharti Infratel found that the best base equipment is a solar/diesel hybrid. Solar panels are modular in nature which allow for an increased scalability that is not available with wind power or other renewable energy sources.

Bharti Infratel uses a modular approach whereby they add additional solar panels as new operator tenants are added to the site. The modular approach can cover a range from one outdoor Base Transceiver Station (BTS) (0.85kW) up to 3 outdoor BTS (3.3kW).

The same modularity that exists with the solar panels does not exist with the battery bank. More careful analysis needs to be done in order to determine the changes to the battery bank when the site load increases. If an initial system is installed and then

there is an increase in the power requirement, meaning the battery bank must be upgraded, a parallel battery bank is added if the initial system was installed less than 6 months before. If the existing system is more than 6 months old then a complete health check of the existing battery bank is carried out and an assessment made as to whether complete replacement of the battery bank is required, or not.

In its endeavour towards energy efficiency and cost reduction, Bharti Infratel has set an initial target of deploying 2000 renewable energy sites. This helps in reducing diesel usage drastically, lowers the cost of operation in addition to reducing environmental impact. The payback period, calculated for the 2000 planned sites, varies between 2 and 3 years depending on the configuration.

In the first phase, 500 sites were completed by March 2010 and balance of 1500 sites will be installed during next financial year 2010 to 2011. This initiative, which is the first of its scale for an Indian Passive Telecom Infrastructure provider (tower sharing), would result in estimated savings of US$16.67 million per year. The project would also result in an estimated reduction of 58,170 tonnes of CO_2 emissions per year, thus helping in the mitigation of global warming potential.

Bharti Infratel is leading the way for operators and tower sharing companies into an era of greener, cheaper and more efficient methods of powering sites while maximising the benefits of site sharing and passive infrastructure outsourcing.

Quote from CEO

"Bharti Infratel, as one of the biggest Passive Telecom Infrastructure providers in the world, has a strategic imperative to not only deliver energy efficiency to all its customers, but also from an environment standpoint, to continuously innovate and pioneer clean technology adoptions that lead to more efficient utilisation of the world's resources. Our P7 programme is aimed at these path breaking objectives. We have been at the forefront in using solar power generation and equipment such as direct current-diesel generators and fuel cells to make a significant contribution in creating a greener and environment friendlier world. We intend to lead the global telecom industry in this area in the coming years." Mr Prem Pradeep, CEO, Bharti Infratel Ltd.

Bharti Infratel Company Information

Bharti Infratel Limited is a leading 'Passive Telecom Infrastructure' provider in India. It owns and operates more than 25,000 towers for mobile communications and related telecom infrastructure. The company was founded in 2006 and is based in New Delhi, India. Bharti Infratel Limited is a subsidiary of Bharti Airtel Ltd.

6. Providing Solar Powered Telephony to Remote Rural Areas

By Rajiv Mehrotra, Founder, Chairman and CEO of Vihaan Networks Limited (VNL)

Around 3 billion people, half the world's population, live and work in rural areas that lack access to voice and data communications. Of these, 1.6 billion live with no or unreliable power supplies. They aren't easy to reach. The obstacles are formidable and remain the same as they have ever been; traditional GSM technology was designed for densely populated, relatively prosperous markets. As such, it is not suitable for the unique challenges posed by remote rural areas.

Traditional GSM

- **is too expensive** – A typical GSM base station alone costs in the region of US$100,000, before Base Station Controller (BSC) and Mobile Switching Centre (MSC) costs. Urban markets can justify this. Rural markets cannot. The cost base of any solution has to be geared to low Average Revenue Per User (ARPU) levels.
- **uses too much power** – Power was not top of the agenda when GSM was conceived in the early 80s. A typical base station site alone requires about 3000W to operate. Most rural markets are not served by any power grid. Power tends to come from costly and unreliable diesel generators – if it can be afforded and delivered at all.
- **relies on highly skilled engineers** – A typical base station deployment takes around three months and involves radio network planners, site acquisition teams, site engineers, civil engineers, equipment vendor installers and operator commissioning teams. This model could never scale to meet the rural opportunity. Rural areas have no trained telecom engineers and few people can read or write. This makes the installation and maintenance of GSM networks highly challenging.
- **is too difficult to deploy** – especially in areas with no electricity and poor roads.

Solar Power is the Solution

Without a doubt, solar is the most feasible way to power networks in rural areas. Solar powered networks can reduce the operating expenses for mobile operators to zero – and at the same time contribute to a much lower environmental impact.

VNL has spent the last six years re-engineering GSM technology to reduce its power requirement and make it suitable for rural environments where electricity is scarce or unavailable and ARPUs are less than US$2 a month.

The task sounds impossible but we have built a true GSM mobile network that is completely different from anything else available on the market, and will be profitable even when supporting only a few hundred users.

The VNL WorldGSM™ Differences

- Zero Operating Expenditure (OPEX) – made possible by major reductions in power consumption; allowing for the use of solar power as the single energy source. No diesel generators are required
- Low Capital Expenditure (CAPEX) – priced at less than traditional GSM base stations; so that it's profitable even at very low population densities and ARPU levels

Villager in Rural Rajasthan with VNL's WorldGSM™ Base Station

- Rural-optimised and easy to transport – compact and rugged; can even be transported on bullock carts
- Self-deploying and zero maintenance – can be installed in just 6 hours by 2 unskilled people and can be maintained by unskilled workers
- Solar powered – needs only 50 – 150W per base station compared to the 3000W required for traditional GSM. Each site can be powered by a 2-8 m² solar panel, rather than the 200 m² panel required to power a traditional GSM base station

WorldGSM™ also opens up a new microtelecom business model where operators partner with local entrepreneurs to accelerate deployment and reduce costs further.

Finally operators have a way to 'Connect the Unconnected'.

7. Community Power: Using Mobile to Extend the Grid

By Sagar Gubbi

A significant opportunity exists to provide environmentally sustainable energy to people in the developing world who live beyond the electricity grid. It is the mobile telecoms industry, which has already brought phones beyond the fixed telecoms grid, that holds the key to this next infrastructure innovation.

The Community Power Opportunity

There are 1.6 billion people in the world living without access to electricity. The mobile industry is experiencing unprecedented infrastructure growth in these same off-grid regions of the developing world. The GSMA estimates that nearly 639,000 off-grid base stations – the pieces of equipment which provide cellular network coverage – will be rolled out across the developing world by 2012.

Since mobile base stations need power to function, network operators have become adept at generating their own off-grid power. This has typically been achieved by running diesel generators at each site, although increasingly operators are installing renewable energy equipment, such as wind turbines and solar panels, to power their base stations.

The opportunity now exists for mobile network operators to provide electricity beyond the base station and into local communities, a phenomenon which the GSMA Development Fund calls 'Community Power'. Mobile network operators are trialling different approaches. At a minimum, operators can provide excess power to the community for small needs like charging up mobile handsets, large household batteries and rechargeable lanterns. At a maximum, the consistent power requirements of a mobile base station provide a stable 'anchor' demand for a bigger investment by a third party company in a village energy system, powering both the base station as well as local homes and businesses.

Electricity from this Safaricom Site is Powering a School in Kenya

In order to succeed, the third party scenario requires a strong business case, availability of suitable renewable energy resource and a favourable regulatory environment, all of which have been identified for India and East Africa.

Community Power is not just about social benefit, although this impact can be significant. It is also about improving the business case for off-grid telecoms by (a) growing revenue streams, (b) improving base station security, (c) charging mobile phones for increased usage, or (d) outsourcing power provision to third party companies to achieve lower cost of power.

Renewable sources of energy such as biomass and wind are suitable for Community Power solutions. GSMA research shows that biomass has the highest potential, due to its low cost of power generation and the availability of feedstock in off-grid areas.

The GSMA Green Power for Mobile (GPM) Programme was Launched in September 2008 to 'Extend Mobile Beyond the Grid'.

The GPM programme, with its proven expertise in accelerating the installation of renewable energy solutions to off-grid telecoms base stations through pilots, technical assistance, case studies and Working Groups, is uniquely positioned to be a global knowledge centre enabling rapid replication of the Community Power model across the developing world. The GSMA now aims to work with key stakeholders to develop pilots using different technologies in different countries and also partner with development finance institutions to help provide financing for large scale deployment of the Community Power model.

To accelerate the formation of this energy ecosystem GPM calls on existing and emerging stakeholders to highlight their interest in this proposal, specifically:

- Operators and tower companies that are interested to pilot and move to full scale implementation of the Community Power model
- Vendors and energy companies that are positioned to provide off-grid, renewable power to both the base station and community simultaneously
- Financing institutions and development organisations that can facilitate large scale implementation of the Community Power model.

Interested parties should contact:

greenpower@gsm.org

8. Mobile Operators take the Long View on Energy Innovation

By Richard Handford

"The mobile industry is spending a lot of time thinking about how much energy it consumes. The drive for innovation will produce major advances in how mobile networks are powered in coming years and might even alter how the mobile and energy industries work together", says Richard Handford.

There was a time when mobile operators did not have to worry about energy consumption. All that mattered was an expanding subscriber base. Now they care a lot. In addition to environmental concerns, energy prices around the world are growing steeply for operators, which is sufficient motivation for them to look more closely at reducing the power consumption of their networks; mobile operators consume a lot of energy. An operator running networks in a large number of markets consumes as much energy as a small country.

In developed countries grid coverage is ubiquitous and generally reliable, so operators focus on improving energy efficiency and adding greater intelligence to their networks to reduce costs.

In addition to rising energy prices, operators in developing countries face an additional challenge because their network expansion takes them into areas outside the reach of the existing electricity grid. Diesel-powered generators still dominate in these off-grid base stations although renewable energy offers a cost-effective alternative that is gaining ground among operators.

"Renewable energy base stations are the best way for mobile operators to extend their networks off-grid while minimising energy costs and their impact on the environment", says David Taverner, Senior Programme Manager with the Green Power for Mobile (GPM) initiative set up by the GSMA. The programme encourages operators to opt for base stations powered by renewable energy in off-grid areas instead of diesel generators. It has set a target of 118,000 off-grid base stations to be powered with renewable energy by 2012; a target which would represent over 20% of all off-grid base stations projected for that date.

The argument for action on cost grounds is clear. Annual diesel bills accrued by operators in the developing world are predicted by the GSMA to be US$14.6 billion by 2012. Bills for individual operators are huge. Indian operator Bharti Airtel estimates that 40% of its annual network Operating Expenditure (OPEX) is spent on energy, a figure that is equivalent to about US$500 million.

Operators with steady electricity supplies spend substantial amounts too. ABI Research predicts annual energy expenditure globally on powering on-grid base stations will grow from US$15.8 billion in 2007 to US$21.9 billion by 2013.

There is now a considerable momentum in the industry behind energy efficiency. *"One of our goals is to reduce the need for electricity in the base station. Once power needs are reduced to a very low level, a whole host of alternative energy technologies become much more economically viable"*, says Suresh Goyal, Bell Labs technical lead for the recently launched GreenTouch initiative, a consortium of operators, universities, government research bodies and industry labs, that has set itself the target of making mobile and fixed networks 1,000 times more energy efficient. Its aim is to demonstrate key components for achieving this goal by 2015. The initiative was announced in January of this year.

Most of the carbon emissions in a cellular network come from its base stations. A consensus figure within the mobile industry is that between 60% and 80% of emissions come from the base station.

Solar and wind are the most prominent green technologies used to power base stations in off-grid locations. Just as important is the role played by batteries and fuel cells which provide the storage when the sun does not shine or wind blow, or in areas where the grid offers only an intermittent supply. Fuel cells are only sparsely deployed today but offer a number of benefits over batteries, the dominant storage technology at present, including being a cleaner technology.

Beyond the base station, there are efforts to increase energy efficiency in areas such as core networks and data centres. In addition to the GreenTouch initiative, is the Energy Efficiency Inter Operator Collaboration Group, established in 2008 by 15 telecoms operators to improve energy efficiency through a more co-ordinated approach towards how they deal with standards and equipment vendors.

Within the base station, vendors are looking at how its design can be altered for developing countries, finding new ways to provide a basic service while consuming less power. The trend is towards smaller, more energy-efficient base stations that more accurately target coverage over a remote community.

In developed countries, progress has already been made in reducing energy consumption and operators are looking at further innovation which could lead to utilising the energy storage in their networks in new ways.

Mobile operators in the developing world are already seeing changes in how they work with the energy sector. If their renewable energy generation produces an excess then a number of operators offer it to power essential services for the local population. Ultimately, the presence of a mobile network in a remote rural village can even act as a catalyst for a power company to expand the grid into that area.

Less Power and More Intelligence

Mobile operators in the developed world have made great progress in improving energy efficiency in recent years. In fact, many of the simplest, and most effective, ideas were imported from the developing world. The simplest step is to turn down the air conditioning in base stations. The technology inside base stations has improved in recent years so that they can run happily at higher temperatures than in the past. A temperature of 35°C is now standard among operators, rather than the previous 25-30°C.

Base stations can also be cooled naturally by putting an air-filter in one wall of the cabin, and a fan in the other wall so drawing outside air through the interior. Replacing air conditioning with natural air is known as freecooling. In warmer climates, as well as turning down air conditioning, operators can paint the exterior white to deflect the sun's rays. They are introducing such low-tech innovations across their networks, so reducing their power consumption and making savings.

"Simple ideas make a massive difference, such as retrofitting freecooling to base stations", says Gabriel Bonilha, Network Transformation Manager with Telefonica Group. The company hopes in the future to entirely replace air conditioning with freecooling in countries with colder climates. In warmer countries, it will minimise the use of air conditioning. Telefonica hopes such innovation will reduce its current energy consumption of five terawatt hours annually across the group, equivalent to that of a small Latin American country.

Internally, the base station itself can be restructured to make it more power efficient. A technique for newly-built base stations called remote radio head involves shifting radio equipment from the base station's cabin up to its radio mast where it can be air cooled, so reducing the need for air conditioning within the cabin and minimising signal loss by shortening the distance between the equipment and the radio antenna.

Other energy efficiency ideas look at making base stations more reactive to external conditions. Already many base stations automatically reduce their power consumption at less busy times such as the middle of the night where there is less traffic to carry.

Further innovation might occur so that a base station is given the intelligence to react to changes in its immediate surroundings. Swedish manufacturer Ericsson is looking at how to programme a base station's software with meteorological data. The base station adjusts its own internal temperature accordingly. If the weather is predicted to turn cold then the base station will turn down its air conditioning, and vice versa if the weather turns warmer. *"We can include all the data and then let that information guide the network on how best to use the available power resources both at the present time but also in coming hours and days"*, says Christian Hedelin, Ericsson's Head of Product Marketing.

Operators need a reliable flow of information about a base station's status to underpin a more flexible energy regime. Operators can place smart meters, which are already used by the energy industry, to gather real-time information on energy consumption within

base stations. A GPRS modem relays a signal from a SIM embedded in the base station to the operator's network with a steady stream of status updates. Currently, this set-up is used by operators including Vodafone to monitor the level of consumption at individual base stations.

Vodafone also deploys similar units called remote meters that take a broader range of measures. *"This way we can get better knowledge of consumption and so drive greater efficiency"*, says Mohammed Belfqih, Vodafone's Senior Manager for site infrastructure and energy. Using sensors placed around the base station, a remote meter gathers information on the temperature, battery consumption and lifecycle, diesel fuel usage, as well as the base station's consumption of power (if it is connected to the grid). The operator is looking at a wider deployment of remote meters mainly in the developing world.

A Place in the Sun

In developing countries, a combination of solar and wind is the optimum power solution for base stations that are deployed off the electricity grid, or at those locations which only receive an unreliable power supply. The alternative to renewables is expensive diesel generators which have lower upfront costs but are more expensive to run (a typical payback time for renewable energy system is two to three years compared to using a diesel generator).

The majority of off-grid base stations will still run on diesel for the next few years. Until economies of scale further reduce the price of solar and wind technology. GPM estimates there will be 520,000 diesel-powered off-grid base stations in 2012, which is several times more than those powered by renewable energy although the gap is narrowing. The initiative backs solar and wind as the best renewable technologies for powering off-grid mobile networks, arguing they are cost effective with proven reliability.

IMS Research predicts by the end of 2014 the number of base stations powered by renewables will rise to 320,000, a total that includes both off-grid sites and those where the grid supply is unreliable.

There is also the prospect of innovation which will make both solar and wind equipment lighter and easier to install, so justifying deployments in more obscure locations. For instance, thin-film solar technology, which uses less raw material and therefore has lower production costs, is gaining ground on heavier solar panels faster than expected. *"What's interesting is that thin-film solar is doing much better than many people thought: costs are down and efficiencies are going up more rapidly than was previously anticipated"*, says Professor Dan Kammen of UC Berkeley.

The market for supplying solar equipment to mobile operators in off-grid areas is growing but is still small compared to the overall solar market. Solar suppliers customise their systems for mobile operators with features such as software that monitors power levels at remote sites. There are also alliances, such as technology co-operation programmes, between solar suppliers and telecoms equipment vendors.

A successful solar-powered base station can contribute to local people staying in their home village rather than migrating to the city in search of work. A thriving rural community can offer an attractive market for a solar supplier. *"More power for mobile networks means people are more likely to stay in rural areas, which represents a great opportunity for us to offer more solar power in the future. That's the reason we are so supportive of operators bringing solar to off-grid areas"*, says Michel Mansard, Export Director of Apex BP Solar, a leading solar system supplier.

In the developed world, base stations powered by renewable energy are rarely used as the reliability of the grid supply is good and its coverage is extensive. The trial started at the end of last year by Australian operator Telstra to test solar energy is unusual because of its on-grid location. *"The primary attraction for us is cost saving"*, says John Romano, Telstra's Director of Wireless Operations. The company says the payback at present on solar-only on-grid sites is more than 20 years against powering the sites with the grid.

John Romano says the operator's energy costs are rising rapidly and if this continues then solar power starts to look more attractive, as the number of years needed for payback falls. It's conceivable in the future that with falling solar panel and wind turbine prices, combined with rising conventional energy prices, on-grid base stations powered by renewable energy will be a viable option.

Cutting the Base Station Down to Size

Mobile operators do not need to deploy full-sized base stations in many off-grid locations where the target market is only small. Smaller base stations such as microcells or picocells offer sufficient coverage for the marketplace of a remote village while consuming far less power than a larger base station which typically provides much broader, but largely unused, coverage.

"I think a lot of operators are discovering it is actually more effective to deploy 5-7 microcells to really target where the population is rather than blasting out a high-powered signal over a radius of 20 kilometres to cover 3-4 towns in different directions", says Richard Lord, CTO of Altobridge, a leading vendor of network equipment for remote network deployments in the developing world. Microcells consume 100-200 watts against 1kW to 1.5kW for a full-size base station which makes them more suited to the vagaries of renewable power. Smaller also means lighter. A microcell can be transported on the back of a 4 x 4 truck to a remote location, thereby also reducing transport costs.

Smaller systems, such as femtocells, consume even less power. Femtocells are currently conceived as a means to boost 3G network capacity for the mobile internet in congested urban networks using DSL broadband lines for backhaul. But Femto Forum, a group dedicated to promoting femtocell take-up, says it has received enquiries from the World Bank and Indian mobile operators about deployments in remote locations. Femtocells have sufficient capacity to offer basic 2G voice and text services to small groups of users.

Currently, the cost of supplying a satellite backhaul to link the femtocell back to the cellular network is an obstacle to its widespread adoption but it would be ironic if over the next decade a technology currently associated with relieving busy urban networks was used to drive basic telephony in remote rural communities.

Shrinking a base station is not the only way to reduce its power consumption. Looking for more power-efficient ways of building it is another. Indian company Vihaan Networks Limited (VNL) uses widely available electronic components from the automobile and consumer electronics industries to reduce power consumption, as well as cost, in its solar-powered base station which offers voice and SMS services.

VNL's base station runs on less than 50 watts, a figure that founder, CEO and Chairman Rajiv Mehrota wants to cut further. *"Reducing energy consumption is an ongoing process because in many rural areas there really is no energy."* He would like to reduce energy consumption by another 10-20% over the next 2-3 years.

Call for Back-Up

When a base station, however small, is powered by renewable energy or an unreliable grid supply then it needs back-up capacity. Historically, batteries have fulfilled that role but now operators are starting to deploy hydrogen-based fuel cells.

Fuel cells are also a greener technology than batteries, the lead-acid variety of which presents a harder disposal problem, particularly in the developing world. Some fuel cell designs occupy less space within the base station than batteries and are easier to install. Fuel cells are also less attractive to thieves than batteries, which is a significant factor in some countries.

Although currently more expensive, fuel cells have the potential to be more cost effective than batteries if widely adopted across multiple industries such as the mobile and automotive sectors. They offer a strong storage capability and are particularly suited to pairing with wind power.

"Wind is the lowest cost renewable technology. If fuel cells got to the right price and were combined with wind then that would be a very powerful offering", says Matt Cooksley, a partner with Cairneagle Associates, an international strategy consultancy whose areas of expertise include telecoms and green technology.

Italian company Electro Power Systems has developed the world's first entirely self-recharging hydrogen fuel cell technology. The base station contains a hydrogen generator which is powered by the electricity grid. If the grid supply fails, hydrogen is automatically released from the generator into the fuel cell and combines with oxygen in the atmosphere to release electrical power. Water is produced alongside the power and sent to a tank attached to the base station from where it will be reclaimed when the blackout is over to convert back into hydrogen and oxygen, thanks to the rejuvenated grid. The product also works with renewable power sources.

Because the fuel cell recharges itself, the base station requires few visits from a technician, unlike other fuel cells or batteries. Once or twice a year, some water needs to be added to the tank whose size depends on how much back-up time the operator needs. A tank of one cubic meter could be enough in an emerging market for more than one year without refill, says the company.

Future advances in electrolysis could enhance hydrogen fuel cell technology. Putting electricity through water to break down its molecules is an undiscriminating process, and relatively energy intensive particularly in a renewably powered base station. Current research is focused on making electrolysis more efficient, says UC Berkeley's Professor Dan Kammen: *"This would dramatically extend the capability of storage because you could produce hydrogen with just a little cylinder filled with water at the back of a fuel cell."*

Safe Storage

Operators can choose when to access their storage capability, either through a battery or fuel cell, if they have the reassurance of a constant grid supply. Operators' creative use of the grid has the potential to evolve further, particularly as the energy industry enters the era of smart grids where it will have a greater need for storage as the proportion of energy generated by renewables increases.

"By installing energy storage at base stations, mobile operators could offer an asset to manage electricity supply and demand and benefit from the spread between peak and base power prices", says Peter Lacy, the Managing Director of Accenture's sustainability services in Europe, Africa and Latin America.

Widespread deployment of SIM-enabled smart meters in base stations would tell mobile operators how much spare storage capacity they have available. Armed with this knowledge an operator can adjust its power consumption depending on wider demands on the grid. It can reduce its consumption at peak times when pressure on the grid is greatest. At off-peak time when demand lessens, and energy is cheaper, the operator can increase its consumption of the grid supply. This approach is being studied by a number of operators.

Alternatively an operator could generate its own excess power. A product such as Electro Power Systems, which is aimed initially at the developing world, is capable of producing sufficient energy so that a mobile operator could sell any excess back to the grid as an additional source of revenue. An operator could generate hydrogen at night when the cost of using electricity is less, and then sell the energy generated back to the energy provider at a peak-rate during the day.

"Performed every day, the conversion would represent an interesting incremental revenue stream. In two to three years, fuel cell innovation and economies of scale could make this idea realistic", says Adriano Marconetto, founder and CEO of Electro Power Systems.

Community Spirit

In off-grid locations, mobile operators might also be generating excess power that could be offered to the immediate community served by the base station. By definition, these communities are in remote locations and are often hampered by a lack of grid power.

At the very least, the base station's excess power can enable users to recharge their handsets locally, so saving a journey to a neighbouring on-grid community. It might be sufficient to make a more substantial contribution, such as providing the energy to introduce outdoor lighting to a community for the first time, or the mobile operator's presence might even attract investment from an energy provider to extend the grid to a remote village.

A number of operators in South Asia and East Africa are involved with projects based on Community Power, the term used by GPM to describe such arrangements. Mobile operator Safaricom is supplying power to remote villages in twenty five locations around Kenya. The operator contributes handset recharging booths in sixteen of the sites. More ambitiously, Safaricom powers the laboratory and maternity wing of a rural clinic in one community. In another community, it is the lighting and computer room of a school that it powers. The country's Rural Electrification Authority, the government body that drives access to electric power in rural areas of Kenya, has extended the grid to a few of these locations but both clinic and school would struggle to pay electricity bills. Safaricom is discussing with

the community the kind of support it could offer. One possibility is for the operator to offer its generator as a back-up for the grid connection. Alternatively it could subsidise the electricity bills of clinic and school.

Beyond altruism, Safaricom sees a number of benefits from subsidising the two locations. *"Theft is less likely from a base station which is contributing power to the local community"*, says George Ponde, Senior Base Station Maintenance Engineer with Safaricom, who also points to another positive aspect for the operator: *"It will give Safaricom a competitive edge over competitors who move into that area. Users will align themselves with someone who is providing for them."*

The operator's action also projects a good image of the company's activities to other consumers in Kenya. This kind of model could become more common as mobile operators explore the economics of penetrating deeper into off-grid locations.

Making a Smarter Grid

Energy has become increasingly important for mobile operators, both in developed and developing countries. That trend is set to continue as operators look at ways to power their networks more efficiently in the face of rising energy prices, as well as seeing operators in the developing world push their networks into more remote off-grid locations.

The pressure to hold down costs in an increasingly competitive mobile market will continue to drive innovation among operators, while the necessity of reaching new customers who live beyond the grid in parts of the developing world will also spur new thinking.

The mobile industry is actively looking to balance its growth targets with lower energy demands. Mobile's Green Manifesto, a proposal published by the GSMA at the end of 2009 for how the industry can reduce its emissions, predicts a 70% rise to 8 billion mobile connections by 2020. The GSMA document also forecasts that total greenhouse gas emissions will remain constant at 245 mega-tonnes of carbon dioxide equivalent (Mt CO_2) between now and 2020, thanks to innovations such as lowering energy consumption in base stations or using renewable energy.

Conclusion

Innovation will be both technical and involve the mobile industry working with new partners. *"As energy becomes more important to operators, they will identify opportunities to work with the energy sector. They have done this before with other industries. Energy could be next in line to feel the impact of mobile technology"*, says GPM's David Taverner.

Operators will look at more clever ways to build and power their networks. They will also look at what benefits come from these new opportunities. This will likely mean more operators sharing power with local communities but could also produce new, as yet unknown, business models. Mobile operators already work closely with sectors such as banking, health and logistics to offer new business models and original thinking. Now it could be the turn of the energy sector.

Richard Handford
Richard Handford is a journalist with twenty years' experience covering the telecoms industry. He has written for the Financial Times, Wall Street Journal and The Economist, in addition to specialist industry publications. His second enthusiasm is renewable energy and sustainability. He recently completed a report on corporate sustainability reporting for the Economist Intelligence Unit.

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

BSC / Base Station Controller - Mobile network component that contains all the logic used to control the operations of the BTS and acts as an interface between the BTS and the MSC

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

CAPEX – Capital Expenditure

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

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

IRR – Internal Rate of Return

kg / kilogram – a kilogram is a unit of mass

km / kilometre – a kilometre is a measure of distance

KPI – Key Performance Indicator

kVA / kilovolt-ampere – the unit of apparent power kVA is used for measuring the power consumption of non-resistive equipments such as generators

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

GDP – Gross Domestic Product

GPM – GSMA Green Power for Mobile programme

GPRS – General Packet Radio Service

GSM – Global System for Mobile communications

GSMA – GSM Association

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

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

OPEX – Operating Expenditure

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

ROI – Return on Investment

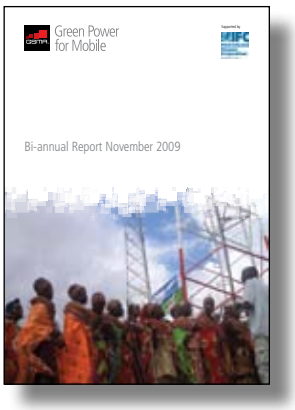
V / volt – the value of the voltage equal to one ampere at one watt of power

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

Resources

www.gsmworld.com/our-work/mobile_planet/green_power_for_mobile/resources.htm

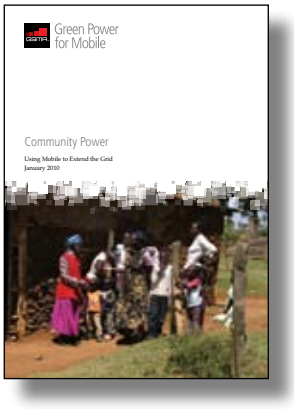
Reports



Green Power for Mobile Bi-Annual Report (Nov 09)
www.gsmworld.com/documents/gpfm_report_09_annual_review.pdf

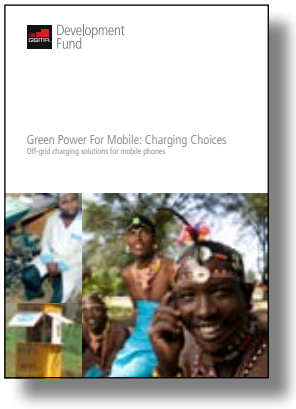
Green Power for Mobile: Top Ten Findings
www.gsmworld.com/documents/green_power_top10.pdf

An overview of the top ten research findings for green power solutions for mobile networks.



Community Power – Using Mobile to Extend the Grid
www.gsmworld.com/documents/gpfm_community_power11_white_paper_lores.pdf

This study discusses how the mobile industry can help provide environmentally sustainable energy to people in the developing world who live beyond the electricity grid.

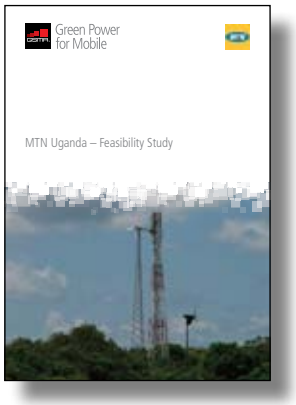


Green Power For Mobile: Charging Choices
www.gsmworld.com/documents/charging_choices.pdf

This study discusses charging solutions for handsets in off-grid areas and identifies a US$2.3 billion market potential for those solutions.

HOMER Software – Training Guide for Renewable Energy Base Station Design
www.gsmworld.com/documents/homer_training_guide_210X297.pdf

A free software application used to design and evaluate technically and financially the options for off-grid and on-grid power systems for remote, stand-alone and distributed generation applications.



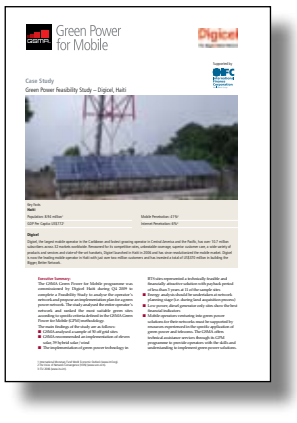
Green Power Feasibility Study – MTN, Uganda
www.gsmworld.com/documents/gpfm_mtn_feasibilitystudy_pages.pdf

A Feasibility Study to provide information to mobile operators who are considering or planning to deploy renewable power resources for base station and transmission sites.

Case Studies

Green Power Feasibility Study – Zantel, Tanzania
www.gsmworld.com/documents/zantel_tanzania_page_layout(1).pdf

A Feasibility Study to analyse the operator's network and propose an implementation plan for a green power network.



Green Power Feasibility Study – Digicel, Haiti
www.gsmworld.com/documents/digicel_haiti_04_10_med_res.pdf

Comissioned by Digicel Haiti, this study analyses the operator's network and proposes an implementation plan for a green power network.

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