Green Power for Mobile

Supported by

Ncell – Nepal – Feasibility Study

In March 2011, Swedish telecom major TeliaSonera Eurasia signed an agreement with the GSMA for a Feasibility Study to be conducted by the Green Power for Mobile (GPM) team. The study encompassed technical and financial feasibility analyses on a large number of base stations in TeliaSonera's existing and planned networks in Nepal, Tajikistan and Azerbaijan, and identified those that are most suitable for green power solutions.

Introduction

A Field Implementation Manager from GSMA's GPM Team was mobilised to each of the above operations where he stayed with each operation for about one month undergoing the information collection and analysis required to study their feasibility for renewable energy on both technical and financial grounds.

The entire projects duration spanned about 70 days, and its Primary Objective was to ensure that TeliaSonera maximises Return on Investment (ROI). Additional objectives of the project were:

- Provide recommendations on alternative energy technology, equipment sizes, new technologies, equipment trial possibilities, forecast CAPEX, forecast ROI & forecast NPV for base stations
- To support establishment of a centre of excellence within TeliaSonera through the provision of training materials and a training curriculum from GSMA Green Power for Mobile
- To assist with vendor identification and RFP (Request for Proposal) interpretations
- To provide a monitoring and evaluation framework (Key Performance Indicators) for assessing the technical and financial performance of the sites
- To provide TeliaSonera with a global platform from which to publicise its environmental

initiatives, through GSMA publicity materials/communication channels

- Introduce TeliaSonera to development banks including the International Finance Corporation (IFC – member of World Bank Group) to investigate financing options to support green power networks

In each of the three operations, a kick-off and close-out presentation was delivered to the technical team and senior management outlining the results of the analysis done. Moreover, an in-depth training on the technical simulation and financial analysis for renewable energy systems were delivered to multiple personnel within each operation.

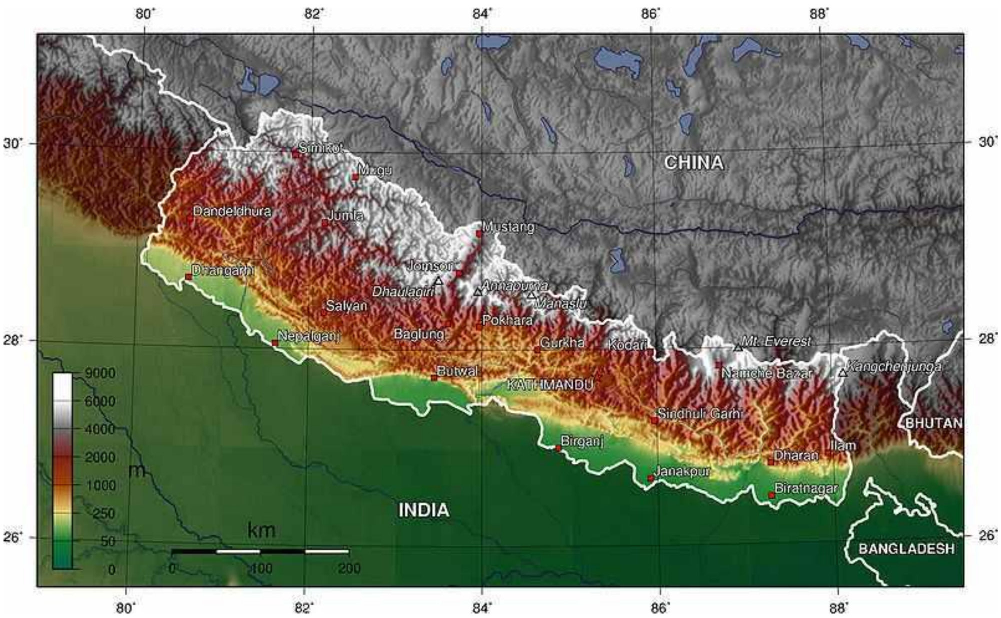
At each of the operations, the following has been explored in detail to come up with a sound feasibility analysis for renewable implementation:

- Site technical information:
    - Power consumption, power plant, expansion plans
    - Outages, traffic volumes, operational pattern
    - Site layouts, connectivity
    - Equipment specifications and feedback on performance
- Equipment and service costing of existing service providers and system integrators
- Financial modelling information:
    - Interest rates, custom duties, insurance and transpo, etc.
    - Traffic patterns and call tariffs
- Logistical costs
- Meteorology office visit, NASA info, 3tier.com, GPM database

About Nepal

Nepal is a landlocked sovereign state located in South Asia. Situated in the Himalayas, it borders China to the north and India to the south, east, and west. Nepal's area is about 147,181 square kilometres (56,827 sq. mi) and its population is approximately 30 million. Kathmandu is the nation's capital and the country's largest metropolis. Nepal's GDP per capita is US$1,270.

Nepal's geography is layered across the country as seen in the below image. The mountainous north has eight of the world's ten tallest mountains (including the highest point on Earth, Mount Everest or Sagarmatha in Nepali). It contains more than 240 peaks over 20,000 ft. (6,096 m) above sea level. The fertile and humid south is heavily urbanised[1].



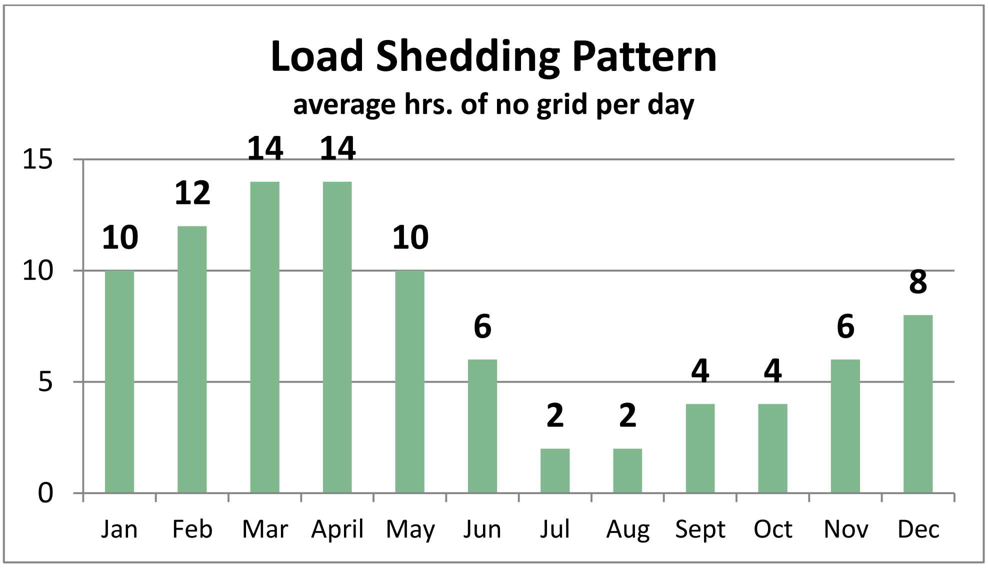
[1] Wikipedia

Power Situation in Nepal

In terms of energy sources, Nepal ranks 2nd in terms of water resources after Brazil, with a hydro-power potential of 83,000mW (42,000mW is economically viable). Only 40% of Nepalese people have access to electricity.[2]

Mr. Anand Raj Khanal, Director of Nepal Telecom Authority, during the National Seminar on Power and Communication Sector Development- 30/12/2010 held in KU, presented the current scenario of tele-penetration rate in Nepal and talked about the difficulties associated in expanding the communication facility in Nepalese terrain.[3]

Grid availability in Nepal is seasonal and sinusoidal in nature, as the primary source of power comes from hydro-plants nationwide triggered by the monsoon and the melting of ice on mountain-tops during the summer time. The average daily power outage (in hours) throughout most of the country is shown in the table below:



Ncell Network – In Brief

Ncell Pvt. Ltd (known as Spice Nepal Private Limited earlier) was established in 2004 as the first private operator of mobile communication services in the GSM standard in Nepal. The services were commercially launched under the Mero Mobile brand on September 17, 2005. As of 2010, it has been operating under the Ncell brand. "N" stands for Nepal. Ncell has been part of TeliaSonera, a leading European telecommunication company since October 2008, with TeliaSonera controlling 80.0% of Ncell.

The total number of on-air sites in Ncell network at the time of this feasibility study exceeded 1250. Three quarters of these sites were under the operations department and the remainder were still under the projects and planning department. Ncell had already rolled-out 17 sites with renewable energy (6 green and 11 hybrid) that includes the highest 3G site in the world operating completely on solar energy at Sagarmatha - Mount Everest; 5200m above sea level. A handful of sites whereby the diesel generator is owned and maintained by either the building owner or Ncell offices and hence were excluded from the analysis (as they do not contribute high OPEX to Ncell operations and will not be financially feasible to implement renewable energy).

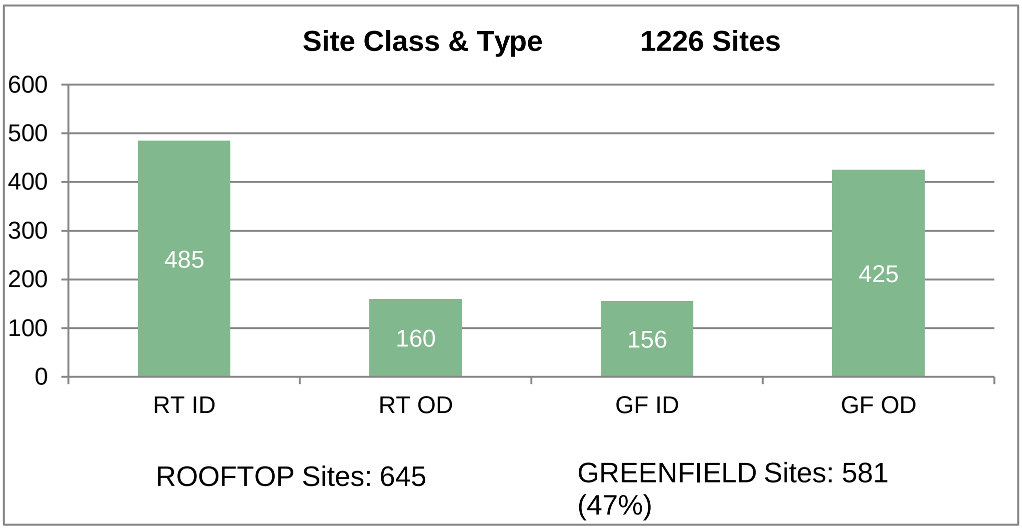
Ncell Network Highlights

The categorisation of Ncell sites is as detailed below. In the first years of Ncell's start-up, it was rolling-out its network mostly in cities and due to the scarcity of greenfield locations in the heavily populated cities and the trend of operators in the past, most sites were rolled-out as indoor rooftop sites. Lately Ncell has been spreading its coverage country-wide to cover villages, suburbs, and high-ways. Moreover, Ncell has recognised the added value of outdoor installations being more energy efficient than indoor sites, therefore most new sites are being rolled-out as outdoor sites.

Additionally, Ncell has taken a lead in green deployments within the region that from the planning stage, Ncell acquires additional land space whilst doing their site acquisition for

[2] http://www.ippan.org.np/HPinNepal.html
[3] http://www.ku.edu.np/news/index.php?op=Default&Date=201101&blogId=1

new roll-outs to allow for the possibility of implementing renewable solutions.



All 1226 sites are grid connected, or planned to have grid connection. The network-wide outage of base station sites average at 2.25 or 7.6hrs daily, throughout the year:

- 1052/1226 sites have 7.6hrs on average daily outage throughout the year
- 174/1226 sites have 2.25hrs on average daily outage throughout the year

Approach to Financial Analysis & Site Modelling

The financial analysis or business case for renewable energy deployment in operational telecommunication networks aims at comparing Existing CAPEX & OPEX vs. Renewable CAPEX & OPEX. Additionally, if a network experiences severe site outages due to grid power unavailability, the mobile network suffers losses in all the following:

- Revenue: outgoing calls & SMS
- Revenue: incoming calls & SMS interconnection charges
- Revenue: VAS services
- Revenue: subscriber churn
- Brand Image: subscriber dissatisfaction

This lost revenue from severe site outages would not be incurred if correctly dimensioned renewable energy systems were deployed on these sites. For networks with severe site outages – primarily due to power unavailability – the business cases for renewable deployment have to include a value for the lost revenue i.e. comparing existing CAPEX, OPEX & lost revenue with renewable CAPEX & OPEX. Since the primary source of revenue for most mobile networks comes from outgoing calls and SMS, only this will be taken into account while calculating revenue losses for a mobile network.

In order to come up with a value for the lost revenue, a dollar value for a minute of outgoing voice traffic and SMS on that network needs to be computed. For that purpose, the following was explored:

- Actual outage time of sites
- Actual traffic volumes of Sites
- Calling charging rates
- Estimate revenue model for sites throughout project life

Ultimately, this value was calculated for Ncell, and a project lifetime of 15 years was considered for renewable energy projects. Furthermore, the discount rate considered for this project in Nepal was taken as 12% (provided by the finance team at Ncell), and the average running hours per diesel generator was considered to be 75 hrs a month.

Whilst doing the dimensioning of renewable systems for Ncell sites, the following was taken into account:

- A Free Cooling Unit (FCU) OR DC Fan should be used for each indoor site to compensate the need for an air condition. Therefore an additional loading of about 300 W was considered whilst modelling indoor sites, and the price for the unit was considered in the business cases.
- A battery cooler should be used in indoor sites to maintain the batteries in good condition (extending / doubling its lifetime) and reduce heat dissipation in the room/shelter.
- Additional new batteries were included as CAPEX for all sites
- Additional new 200A rectifiers were included as CAPEX for all sites
- Average transportation & warehousing cost of US$850 were considered in all business cases (airport to W/H + W/H to reachable site.

Site Modelling

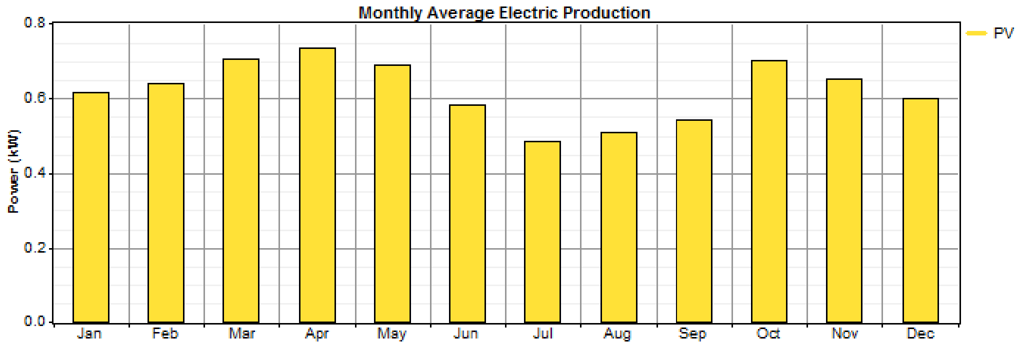
All 1226 sites were then grouped into models (16 in total) according to the following:

- Average site power requirements
- Power outages experienced
- DG availability on site.

Sample Results 1: Model 4 (32 sites rooftop outdoor)

- Average Site Load: 1000W
- DG Status: No DG
- Grid Power: Connected with 7.6 hrs average daily outage throughout the year

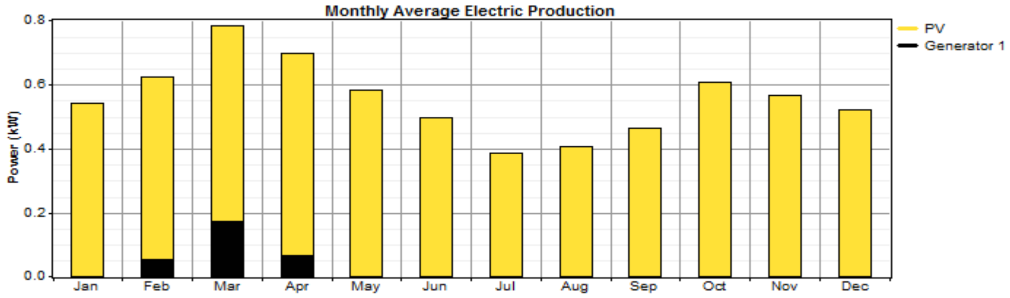
Proposed Architecture				Renewable Indicators		Financial Indicators				
Solar Power	Solar Controller	Batteries	Rectifier	Autonomy	Excess Electricity	Payback Period (yr)	ROI	IRR	CAPEX	NPV
3.6kW	Power2000/ Powermaster	GFMJ-600Ahr GEL (2 strings)	9.6 KW new rectifier 200A included - (4.8KW needed)	116hrs	43%	2.45 years	40.8 %	50.47 %	US$64,629	US$128,103



Sample Results 2: Model 10 (146 sites outdoor)

- Average Site Load: 1,100W
- DG Status: 15kVA
- Grid Power: Connected with 7.6hrs average daily outage throughout the year

Proposed Architecture				Renewable Indicators		Financial Indicators				
Solar Power	Solar Controller	Batteries	Rectifier	Autonomy	Excess Electricity	Payback Period (yr)	ROI	IRR	CAPEX	NPV
2.88kW	Power2000 / Powermaster	GFMJ-300Ahr GEL (2 strings)	9.6KW new rectifier 200A included - (2.4 KW needed)	66.1hrs	36%	2.24years	44.7%	53.7%	US$54,581	US$119,502


Monthly Average Electric Production
Power (kW)
0.0
0.2
0.4
0.6
0.8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
PV
Generator 1

Priority Assignment and Financial Analysis

The decision to implement renewable energy as a means of reducing OPEX by a mobile network is best done by prioritising which sites the operator wishes to start with. Similar to rolling out a network, the operator may choose to expand coverage in rural areas, or focus on increasing capacity in highly urbanised cities.

An operator may choose to prioritise their renewable rollout based on one or more variables. GSMA was keen on presenting different variables to Ncell management based on which they could ultimately come up with an informed decision on the way forward for renewable implementation.

The base station sites were hence analysed and prioritised based on the following factors:

Sites with transmission priority significance

Based on the number of sites linked to each site via microwave transmission, a priority has been assigned.

- (P1) Priority 1 sites have 40 or more sites linked to them – Total 9+10+7 = 26 sites. Out of these, 2 sites already having renewable energy implemented and 15 sites not producing a viable business case for renewable energy hence are recommended for Deep Cycle Batteries (DCB).
- (P2) Priority 2 sites have between 10 and 40 sites linked to them – Total 27+48 = 75 sites. Out of these, 7 sites already having renewable energy implemented and 26 sites not producing a business case for renewable energy, hence are recommended for Deep Cycle Batteries (DCB).

Site Priority - Transmission Chain

(1) ONE						(2) TWO			
Site	Linking x >= 100	Site	Linking 50 =< x < 100	Site	Linking 40 =< x < 50	Site	Linking 20 =< x < 40	Site	Linking 10 =< x < 20
9	9	10	10	7	7	27	27	48	48

Sites with Transmission Priority Significance

	Financial Analysis				
	CAPEX	OPEX/yr	Payback Period (yr)	ROI	NPV
(P1) Total - 9 sites (15 sites – DCB)	$743,379	$50,310	4.85	25%	$583,207
(P1) Average	$82,600	$5,590			$64,800
(P2) Total - 42 sites (26 sites – DCB)	$3,185,083	$229,197	4.04	29%	$3,611,229
(P2) Average	$75,835	$5,457			$85,982

Sites with Traffic / Availability / Data Significance

Based on a combination of the following 4 factors, a priority level was assigned to each of the sites:

- A) Average voice traffic in peak busy hour (in Erlangs)
- B) Average total voice traffic per day (in Erlangs)
- C) Average site availability (% of time the site is up and running)
- D) Whether or not the site has 3G

Each of these factors was then assigned levels L1 (most important) → L5 (least important)

A combination of the factors and levels then determines the priority of the site for renewable implementation as shown in the table below.

	Parameter		Range	L1	L2	L3	L4	L5
A	Voice Traffic Peak Busy hour	782 Sites	3-300 Erl	X >= 250 26	250 > X >= 100 328	100 > X >= 25 384	25 > X >= 10 37	10 > X 7
B	Total voice traffic for whole day		18-2800 Erl	X >= 2K 19	2K > X >= 1K 302	1K > X >= 0.5K 388	0.5K > X >= 0.1K 67	0.1K > X 6
C	Availability		27-100 %	X < 50 31	90 > X >= 50 151	97 > X >= 90 123	99 > X >= 97 78	X > 99 399
D	3G Sites		173 Sites		L1			

Site Priority - Traffic

(1) ONE				(2) TWO
A,B,C,D 3/4 L1 (no L4L5 for C)	A,B,C,D 2 L1 (no L4L5 for C)	A,B,C,D 1 L1 & 2/3 L2, 1L1 & 2L3 1 L1 & 1L2 & 1L3 (no L4L5 for C)	A,B,C,D 3 L2, 3G, (no L4L5 for C)	A,B,C,D 3L3, 2L2 & 1L3, 1L2 & 2L3 (no L4L5 for C)
1 A B C D	12 A B C D	62 A B C D	65 A B C D	193 A B C D

Sites with Traffic Priority Significance

	Financial Analysis				
	CAPEX	OPEX/yr	Payback Period (yr)	ROI	NPV
(P1) Total - 123 sites (16 sites – DCB)	$10,020,452	$646,773	3.15	53%	$27,782,620
(P1) Average	$81,467	$5,258			$225,874
(P2) Total - 183 sites (6 sites – DCB)	$12,532,480	$815,067	2.61	54%	$36,638,925
(P2) Average	$68,483	$4,454			$200,212

Sites that are Problematic in terms of Field Maintenance

The field maintenance team at Ncell have trouble maintaining 56 sites in their network due to the difficulty of accessing these sites either during months of bad weather resulting in poor/no road access to the site (which implies maintenance personnel have to walk for long distances or even use a helicopter). If these sites could be implemented with renewable energy, this could significantly reduce the burden on Ncell's operations team in maintaining these sites and as a result, enhancing overall network KPI's.

56 Sites - FLM Problematic

	Financial Analysis				
	CAPEX	OPEX/yr	Payback Period (yr)	ROI	NPV
(P1) Total - 54 sites (2 sites – DCB)	$4,667,275	$248,184	1.66	86%	$24,045,230
(P1) Average	$86,431	$4,596			$445,282

Sites with certain ROI ranges

Another category which mobile operators may choose in prioritising the sites in their network for renewable implementation is financial – meaning the sites which yield higher ROI (less payback) could be considered a higher priority (investment-wise) than other sites with lower ROI (higher payback).

Sites with ROI Priority Significance

	Financial Analysis				
	CAPEX	OPEX/yr	Payback Period (yr)	ROI	NPV
0 yrs < Payback < 2 yrs (300 sites)	$19,848,665	$807,177	1.3	79%	$94,387,481
Average per site	$66,163	$2,690			$314,625
2 yrs < Payback < 4 yrs (485 sites)	$30,981,450	$2,345,743	3.06	34%	$45,690,915
Average per site	$63,879	$4,837			$94,208
4 yrs < Payback < 7 yrs (303 sites)	$20,205,746	$1,437,050	5.74	18%	$5,736,745
Average per site	$66,685	$4,743			$18,933

Ideally, a mobile network may elect to combine two or more of the above factors prior to deciding the implementation priority for large-scale renewable implementation.

Overall Summary

Upon analysis of the entire network, the following summarises the results that were outputted:

Green solution can be implemented for	1116 on-grid sites
Green solution will be not feasible for	111 on-grid sites
Deep battery cycling recommended for	111 sites above
Total CAPEX for Green solution implementation	US$65.3 million
After Green solution implementation, CO_2 emission will be reduced by > 33,300 tonnes / yr (>70%)	