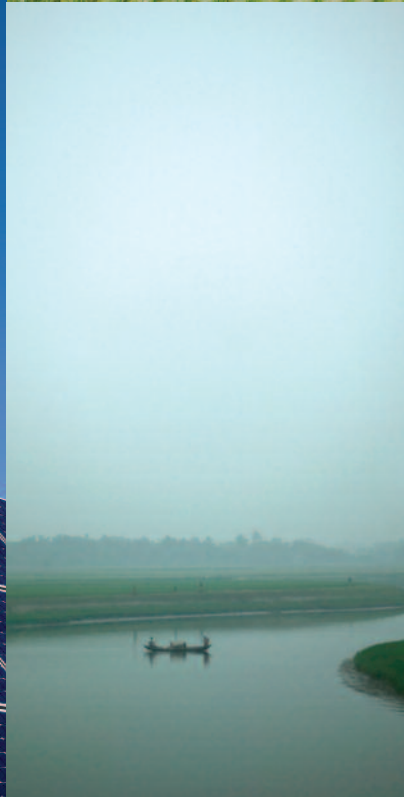
Development Fund

Green Power for Mobile: Top Ten Findings



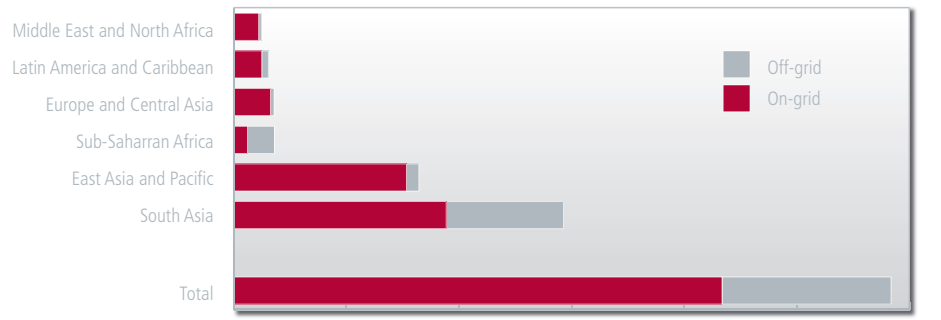
The GSMA Development Fund has initiated the Green Power for Mobile programme to catalyse the deployment of green power solutions across mobile networks. Green Power for Mobile consists of a diverse set of assets made available to mobile operators considering alternatives to conventional sources of power for base station sites. The programme has recently concluded market research through in-depth desk research and interviews with operators, green power vendors, green power systems integrators and telecommunications equipment vendors.

The results of this assessment consist of analysis of various market dynamics and projected market potential for green power solutions. The following are the top 10 central themes identified. Note that these themes are not in order of importance.

1 Off-grid locations are increasingly prevalent for mobile network sites

An estimated 75,000 new off-grid sites will be built each year in developing countries through 2012.

Annual Growth in BTS in Developing Regions 2007-2012



Source: GSMA Analysis

Connectivity to the grid presents four challenges:

- Grid connectivity is unavailable in many locations. The portion of the population targeted by current mobile network expansion is increasingly off-grid.
- Where grid power can be attained, the costs of extending the grid to power off-grid base stations can be enormous. The cost is based primarily on the distance of new infrastructure required. In some cases the operator is required to finance "standard" grid equipment (such as transformers), which remain the property of the utility. The following are some examples of high grid connection costs:

Region	Grid Connection Cost
Indonesia	Up to $30,000
Nigeria	$25,000 (plus purchase of transformer)
Sri Lanka	Up to $35,000

Source: GSMA Member Operators

- Lead times for grid extension can materially affect network planning. Examples of grid connection lead times:

Region	Grid Connection Lead Times
Bangladesh	Up to 2 years
Namibia	6-12 months

Source: GSMA Member Operators

■ Grid reliability is a concern in rural regions of developing countries. In many countries, grid reliability in urban areas is problematic as well. The following are examples of rural grid reliability issues:

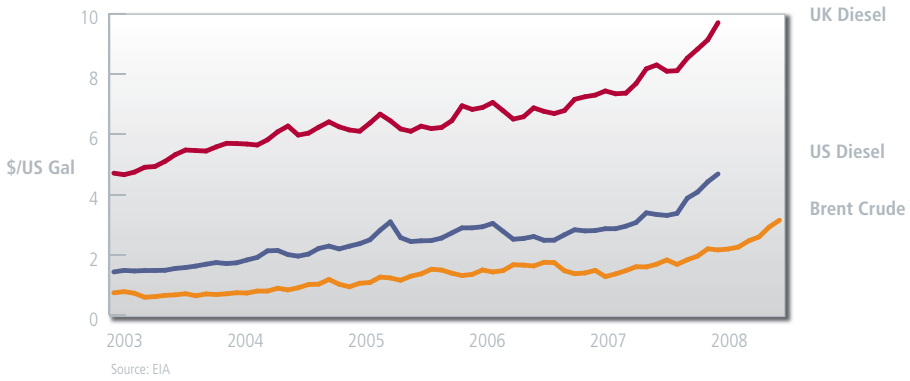
Region	Grid Uptime in Rural Locations	
Bangladesh	Urban: 4x 1hr outages / day	Rural: 2x 4hr outages / day
East Africa	Power outages 1 day / week	4 hour rolling outages
India	14 hours outage / day	
Nigeria	Available 15-25% of the time	
Pakistan	3,000 – 6,000MW capacity shortage	
Sri Lanka	Daily unpredictable outages	
Sumatra	4 hours outage / day	

Source: GSMA Member Operators

2 Off-grid and unreliable grid sites have rapidly increasing costs

Both existing and new off-grid sites, and sites in regions of unreliable grid power have experienced substantially increased costs during the last two years. The average price of diesel has risen more than 50% in many locations within the past year, and contributes to a significant portion of operating costs for operators. The sustained rise of global energy prices is a direct contributor to these costs.

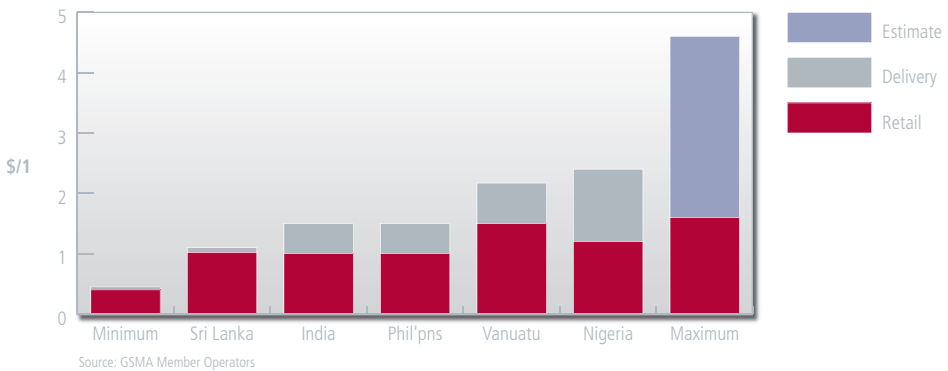
Historical Retail Diesel and Crude Prices



Source: EIA

Additionally, the cost of distribution is a significant contributor to operational costs of using diesel generators. This cost is amplified in regions with sparse, rural networks or in regions with poor transportation infrastructure.

Build Up of Delivered Diesel Price



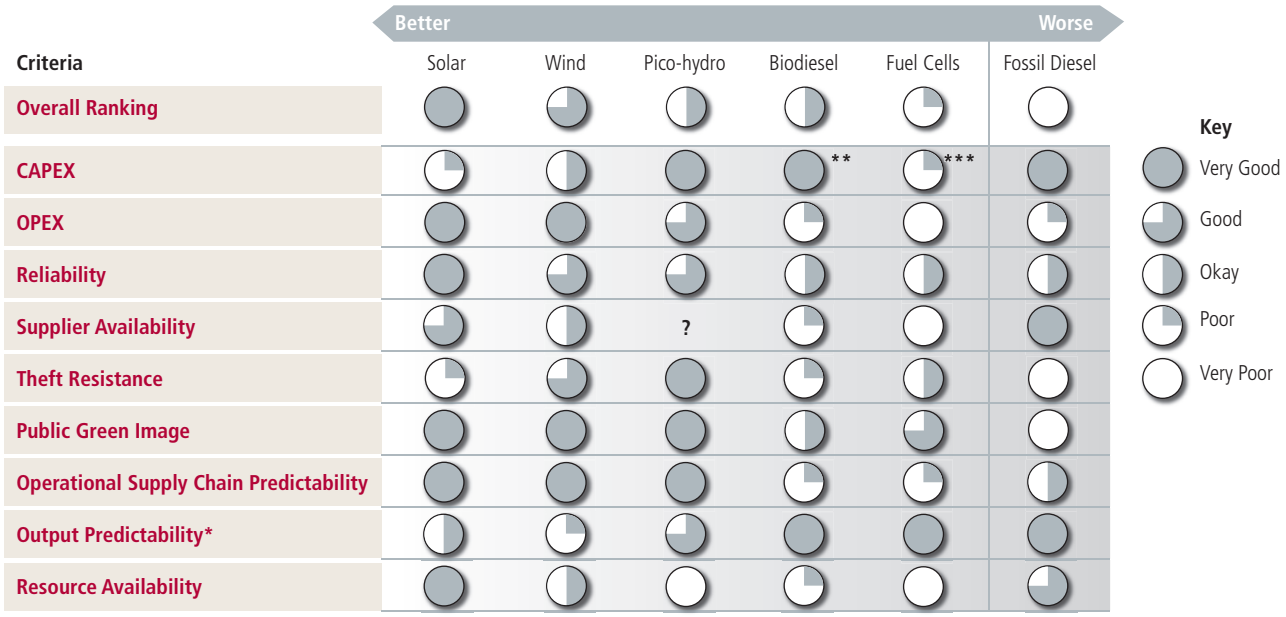
Source: GSMA Member Operators

The reliability of diesel distribution is an incremental constraint to the cost of distribution. Several operators (e.g. Nigeria, Tanzania) have cited routine losses of 10% of total diesel supplies to theft or adulteration and even higher percentages in certain regions. Fuel loss further amplifies high commercial fuel costs.

3 Solar and wind power are viable today and other solutions may become suitable in the future

There are three primary factors that determine technical and financial viability of green power deployments for mobile network sites:

- The regional cost of distributed diesel – For example green power is not attractive in Venezuela where the cost of diesel is $0.02/L, however is compelling in regions where the cost is higher (in excess of $2.00/L in some African countries).
- Solar and wind conditions at the site - Insolation (strength of solar radiation) as well as wind strength vary widely around the world. Site selections must consider the availability and consistency of green power sources.
- Load requirement of the site - The financial and technical viability of green power degrades at higher load requirements.



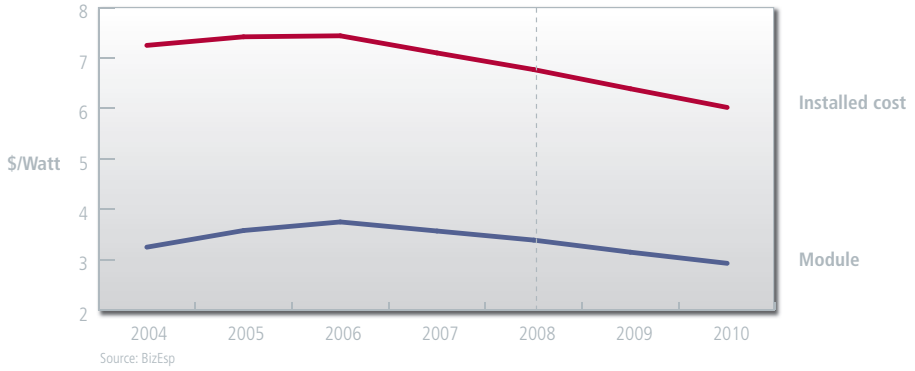
Source: GSMA Analysis

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

Solar and wind technologies (including solar and wind hybrids) are currently the most attractive technologies for powering base station sites.

Due to the abundance of solar resource, commoditisation of solar modules, ease of planning and low running costs, solar is a favoured choice for green power solutions in many regions for small load sites (<2kW). However, CAPEX scales proportionately with load and solar solutions are less economically attractive for larger sites. Costs of solar solutions are projected to decrease further as market entry by silicon (primary raw material for solar modules) suppliers is projected to substantially increase silicon supplies within the next 2 years.

Trend in Global Solar Module Prices



At standard base station loads, the installed cost of energy from wind is cheaper than for an equivalent solar system due to a lower basic equipment cost. The cost of small scale wind solutions is approximately $0.10-$0.11 per kWh, and projected by suppliers to reach $0.07 within 5 years (American Wind Energy Association – "Small Wind Turbine Global Market Study 2007"). However, due to variability in wind speeds across the globe, wind-only solutions are likely to be restricted to locations with abundant wind resource such as coastal and mountainous regions.

Hybrid solutions deliver the benefits of both wind and solar technologies and will be more common than wind-only solutions.

Other niche technologies will continue to develop including:

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 other applications such as rural electrification and has the lowest CAPEX of all solutions. The limited number of appropriate locations will limit mass deployment.

Biofuels

The application of biofuel to telecommunications must be treated as a case-by-case prospect rather than a universal alternative. The primary consideration will be local access to a regional supply of biofuel. The impact of biodiesel production upon regional agriculture should also be evaluated. Biofuel application has increased appeal in regions not competitive with food supplies (semi-arid crops such as jatropha).

Fuel cells

Fuel cells provide an alternate battery solution to sites in unreliable grid power locations. They are primarily considered for limited power load requirements as a backup power source. Fuel cells are a developing technology with currently limited proven commercial application to base station sites. However there is substantial investment in this space by several development organisations. Suppliers have forecast a cost reduction of 30% by 2010.

4 Capital expenditure is high for green power but at low loads the payback period is short

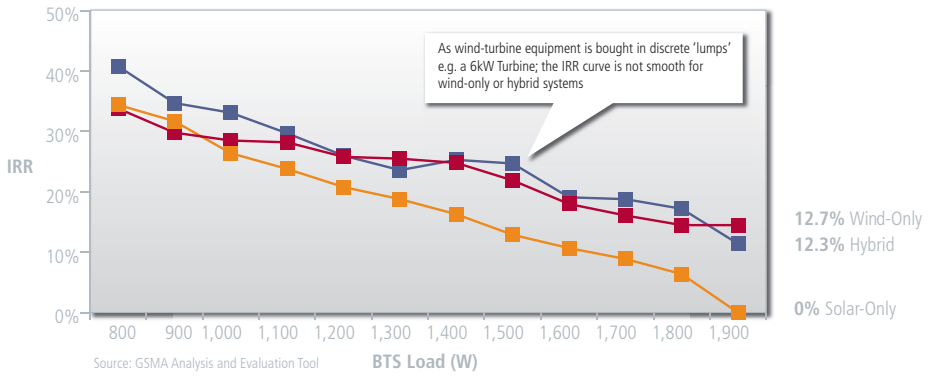
Mobile networks in regions without access or unreliable access to conventional grid power typically rely on diesel generators as either a primary power source or backup power source. Diesel generators offer a lower and standardised initial capital cost. However fuel, maintenance and replacement costs are high and extremely vulnerable to market conditions.

In regions with unreliable grid, green power solutions primarily benefit operators by providing coverage during grid outage. Secondarily, use of grid power is offset by green power, reducing operational costs.

In off-grid regions green power solutions can replace the reliance on diesel generators, eliminating capital (generator) and operational (fuel) costs in some cases. Higher power load sites can be supplemented by green power solutions, reducing the operational (fuel) costs.

The deployment of green power, provides on average (solutions are extremely scenario-sensitive), compelling returns on investment, particularly at lower loads.

Load Effect on IRR by Technology



Although there is broad acknowledgement that green power sites may be operationally cheaper than diesel generator powered sites, operators work within allocated funding for network expansion and are motivated by market competition to choose greater expansion (to benefit from early mover advantage) rather than optimised expansion. Operators manage the business by configuring networks for optimal coverage and immediate commercial returns. Power requirements are often a secondary consideration and are not a prevalent factor in determining site locations for mobile network sites. In a scenario with a cost of green power approximately 50% greater than conventional power and an operator allocation of funds for 600 new sites, only 400 green sites could be deployed with the same amount of funds.

Operators facing capital limitations may increase investment in green power solutions if capital financing options were available. Green Power for Mobile is working with financial institutions to advance potential financial vehicles to support green power deployment in mobile networks.

5 Power provision is a non-core activity for operators that presents an additional challenge

Powering base stations is a "cost of doing business" for operators and is not intuitively a part of network design. As networks have expanded into regions without direct or reliable access to grid power, operators have been forced to become increasingly involved in the business of powering network sites. Contracts are established and maintained with power equipment suppliers (typically generators), fuel suppliers and distributors, and equipment service and maintenance providers. The resultant cost of development of establishing a capability to manage energy portfolios is a deviation away from the core business.

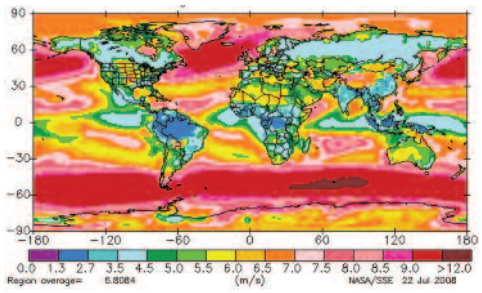
Utilising green power solutions adds a new layer of complexity to an operator's management of their energy portfolio. Operators are investing to various degrees in building internal expertise in green power solutions. Some are buying directly from green power suppliers and specifying, installing and operating the solutions in house, whilst others are seeking an outsourced turnkey solution.

6 Green power feasibility assessments are complex and scenario-based

Assessment of green power for specific base station sites is based upon a number of meteorological and geographical factors. Meteorological conditions and seasonality strongly influence the optimal configuration, and anticipated performance of a green solution. In combination with this localised topography and vegetation would impact the selected configuration.

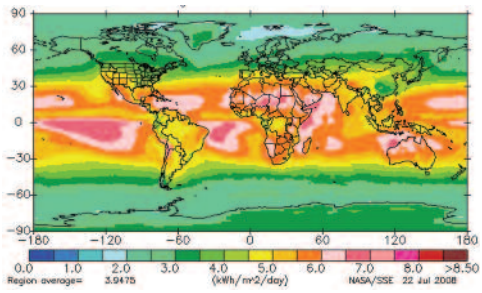
For a solar, wind or hybrid solution, data on insolation and wind strength is used in conjunction with diesel cost information to assess the selected region for viability of a green power solution.

Wind Resources



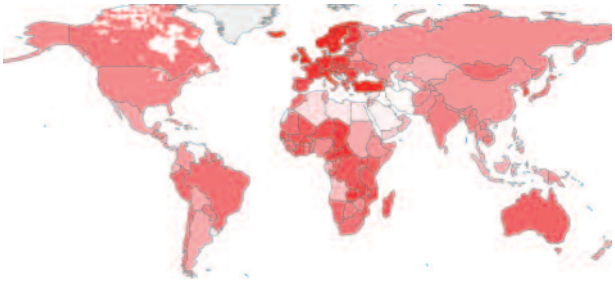
Source: NREL

Solar Resources



Source: NREL

Diesel Price+



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

Although assessment is complex, knowledge within the industry is evolving rapidly and Green Power for Mobile aims to consolidate these learnings. If green power is an option for powering all or part of a greenfield rollout it is strongly recommended that the operator's power expert is engaged early within the network planning process, to ensure the complexities above are understood and incorporated.

7 Energy optimisation has become a focus of mobile network technology development

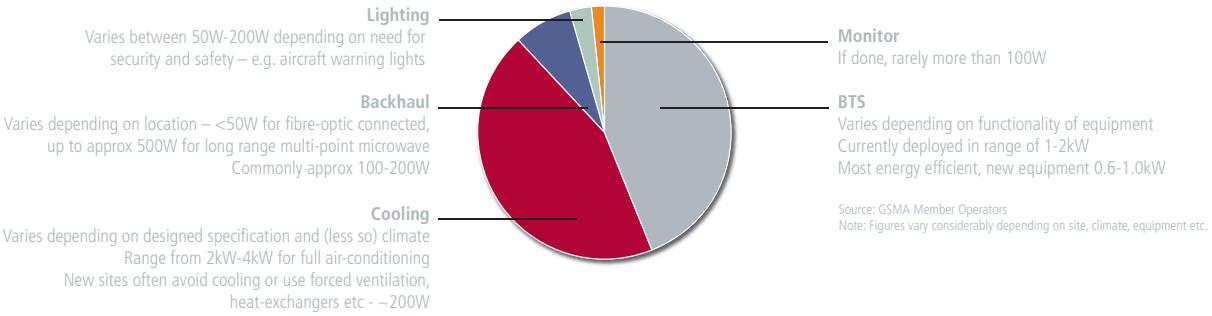
Telecommunications equipment vendors are making considerable investments in the development of lower power equipment, providing operators with the ability to reduce the cost profile of new sites and retrofitted existing sites.

Battery technology has evolved and is capable of substantially reducing reliance on diesel runtime. In some cases, unreliable grid access can be addressed by adequate battery backup for brownouts or blackouts.

Recent advances in telecommunications equipment such as remote radio heads (reduced feeder cable losses) and improved tolerance of equipment to ambient temperature from 25C to 45C may permit the reduction or in some cases complete removal of air conditioning from sites. This can result in substantial energy savings for operators. Operators can at a minimum achieve efficiency gains, and potentially reduce loads to levels commensurate with green power solutions.

The power load for a typical base station varies widely on the type of site. Additionally there are several main contributors to power load. One substantial 'non-core' requirement is cooling.

Overall Site Power Consumption



Energy efficient base station sites are integral to the viability of green power solutions as the financial and technical viability of green power degrades at higher load requirements.

8 Accurate specification is critical for green power sites

Operators typically require 100% uptime for sites. In unreliable grid regions, green solutions can provide coverage capacity during grid outages. In off-grid locations, assessment and solution specification is crucial for maintaining uptime.

Diesel generator solutions rely on only two factors:

- Working condition of generator
- Supply of diesel

Green power solutions introduce additional complexity that must be accounted for:

- Variability in renewable resource availability, such as still and cloudy days
- Battery capacity design to support site autonomy when no power is produced
- Control of power flow, capacity, and AC/DC power conversions

Green power solutions rely substantially on power controllers to optimise and maintain performance. Intelligent management is introduced through controllers to ensure optimum power management, control and protect the batteries, and to ensure availability of critical components (e.g. backhaul).

To insure against inherent variability and uncertainty, operators may choose to rely on a diesel generator as a fall-back power source for critical sites during rollout.

Due to the level of complexity in the process of specifying a site and selecting appropriate equipment, it is suggested that operators seek guidance from vendors with experience in deploying green power solutions for base station sites.

9 Nearly all operators in the developing world have green power initiatives

Of interviewed operators, 39% have trial sites, 50% have commercial green power deployments and nearly all have plans for green power. Remaining operators have expressed interest in initiating activity.

Current Green Power Deployments in Developing Countries

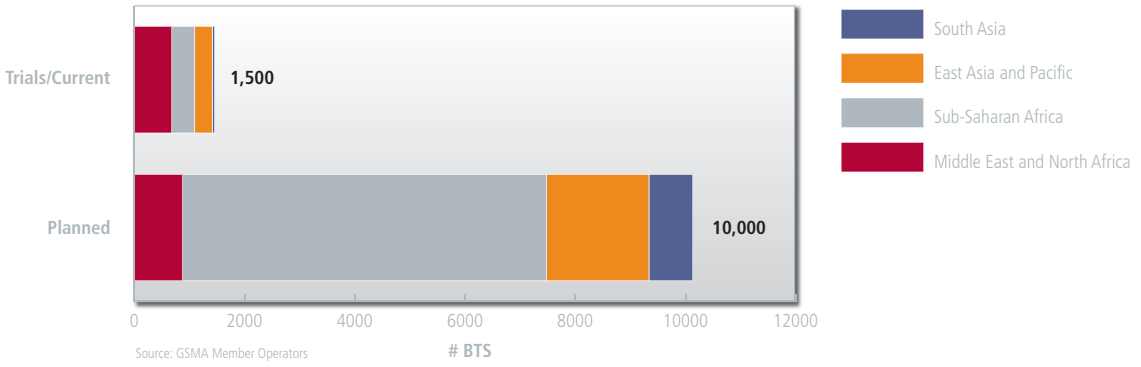
Note: Number represents number of deployments.
No number indicates single or unknown number of sites
Source: GSMA Memeber Operators

Operators are motivated by:

- Mitigation of rapidly rising energy costs across networks.
- Access to regions that lack an electricity grid and do not support regular distribution of diesel.

Many operators request project support in design and launch of trials and pilots. Additionally, most operators have stated intentions to invest in the deployment of green power on networks.

Current and Planned Green Power BTS



Source: GSMA Member Operators

Based on analysis of current market conditions, we project that a significant number of new and existing off-grid base stations can be green power sites.

	3 year Payback Period	5 year Payback Period
% off-grid BTS sites viable for green power	9%	30%
# green sites by 2012	53,000	176,000
Reduction of diesel / yr	1.1bn litres	3.5bn litres
Fuel cost savings / yr	$1.3bn	$4.2bn
CO2 emission reduction / yr	2.8M tonnes	9.6M tonnes

Source: GSMA Analysis

An interpolated 20% penetration yields a target of 118,000 green power sites by 2012. Additionally, the GSMA predicts that by 2012 up to 50% of new off-grid base stations in the developing world could be powered by renewable energy.

Green Power for Mobile is uniquely positioned to provide guidance and support in this space through the delivery of knowledge assets and methodologies, aggregation of relationships with suppliers, and community building bridging operators, green power vendors and telecommunications equipment vendors.

10 Innovation will be driven by a cohesive industry community

The GSMA seeks to work with operators, green power vendors, and telecommunications equipment vendors to impact a global reduction in industry-wide greenhouse gas emissions and increase the number of people connected today. A cohesive community with regular events and leadership will facilitate the exchange of ideas and needs to drive the use of green power solutions within the mobile industry forward.

Areas at each of GSMA Mobile Congress events will be dedicated to green power. These areas will provide a recurring opportunity for operators and vendors to present notable milestones and emerging technologies

The Green Power for Mobile Working Group

The objective of the Green Power for Mobile Operator Working Group is to consolidate industry insight and experience of green power to catalyse deployment across the industry. The Working Group consists of more than 30 operators that have indicated a commitment to Green Power for Mobile and have allocated delegates for quarterly meetings. The Working Group will provide a forum to highlight operator initiatives, address industry challenges related to Green Power for Mobile, and collectively assess available products and solutions.

Carbon Credit Trading

Additionally, the GSMA is also evaluating the potential for the industry as an aggregate to benefit from carbon credit trading. At a site level, carbon credits produced by replacing an off-grid diesel generator site with green power range from US$450-$1,500 per site, per year. Although this amount is too small to warrant the overhead of carbon trading at a site level, the economics of aggregating network credits are immense. The programme has evaluated suitable carbon trading methodologies to support trading through the UN Framework Convention on Climate Change (UNFCCC) and plans to move to a pilot phase are underway. Under consideration are options as granular as at an operator level up to aggregation at an industry level.

Conclusion

Operators all pass through a similar set of decision points in defining power portfolios and the applicability of green power solutions to their networks.

Green Power for Mobile targets the provision of these assets using a set of customised, scenario specific analytical tools to improve the quality of decisions and suitability of green power deployments. The programme provides a decision tree tool and financial viability forecasts to assist operators in raising the right questions to improve predictability and success of power decisions. While not all scenarios are suitable for green power, operators will be equipped to define network power portfolios appropriately and be better positioned to identify and act on opportunities to deploy green power reliably and productively. Operators will be able to realise tangible added economic, environmental and social benefits within mobile networks.

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