Green Power for Mobile

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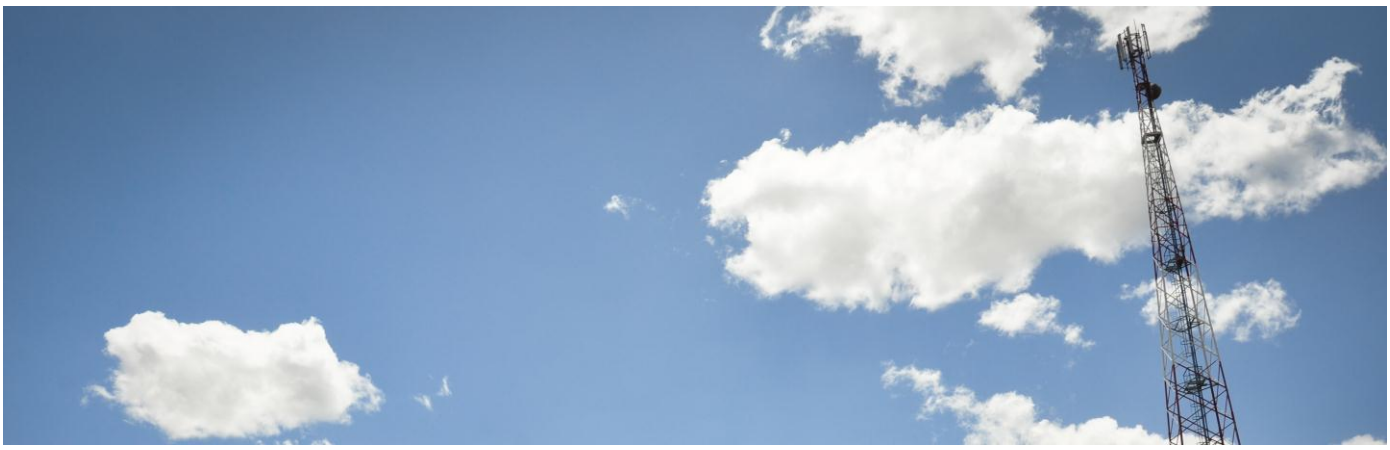


LEO (U-Com) – Burundi – Feasibility Study

Burundi is a small landlocked hilly country with considerable altitude variation from 772m to 2670m in the East Africa. It has a population of over 10.2 million, 90% of them living in rural areas[1]. The climate in Burundi is equatorial and there are two rainy seasons from February-June and from September-December; the rest of the year is dry. Despite the rainy seasons, sun radiation levels are satisfactory for green power applications throughout the year, but average wind-speed is less than 4m/s which is typically not suitable for wind turbines.

Introduction

Burundi's GDP grew around 4% annually in 2009-10[2]. Agriculture is the major activity employing more than 90% of the population and contributes about 30%[3] of the GDP. Despite improvements in economic activity post-civil war, Burundi remains one of the poorest economies in Central and East Africa with high poverty and poor infrastructure. Food, medicine, and electricity remain in short supply. Burundi has recently joined the East African Community, which should boost Burundi's regional trade ties.

LEO (U-Com)

LEO (U-Com) Burundi is the largest telecom operator in Burundi, is owned by Orascom Telecom Holding a subsidiary of Vimpelcom group. As a leading telecom operator in Burundi, LEO is providing voice services since 1993 and data services since 2007. The Company was founded in 1985 and started an MAPS-800 mobile network in Burundi in

[1] CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/by.html)
[2] CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/by.html)
[3] CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/by.html)

September 1993. The Company was subsequently awarded a GSM license in 1999 and launched a GSM services in February 2000. LEO has 1,132,000 subscribers and market share in excess of 56% (Q3 2011)[4].

Orascom Telecom is a leading international telecommunications group operating in mobile networks in high growth markets in the Middle East, Africa, Asia, Europe, North America, Russia and CIS. Orascom Telecom reached over 105 million subscribers as of June 30th, 2011.

Power Infrastructure in Burundi

Burundi is a small country with no natural gas or oil resources. The commercial power infrastructure in Burundi is very poor with access limited population. Only 2% of Burundians have access to electricity, far behind the average of 16 per cent in the rest of sub-Saharan Africa[5].

The average per capita consumption of electricity in Burundi is 23 kWh[6] per year which is one of the lowest in the world. With the support of African Development Bank, government of Burundi aims to establishment of a national power grid by 2015 and hopes to provide 40 per cent of its population with regular access to power by 2030[7].

The lack of energy sources put Burundi under extreme pressure when it comes to producing electricity. Currently Burundi provides only 92 million kWh of power on grid infrastructure which only covers approximately 15% of the total land area.[8] Bujumbura has highest electrification rate with access to approximately 50% while only 0.5% households having access in the rest of the country. Even in electrified cities the connection rate is generally less than 10%.[5] Even in areas where grid connectivity is available, power outages are common and range from 6-16 hours per day due to the limited production. The current power consumption in Burundi stands at 126 million kWh with 34 million kWh imported from neighbouring countries.[8]

Telecoms and Power infrastructure

This lack of power infrastructure and production has prevented the mobile operators in Burundi from rolling out telecoms infrastructure aggressively due to the increased operating expense which has drastically impacted the market penetration and availability of telecoms service. The market penetration of telecom services in Burundi remains low at 23.36% (Q3 2011).[9] The regulatory authority in Burundi has put pressure on network operators to expand network coverage to more rural and remote areas as a part of their license obligations.

[4] GSMA Wireless Intelligence
[5] https://energypedia.info/index.php/Burundi_Country_Situation
[6] https://energypedia.info/index.php/Burundi_Country_Situation
[7] https://energypedia.info/index.php/Burundi_Country_Situation
[8] CIA World Fact Book (http://www.indexmundi.com/burundi/electricity_production.html)
[9] GSMA Wireless Intelligence

LEO's Challenges

The major challenge for LEO is the cost of energy to run the entire network of 245 telecom sites. The current network consists of telecom sites deployed in both off-grid locations and on-grid locations. The off-grid sites completely rely on diesel generators to power the equipment. The on-grid sites have unreliable power supply from the grid with power outages ranging from 6 to 18 hours per day. Due to frequent power outages from the grid, the on-grid sites also depend on diesel generators for powering the site equipment.

In addition to the cost of diesel to run the diesel generators, most of the off grid sites are in remote locations where accessibility is a challenge. This adds to the cost of running a diesel generator by increased logistics costs due to periodic refill of diesel.

The higher cost of energy due to poor power infrastructure affects the bottom lines in a highly competitive telecoms market in Burundi. Planning for energy provision to off grid and unreliable grid sites is very critical in meeting the demand for network expansion across the country.

The challenges to power the network efficiently and cost effectively has necessitated the operator to take up comprehensive study to optimize the power requirement and to evaluate green power technologies as an alternative to power the network.

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. Collection of data is one of the major challenges encountered during the feasibility study. Data validation was also a challenge as there were discrepancies due to manual collection of data. The availability of supplier and pricing information, equipment specifications and other commercial information was another challenge faced during the feasibility study.

The availability of reliable data on wind resources would have helped for better analysis of Wind power solutions. However, lack of reliable data on renewable energy resources from the local meteorological department has led to using the generic data available from NASA global database.

Feasibility Study and 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

Complete data on base station sites is collected for the entire network and validated through several iterations. The sites have been categorized and grouped based on various site parameters.

LEO has a network of total 245 base station sites and transmission sites across the country. After overall network analysis, 231 sites are shortlisted for Green Power solutions including 107 off-grid and 124 on-grid sites.

The total operating load of the entire network is 570 kW out of which 221 kW (~40%) is air-conditioner load at 59 indoor (shelter) sites.

The on-grid locations have an average daily power outage of 9.25 hours per site and are powered by diesel generators. The diesel generators are run for 2,599 hours every day to power the entire network including on-grid and off-grid sites. This accounts for a daily diesel OPEX of over US$ 12,000 to power the entire network.

Table 1: Network Analysis

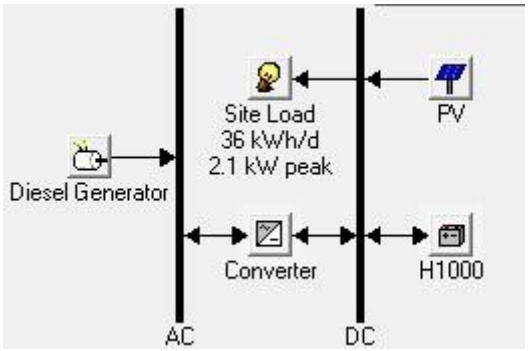
Basic Analysis	Deep Analysis		Observation	Key note
	Off Grid	On Grid		
- Total 245 sites. - 108 off-grid, 132 on-grid & rest are shared sites - 231 sites (107 off-grid & 124 on-grid) are considered for Green Power solutions - All sites are Greenfield, except one rooftop site in Bujumbura	- Average load for outdoor sites is 0.9 kW - Average load for indoor (Aircon) sites is 4.0 kW - 96 sites have less than 1.5kW, Rest sites have load of ≥2kW - 94 sites have 9KVA DG, 10 sites have 30KVA DG	- Average load for outdoor sites 1.1 kW - Average load for indoor (Aircon) sites is 6.1 kW - 93 sites have site load ≤ 3kW, Rest all sites have >3kW load - Average daily power outage 9.25 hours - 94 sites have 9KVA DG, 10 sites have 30KVA DG for backup power	- Diesel Generator runs for **2599 hours** everyday - Each Air-conditioner consumes an average of 3.32 kWh power.	- Daily OPEX to run Diesel Generator is US$ 12,710 - Daily CO_2 emission is 19.8 Tonnes

Model Design & Solution Dimensioning

Based on site data analysis, GPM found 231 sites feasible for renewable power solution design. 14 design models covering 231 sites are evaluated and dimensioned for renewable energy solutions. Out of the 14 design models, 13 are solar and one wind-solar hybrid model. Every design model is prepared for optimum technical solution and proposed based on best financial results for optimum operations. Each model provides technical dimensions for all the equipment proposed as part of the green power solution.

An example of a site design model is presented below.

Figure 1 - Site design sample



Business Cases & Financial Analysis

GPM has developed business cases for each model and evaluated for financial feasibility considering a 10 year business plan. 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.

Prioritization & Investment Plan

After careful analysis, solution design and financial evaluation, the sites are grouped into implementation priorities in order deploy the proposed solutions in a phased manner. Based on site characteristics, investment requirements and financial returns, GPM has proposed 7 implementation priorities for deploying the proposed renewable power solutions. Every priority is supported with investment plan and financial analysis.

Results and Recommendations

The recommendations of GPM fall in to two categories,

- Energy solution recommendations
- Energy efficiency recommendations

The recommendations for energy solutions is based 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 LEO team.

Energy Solution Recommendations

GPM, after a thorough analysis of the design models and business cases, has proposed renewable energy solutions for 156 sites out of which four sites are proposed for solar-wind hybrid solution and rest are proposed for solar solution deployment. Remaining 75 sites out of the 231 sites modelled are recommended with battery cycling solution combined with grid power as primary source.

The energy solutions are designed based on precise site load characteristics and are optimized for best financial indicators reducing the cost of energy and dependence on diesel generators for powering the network. The technical parameters for deployment are also considered while recommending the energy solutions especially the space requirement for solar photovoltaic installations.

Solution dimensions

Each design proposes optimum solution dimension and equipment sizes to minimize the cost of energy produced and maximum utilization of the energy generated. The solution dimensioning for all the design models is presented below.

Table 2: Solution and Equipment dimensions

	Proposed Solution Dimensioning					
Model	PV (kW)	Wind (kW)	Battery OPzS (Ah)	DG (kVA)	Controller (Amp)	Converter (kW)
Offgrid_Model_0	1.44 KW	-	1 x 600 Ah	-	60 A	2 KW
Offgrid_Model_1	6.24 KW	-	1 x 1000 Ah	9 KVA	150 A	8 KW
Offgrid_Model_2	7.2 KW	-	1 x 1000 Ah	9 KVA	150 A	8 KW
Offgrid_Model_3	11.52 KW	-	1 x 1500 Ah	9 KVA	240 A	10 KW
Ongrid_ID1	-	-	1 x 1500 Ah	-	-	6 KW
Ongrid_ID2	4.32 KW	-	1 x 1500 Ah	-	80 A	6 KW
Ongrid_ID3	6.72 KW	-	1 x 2000 Ah	-	140 A	8 KW
Ongrid_ID4	8.16 KW	-	1 x 2000 Ah	-	180 A	12 KW
Ongrid_ID5	-	-	1 x 3000 Ah	-	-	12 KW
Ongrid_OD1	-	-	1 x 600 Ah	-	-	4 KW
Ongrid_OD2	-	-	1 x 1000 Ah	-	-	6 KW
Ongrid_OD3	0.72 KW	-	1 x 1000 Ah	-	10A	4 KW
Ongrid_OD4	3.36 KW	-	1 x 1500 Ah	-	80 A	6 KW
H_Offgrid_Model_2	8.4 KW	3.0 KW	1 x 1500 Ah	9 KVA	150 A	10 KW

The solution recommendations for all the on-grid sites enable the operator to completely remove the diesel generator from the sites. However, GPM recommends keeping the existing diesel generators as auxiliary backup for all the solutions where the use of diesel generator is completely reduced.

Based on the proposed equipment dimensions, each design model is evaluated for commercial viability by developing business cases for each design model. The business case incorporates all the commercial parameters associated with the solution including CAPEX, OPEX and other commercial items. Based on the technical parameters and commercial inputs, GPM has prepared the financial model over a 10 year planning period and demonstrated the benefits as compared to the existing scenario. The business case and financial analysis provide an overview of CAPEX, OPEX, Savings and investment metrics such as NPV and ROI for each design model.

Green Power Solution & Excess Electricity

Green power solutions for off-grid locations can be designed to produce excess electricity which can be provided to the local community for small needs such as charging the handsets, batteries and lights.

The following table shows the excess electricity produced in each of the proposed designs for off-grid sites.

Table 3: Green Power Solution & Excess Electricity

Model	PV (kW)	Wind (kW)	Battery OPzS (Ah)	DG (kVA)	Battery Autonomy	Excess Electricity
Offgrid_Model_0	1.44 KW	-	1 x 600 Ah	-	101.0	16.40%
Offgrid_Model_1	6.24 KW	-	1 x 1000 Ah	9 KVA	30.7	5.03%
Offgrid_Model_2	7.2 KW	-	1 x 1000 Ah	9 KVA	22.5	3.80%
Offgrid_Model_3	11.52 KW	-	1 x 1500 Ah	9 KVA	21.1	3.81%
H_Offgrid_Model_2	8.4 KW	3.0 KW	1 x 1500 Ah	9 KVA	24.0	3.49%

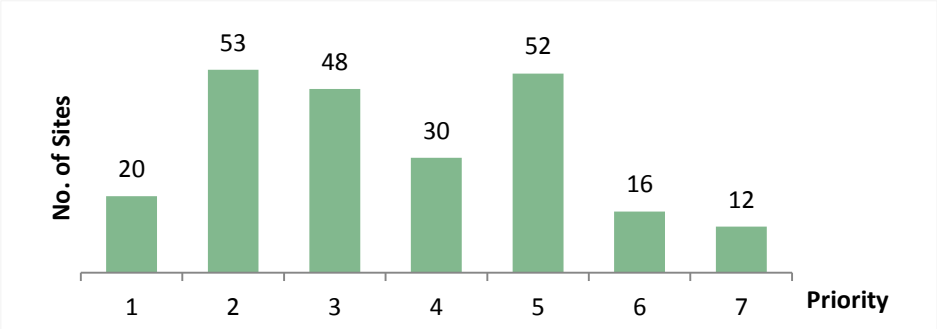
The excess electricity shown above is not continuously available for the community; however a modified design will provide continuous excess electricity for planned community power activities. The Community Power from Mobile (CPM) work stream at GSMA works with the operators to design, develop and promote community power business models utilizing the excess electricity produced at each site.

The operators can benefit from increase in ARPU due to increased minutes of usage and reduced OPEX per user due to increased subscriptions.

Implementation Priorities

Based on the technical solution and financial analysis the sites have been grouped into implementation priorities to better plan for deploying the green power recommendations. The total 231 sites are grouped into seven implementation priorities. Priorities are assigned based on site importance, site characteristics, CAPEX, ROI and OPEX saving for each site. Off grid sites, critical sites and sites with better financial indicators are given higher priority for implementation.

Figure 2: Number of sites by Priority



Investment plan

Financial analysis for each priority is carried out 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 investments, performance indicators and financial returns are given below for all the priority groups.

Table 4: Priority wise Investment summary

Priority	No. of Sites	Total CAPEX (US $)	Total OPEX (US $/yr)	OPEX Saving (US $/yr)	Payback Period (yr)	ROI	IRR	NPV (US $)	CO_2 Emission Reduction (tonnes/yr)
1	16	906,684	80,104	394,595	2.21	48%	47%	963,110	272.3
	4	376,300	5,680	130,652	2.88	35%	33%	231,384	60.8
2	53	1,587,943	300,658	897,772	1.49	75%	71%	2,548,068	1179.2
3	48	892,299	171,427	599,844	1.27	88%	83%	1,873,351	653.0
4	30	1,684,500	76,710	787,200	2.14	47%	46%	2,062,620	270.0
5	52	2,919,800	132,964	1,364,480	2.14	47%	46%	3,575,208	468.0
6	16	957,515	88,226	415,100	2.25	46%	44%	989,395	442.4
7	12	1,000,080	124,308	392,916	2.55	39%	37%	819,264	490.8
Total	**231**	**10,325,121**	**980,077**	**4,982,559**					**3836.5**

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.

Through its Green Power for Mobile programme sponsor IFC (International Finance Corporation), GSMA provides operators with various funding alternatives to deploy green power solutions. 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 LEO, Burundi reduce their energy requirement at every site.

Generic recommendations to optimize and reduce passive load (thermal and lighting load) -

- Use separate battery cabinet with cooler for deploying batteries
- Install VDT(Voltage Dependent Timer)/intelligent controller to manage battery and DG operation
- Use a battery cooler for all sites. It will increase battery life by 50%.
- Use energy saving light for all sites
- Recommended against using AC Aircon for all indoor sites
- Recommended for use of Free Cooling Units (FCU) or DC Aircon for Shelter/BTS-room environment control in combination with a separate battery cabinet with cooler for batteries
- To reduce the other thermal load by keeping only the telecom equipment in BTS-room

Generic recommendations to optimize active load at base station sites -

- Smart control of TRX on/off based on traffic and time of day
- Purchase outdoor BTS for upcoming deployments
- Upgrade to low power outdoor BTS equipment for all the existing indoor deployments

Implementation of these recommendations would enable LEO-Burundi to improve energy efficiency of the network, reduce OPEX up to 80% and remove dependency on diesel generators to power the network.

Summary

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

Green Power Solution Recommended for:	156 Sites
No Green Power Recommendation for:	14 sites
Recommend Battery Cycling for:	75 sites
A list of generic recommendations those can save up to 25-40% 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$ 10.32 million
Current Energy OPEX for all sites	US$ 5.96 million/yr
Energy OPEX post Green Power deployment	US$ 0.98 million/yr
OPEX Savings by implementing Green Power Solutions	US$ 4.98 million/yr
Average Pay back period	2.05 years
Average NPV	US$ 56,547
Average ROI	54.3%
Reduction in CO2 emissions	3,836 Tons/yr

GSMA Green Power for Mobile Programme

Promoting Green Power to Extend Mobile beyond the Grid

An estimated 1.6 billion people live without electricity. An additional 1 billion people live in areas with unreliable access to power. In order to expand into areas without regular electricity, mobile networks have primarily used diesel generators for power. However, as diesel prices rise and mobile network infrastructure is built in increasingly inaccessible regions, mobile operators need a viable alternative to diesel, such as solar and wind power. Recent technological improvements and cost reductions in green power solutions have made this alternative more commercially attractive. Coupled with the environmental benefits of reduced diesel use and subsequent emissions, green power solutions provide a promising opportunity for operators.

The GSMA Green Power for Mobile programme has set the goal of helping the mobile industry use renewable energy sources, such as solar, wind, or sustainable biofuels, to power 118,000 new and existing off-grid base stations in developing countries by 2012. Achieving that target would save up to 2.5 billion litres of diesel per annum and cut annual carbon emissions by up to 6.8 million tonnes.

The Green Power for Networks work stream within the Green Power for Mobile programme focuses on aiding the mobile industry to deploy solar, wind, or sustainable biofuels technologies to new and existing off-grid base stations in developing countries. The Green Power for Networks work stream supports the mobile industry in this initiative by providing:
- Network Feasibility Studies: Complete network assessments on technical and financial viability of renewable energy for BTS sites.

Aiding network operators to deploy renewable energy, GPM will be promoting the expansion of mobile networks into regions currently lacking coverage (to bring coverage to the unconnected) and the systematic reduction of reliance on diesel consumption by operators.

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/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