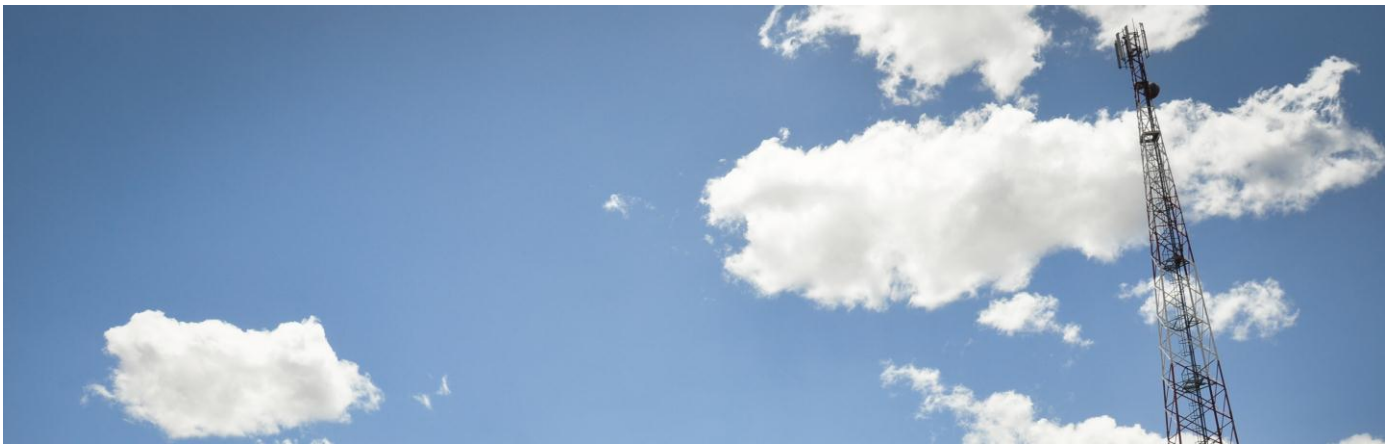
IFC International Finance Corporation World Bank Group

GSMA Green Power for Mobile

In partnership with the Netherlands



Ucell – Uzbekistan – Feasibility Study

Uzbekistan is one the only two doubly landlocked countries in the world. Uzbekistan is the most populated country in the Central Asia having a population of over 28 million with more than 60% living in densely populated rural communities and ranks 7th in the world in terms of unemployment rate at 1%.[1] Tashkent is Uzbekistan's capital and largest city. Uzbekistan's area is 447,400 km2 (172,741 sq. mi). The GDP per capita is US$3,300.

Introduction

Background

Uzbekistan's economy has demonstrated a growth of over 8% starting mid-2000's fuelled by increase in international commodity prices of its key export commodities including copper, gold, natural gas and cotton. Natural gas exports accounted for about 40% of foreign exchange earnings in 2009. Uzbekistan is the 2nd largest exporter and fifth largest producer of cotton.[2]

Uzbekistan is on of largest Central Asian countries and only country bordering the other four - Kazakhstan and Aral Sea in the northwest, Turkmenistan in the southwest, Tajikistan to the southeast and Kyrgyzstan in the northeast. Most of the country is a dry land with only 11% of the land intensely cultivated in irrigated river valleys. The climate of Uzbekistan is continental with average extremes of 40 ^{0}C and -23 ^{0}C in summer and winter respectively.[3]

Operator: Ucell

Ucell was established in 1996 as COSCOM LLC as a joint venture between MCT Telecom Corp (a major stake holder) and a local partner. In 2007, COSCOM LLC was acquired by TeliaSonera group, one of the leading European players in the telecommunications industry with operations across 18 countries.

[1] CIA World Fact Book

[2] Uzbekistan Country Partnership Strategy 2012-2015 (World Bank)

[3] Wikipedia

Ucell part of TeliaSonera group, started its network modernization in 2008 with the aim of launching 3G and associated new services for the subscribers. The company has aggressively focused on expansion of network coverage in order to enable cellular coverage to the most remote districts of the country.

Ucell is the second largest mobile operator by subscriber numbers with a connections base of 7.8 million.

Overall Context

Telecoms Industry - Uzbekistan

Uzbekistan's telecommunication market is dominated by 3 major GSM cellular players including Ucell, MTS and Beeline. The state owned Uzbek-Telecom controls the fixed line and fiber backbone infrastructure across the country and also operates mobile services under UzMobile a major CDMA operator.

The total mobile subscribers count stands at 24.8 million as on Q1 2012. MTS leads in terms of number of subscribers at 9.5 million followed by Ucell and Beeline respectively with 7.8 and 7.3 million subscribers. The yearly growth rate in mobile connections for Uzbekistan is around 15% at penetration levels of just below 90% as on Q1 2012.[4]

Power Supply Scenario - Uzbekistan

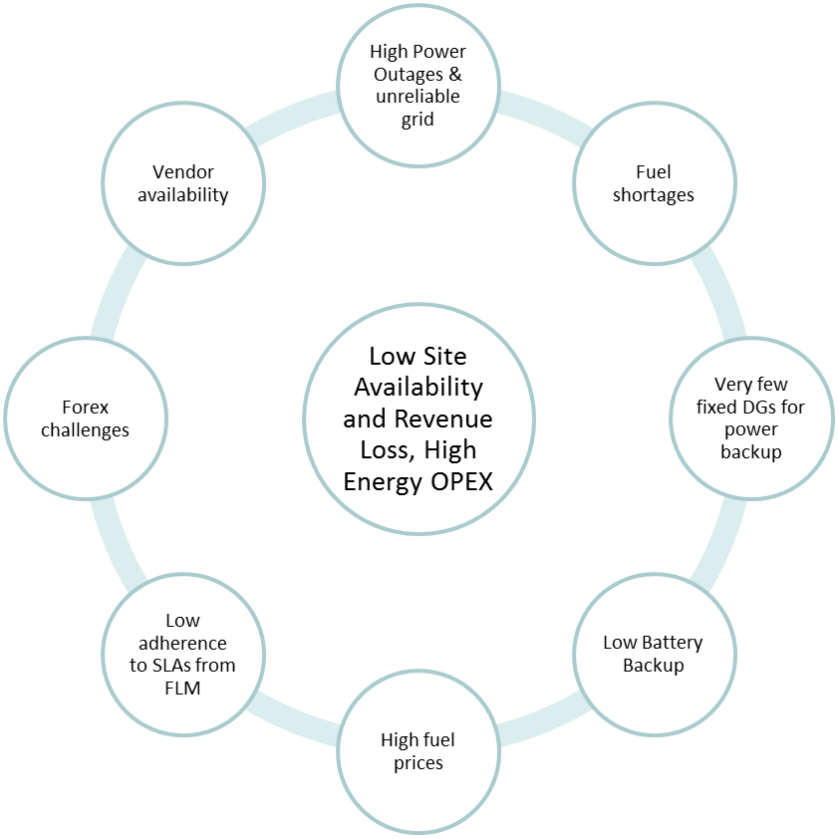
The power supply scenario in Uzbekistan is characterized by frequent and long hours of power outages throughout the year and more severe during winter period. The power outages range from 5 hours a day to more than 12 hours a day in some the regions. The power outages are more severe during winter period with power cuts lasting for almost entire day in some regions of the country.[5]

State owned UzbekEnergo is the sole company responsible for generation, transmission and distribution of electricity in the country. Uzbekistan is the hub of Central Asia's power network constituting to around 50% of the total electricity production in the region. However, Uzbekistan faces a severe infrastructure modernization challenge to reduce inefficiencies across the value chain including generation, transmission and distribution by adopting modern technology.

[4] GSMA, Wireless Intelligence
[5] Field Operations Data - Ucell

Operator Challenges – Ucell

Ucell faces major operational challenge to power the entire network of sites spread across 13 operating regions. The overall context of Ucell's network operations and associated challenges is presented below.



The challenges faced need to be addressed through strategic long term initiatives and adopting new alternative options for reliably powering the network.

- Need for alternative energy models to improve site availability and thereby remove revenue losses
- Need for improved energy monitoring and site control mechanism for improved efficiency and reduced OPEX
- Improve O&M models with strict SLAs (Service Level Agreements/KPIs)
- Develop more vendor choices and address FOREX challenges for importing equipment.

Challenges during Feasibility Study

A comprehensive green power feasibility analysis on the entire network of telecom sites will require extensive data about the network. In addition to the technical data on site configuration and power requirements, other specific details about each site including geography, accessibility, logistics and renewable energy resources is critical to the analysis.

GPM has faced major challenges during the initial phase of the study which includes data collection and validation. GPM has gone through several iterations of data-collection and validation steps to make sure that the analysis performed on accurate network data.

Lack of reliable information about power supply scenario and duration of power cuts for the entire network of sites posed a major challenge for carrying out green power solution design and analysis. GPM has gone through alternative approach to estimating the power outage scenario from the actual monthly energy bills along with other reliable operational information available.

Feasibility Study & Approach

The feasibility study has carried out according to GSMA Green Power for Mobile methodology involving detailed data collection, data analysis, model design, business case development, implementation prioritization and financial analysis followed by recommendations.

Network & Data Analysis

GPM has collected data for the entire network of 2448 sites in Ucell's network to carry out green power feasibility analysis. The data was collected extensively to understand overall network characteristics including power infrastructure, geography, accessibility infrastructure, environment, logistics and operational parameters, and later, validated through several iterations.

Ucell has a network of total 2448 base station sites and transmission sites across the country. All the sites are connected to the commercial grid. However, grid power outages are very common and severe during winter period. Therefore, Ucell relies heavily on fixed diesel generators and mobile generators running on benzene fuel.

Looking at the grid power outage scenario and heavy dependence on fuel/diesel generators, GPM has considered all the sites in Ucell's network for green power feasibility and analysis.

Network Analysis

Ucell's network is spread across 13 regions with region specific FLM (First Line Management) teams for site operations and maintenance. The capital city Tashkent has the highest number of sites constituting about ¼ of the sites and has better commercial power supply scenario compared to other regions.

Out of the 2448 sites in the network, 709 are indoor sites and the remaining sites are out door sites. Ucell's network has only 218 fixed diesel generators and remaining sites are supported by 216 mobile generators across operating regions. There are 1187 hub/critical sites in the network, however only 187 of them have fixed diesel generators.

Ucell has very poor network availability statistics compared to industry standards. This can be attributed to highly unreliable commercial power supply scenario and very few number of fixed diesel generators. The average overall network availability is 90% and it reduces to 82% during winter period during which there are severe power cuts and acute fuel shortages. This leads to revenue forgone and underutilization of installed network capacities.

In five of the operating regions, more than 45% of the sites in each region have uptime of less than 90%. In Karshi region 91% of the sites are less than 90% available.

The overall daily power requirement for a network of 2448 sites is 6,093 kWh of which around 41% is for powering air-conditioners at 709 indoors sites. The average site load is 2.49 kW of which telecom equipment load is 2.04 kW on an average.

For 100% network uptime based on current diesel based power source, Ucell will require 26,000 litres of diesel on a daily basis to power its 2448 sites (at an overall average daily DG run of 5 hours). This will lead to a daily diesel OPEX of approx. 56,000 US$ (including the diesel logistics expenses). This amounts to an environmental impact of 70 tons of CO_2 emission on a daily basis. The current battery backup planned for a site is around 2 hours on average.

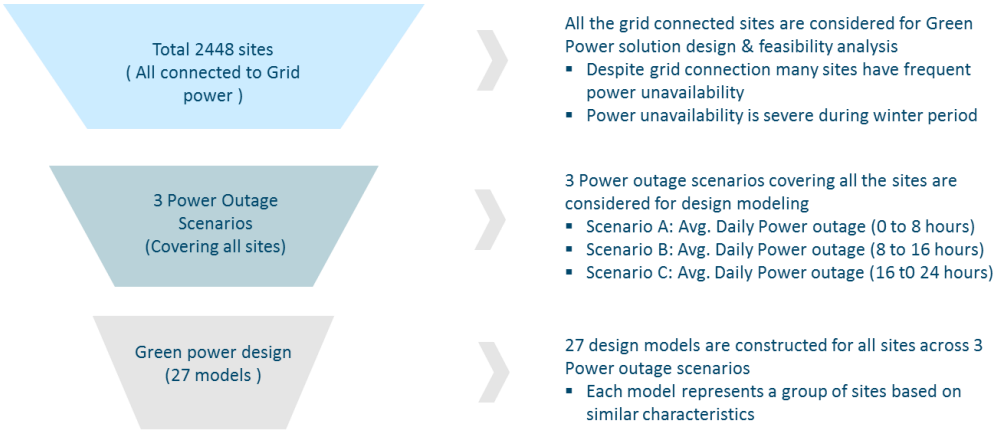
Table 1: Network Analysis

	Network	Load	Power Source
Characteristics	▪ A total of 2448 sites. All connected to commercial grid power supply ▪ 709 sites are indoor sites ▪ Only 218 fixed DGs installed and remaining sites are provided backup power through 216 mobile generators ▪ 1187 are Hub sites, of which only 187 have DG for backup power ▪ 1285 sites are green field and remaining are rooftop sites	▪ Overall average site load of 2.49 kW ‣ Average telecoms load of 2.04 kW ▪ Overall Daily power requirement of 6,093 kWh	▪ 139 sites have avg. daily power outage more than 16 hours ▪ 553 sites have avg. daily power outage more than 8 hours ▪ Daily power outage of 13,464 hours (overall network) ▪ Avg. battery backup planned 2.2 hours
Observation	Network Operations ➢ Lack of strict SLAs linked to network uptime ➢ Only less than 10% of the sites have fixed DG for backup power Network Availability ➢ Overall network availability: 90% ✓ Only 82% during winter period ➢ 35% of the sites are less than 90% available ✓ 44% during winter period ➢ 44% of the Hub sites are less than 95% available ✓ 51% during winter period ➢ Revenue loss due to low network availability is significant	➢ Telecom equipment load requirement of 54 kWh per day ➢ Air-conditioner load requirement of 37 kWh per day @60% load factor ➢ ~41% of power requirement is for Air-conditioner to maintain indoor environment	For 100% network uptime 2448 sites will require – ➢ Daily diesel OPEX of ~ US$ 56,000 ✓ Approx. 26,000 L of diesel consumed daily ✓ Daily DG run of 12,000 hours ➢ Daily CO2 emission of 70 Tons

Model Design & Solutions

Based on the overall network data analysis and current power supply scenario, GPM has considered all the 2448 sites for renewable power solution design and feasibility analysis. The overall approach to design modelling is highlighted below.

Figure 1: Design Approach



The sites are grouped in 3 groups based on power outage scenarios – Scenario A, B and C. All the sites with power outage between 0 to 8 hours per day fall in Scenario A. Similarly sites with power outage between 8 to 16 and 16 to 24 are grouped in to Scenario B and C respectively.

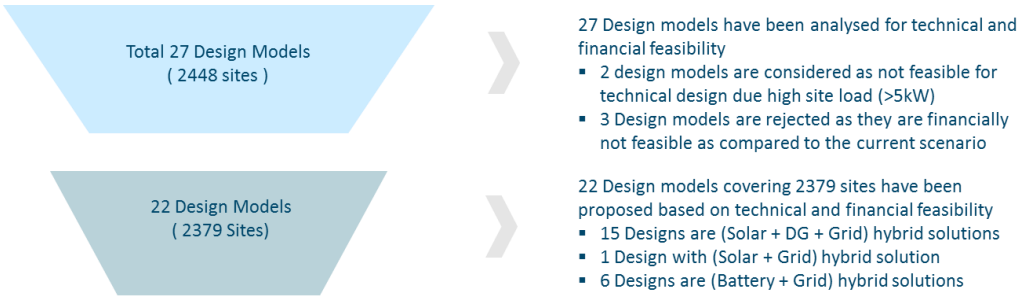
Later each scenario is regrouped based on renewable energy resources and load characteristics to give 27 design models covering 2448 sites. Each design model represents similar characteristics (renewable resource, load and power outage scenario) across modelled group of sites.

Business Case Analysis & Financial Evaluation

Business cases are developed for each design model over a 10 year business plan and compared against the existing scenario. The business cases are prepared considering actual market data and rates provided by the operator and vendors. Each business case demonstrates an overview of CAPEX, OPEX, Savings and investment metrics such as NPV and ROI.

The evaluation approach and results are presented below.

Figure 2: Analysis & Recommendations



- Each of the 27 design models is evaluated for financial feasibility through business case analysis
- 5 design models are rejected based on financial and technical feasibility analysis
- 22 design models covering 2379 sites have been proposed as most feasible solutions

Based on design analysis and comparative evaluation of different solution options, each site is recommended with the best feasible solution.

Prioritization & Investment Plan

After careful analysis, solution design and financial evaluation, the sites are grouped into implementation priorities for phased deployment. Two levels of implementation prioritization are considered.

The first level prioritization is based on 4 network characteristics including BH Traffic, Site Traffic, Site importance, Site Availability. Sites with higher traffic, high importance (3G and Hub sites) and Low availability are ordered higher in priority for implementation.

Second level prioritization is based on Power Outage scenario, Site Ownership and Site Type (GF or RT). High power outage sites, green field (GF) sites and sites owned by entities other than government are given higher priority for implementation.

Green sites with better financial indicators such as smaller payback period and higher OPEX reduction are given higher priority.

Based on the above two levels of prioritization and criteria, GPM has come up with 5 priority groups covering 2379 sites for phased implementation of recommendations. Every priority group is supported with investment plan and financial analysis.

Results & Recommendations

The recommendations of GPM fall in to two categories,

- Energy solution recommendations
- Energy efficiency recommendations

The recommendations for energy solutions is based on comprehensive technical analysis, design and evaluation of the sites through GPM feasibility study, while the energy efficiency recommendations are based on qualitative analysis through site surveys and discussions with the site engineering and operations team.

Energy Solution Recommendations

After thorough design, analysis and financial evaluation, GPM has come up with detailed solution recommendations covering 2379 sites in Ucell's network.

A total of 697 sites have been proposed for Green Power solution and 1682 sites have been recommended for Grid + battery hybrid solution. The remaining 69 sites are provided specific recommendations since they are not feasible for green power.

Solution dimensions

The solution dimensions for a few selected designs out of the 22 design models proposed are presented below along with number of sites in each design model. Each design proposes optimum solution dimension and equipment sizes to minimize the cost of energy produced and maximum utilization of the energy generated.

Table 2: Solution and Equipment Dimensions

Design Model				Proposed Solution					
No. of Sites	Model	Model Load	Site Load Range	PV	Battery	DG	Controller	Converter	Land Requirement (Sq.m)
1	C_0	725W	725W	3.6 kW	2 x 300 Ah	11 KVA	80 A	6 kW	25.92
10	C_1	1049W	956-1229W	3.6 kW	1 x 800 Ah	11 KVA	80 A	8 kW	25.92
14	C_2	1607W	1303-1690W	5.2 kW	1 x 1000 Ah	11 KVA	120 A	10 kW	37.44
46	C_3	1936W	1712-2272W	7.6 kW	1 x 1500 Ah	11 KVA	150 A	10 kW	54.72
40	C_4	2509W	2327-2759W	9.2 kW	2 x 800 Ah	11 KVA	200 A	10 kW	66.24
18	C_5	2962W	2822-3281W	11.2 kW	1 x 2000 Ah	11 KVA	250 A	12 kW	80.64
7	C_6	3425W	3306-3726W	13.2 kW	2 x 1000 Ah	11 KVA	300 A	10 kW	95.04
16	B_1	1161W	956-1292W	4.0 kW	1 x 600 Ah	11 KVA	80 A	8 kW	28.8
Continued…									
283	A_5	3010W	2804-3296W	-	1 x 800 Ah	-	-	6 kW	-
135	A_6	3525W	3306-3789W	2.4 kW	1 x 1000 Ah	-	50 A	6 kW	17.28
18	A_8	4495W	4310-4908W	6.8 kW	1 x 1000 Ah	11 KVA	150 A	10 kW	48.96

Implementation Priorities

The prioritization is performed based on the prioritization criteria explained in earlier sections. A total of 5 priority groups are derived covering 1682 sites proposed for grid + battery hybrid and 697 sites proposed for green power.

The below table shows priority-wise number of sites recommended.

Table 3: Priority Summary

Priority Group	Number of Sites	Site Availability (Avg.)		Energy contribution (Avg)			Battery Autonomy (Avg. Hrs)	DG run (Avg. Hrs/yr per site)	Diesel Savings (L/yr)	Green Power Generation (kWh/yr)	Grid Power Usage (kWh/yr)	CO2 Emission Reduction (tonnes/yr)	Payback Period (yr)
		Overall	Winter	Solar	DG	Grid							
A	289	80%	66%	18%	7%	75%	11.0	214	1,174,876	1,413,167	5,660,714	3,667	1.77
B	111	68%	56%	46%	17%	36%	17.9	463	860,190	1,134,217	904,838	2,333	1.98
C	386	84%	71%	7%	3%	91%	8.6	73	1,127,330	628,996	7,526,880	3,761	1.39
D	123	87%	78%	44%	17%	38%	15.7	491	804,078	1,180,171	1,038,112	2,272	2.05
E	1470	95%	90%	5%	2%	93%	8.2	52	3,863,826	1,864,768	28,452,844	13,668	1.44
Total	**2379**								**7,830,300**	**6,221,319**	**43,583,388**	**25,700**	

Investment plan

Each priority group is presented with detailed financial analysis to give a clear understanding of investments in proposed solutions as well as the associated financial and environmental benefits of implementing the proposed green power solutions. The calculations are based on a 10 year project lifespan.

The summary of the priority-wise investments, performance indicators and financial returns are given below.

Table 4: Priority Wise Investment Summary

Priority Financial Summary

Priority	No. of sites	CAPEX ($)	OPEX ($/yr)	OPEX Saving ($/yr)	Payback period (Yrs)	ROI (%)	IRR (%)	NPV ($)	
A	289	44,706	4,132	23,816	1.77	66%	67%	51,936	Per Site
		12,920,047	1,194,198	6,882,716					Total
B	111	75,984	5,198	40,299	1.98	52%	52%	85,403	Per Site
		8,434,279	576,949	4,473,190					Total
C	386	24,500	2,593	16,241	1.39	80%	80%	41,000	Per Site
		9,457,053	1,000,860	6,269,091					Total
D	123	72,037	5,099	36,457	2.05	50%	49%	73,966	Per Site
		8,860,595	627,160	4,484,185					Total
E	1470	22,152	2,400	14,361	1.44	79%	79%	35,933	Per Site
		32,562,705	3,528,086	21,111,255					Total
Overall	2379	30,363	2,912	18,167	1.53	75%	75%	42,974	Per Site
		72,234,679	6,927,253	43,220,437					Total

Investment Alternatives

The operator is presented with various models of funding the implementation of green power solutions on their network.

CAPEX based model

In this approach, the operator is responsible for mobilizing the investment required for

implementing the green power solutions. One option for the operator is to budget entire investment from own reserves or investment pumped in from its investors. Another option is to explore funding alternatives with financial institutions through various financial instruments including debt financing.

GPM provides access to various funding alternatives for green power implementation through IFC (International Finance Corporation). IFC has come up with various financial instruments such as debt, quasi-equity etc. to finance and promote green power implementations.

Outsourced model or OPEX based model

The outsourced model or OPEX based model provides the operators with an alternative to deploy green power solutions on their network. In this approach the operator outsources the deployment of green power solutions to third party energy service companies (ESCOs). The ESCOs will take the investment responsibility and provide the operator with energy services based on a fixed cost basis or a variable rate based on kWh consumed.

GPM can assist the operator in developing an outsourced energy model by bringing in and connecting with third party energy service providers.

Energy Efficiency Recommendations

For overall energy optimization, GPM came-up with a list of recommendations which could help Ucell to reduce their energy requirement at every site.

Below are some of the generic recommendations to optimize and reduce energy requirement and improve equipment performance.

- Implement smart energy monitoring and site equipment control mechanism to improve site operational efficiency and reduce OPEX
- Use Free Cooling Units (FCU) for indoor sites during winter period and shutdown AC Aircons. This will reduce energy requirement up to 40% during winter period.
- Use separate battery cabinet with cooler for deploying batteries
- Install VDT/intelligent controller to automate battery and DG operation.
- Implement smart power source control mechanism to intelligently select between various power sources including Renewables, Grid power, Batteries and DG
- Install Fixed Diesel Generators for all critical Hub/3G sites
- Clear KPI/SLAs to FLM for site availability. Collaborate with FLM contractors to improve site uptime and reduce revenue losses.
- Provide incentives and penalties for KPI/SLA adherence

By implementing these recommendations, Ucell will improve the energy efficiency of the network through optimized power requirements and reduce energy bills by reducing diesel consumption. This will also lead to improved site availability, higher capacity utilization and reduced revenue loss.

Summary

After a comprehensive Green Power Feasibility Study, GPM concluded that:

Green Power Solution Recommended for	697 Sites
Grid + battery hybrid recommended for	1682 Sites
No Green Power Recommendation for	69 sites
A list of generic recommendations those can save up to 40% of energy OPEX.	

The investment parameters and financial metrics for implementing the green power recommendations are provided below.

CAPEX requirement for Green Power Solution deployment	US$ 72.23 million
Current Energy OPEX + Revenue forgone for all sites	US$ 50.15 million/yr
Energy OPEX post Green Power deployment	US$ 6.93 million/yr
OPEX Savings (incl. revenue loss mitigated) by implementing Green Power	US$ 43.22 million/yr
Average Pay back period	1.53 years
Average NPV	US$ 42,974
Average ROI	75.0%
Reduction in CO2 emissions	**25,700 Tons/yr**

GSMA Green Power for Mobile Programme

Promoting Green Power to Extend Mobile beyond the Grid

Green Power for Mobile is a joint IFC and GSMA Development Fund programme which, in partnership with the Ministry of Foreign Affairs of the Netherlands, promotes the use of green power, such as solar and wind, at mobile network tower sites in remote rural areas around the world, where there is limited or no grid power.

There are about 640,000 off-grid sites globally, primarily powered by diesel generators, out of which 120,000 could be eligible for green power solutions. IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector.

GSMA is the industry association which represents the interests of nearly 800 mobile operators worldwide, serving more than 6 billion connections and 4 billion individual subscribers.

Figure 3 – Project Locations and Operator Partners:

Community Power:

Community Power aims to utilize the excess power created by base stations, by distributing it into the local community. At a minimum, operators can provide excess power to the community for small needs such as charging up mobile handsets, large household batteries and rechargeable lanterns. At a maximum, the consistent power requirement of a mobile base station provides a stable demand for a bigger investment by a third party company in a village energy system, powering the base station as well as local homes and businesses. This is currently being investigated by the GPM team in India and East Africa with the hope of extending further into the developing world upon success.

GSMA Contacts

If operators are interested in finding out more about this service or the GPM programme please enquire at the contact information given below:

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http://www.gsma.com/developmentfund/programmes/green-power-for-mobile/

About the GSM Association

The GSMA represents the interests of mobile operators worldwide. Spanning 220 countries, the GSMA unites nearly 800 of the world's mobile operators, as well as more than 200 companies in the broader mobile ecosystem, including handset makers, software companies, equipment providers, Internet companies, and media and entertainment organisations. The GSMA also produces industry-leading events such as the Mobile World Congress and Mobile Asia Congress.

About the Development Fund Serving the underserved through mobile

The GSMA Development Fund brings together our mobile operator members, the wider mobile industry and the development community to drive commercial mobile services for underserved people in emerging markets. We identify opportunities for social, economic impact and stimulate the development of scalable, life-enhancing mobile services.

For more information on the GSMA's Green Power for Mobile, please email greenpower@gsm.org

Development Fund