Green Power for Mobile Feasibility Study Service

GSMA Development Fund
David Taverner
Programme Manager

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Presentation Objectives

- Highlight Feasibility Study service now available from GSMA Green Power for Mobile
- Provide example output deliverable from previous Feasibility Study project
- Demonstrate the Green Power for Mobile methodology for green power solutions
- Highlight previous Green Power for Mobile projects with operators

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Agenda

- Feasibility Study Overview
- Example Deliverable
- Feasibility Study Methodology
- Appendix – Operator Project Experience

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Vendor Neutral Feasibility Studies

- **Objective:**
  - The primary objective is to maximise an operator's Return on Investment (ROI)
  - Provide **vendor neutral**, non-biased advisory services from GSMA
  - To educate operators on the use of green power solutions (renewable energy & energy efficiency)
- **Approach:**
  - Complete a 10-12 week feasibility study of real life operator network
  - Collaboratively generate suggested deliverables as per next slide
- **Next Steps:**
  - Operator requests for feasibility studies are welcome

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Feasibility Study Deliverables

- Feasibility Study Report:
  - Ranking of Priority Target Sites
  - Site Dimensioning Proposal for Target Sites inc CAPEX & ROI
  - Suggested Implementation Plan
- Centre of Excellence Training Curriculum
- Monitoring and Evaluation Framework
- Draft RFP Document

- Example Feasibility Study for East African Operator:
  - See file:
  - GPM Feasibility Study sample 310509.pptx
  - OR contact – David Taverner - dtaverner@gsm.org

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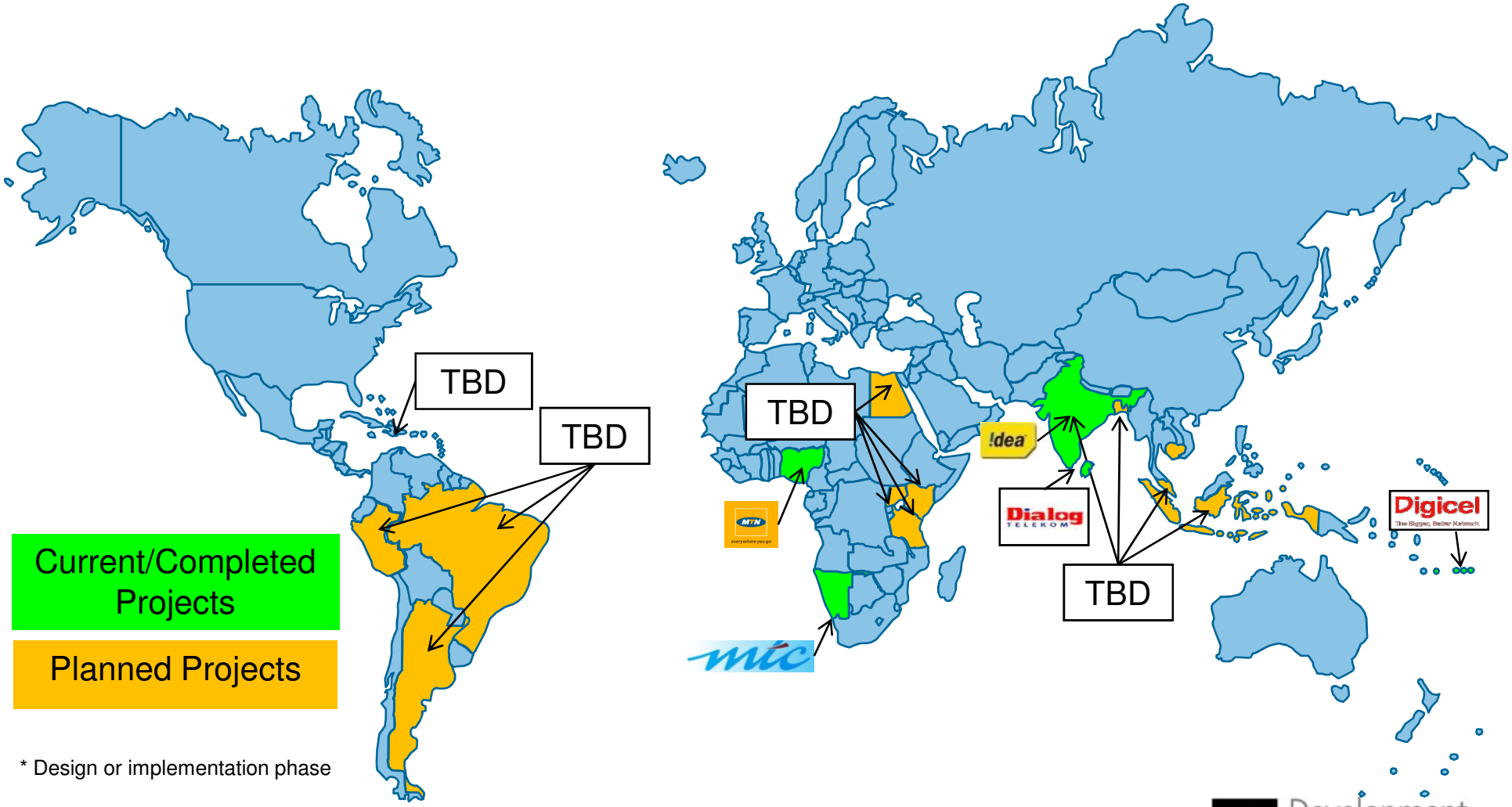
Feasibility Study Costs

- Free Service
  - Green Power for Mobile has a budget for conducting free Feasibility Studies
  - The pipeline for this budget is booked until Feb 2010
  - Operators are welcome to submit post Feb 2010 request
- Paid Service
  - For accelerated delivery operators are open to subsidise the additional GSMA resource
  - Example costs are in the region of US$40k-60k, dependant on project complexity and length (typically 8-12 weeks).

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GSMA will have completed projects with 15 operators across 1000 sites by 2010*



* Design or implementation phase

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Contact

- Please contact David Taverner (dtaverner@gsm.org) for further information and detailed project reports

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Feasibility Study – Project Scope

- GSMA Green Power for Mobile conducted a 10 week feasibility study to assess the viability of green power solutions in XXX's network. The scope of this work includes:
  - Regional Prioritisation
  - Site visits for 10 sites
  - Renewable energy equipment dimensioning for 9 sites
  - Detailed recommendations report
  - Example RFP document

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Site selection

- 10 sites have been selected for the GPM Feasibility Study
- Selection criteria included regional prioritization, power load and solutions, different vendors, etc.



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GPM Feasibility Study on Google Earth



Selection criteria include:

- 4 regions
- 2 vendors
- Power load ranging from 1.4kW to 6.5kW
- Indoor and outdoor sites
- Single BTS and multiple BTS sites

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Sites categorization

- 4 Site categories have been identified basing on site type, power load and current power solution



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Sites overview

Site	Region	Sun	Wind	Load (*) – current	Load (*) – suggested	Type	DG + Batteries	Group
Site #1	XXX			1.4kW	1.4kW	outdoor	no	outdoor/DG only
Site #2	XXX			1.4kW	1.4kW	outdoor	no	outdoor/DG only
Site #3	XXX			1.4kW	1.4kW	outdoor	no	outdoor/DG only
Site #4	XXX			1.4kW	1.4kW	outdoor	yes	outdoor/DG + batteries
Site #5	XXX			1.4kW	1.4kW	outdoor	yes	outdoor/DG + batteries
Site #6	XXX			4.6kW	2.3KW	indoor	no	indoor/DG only
Site #7	XXX			6.5kW	4.2kW	indoor	no	indoor/DG only
Site #8	XXX			4.4kW	2.2kW	indoor	no	indoor/DG only
Site #9	XXX			5.4kW	3kW	indoor	yes	indoor/DG + batteries
Site #10	XXX			4.4kW	2.3kW	indoor	yes	indoor/DG + batteries



(*): Load calculated as average daily kWh/24h

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XXX Results and Recommendations – Executive Summary

- **Results:**
  - GSMA has identified 6 sites where solar solutions pay back within 3.5 years
  - Across 10 sites the spread of ROI is between 25.1% and 64.8%
  - The CAPEX range for these solutions is US$ 34,177 to US$ 64,315 per site
- **Recommendations:**
  - GSMA recommends implementing 5 trial sites for a forecast implementation CAPEX of US$ 231,912. The recommended sites are based on two conditions being satisfied:
    - Payback period less than 3.5 years
    - Renewable contribution greater than 25%
  - This rollout plan would save 61,774 litres of diesel per year and 162.6 tonnes carbon per year
  - GSMA would be interested in assisting XXX to implement these suggestions
  - GSMA would be interested in replicating this feasibility study for other XXX countries

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Sites financial overview

Site	Region	ROI (%)	Payback Period (yr)	NPV (USD)	CAPEX (USD)	Renewable vs DG power contribution	Autonomy (hr)	Group	Suggested trial
Site #1	XXX	49.1	2.04	26,842	47,874	solar 41%/DG 59%	13.4	Outdoor/DG only	Y
Site #2	XXX	64.8	1.54	44.230	45,379	solar 35%/DG 65%	13.4	Outdoor/DG only	Y
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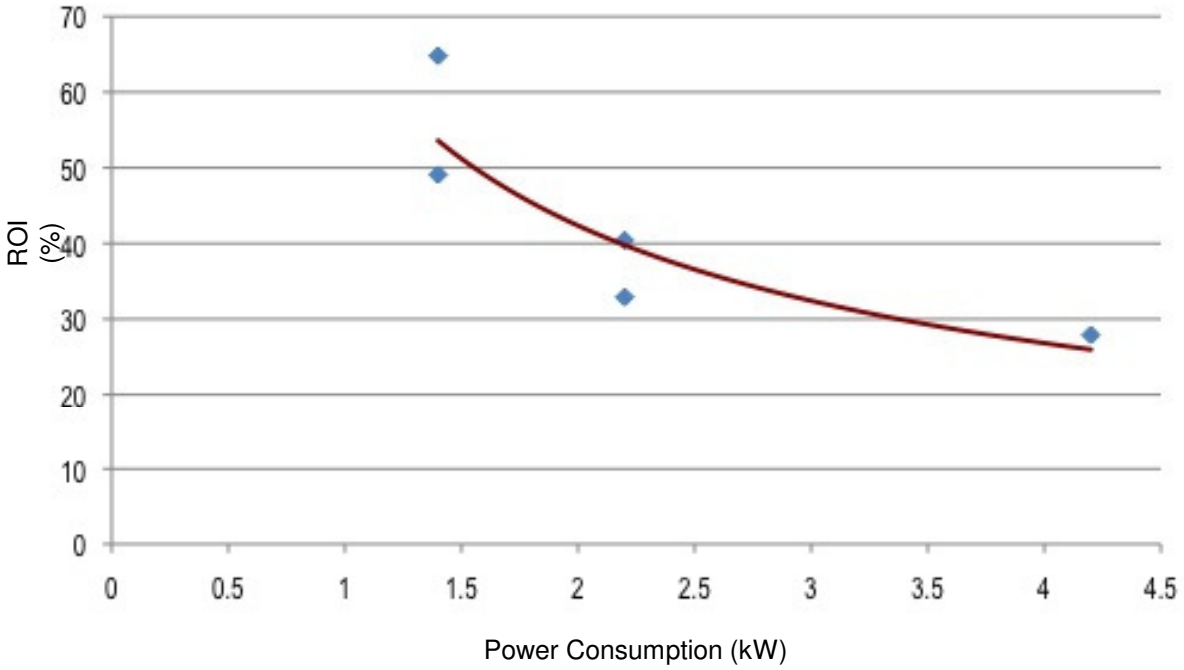
- **Key Results:**
  - Outdoor, DG-only, low power sites shows best financial indicators. In these sites generators are often oversized and runs 24h/day. The usage of a renewable solution (solar + batteries) would allow a sensible decrease in generator run-time and OPEX
  - Low power sites shows best financial indicators
  - Renewable contribution to power is critical for achieving good financial indicators

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ROI range from 27.9% to 64.8% for DG only sites

Site numbers and ROI(%) vs Power Consumption (kW) – DG



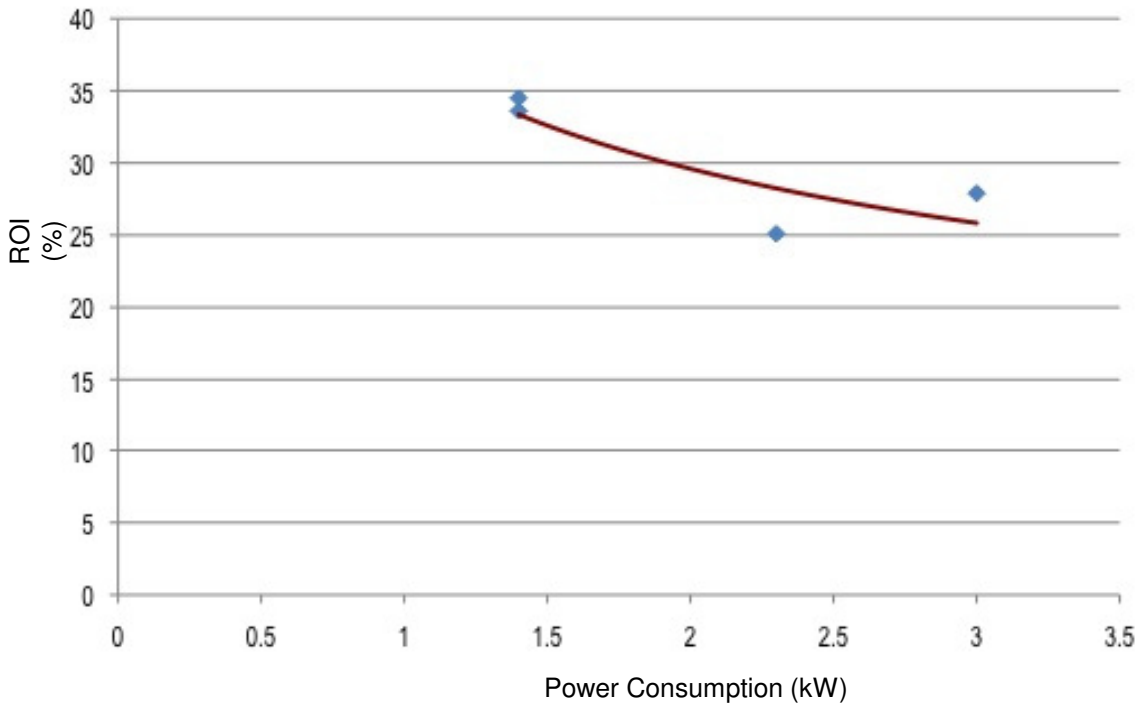
- DG only sites: 5
- Power load range from 1.4kW to 4.2kW
- ROI range from 27.9% to 64.8%
- Renewable contribution range from 17% to 41%

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ROI range from 25.1% to 34.5% for DG + batteries sites

Site numbers and ROI(%) vs Power Consumption (kW) –



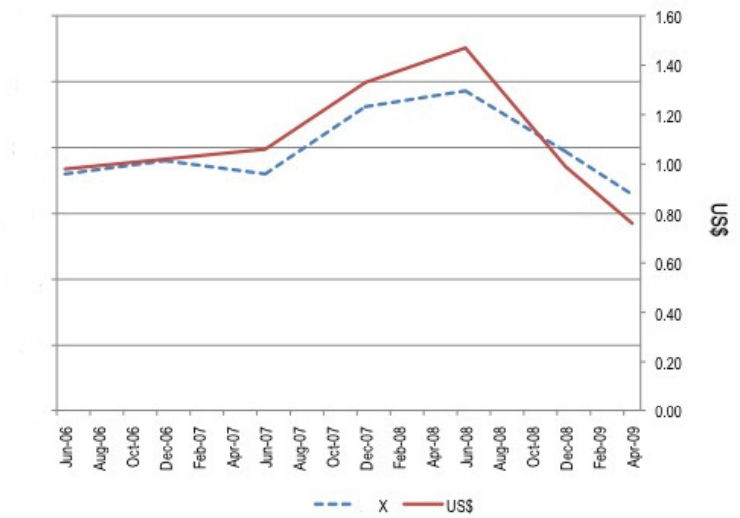
- DG+batteries sites: 4
- Power load range from 1.4kW to 3kW
- IRR range from 25.1% to 34.5%
- Renewable contribution range from 36% to 52%

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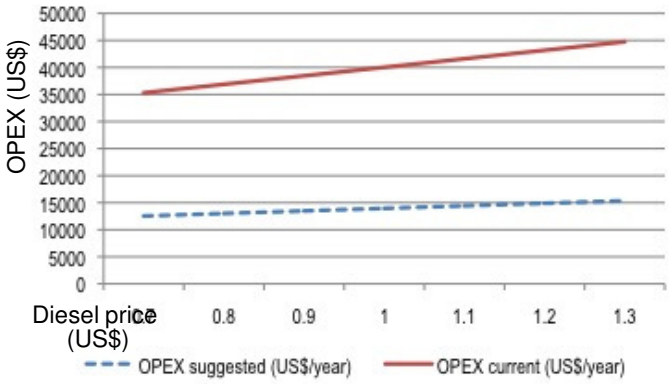
Diesel price has a large impact on ROI

Diesel price from June 2006 to April 2009

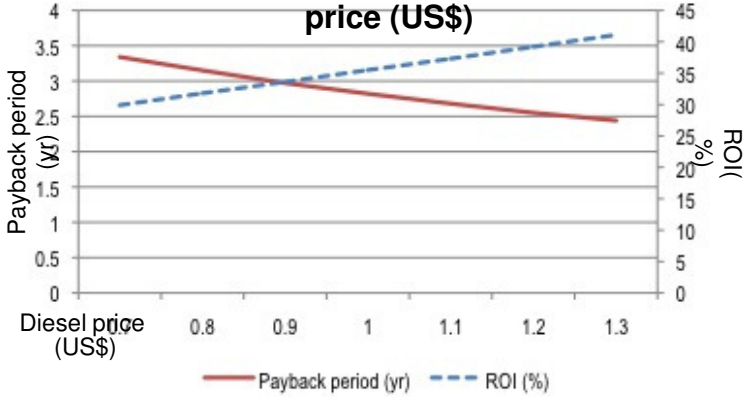


- Source: XXX Finance Department,www.oanda.com
- Currency exchange fluctuations have a strong impact on diesel price
- US$ 0.9 selected as reference price for diesel in financial analysis
- ROI increases when diesel price increases
- Payback period decreases when diesel price increases

Site #1 site - OPEX current and suggested versus



Site #1 site - Payback period and ROI versus Diesel price (US$)



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Key issues and learning points

- **Key issues**
  - Limited space available on site
  - Current power provision solution not optimized for low power, DG-only, outdoor sites. In these sites DG often do not run in efficient way determining a relevant waste of diesel.
  - Meteorology is a critical factor – site modeling based on simulation software and weather databases
  - Limited contribution to power provision from renewable in medium power/limited size sites
  - Lack of consistent data on site power requirement, site equipment, diesel consumption, etc.
- **Learning points**
  - Energy analysis should be included in network planning (i.e. land acquisition)
  - Solar/diesel hybrid are the most effectiveare the most effective renewable solution in XXX
  - Optimization of power provision is critical (DG sizing, adoption of alternative cooling systems, etc.)
  - Remote radio heads should be considered for future rollouts/upgrades to optimise energy efficiency
  - Renewable solution can represent a financially viable option, especially in DG only low power sites
  - Data collection is critical for a successful energy planning – site surveys could be conducted by Regional Engineers during their regular monitoring visits
  - Financial indicators strongly depend on:
    - Site category – current power provision system
    - Renewable contribution to power provision
    - Power load
    - Diesel price

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Methodology – Site selection

- GPM site selection methodology comprises several steps
- XXX Feasibility Study started from the Country Prioritization



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Identify Geographic Locations of the Base Stations and Prioritise Regions



Selection criteria include:

- 4 region

The selection of these regions enabled to cover:

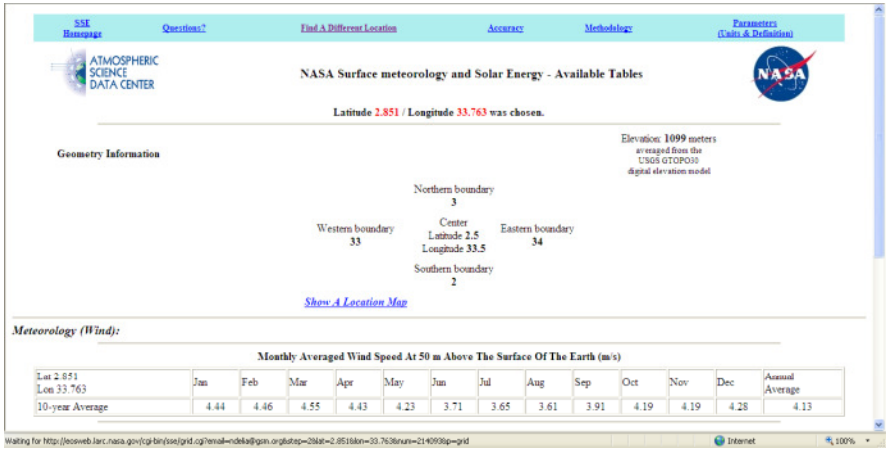
- 2 vendors
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- Indoor and outdoor sites
- Single BTS and multiple BTS sites

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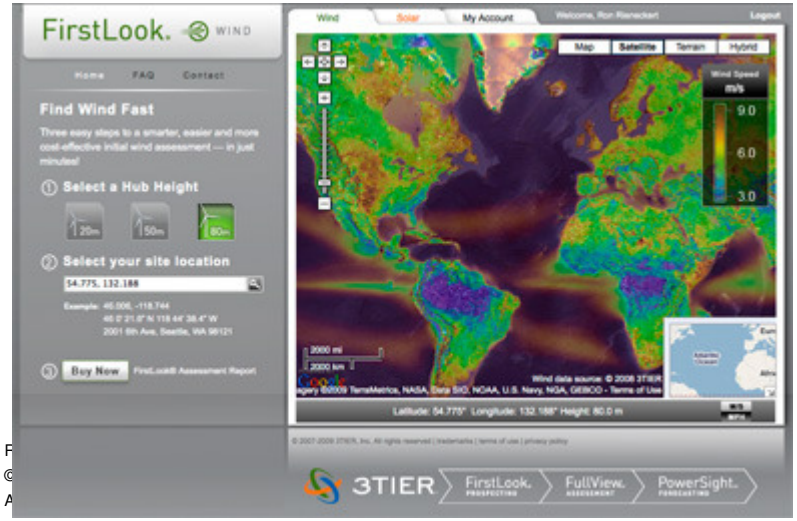
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Cross Reference Priority Regions against Climate Data

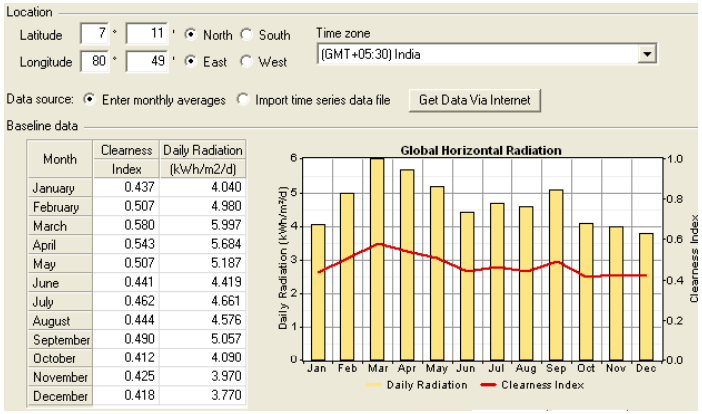
- Nasa website for wind resources



- 3tier website for wind resources



- Homer in-built tool for solar resources



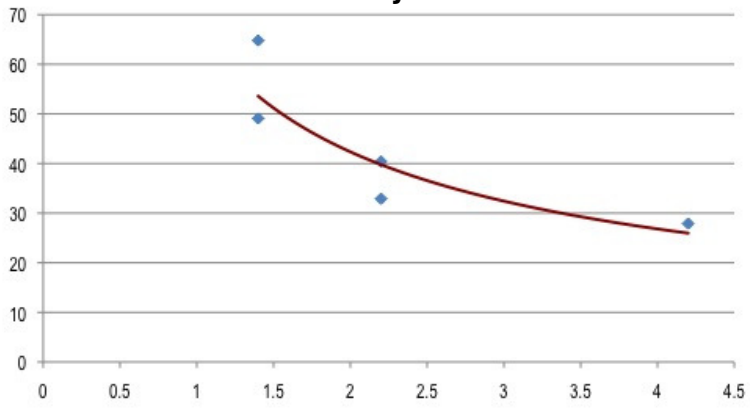
Month	Clearness Index	Daily Radiation (kWh/m2/d)
January	0.437	4.040
February	0.507	4.980
March	0.580	5.997
April	0.543	5.684
May	0.507	5.187
June	0.441	4.419
July	0.462	4.661
August	0.444	4.576
September	0.490	5.057
October	0.412	4.090
November	0.425	3.970
December	0.418	3.770

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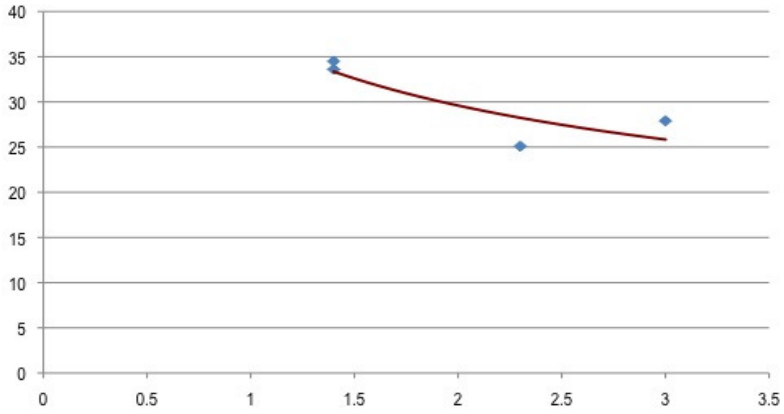
Prioritise Sites by Financial Viability

Site	Region	ROI (%)	Payback Period (yr)	NPV (USD)	CAPEX (USD)	Renewable vs DG power contribution	Autonomy (hr)	Group	Suggested trial
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Site numbers and ROI(%) vs Power Consumption (kW) – DG only sites



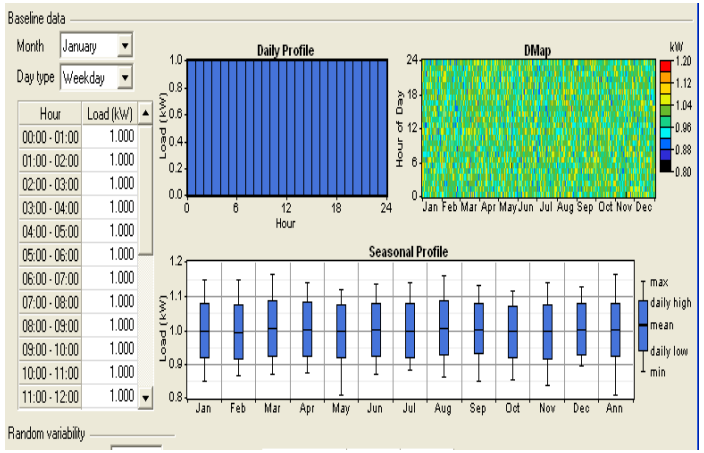
Site numbers and ROI(%) vs Power Consumption (kW) – DG+batteries sites

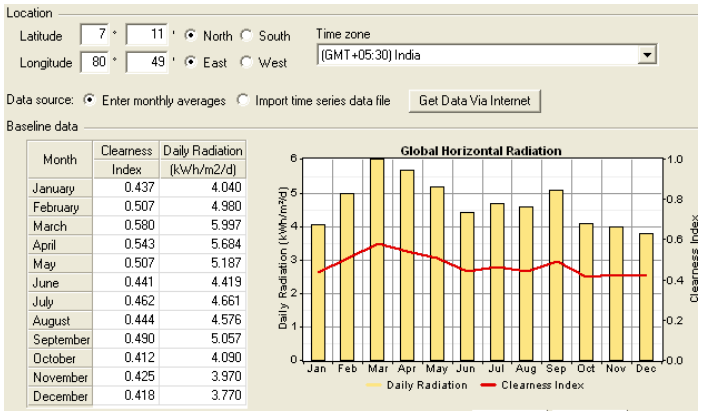


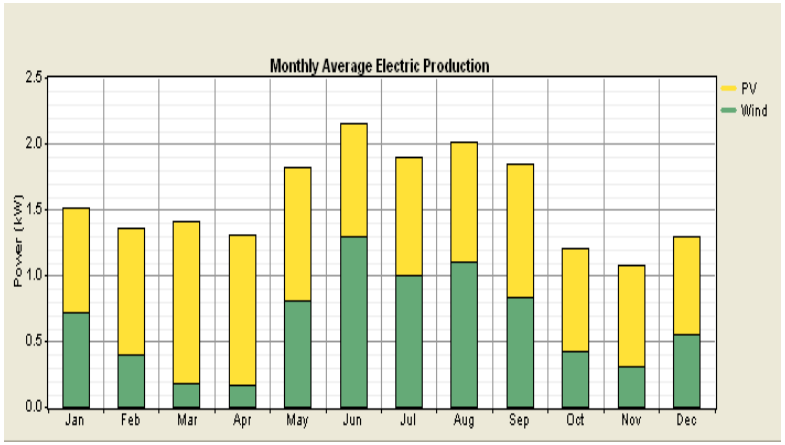
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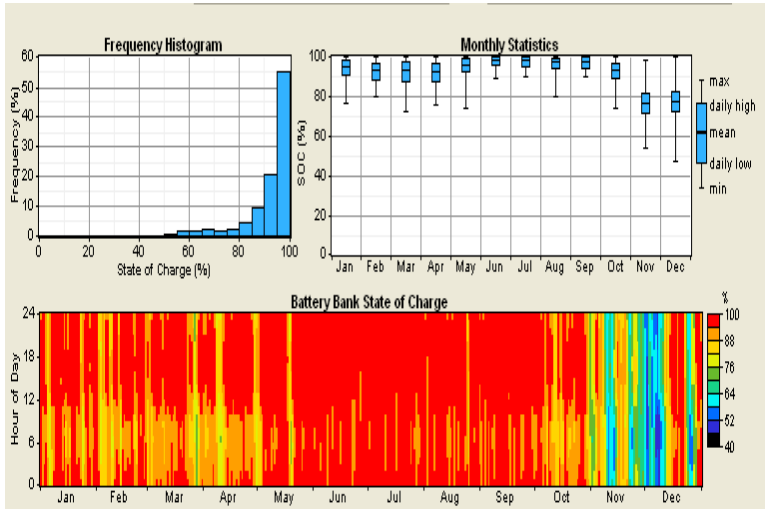
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Use HOMER (NREL) Software to Dimension the Renewable Energy Equipment









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Generate Accurate Financial Forecasts of Solution Options

		1	2	3	4	5	6	7	8	9	10
	Diesel Solution Net Cashflow	0	19,486	19,486	24,698	37,055	19,486	24,698	37,055	24,698	19,486
	Renewable Solution Net Cashflow	34,177	10,693	10,693	10,693	10,693	10,693	21,117	10,693	28,262	10,693
	Net Difference	-34,177	8,793	8,793	14,005	26,362	8,793	3,581	26,362	-3,564	8,793
	Total Diesel Solution OPEX	0	19,486	19,486	24,698	37,055	19,486	24,698	37,055	24,698	19,486
	Total Renewable Solution OPEX	0	10,693	10,693	10,693	10,693	10,693	21,117	10,693	28,262	10,693
	Average Diesel Solution OPEX	24,972									
	Average Renewable Solution OPEX	13,481									
PayBack	2.97										
ROI	33.6%										
IRR	34.5%										
NPV	$4,124										
Discount Rate	30%										

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Provide Implementation Recommendations

- **Results:**
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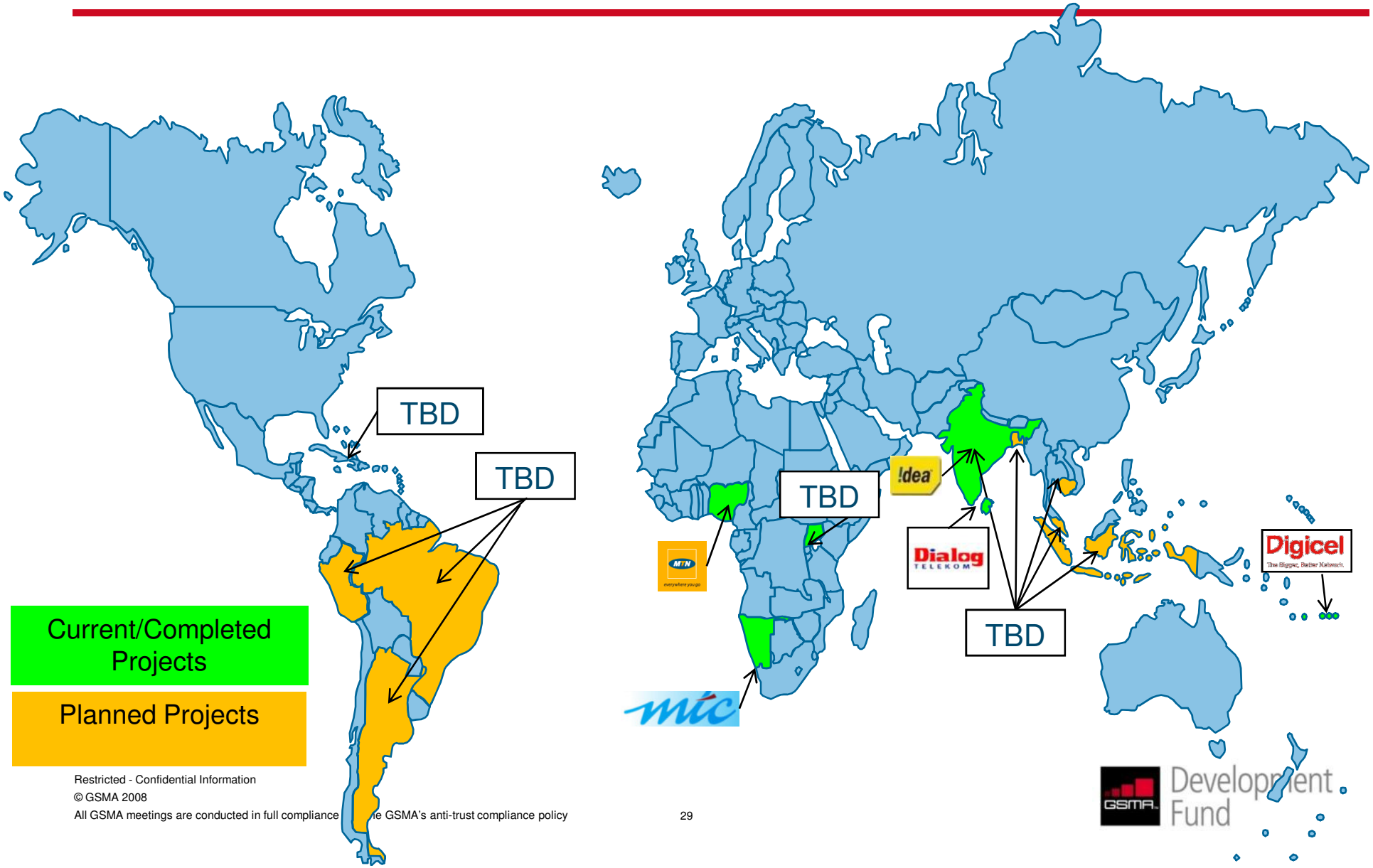
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Green Power for Mobile – Operator Projects



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Single Site Solar/Wind Hybrid BTS Trial in Nambia – MTC



- Confirmed **technical viability** of solar/wind solution supporting a 1.2kW base station
- Confirmed **financial viability** of less than 3 year payback period
- GSMA report available now

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Operator Project Experience – MTC Namibia

Single site solar/wind hybrid BTS trial in Nambia

Situation:

In April 2007, the GSMA Development Fund, together with Mobile Telecommunications Limited (MTC) of Namibia and Motorola, commissioned a trial site for a wind and solar power solution to support the operator's remote GSM cellsites.

The purpose of the 90-day trial was to validate the use of wind and solar power as a feasible and cost-effective alternative to using fuel generators at sites where the main grid connection is not available, too costly to run, or would take months, even years, to connect.

Project Approach:

Phase 1 (Feb 07 – April 07)

- Defining renewable power system KPIs
- Stakeholder management of operator and vendor to ensure solution design for base station site complete
- Installation of solar/wind hybrid site

Phase 1 (May 07 – Sept 07)

- Site monitoring to capture live KPI data
- Calculation of business case for solar/wind solution against grid and diesel options
- Monitoring and evaluation of system performance
- Documented project results and lessons learnt

Results:

- Technical viability of wind & solar base stations demonstrated by 90-day evaluation and monitoring confirming that ouput was sufficient to reliably power the 1400W- 1800W, 6-carrier base station
- Financial viability demonstrated with a forecast payback period of three years

Albertus Aochamub, Corporate Services General Manager, MTC Namibia quoted:

"With the implementation of cell sites into more remote areas the Motorola solution provides us with an efficient and reliable alternative to the often costly roll-out of mains grid electricity. It is a commitment to our customers to provide the essential communication services needed in the region."

Further Materials:

- Case Study
- Press Release

Multi Site Biodiesel BTS Trial in India – Idea Cellular



- Test the **technical feasibility** of jatropha biodiesel for use in base station diesel generators
- Definition of the **operations and maintenance process**
- Definition of **logistical processes**
- Idea Cellular now biodiesel at more than **350 base stations**
- GSMA report available now

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Operator Project Experience – Idea India

Multi site biodiesel BTS trial in India

Situation:

Local Operator IDEA Cellular, Ericsson and the GSMA's Development Fund teamed up to develop biodiesel as a power source for wireless networks in rural India. In a pilot project, biodiesel will be used to power mobile base stations located in Pune, Maharastra, where mains electricity is highly unreliable.

Project Approach:

Phase 1 (Technical Testing)
- Technical test of biodiesel B100 in new diesel generator
- Technical test of HSD in new diesel generator for benchmarking purposes
- Quality test of biodiesel produced by supplier to ensure it meets standard EN21214

Phase 2 (Rollout Scheduling and Management)

Definition of following:
- Base stations details
- Map of locations
- Storage of biodiesel
- Process for refuelling
- Performance monitoring

Phase 3 (Socio-economic Workshop)
- Initial report from NGO BAIF detailing estimates of costs involved in workshop delivery and ongoing operational cost
- Final report detailing delivery, ownership and costs involved. Also involves metrics for performance monitoring.

Results:

The original scope to power between 20 – 40 base stations by mid 2007 in the Maharashtra region has been significantly expanded with 100's of sites in the network now powered by biodiesel.

Sanjeev Aga, Managing Director of IDEA Cellular quotes:

"Almost three-quarters of India's population lives in rural areas that often lack a reliable power supply," said Sanjeev Aga, Chairman of IDEA Cellular. "Biofuels will help us further extend mobile coverage into these areas bringing major economic and social benefits to rural communities."

Further Materials:

- Case Study
- Press Release

Commercial Scale Rollout of Solar/Wind Hybrid BTS in Vanuatu (25 sites) – Digicel



- Demonstrated the viability of wind and solar solutions in **commercial scale rollouts**
- Define **best practice methodology** for commercial scale rollouts
- Understand **disaster planning** considerations in hazardous environment
- GSMA report available in May

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Operator Project Experience – Digicel Vanuatu

Commercial scale rollout of solar/wind hybrid BTS in Vanuatu (25 sites)

Situation:
Digicel Vanuatu and GSMA have partnered to deploy wind and solar energy solutions to 25 base stations on the Pacific archipelago of Vanuatu. By Feb 2009 it is expected that 33 green powered sites (including 8 low power RF repeaters) will have been deployed. This will bring Digicel's network to approximately 65% green powered.

Project Approach:

Phase 1 (May 08 – October 08)

- Defining renewable power system KPIs
- Reviewing site power consumption on all off-grid sites
- Preparing business case calculations for green energy on off-grid sites
- Site visits to ascertain site suitability for green energy
- Preparing a short-list of suitable sites for green energy for agreement with Digicel
- Dimensioning agreed sites and preparing BoMs for green energy materials to be shipped to each site

Phase 2 (October 08 – April 09)

- Dimension agreed sites (8 GSM sites plus 1 MW repeater site) and prepare BoM of green energy materials to be shipped to each site
- Design and dimensioning of RF repeater renewable power systems
- Advising on renewable equipment purchases, including upgrades to existing sites
- Documented rollout methodology, key learnings and project results

Results:

- The Digicel Vanuatu project is being used as a template approach for rolling out renewable energy across Digicel Group's networks around the world . Tanya Menzies, CEO of Digicel Vanuatu quotes:

"The work we are doing in Vanuatu is particularly important to the Digicel Group, as it's serving as a model for alternative power deployments for other Digicel networks around the world"

- Digicel Vanuatu now carries more than 60% of its network traffic on base stations powered by renewable energy sources
- The total number of renewable energy powered base stations is currently 25 and is expected to expand to 33
- A payback period of less than 3 years has been forecast for the majority of sites

Further Materials:

- Press Release

Commercial Scale, Multi-Vendor Rollout of Solar/Wind Hybrid in Sri Lanka (10 sites) – Dialog



- Define a **best case renewable energy** site
- Use both **renewable energy** and **energy efficiency** approaches
- Identify which technologies were suited to **specific network scenarios**
- Highlight the multitude of **top-tier green power vendors**

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Operator Project Experience – Dialog Sri Lanka

Commercial scale, multi-vendor rollout of solar/wind hybrid BTS in Sri Lanka (10 sites)

Situation:

Dialog Telekom and GSMA have partnered to deploy ten solar and wind-powered base stations in Sri Lanka. This will save up to 109,000 litres of diesel per annum and cut carbon emission by up to 294 tonnes per annum.

The trial will assess the plethora of renewable energy providers in the marketplace today by deploying equipment from eight top-tier vendors.

Project Approach:

Phase 1 (October 2008 to February 2009):

- Defining renewable power system KPIs
- Prioritising target 10 sites from an on-grid and off-grid network shortlist of 51 sites
- Site visits to ascertain site suitability for green power & reviewing site power consumption on all target sites
- Preparing business case calculations for green power on off-grid sites
- Dimensioning agreed sites and preparing BoMs for green energy materials to be shipped to each site
- Identification of top-tier equipment vendors
- Implementation of 2 sites

Phase 2 (February 2009 to July 2009):

- Preparing business case calculations for remaining 8 sites
- Dimensioning remaining 8 sites and preparing BoMs for green energy materials to be shipped to each site
- Implementation of 8 sites
- Documented rollout methodology, key learnings and project results

Results:

Project is incomplete. Results to be confirmed in future.

Further Materials:

- Press Release

Single Country Feasibility Study (10 sites) – East African Operator



- Site visits for 10 sites
- Renewable energy equipment dimensioning for 9 sites
- Detailed recommendations report
- Example RFP document

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GSMA Development Fund

Operator Project Experience – East African Operator

Feasibility Study of 10 Sites in the Operator's Network (10 sites)

Situation:

An East African Operator and GSMA have partnered to conduct a feasibility study for the use of green power solutions within the network. The suggested implementation of 5 sites would save 61,774 litres of diesel per year and 162.6 tonnes carbon per year.

Project Approach:

Phase 1 (February 2009 to May 2009):

- Site visits to 10 sites to ascertain site suitability for green power & reviewing site power consumption on all target sites
- Renewable energy equipment dimensioning for 9 sites
- Preparing business case calculations 9 sites
- Detailed recommendations report
- Example RFP document

Phase 2 (May 2009 to June 2009):

- In progress

Results:

Project is incomplete. Results to be confirmed in future.