Green Power for Mobile

Supported by

IFC International Finance Corporation
World Bank Group

Bi-annual Report November 2009

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Welcome

The GSMA Green Power for Mobile (GPM) programme was launched in September 2008 to 'extend mobile beyond the grid'. Just over a year later we have witnessed a huge increase in activity in this sector as mobile operators seek solutions to providing mobile access to the 1.6 billion people who live without grid electricity.

An indication of this growth was the strength and diversity of attendance at the fifth GPM Working Group meeting in India in September. The meeting was attended by a spectrum of global operators, tower sharing companies, equipment vendors and representatives from the International Finance Corporation (IFC-World Bank Group), the Cellular Operators Association of India (COAI) and the Universal Service Obligation Fund.

The programme has entered an exciting new phase of development through a partnership with the IFC. The IFC are providing both financial support for the programme's activities and seeking to assist operators with financing for green base station rollouts. An overview of this partnership is contained within.

The Clinton Global Initiative has recently recognised GPM for its exemplary approach to accelerating solutions that address climate change, and the programme has been profiled in its 2004-2008 commemorative publication, "Action Speaks Louder than Words'.

For the first issue of the GPM Bi-annual report we have focused the content into two sections – current and future market trends.

Current Market Trends

With a viewpoint on present day trends we first address the challenge of selection of specific renewable energy technologies, by providing the GSMA point of view on the applicability of the major technologies, such as solar and wind, to power network infrastructure. MTN South Africa provides an innovative case study of a trial site where they have deployed solar, wind and fuel cell technologies at a single site. BP Solar provide their perspective on why the industry is now ready for large scale, commercial application of solar technologies for powering off-grid networks.

There are two distinct stages to any green network rollout, a feasibility study phase and then an implementation phase. GPM has partnered with operators across Africa, the Pacific and South Asia to deploy 75 green power base stations over the past eighteen months. Two key projects with MTN Uganda and Digicel Vanuatu which outline both the feasibility study phase and implementation phase are profiled. We are pleased to be able to offer a Feasibility Study service to operators.

Future Market Trends

With an eye on emerging trends and future evolutions we profile the pioneering work of Bharti-Airtel to reduce the energy consumption of their network – a key priority when network energy expenditure is US$500 million per year for Bharti-Airtel.

We also introduce a new report from the GPM programme entitled Charging Choices, which has revealed a US$2.3 billion opportunity for mobile operators through the provision of off-grid charging solutions in emerging markets.

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. We will be holding a seminar alongside the main agenda at Mobile World Congress in Barcelona in February 2010 and we hope to see many of you in attendance. The next Working Group meeting will be in Africa in March 2010.

I trust you will find the first 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

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Introducing Green Power for Mobile

The Industry Challenge

David Taverner, GSM Association

Access to information is essential to economic growth, yet a study by Deloitte[1] commissioned by the GSMA suggests that access rates in developing countries often lag more than twenty years behind those in the developed world. Fortunately, important advances in technology are closing this gap. Mobile telephony appears to be particularly promising – economists have demonstrated that a 10% increase in mobile penetration is associated with a 1.2% increase in a developing country's GDP.

Mobile technology requires less infrastructure and consequently less capital investment than traditional communications networks. This contributes to positioning the developing world as a significant market with relatively untapped potential. Thanks to the high demand for access to information and ever-decreasing supply costs, mobile operators are taking a lead role in addressing the digital divide between developing and developed nations.

As the total number of mobile phone connections worldwide approaches 4.5 billion[2], mobile operators are increasingly looking towards the rural regions of the developing world for future subscriber growth. The acceleration of mobile technology in the developing world is not without obstacles – cellular networks rely on radio towers or base stations that convert electricity into radio waves and need a constant supply of energy to operate. In developed areas, base stations are easily connected to a main power grid for a reliable energy supply. In developing areas however, 1.6 billion people lack access to grid electricity and an additional one billion people have unreliable electricity. Though providers have relied largely on diesel powered generators to power off-grid and unreliable grid base stations, it is becoming increasingly apparent that this is not the optimal solution for off-grid power.

The Earth at Night Highlighting Large Regions that are Off-Grid

Source: NASA

1 Global Mobile Tax Review 2006-2007 (http://www.gsmworld.com/documents/tax_review_06_07.pdf)
2 Wireless Intelligence

The GSMA estimates that in 2007 there were over 290,000 off-grid diesel base stations in developing regions, and forecasts that by 2012 there will 520,000 off-grid diesel base stations and 118,000 green renewable energy base stations.

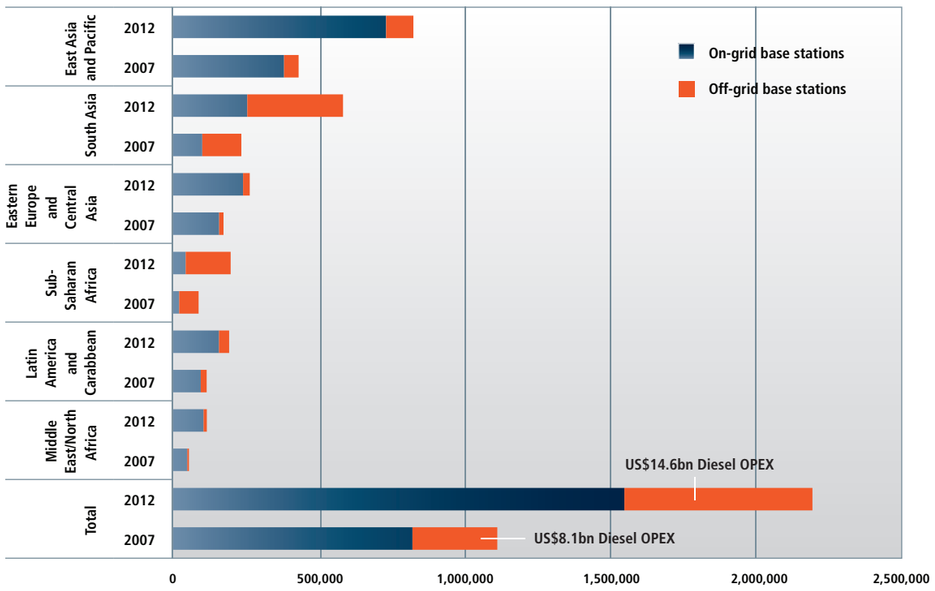
The impact of running off-grid diesel powered sites on an operator's operating expenditure (OPEX) can be significant. Diesel generators are expensive to run both in terms of fuel and maintenance cost. The price of diesel has demonstrated extreme volatility over the last two years causing wild fluctuations in OPEX which in turn creates difficulty in business planning/forecasting. It is not just the cost of the fuel itself that can make diesel an unattractive option – the cost of transporting it to remote locations can be high, and there is also the risk of theft. The GSMA estimates that by 2012 operators across the developing world will incur a US$14.6bn diesel bill from powering off-grid base stations. Bharti-Airtel estimates that 40% of network OPEX is spent on energy which is equivalent to US$500 million.

Operation and maintenance of remote off-grid sites is also a major challenge for operators. Due to the lack of infrastructure in remote regions, delivery of diesel or a generator maintenance engineer can take up to eight hours by dirt track, or in some instances will need to be transported by boat or helicopter. As operators continue to expand their networks into remote regions, these challenges can escalate to a point where further expansion is unfeasible. This highlights a foreseeable situation whereby some regions are left without mobile or classic telecommunications access, creating a permanent digital divide between the developed and developing world.

The final major issue surrounding the use of diesel to power base stations is the significant emissions that result from their 24 hour a day operation – a typical rural base station will generate approximately 60 tonnes of carbon per year.

In addition to the challenges associated with operating base stations in off-grid regions, there is the difficulty of charging mobile phones. Nearly 500 million people currently have access to a mobile phone but do not have their own means of charging it – their alternative is to seek expensive solutions such as lead-acid batteries which can have a harmful impact on the environment.

Growth in Base Stations and Diesel OPEX in Developing Regions 2007-2012



Source: GSMA

'Extending Mobile Beyond the Grid'

Lauren Dawes, GSM Association

In September 2008, the GSMA Development Fund launched its Green Power for Mobile (GPM) programme with two primary 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

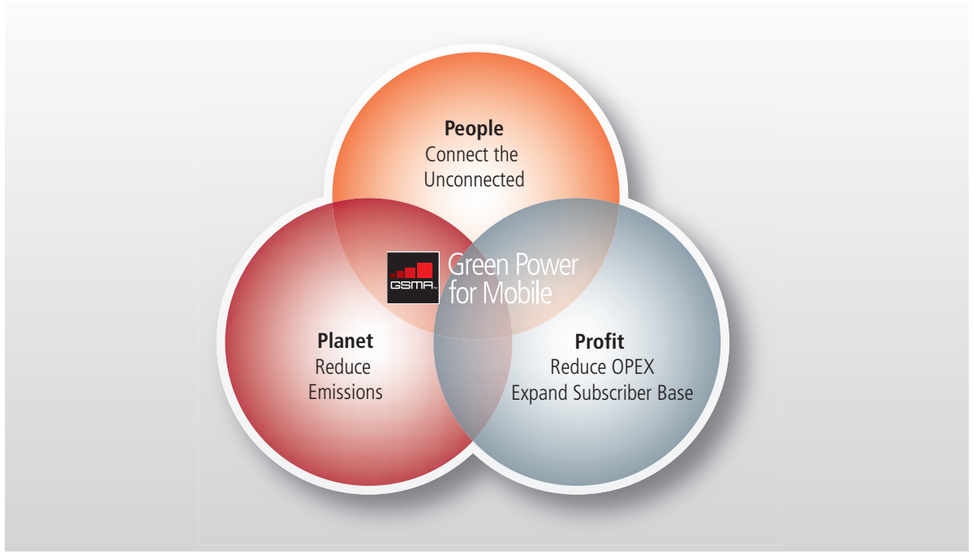
Through its work the GPM programme aims to advance the use of renewable energy sources by the mobile industry to power 118,000 new and existing off-grid base stations in developing countries by 2012. Achieving this target will save up to 2.5bn litres of diesel consumption, cut annual carbon emissions by up to 6.8 million metric tons – which equates to Tanzania's annual emissions – and connect 118 million people in developing countries to mobile networks using green power.

The GSMA sees this programme as an exemplification of the triple bottom line concept which brings strong benefits to the people, planet and profit.

The GPM programme has recently been recognised by the Clinton Global Initiative for its exemplary approach to accelerating solutions that address climate change, and has been profiled in its 2004-2008 commemorative publication, "Action Speaks Louder than Words", from which sections of this chapter have been extracted.

GPM has established an implementation strategy of three complementary work streams – Market Clarification, Capital Expenditure (CAPEX) Financing and Ongoing Innovation. An overview of each of the streams can be found on the next page.

Triple Bottom Line Benefit



Market Clarification

The objective of the Market Clarification work stream is to give mobile operators a full understanding of the opportunities for renewable energy in their respective markets and demonstrate how green technology poses less risk than may be perceived. Specifically GPM offers three tools within Market Clarification:

1. A web portal to disseminate information on the challenges and successes of renewable power implementation - www.gsmworld.com/greenpower
2. A Working Group – currently comprising 35 mobile operators – to promote and facilitate the sharing of lessons learned and concerns around deploying renewable energy solutions
3. A rapid assessment toolkit used to guide providers through the decision making process

CAPEX Financing

Through the CAPEX Financing work stream, GPM acts on behalf of its members to secure funding through development banks. Given the nascent nature of the market, the capital cost of implementing green technology to power base stations can appear to be too risky an investment for many mobile operators. The aim of CAPEX Financing is to provide mobile operators with financial instruments to enable the implementation of viable business models that leverage renewable power for long-term efficiency gains.

Ongoing Innovation

The GPM programme's Ongoing Innovation work stream utilises several methods to promote continued innovation in the field of renewable power. Specifically, GPM has the ability to support trials and test the potential of renewables in a given region. The programme is on target to complete projects for fifteen operators across 1,000 solar, wind and biofuel base stations by Q4 2010. GPM is also researching the solutions available to operators to solve the challenge of off-grid charging of handsets, the results of which can be found in 'Green Power for Mobile – Charging Choices'[3].

Green Power for Mobile Working Group

3 The GSMA publication 'Green Power for Mobile – Charging Choices' can be found at www.gsmworld.com/documents/charging_choices

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Feasibility Study Service for Mobile Operators

David Taverner, GSM Association

Over the past eighteen months, the Green Power for Mobile (GPM) programme has partnered with operators across Africa, the Pacific and South Asia to deploy 75 green power base stations in order to acquire knowledge, demonstrate feasibility and build operator confidence in the use of alternative energy to power base stations.

The experience and learnings from these deployments across a wide number of sites and geographies has given the GPM programme world class understanding of the methodology involved in designing and implementing alternative energy base stations.

Mobile operators can benefit from this knowledge and methodology through the GSMA's GPM Feasibility Study service.

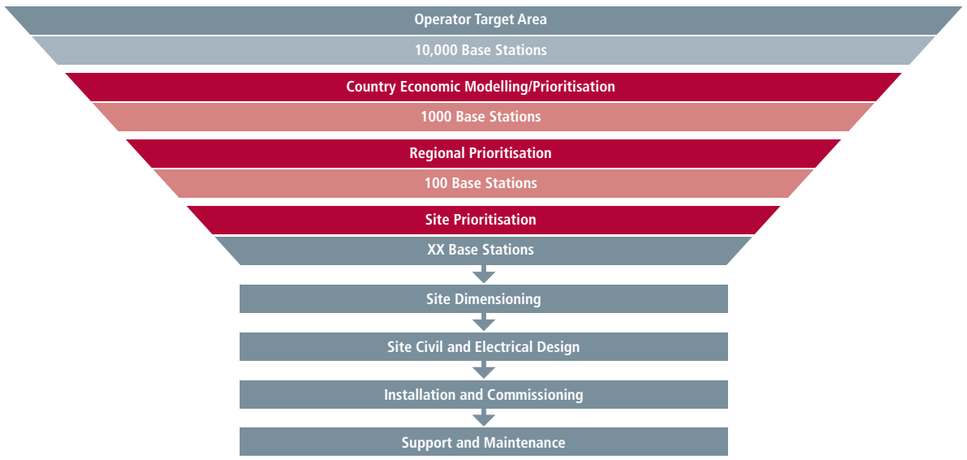
The GPM Feasibility Study service offers a technical and financial feasibility study of an operator's base station network to identify priority candidate sites, optimum alterative energy technology, forecast CAPEX and ROI, and assist with implementation planning. The GSMA uses best practice, public domain software tools to complete the analysis. Training on the software is provided and a centre of excellence can be established within the operator through a training curriculum offered by the GPM programme.

The key challenge faced by operators when moving from a pilot site phase to network or group level implementation is reducing the list of candidate sites in its global or country footprint to the optimum targets based on technical and financial viability. GPM's methodology which is summarised in the graph below solves this issue.

The primary objective of the GPM Feasibility Study service is to ensure that mobile operators maximise return on investment on CAPEX investments. Operators who take advantage of the service will benefit from the GSMA's unique value proposition:

- Advice from an unbiased perspective
- Significant experience from deploying over 75 alternative energy sites across Africa, the Pacific, and South Asia
- Establishment of a Centre of Excellence with the help of the GPM training curriculum

Green Power for Mobile Methodology



MTN Uganda – Example Green Power for Mobile Feasibility Study

The GPM programme was commissioned by MTN Uganda during April to June 2009 to analyse MTN's existing network and outline an implementation plan for a green power network.

After assessing the operators' network and analysing the sites which could best represent MTN Uganda's operating environment in terms of climate, site configuration, equipment and power requirements, eleven target sites were identified (ten existing sites and one planned site). The selected sites can be grouped into four main categories according to two dimensions – indoor /outdoor and diesel generator/hybrid battery system powered sites.

Site visits were conducted to ten of the targeted sites. Site visits are a key element of site prioritisation – availability of space on site for renewable equipment, terrain obstacles, and local micro-climate data are all key pieces of information that can be efficiently gathered through conducting on site assessments. For each of the targeted sites accurate financial and renewable forecasts were completed adopting HOMER (public domain software from US National Renewable Energy Laboratory) to dimension the renewable energy equipment and integrate the results into the GPM methodology.

A sensitivity analysis of diesel price variation was conducted considering values ranging from US$0.7 to US$1.2 with increments of US$0.1. In many developing countries currency exchange fluctuations, theft and transportation costs can have a strong impact on the final delivered price of diesel.

Financial Viability Results:

- Seven out of eleven site were identified as having a green power solution payback within three and a half years
- The spread of ROI was between 25.1% and 64.8% across ten sites
- The CAPEX range for the green power solutions was US$34,177 to US$64,315 per site, with an average US$48,883
- The GSMA advised MTN Uganda to implement green power solutions in six out of the eleven sites studied
- This rollout has the potential to save 68,885 litres of diesel per year and reduce carbon emissions by 219.6 tons per year

Feasibility Study Key Findings:

- The implementation of green power technology in base station sites represented a technically feasible and financially attractive solution
- Energy analysis should be conducted at network planning stage (i.e. during land acquisition). In existing sites there is often not enough space for installing the ideal photovoltaic system
- Low power, diesel generator only sites demonstrate the best financial indicators
- Accurate data on installed network infrastructure is critical for successful energy planning
- Mobile operators venturing into green power solutions for their networks must be supported by resources experienced in the specific application of green power and telecoms. The GSMA offers technical assistance through its Feasibility Study service

Summary of Financial Viability and Renewable Energy Indicators for MTN Uganda Feasibility Study

Site	ROI	NPV	CAPEX	Contribution to Power	Battery Backup (hr)	Base Station Type	Suggested for Implementation
Site #1	33.6%	$4,124	$34,177	solar: 41% DG: 59%	13.4	outdoor/DG only	Y
Site #2	32.9%	$8,791	$64,315	solar: 32% DG: 68%	17.6	outdoor/DG only	Y
Site #3	27.9%	-$1,284	$45,830	solar: 37% DG: 63%	13.2	outdoor/DG only	N
Site #4	49.1%	$26,842	$47,874	solar: 41% DG: 59%	13.4	outdoor/hybrid battery system	Y
Site #5	64.8%	$44,230	$45,379	solar: 35% DG: 65%	13.4	indoor/DG only	Y
Site #6	25.1%	-$3,632	$40,840	solar: 36% DG: 64%	17.2	indoor/DG only	N
Site #7	34.5%	$5,378	$40,167	solar: 52% DG: 48%	13.4	indoor/DG only	Y
Site #8	27.9%	$2,360	$56,830	solar: 17% DG: 83%	9.61	indoor/hybrid battery system	N
Site #9	40.4%	$19,561	$56,830	solar: 25% DG: 75%	18.4	indoor/hybrid battery system	N
Site #10	52.8%	$34,042	$57,738	solar: 90% DG: 10%	18.7	outdoor/DG only	Y

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International Finance Corporation Supports Green Power for Mobile

The International Finance Corporation (IFC), a member of the World Bank Group, fosters sustainable economic growth in developing countries by supporting private sector development, mobilising private capital, and providing advisory and risk mitigation services to businesses and governments. IFC's new investments totalled US$15 billion in fiscal 2009, helping channel capital into developing countries during the financial crisis. For more information, visit www.ifc.org.

The IFC is providing financial support to the GSMA Green Power for Mobile (GPM) programme, to assist mobile operators in exploring the use of renewable power base stations as a means of optimising capital and operating expenditures. Specifically, IFC is seeking to partner with mobile operators in developing countries, offering a variety of financial instruments to enable the implementation of viable business models that leverage renewable power for long-term efficiency gains.

Through this collaboration, mobile operators in developing markets can benefit from an anchored investor, a technical assistance programme, market research, better access to carbon finance and knowledge sharing programmes. For more information contact greenpower@gsm.org.

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Current Market Trends

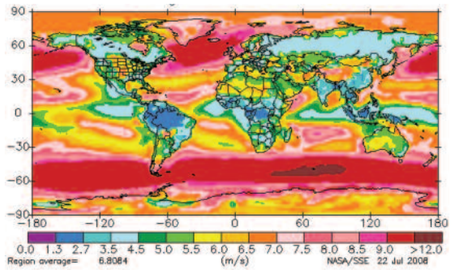
Evaluating Green Power Technologies

David Taverner, GSM Association

Solar and wind technologies (including solar and wind hybrids) are currently the most attractive technologies for powering base stations. Due to the abundance of sun, commoditisation of solar modules, ease of planning and low running costs, solar is the favoured choice for green power solutions in many regions for small load sites (<2kW). However, due to the fact that CAPEX scales proportionately with load, solar solutions are less economically attractive for larger sites.

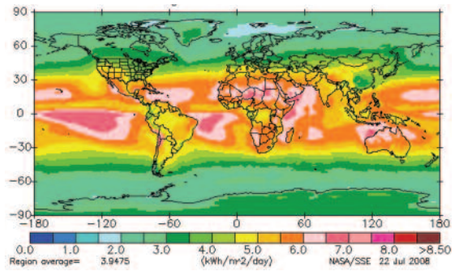
At standard base station loads, the installed cost of wind technology is more economically viable than for an equivalent solar system due to a lower basic equipment cost. However, variability in wind speeds across the globe means that wind only solutions are likely to be restricted to locations such as coastal and mountainous regions where wind is abundant. Hybrid solutions that deliver the benefits of both wind and solar technologies will therefore be more common than wind only solutions at standard base station loads.

Wind Resources



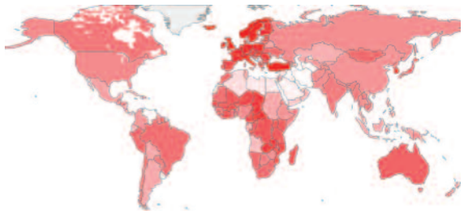
Source: NREL

Solar Resources



Source: NREL

Diesel Price+



Note: *Some estimates have been made
+Forecasts have been made from 2006 prices
Source: GTZ

Going forwards, other niche technologies will continue to develop, some of which are explored below.

Pico-hydro

Pico-hydro refers to very small hydro power solutions – typically less than 10kW – that can harness the power of streams and rivers. It is a mature technology for applications such as rural electrification and has the lowest CAPEX of all solutions. However, the number of locations that are suited to the deployment of pico-hydro power will limit mass deployment.

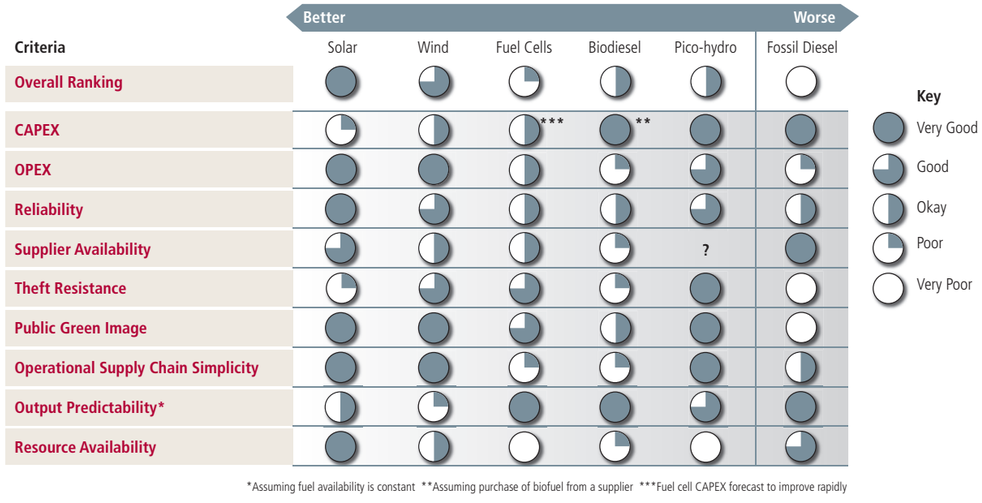
Biodiesel

Biodiesel can be used as a direct replacement for fossil diesel in base station generators. The application of biodiesel to telecommunications must be treated on a case-by-case basis rather than as a universal alternative. The primary consideration for biodiesel will be local access to a supply, and the impact of production on regional agriculture should also be evaluated. Biodiesel application has increased appeal in regions that are not competing with food supplies – semi-arid crops such as jatropha.

Fuel Cells

Fuel cells are a developing technology with limited proven commercial application to provide the entire load for base stations. They are therefore at present primarily considered for limited power load requirements such as an alternate battery solution in unreliable grid power locations. Rapid progress is being made in the use of fuel cells for base stations however, and the GSMA Green Power for Mobile (GPM) programme is continuing to monitor these developments.

The Green Power for Mobile point of view on fuel cells below has been updated as of October 2009.



*Assuming fuel availability is constant **Assuming purchase of biofuel from a supplier ***Fuel cell CAPEX forecast to improve rapidly

MTN South Africa is Switching to Green

Sameer Dave, MTN South Africa

This case study from MTN South Africa (MTN SA) provides an excellent example of an operator base station deployment that incorporates multiple alternative energy technologies including solar, wind, fuel cells and lithium-ion batteries.

MTN SA is committed to expanding its network coverage and providing coverage to even the smallest of places. The recent green project, under Sameer Dave, Chief Technology Officer, MTN SA, not only provides coverage to people and an area which never before had coverage – it is taking network towers to new heights, relying on the power of nature.

Kleinaarpan is a small area in the Northern Cape, about 120 kilometers north of Upington – if you search for it on Google you get a one page result. The area is however well used by tourists who are on route to Botswana and Namibia, and home to South Africans who love small town living and an 80 metre GSM tower that operates purely on what nature has to offer. "The long time to market for sites without power necessitated a different approach to realize revenue earlier. Alternative energy sources were funded from the budget normally used for the construction of power lines and generators, thereby reducing the time to market and investing in green infrastructure that belongs to MTN" says Sameer Dave

A Green Network Tower

The GSM tower site in Kleinaarpan provided the network team at MTN SA with insight into the application of renewable energy resources such as wind and solar and provided an opportunity to test 'green' technology.

The area which previously had no network coverage also had no alternating (AC) electrical power. An electrical supply could have been established but at a high cost.

How the 'Green' GSM Tower Works

The primary energy source is from photovoltaic (PV) solar arrays and a wind turbine generator. The energy gathered is stored in rechargeable lithium-ion batteries which unlike acid batteries can handle high temperature and change in weather conditions. Lithium-ion batteries, which are similar to mobile phone batteries, can be recharged time and time again.

The back-up energy source is from a hydrogen powered fuel cell which starts up automatically when no energy is available from the PV solar arrays and wind turbine generator, or if the battery voltage drops below a certain threshold. The hydrogen powered fuel cell can also operate for up to eighteen days should there be insufficient sun or wind.

In this pilot phase – in order to ensure that the 'green' technology was efficient and provided sufficient coverage – the GSM tower also had a weather station installed which measures the sun's intensity, wind speed, temperature and humidity. Data collected will be used to analyse the efficiency and utilisation of the green energy resources and the output will be incorporated into the design of the next green site.

The GSM tower's coverage footprint has a 50km radius.

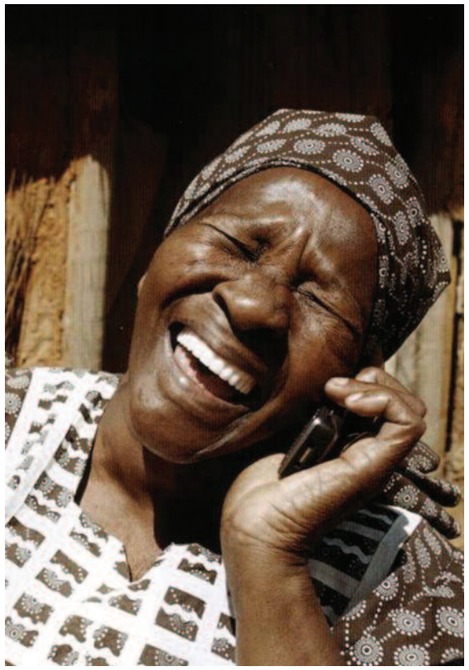
The average consumption of the site is 1.3kW. The solar array is capable of generating 12kW and the wind turbine 7.5kW. MTN is living up to its expectation of a 'green' movement in telecoms.

The People of Kleinaarpan

"The people we stayed with at the Rooipan Guesthouse had their phone lines stolen almost two years ago and because there was no network tower available, mobile phones were also out of the question," says Johan Roos, Contractor, MTN SA. "The only way they could make calls was to drive some distance to high ground where a mobile phone signal was available."

To ensure that the people of Kleinaarpan are connected all the time, the PV solar arrays used on the site were built in such a way that they cannot be stolen easily without damaging the equipment.

Thanks to the establishment of the GSM tower, the people of Kleinaarpan can now use mobile phones and connect to the Internet.



BP Solar – The Right Time for the Right Energy Mix

Michel Mansard, Apex BP Solar

After 30 years of development, the solar industry has now scaled to be a major contributor to the global energy sector. While the major focus today is oriented towards grid connected solar power plants, a significant number of photovoltaic (PV) solar companies are still playing an active role where it all started – in the rural off-grid regions. Recently, a new market has opened with the deployment of solar solutions to power off-grid GSM networks.

The basic ingredients of a successful solar solution – accurate system sizing and use of high quality PV modules remain the key requirements for a reliable energy infrastructure. Sizing calculations are well understood and many quality sizing software packages are available on the market. However, best practice in weather database selection and sizing methodologies still need to be heavily promoted as a pre-requisite to ensure every solar deployment delivers optimum performance.

By deploying massive production capacity, Apex BP Solar is able to promote off-grid solar solutions at a cost that is economically attractive. After decades of local capacity building from the private sector, the solar industry benefits from the availability of skilled labour and spare parts at an affordable price and that are easily accessible in most emerging markets. This ensures operation and maintenance costs are minimised.

For many years, the solar industry and mobile operators have worked collaboratively to implement solar power solutions for network infrastructure. Thousands of solar systems are now powering GSM networks in off-grid areas with no interruption of service. On the technical side, most PV only solutions can power base station site loads under 2kW. Solar / diesel hybrid solutions are deployed at sites over 2kW of load.

Case Study: Telma Mobile, Madagascar

Key input parameters:
Site power requirement: outdoor base station, transceiver configuration 2+2+2, 0.6kW peak load
Insolation (sunlight availability): 4.5kW/m²/day

Site design overview:
100% PV solar powered
Solar PV modules total 4.7kW (48V DC)
Two battery banks of 985Ah (48V) in parallel, totalling 1970Ah (48V)
Battery autonomy: 5.4 days without sun

More than 50 sites installed in one year, by two teams from Electricité De Madagascar (Ocean Trade Group)

Lessons learnt:
- Technical team leader fully capable of installation and commissioning after a three day training session at Apex BP Solar factory
- High reliability and light maintenance allows local resources to maintain equipment even in very remote areas
- Use of various multiple meteorology databases helps find the optimum solution design

Solar companies such as Apex BP Solar offer a number of services – system design engineering, site planning, and modular, cost effective solutions including specific structures, anti-theft options, remote monitoring, as well as deployment support.

From the various initiatives within both the energy and telecommunications sectors today, there is no doubt that commitment to green power is a reality. With this in mind, now may be the right time to produce the right energy mix.

Contact:
Bérangère Lançon- Communications dpt :
b.lancon@bpsolar.fr

To Learn More:
www.apex-bpsolar.com

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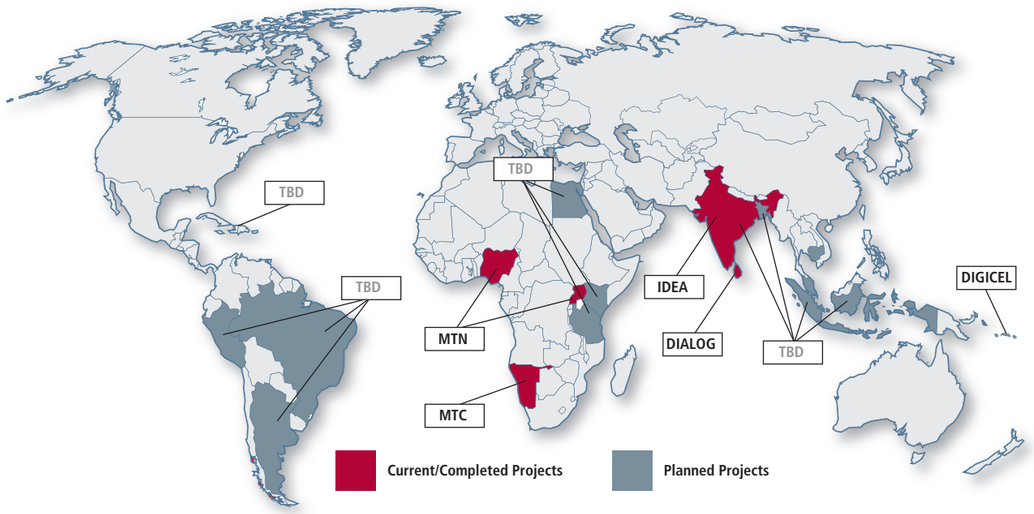
Case Study – Digicel Vanuatu Deploys a Green Network

Areef Kassam, GSM Association

Over the past eighteen months, the GSMA Development Fund Green Power for Mobile (GPM) programme has supported six alternative energy projects and deployed a total of 75 'green' base stations with operators across Africa, the Pacific, and South Asia. The programme is on target to complete projects for fifteen mobile operators across 1,000 solar, wind and biofuel base stations by Q4 2010.

Green Power for Mobile Project Locations



Digicel Vanuatu Network Wide Implementation

The GSMA Development Fund collaborated with Digicel Vanuatu to assess and start to develop best practice for commercial scale rollouts of green power technology[4]. There are currently 24 live sites in the Digicel Vanuatu network running on green power, including eight mission-critical backbone sites carrying up to 60% of Digicel's traffic.

Vanuatu is a volcanic archipelago of 82 islands in the South Pacific. Sixty-five islands are inhabited, but the majority of the population live on just ten of them. Digicel Vanuatu is part of the Digicel Group and has a 900 and 1800MHz band licence which stipulates licence conditions of coverage for 85% of the population.

Implementation Challenges

The major implementation challenges faced by Digicel Vanuatu were:

Population

The population of Vanuatu is extensively rural and the geography of the archipelago is such that the ten main islands are spread north to south over approximately 700km. The population is 220,000 of which only 25% live in the four main urban areas.

Geography

75% of the 250,000 population live in rural areas, so fulfilment of the 85% population coverage under the licence mandates a major focus on off-grid remote sites. The north to south alignment of the islands over considerable distance requires these rural areas to support the transmission backbone, further exaggerating the importance of many rural sites. The islands are found in the path of the South Pacific cyclone track which, with seasonal weather variations, places a high autonomy requirement on remote sites with critical high revenue traffic.

Road Access

The cost of delivering high and regular volumes of diesel to remote off-grid locations was predicted to be exceptionally high. Furthermore, many mountainous locations are inaccessible to large vehicles carrying heavy loads during the rainy season.

Weather

The weather generally offers fair winds during the rainy season when solar radiation is lower, and higher solar radiation outside the rainy season when there is less wind. However, the mountainous terrain requires some sites to be positioned high on mountains where thick cloud can disrupt solar radiation for extended periods and where wind is subject to localised dynamics.

Historic Data

There is only a limited amount of historic meteorological data available in Vanuatu with which to perform initial green power site dimensioning. Often this comes from satellite data and in remote areas such as Vanuatu, contains generic data relating to 100km wide square sections.

Implementation Solution

Selection of the green powered solutions for the twenty-four off-grid sites was based upon an initial evaluation of commercial viability, site logistics and the green power viability of each specific site. The overriding case for green power solutions for these sites was based on commercial and operational advantage, with environmental benefits being a secondary advantage. Although the capital cost of deploying the green power solutions was higher than the diesel generators, they have a fifteen to twenty-five year life span and the operating costs are substantially lower without compromising the quality of power availability.

Green power solutions require an integrated platform of photovoltaic arrays, wind turbines, batteries and power controllers which are normally supported by a GPRS, GSM or remote monitoring package. In deployments such as Vanuatu where there are significant variances between individual sites, no one standard solution can be deployed on a volume scale. Variances included differing power load requirements as well as local micro-climate on account of specific terrain.

4 The full GSMA report on the Digicel Vanuatu project is available at www.gsmworld.com/documents/digicel_vanuatu.pdf

Key Financial Viability Results

Digicel Vanuatu determined that a financial case for green power existed where a 30% or greater Internal Rate of Return (IRR) was predicted. The financial case for wind and solar in Vanuatu was developed based on existing budgetary quotes and purchase orders that had been supplied to Digicel plus additional dimensioning studies.

The chart below shows the forecast strong IRR for the Phase 1 green power sites. It clearly shows financial viability for sites with less than a 1kW load, but the viability deteriorates as the site load increases. Even medium power load sites of 1550W to 1750W are forecast at an IRR of 30%, and are therefore financially viable for Digicel.

Problems and Lessons Learned

For detailed information on the problems and lessons learned during the Digicel Vanuatu project, please see the full GSMA report at www.gsmworld.com/documents/digicel_vanuatu.pdf

Financial Viability for Digicel Vanuatu Sites

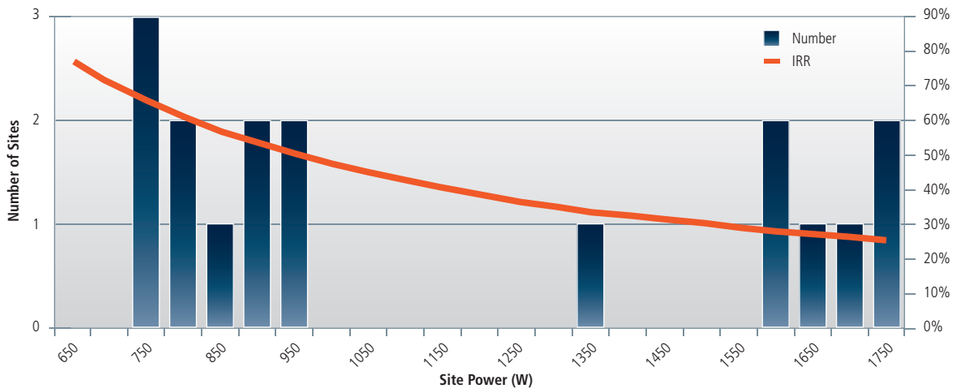


Chart shows the trend curve for IRR vs site power consumption and a histogram of the site power consumption distribution of Phase 1 (seventeen total) green power sites.

A Developed World Viewpoint – Interview with John Romano, Telstra

Danielle Pellikaan, GSM Association

Can you please give an overview of Telstra, its network and its solar activities?

Telstra provides fixed, wireless and internet services. We operate Australia's largest and fastest 3G network, but also operate 2G. At 30th June 2009 there were 10.2 million Telstra mobile service subscribers. More than 60% of these were for 3G services. We're seeing 300% growth in data over our network.

We have over 6800 base stations, 2G and 3G mixed. Two hundred of those are green base stations, all solar powered. These are all located in remote locations where connection to the electricity grid is just not possible.

Solar allows us to move into areas and provide coverage where we normally wouldn't be able to. It is however expensive – we would do more with it if it cost less.

What other 'green network' initiatives does Telstra have?

We have put a lot of effort over the last few years into making our base stations more efficient. They all have free air cooling and we use special insulation in our huts. Also the temperature levels have been raised to reduce the need for cooling. We do install air conditioners in the huts, but they are only operative at high temperatures, so are rarely used any more.

The impact of building efficiency into our base stations has been a reduction in electricity usage of about 25%. Furthermore, we're installing remote radio heads which are all passively cooled. Power consumption on those is about 30% less than standard equipment. This is now a standard for installation on rooftops in Australia. We did a roll-out of more than 2000 remote radio heads in Hong Kong with CSL of which Telstra is a majority owner.

What are the similarities/differences in your solar strategy for developed and developing world scenario?

China and India for example, are similar to Australia – they are big and have a dispersed population and a lot of sunshine. Even though the ARPU is higher in Australia, a community of a hundred people is not enough to put up a site. India's and China's ARPU may be low, but their volume is high.

Their infrastructure however is not great in terms of roads but also electricity, especially outside the urban areas, but they have got the same issues; how to cover the remote locations in a cost effective way?

What is your strategy for the future?

Our strategy is threefold:

1. To increase efficiency by reducing power loads because at low loads solar power becomes more viable. We are also installing new software that switches off the telecoms equipment when it's not in use, such as at night
2. Secondly we are installing modern telecoms equipment that is more energy efficient
3. Lastly we are looking at alternative energy sources – especially solar, and hoping that by lowering the site loads and reducing the cost of solar equipment more sites will be solar powered.

Do you see Telstra's strategy as the future for other developed countries?

The energy efficiency approaches, such as use of free air-cooling, payback time is less than two years, so this is interesting for all countries. This approach is really simple and not costly – if you knew you were going to make profit within two years, through energy cost savings, you would do it. It makes good business sense.

At low site loads and if the cost of solar goes down, I am sure there will be higher take-up, especially in developing countries. In all those countries that have a lot of remote locations, this would open up a whole new world. It opens up opportunities to expand in a smart way.

Future Trends

Bharti Airtel Addresses Energy Efficiency to Tackle a US$500 Million Problem

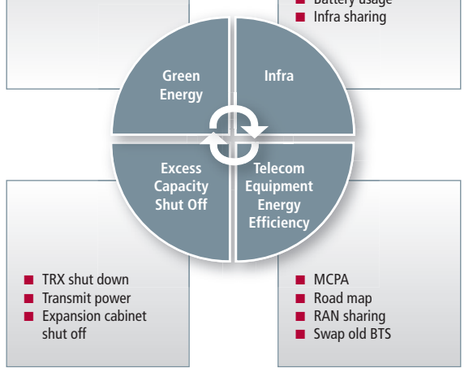
Randeep Sekhon, Bharti Airtel

In an era of diminishing returns on capital invested, operators across the world are reviewing their costs. For a mobile operator, network OPEX represents a significant portion of its overall operating cost, and energy expenditure in turn represents a significant portion of network OPEX – 40% in the case of Bharti-Airtel.

Bharti-Airtel, the market-leader in India, operates 98,000 base stations and has an annual energy expenditure of US$500 million. It has made significant efforts to analyse and reduce the energy costs of its network by 6%-7% since 2008.

There are four main areas across which Bharti-Airtel has concentrated efforts to improve energy efficiency – green energy, infrastructure, telecom equipment and excess capacity shut off.

Bharti-Airtel's Energy Efficient Base Station Initiatives:



*Old BTS – Old generation & high power consumption BTS
Source: Bharti-Airtel

Green Energy

As green energy is the focus of the majority of this publication, this article will focus on the other three areas that have been identified by Bharti-Airtel.

Infrastructure

A significant portion of the site load for a base station is used to power the infrastructure of the site – for example, lighting and cooling – instead of the telecommunications equipment. Active cooling, through the use of air conditioners can be equivalent to 40% of site load. Reduction of this cooling load should be an operator's priority 'quick-win' to reduce the energy consumption of the site.

Modern telecommunications equipment can operate at 45ºC. By raising the operating temperature of its shelters, through removal or reduction of active cooling, Bharti-Airtel has reduced the power load of each site by 5%, without any impact on equipment performance.

Lead-acid batteries – commonly used for backup power – are more problematic than telecommunications equipment and suffer from lifespan degradation if operated at temperatures of over 25ºC. Some sites therefore still require active cooling. By using compact outdoor shelters, the volume of cooled air surrounding the battery bank is minimised, and active cooling power requirements are significantly reduced. Bharti-Airtel has some outdoor sites operating with a total site load of 500W to 1.5 kW, which subsequently ensures the site load is suitable for alternative energy technology.

An Outdoor Shelter Housing the Battery Bank

Telecommunications Equipment Energy Efficiency

One of the most effective ways to improve the energy efficiency of telecommunications equipment is to use remote radio head technology. This technology involves positioning the radio aspects of the base station – including the transceiver and power amplifier – close to where the antenna is mounted, which is typically at the top of the tower. This technology can reduce the power loss incurred when the signal is transmitted from the bottom of the tower by a long feeder cable (>50m for some towers) to the antenna.

Bharti-Airtel has implemented remote radio head technology on more than 8,000 towers and has yielded a 15%-20% energy saving for those sites.

Excess Capacity Shut Off

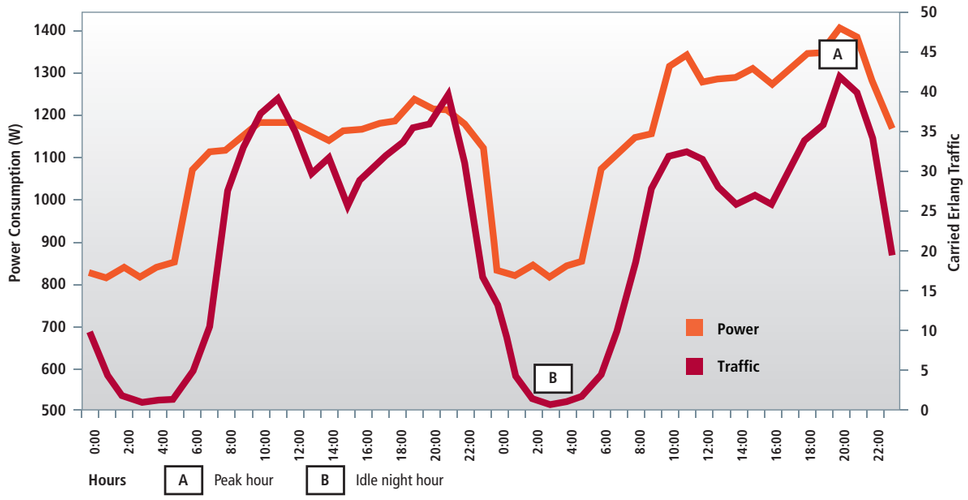
Mobile networks are designed for peak traffic requirements to prevent degradation to quality of service at peak times. Network peak hours usually last for between six to eight hours a day. During the remaining part of the day and more significantly, during the eight to ten hours of night time, the networks are mostly idle.

To optimise power consumption telecoms vendors have recently developed hardware and software functionality that automatically switches off excess capacity when it is not needed, i.e. during the night. This can have a dramatic effect on power requirements through the day/night cycle as highlighted in the field trial results below.

Summary

There are many areas in which mobile operators can focus their efforts to drive OPEX reductions, and long term investment needs to be made to save on energy bills. However, challenges relating to technological understanding, business case definition, access to technology and legacy upgrade cycles need to be addressed before significant progress can be made. The GSMA Green Power for Mobile Working Group provides an effective platform for mobile operators, OEMs and niche solutions providers to share learning and develop best practices.

Bharti-Airtel Trial Results of Excess Capacity Shut Off Technology
(24 Hrs Carried Erlang Traffic vs. Power Consumption)



Source: Bharti-Airtel field trial

Off-grid Charging Solutions for Mobile Phones: A US$2.3 Billion Market Opportunity

Danielle Pellikaan, GSM Association

Introduction

There are more than four billion mobile connections worldwide. Over the coming years, many more millions of people at the base of the economic pyramid are expected to acquire mobile phones, greatly benefiting their lives, business activities and access to information. However, most of these new subscribers will not have direct access to electricity. This makes it more challenging and expensive for them to charge their mobile phone, not to mention to power the myriad of other daily functions for which electricity is important such as lighting, cooking and refrigeration.

The GSMA Development Fund believes that the issue of electrification is extremely relevant to mobile operators. The innovative nature of base of the pyramid markets has spawned creative solutions to the charging problem – primarily via entrepreneurs who provide electricity on a per-charge basis, powered either by their own access to the grid or through the use of portable car batteries. But now is the time for the mobile industry – including operators, handset vendors, and renewable energy providers – to better understand and address the challenge of electrification. Excitingly, it seems likely that renewable energy devices, such as photovoltaic chargers, will provide a practical and environmentally friendly fix. These solutions will therefore be beneficial to low income consumers, the planet and the bottom line.

The Market Opportunity

There are 1.6 billion people in the world without access to grid electricity. The GSMA and Wireless Intelligence research estimates suggest that 30% of those people have a mobile phone connection. This means nearly 500 million people currently have access to a mobile phone but do not have their own means of charging it.

When mobile phones are switched off due to lack of power, it can result in missed calls and reduced airtime revenues for mobile operators. Recent field trials suggest that when off-grid subscribers are provided with mobile charging solutions, usage and revenues (measured as Average Revenue per User per month – or ARPU) increases by at least 10%[5].

> "All of Digicel's operating territories lend themselves to solar technology given their location in relation to the equator. We have seen ARPU lift in the 10-14% range by assessing airtime usage before and after customers were presented with a solar charger." **Tom Bryant,** Digicel

Then what does this mean for operators? Even when applying conservative estimates about the increase of ARPU resulting from charging solutions (10%), as well as the average airtime spending of the average off-grid customer (US$4 per month[6]), the implication of Digicel's case study suggests a formidable commercial opportunity for mobile operators. Were the immediately addressable market of 500 million consumers provided with charging solutions, the expected increase in direct revenues would total US$2.3 billion per year.

Market Momentum

GSMA research has shown that the market is gathering momentum: 60% of mobile operators surveyed already have off-grid charging initiatives or are investigating off-grid charging solutions.

Two good examples of operators venturing into the field of off-grid charging solutions are Digicel and Safaricom. Digicel has given out free solar chargers to its consumers and has launched the ZTE produced solar phone in several markets. Safaricom has installed small charging docks on its base stations where people can charge their phones free of charge, and has also launched the ZTE produced solar phone. Operator examples are still few and far between however and the GSMA Development Fund is of the opinion that the opportunity can be tapped by many more operators.

5 Digicel
6 GSMA research / Wireless Intelligence

The Digicel ZTE Solar Phone, and the Safaricom Base Station Charging Dock

Considerations

When deciding on which of the many off-grid charging solutions to implement, there are four important choices to consider:

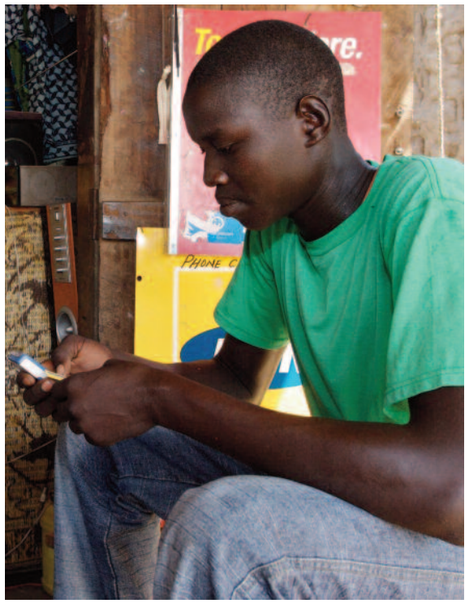
1 Who will use it?
Is the solution designed for use by an individual, or by a larger number of people?

2 Who will own it?
Will the solution be owned by a consumer, an entrepreneur, a community, a technology company, a mobile operator or an NGO?

3 What will it charge?
Will the solution charge only one phone, a few phones, or can it also charge other devices such as lights and radios?

4 Who will finance it?
Will the consumer or the entire community pay for the solution? Will the operator subsidise it, or will it be necessary to provide microfinance?

The answers to these questions have implications on the amount of people reached, the maintenance of the solution, the amount of phones charged and the cost. The GSMA report 'Charging Choices: Off-grid Charging Solutions for Mobile Phones', published in September 2009, answers these questions in depth for the various solutions that are currently on the market.



The Road Ahead

In a world in which 500 million people have mobile phones but lack access to the electricity grid, it is ever more important to develop off-grid charging solutions. Early studies and pilot projects suggest that charging solutions lead to increased airtime usage and revenue for mobile operators, as well as providing tangible social and environmental benefits.

Several possibilities exist for charging mobile phones in off-grid areas and charging solutions will vary depending upon particular market scenarios. The GSMA Development Fund expects that many more trials will take place in the coming years and looks forward to helping accelerate wide scale deployment of mobile phone charging solutions for the off-grid population. For further information email chargingchoices@gsm.org or download the full publication at
www.gsmworld.com/documents/charging_choices.

Green Power for Mobile
Bi-annual Report 2009

A Solar Strategy for the Future – An Interview with Tom Bryant, Digicel

Danielle Pellikaan, GSM Association

Can you tell us a bit about Digicel and the markets you operate in?

Digicel is now operating in 33 markets. Our most recent acquisition is the world's smallest country called Neru, with 10,000 inhabitants, in the South Pacific. But we are also present in medium size population markets, such as Haiti and Jamaica, where our customer base exceeds two million users in both countries.

The concentration of the company is in the Caribbean, Central America and now the South Pacific. More than two thirds of the countries we do business in would be characterised as developing nations by the United Nations. The majority of our users spend less than a dollar a day on their mobile telephony.

What challenges does Digicel face in these markets and how do you overcome those challenges?

By virtue of the fact that these are developing countries, access to the power grid is extremely challenging and in many of our markets between half and a third of our users have little or no reliable power. That necessitated our critical, commercial and ethical requirement and need to make a contribution to the population by seeking a manufacturer who would develop a solar powered handset.

From a base station and network viability perspective a core element of Digicel's network strategy is to have as many sites as possible that have backup power from solar panels, as opposed to diesel generators on site. Especially on the islands there is a geographical challenge in terms of remoteness of sites that makes them difficult to access. Associated with that is the unreliability and the difficulty of getting diesel to remote locations. As a result of that, Digicel is really at the forefront of solar and fuel cell technology for base stations.

Is providing charging solutions a strategic decision to gain more market share?

Providing charging solutions to our consumers is a strategic choice targeted at gaining market share. Remarkably, we are now twenty months on from the distribution of our first chargers and our competitors have still not responded to the hand-held charger we launched first, or the more recent solar powered mobile phone. It is astonishing to us that our competitors are not commercially compelled to meet us at this junction of offering green power solutions for handset charging to their customer base. We know it's now a necessity and we could never stop doing it.

Are there any other challenges you are facing with regards to base stations?

I maintain that the advances in alternate power for base stations are happening right now. Some of the best technologies are available at the moment. We are not on the brink of some huge breakthrough – the revolution is here.

What is Digicel's solar strategy?

We started distributing the RMK solar charger from the beginning of 2008 and have recently launched the Digicel/ZTE solar phone – with the Intivation step up converter technology – in a few of our markets. The Solio mono solar charger will be introduced into various markets over Q4 of 2009. We will be handing out a solar powered flashlight that can also power a mobile phone as a Christmas present to our customers this year.

What's Digicel's future solar strategy?

Solar power is a core component of Digicel's strategy going forwards. It is not some sort of public relations gesture for 2009, it is the nature of the way the company will conduct itself indefinitely.

Glossary of Terms

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

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

CAPEX - Capital Expenditure

COAI - Cellular Operators Association of India

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.

NGO - Non Governmental Organisation

OEM - Original Equipment Manufacturer

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

Green Power for Mobile
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Green Power for Mobile Resources

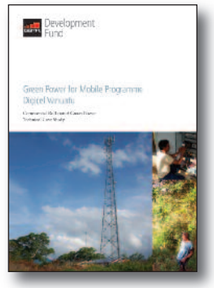
www.gsmworld.com/our-work/mobile_planet/green_power_for_mobile/resources.htm

Reports

Green Power for Mobile: Charging Choices
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.

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.

Case Studies



Commercial Roll-out of Green Power, Digicel Vanuatu (pdf)
www.gsmworld.com/documents/digicel_vanuatu.pdf
Technical case study of the commercial roll-out of green power for Digicel Vanauatu.

Wind and Solar, MTC Namibia (pdf)
www.gsmworld.com/documents/gsma_case_study_wind_solar.pdf
Trial case study; a wind and solar site trial in Namibia with MTC and Motorola.

Biofuels, IEDA Cellular, India (pdf)
www.gsmworld.com/documents/gsma_case_study_biofuels.pdf
Trial case study; two biofuel trials, one in India with IDEA Cellular and one in Nigeria with MTN.

Notes

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November 2009