IFC International Finance Corporation
World Bank Group

GSMA Green Power for Mobile

In partnership with the Netherlands

Powering Telecoms: Francophone Africa Market Analysis

Sizing the Potential for Green Telecoms in Cameroon and Senegal

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Objective

The Green Power for Mobile (GPM) Market Analysis report for Francophone Africa aims to provide market insights and potential opportunity for green power for telecoms in the countries of focus – Senegal and Cameroon. GPM selected Senegal and Cameroon as the focus markets for the Francophone region based on initial basic market research looking at various parameters including the market size, the current focus on green power and the possibility of impact creation.

The objective of the report is to analyse the current state of the telecom market and highlight the approach to powering networks for the readers to understand the potential of alternative energy solutions, in particular green power. The report looks at various elements including the industry structure, the regulatory environment, as well as the current state of power within the telecoms infrastructure sector in order to identify the potential opportunity for green power solutions.

The report presents the reader with the current size of the market and takes a look at the future of green power for mobile. The report also looks at future trends and sizes the potential market opportunity for 3rd party outsourced energy models.

Approach

The Green Power Market Analysis for Francophone Africa is based on information gathered using primary data collection through stakeholder interactions and questionnaires. The market analysis report also utilises some generic market data collected through various secondary resources and used as appropriate for analysis.

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Definition

MNO:	Mobile network operator or mobile operator
Tower Company:	A company that manages a part or the entire assets of a telecom tower.
ESCOs:	An energy service company that provides turnkey or end-to-end GPM solutions to an operator for off-grid telecom BTS.
CAPEX Model:	Mobile Operator or Tower Company invests CAPEX of their own to rollout the renewable solution.
OPEX Model:	A Renewable ESCO invests CAPEX to generator power at site level and sells power to Mobile Operator or Tower Company.
Tenancy Ratio:	Tenancy ratios are expressed as a fraction of total number of operators sharing towers/total number of sites present.
Off-grid site:	Telecom Base Station Site which is NOT connected to the commercial Grid power supply
On-grid site:	Telecom Base Station Site which is connected to the commercial Grid power supply
DG:	Diesel Generator
IRR:	Internal Rate of Return is the Rate of Return of an Investment.
CAGR:	Cumulative Annual Growth Rate
ARPU:	Average Revenue per User of mobile services
PPA:	Power Purchase Agreement

Figures and Tables

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Executive Summary

The mobile telecommunications industry in Senegal and Cameroon has reached a subscriber base of 10.9 and 3.5 million, recording a penetration level of 85.3% and 67.3% respectively. Currently, 85% of the Cameroonians and 87% of the Senegalese are covered by mobile network signals.

The total number of telecom towers stands at 4,990 sites providing mobile network coverage to around 85% of current population in both the countries. Senegal and Cameroon have a base of 2,900 and 2,090 total sites respectively.

Nearly 28% of the total 4,990 sites are off-grid, located in places without access to grid power supply. The number of off-grid sites stands at 850 and 533 sites in Senegal and Cameroon respectively. The remaining sites are on-grid sites and have grid power supply with variable quality and reliability.

Approximately 29% of the existing off-grid sites are deployed with green power while nearly 52% of off-grid sites are powered by diesel generators running 24x7. The remaining off-grid sites are deployed with battery hybrid solutions. Most of the on-grid sites have diesel generators as a backup power source.

Based on the current network parameters, The Green Power for Mobile (GPM) programme estimates that a total of 793 sites are potential candidates for green power deployments in Senegal and Cameroon. The potential green sites above exclude the current deployment of 397 green sites between the two countries. Most of the potential sites are off-grid.

The current market potential for a 3rd party ESCO model stands at USD 13.4 million every year at a PPA rate of 0.6 USD/kWh. If the PPA rate is increased to 1.0 USD/kWh, the ESCO market potential would become USD22.3 million. The market potential does not include the community power opportunity that an ESCO would consider as a business.

GPM forecasts that the total number of telecom tower sites would reach 6,589 by 2015 at a CAGR of 9.7% for both Senegal and Cameroon combined. The ESCO market potential at PPA 0.6 USD/kWh would reach to USD 21.8 million per annum by 2015. The ESCO market potential at a PPA rate of 1.0 USD/kWh would be approximately USD36 million per annum by 2015.

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1. Powering Telecoms: Current State of Affairs

The mobile telecom industry in Senegal, with over 85% mobile penetration, is represented by three major GSM operators including Expresso, Sentel (Tigo) and Sonatel (Orange). Cameroon has a mobile penetration of over 67% with two dominant GSM mobile operators: MTN and Orange.

Over the past few years Senegal and Cameroon have improved their mobile network coverage bringing respectively 87% and 85% of the population under GSM signal coverage. The reach of power infrastructure in these countries has played a major role in extending the coverage and has tremendously impacted the operations and costs of running the network in areas without grid power infrastructure. The mobile network operators have looked at various alternatives, including green power options, such as solar, to address the power challenges of running their network.

In the following sections GPM analyses the current state of the mobile telecoms sector in Senegal and Cameroon including:

- The current growth context of mobile telecommunications industry
- Powering infrastructure and its impact on growth of mobile telecommunications
- Current approaches to powering telecommunications network infrastructure
- Challenges faced by telecom operators to power their networks.

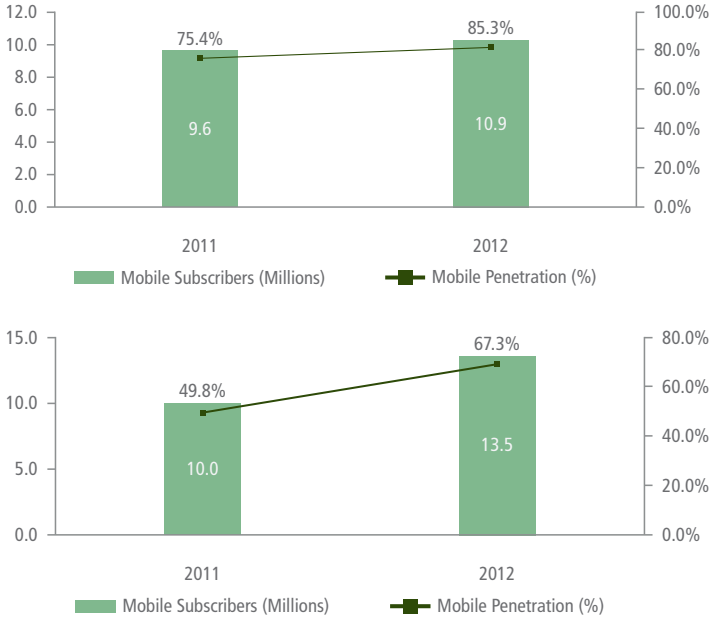
1.1. Telecoms: The Growth Context

In this section, we provide an overview of the mobile industry in Senegal and Cameroon in terms subscribers, mobile coverage and reach of the mobile network.

1.1.1. Subscribers, Penetration and Coverage

Senegal, with a population of 12.8 million, has managed to achieve a mobile penetration level of over 85% as of September 2012, against 75.4% recorded in September 2011 and the number of mobile subscribers l stands at 10.9 million.

Figure 1: Subscribers and Penetration (numbers, growth)[1]



Cameroon has had tremendous growth over the past year recording a subscriber base of 13.5 million as of September 2012, with an increase of 3.5 million additional subscribers since September 2011. However, with a population of over 20 million, the mobile penetration level in Cameroon remains below 70% and presents an opportunity to tap the unrealized market potential.

Both Senegal and Cameroon have achieved mobile network coverage of over 85%. Over 1.6 million people in Senegal and nearly 3 million in Cameroon are yet to be brought under mobile network coverage.

1 Published reports from regulators – ART, Cameroon (www.art.cm) and ARTP, Senegal (www.artpsenegal.net)

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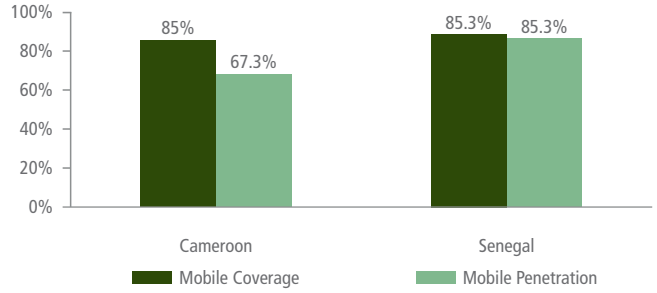
Figure 2: Mobile Penetration vs. Mobile Network Coverage (% population)[2]



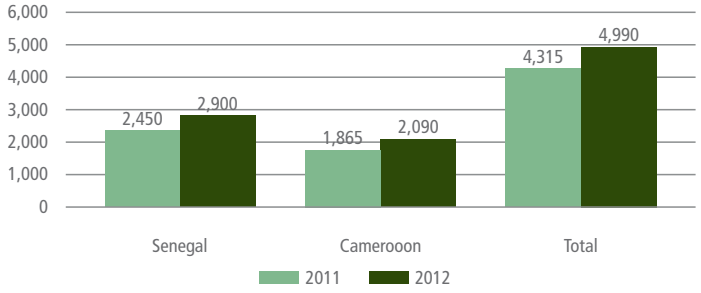
Growth Context of Subscribers, Penetration and Coverage

Senegal and Cameroon have recorded a subscriber growth of 13.1% and 35.1% respectively between September 2011 and 2012. Over the same period, the penetration level has increased from 75.4% to 85.3% in Senegal and 49.8% to 67.3% in Cameroon. Cameroon has tremendously improved its mobile network coverage from 58% in 2006 to the current level of 85%.

1.1.2. Size of the Mobile Network

The number of telecom tower sites (base station sites) covering 87% of the population in Senegal and 85% of the population in Cameroon is presented below.

Figure 3: Size of the Mobile Network (numbers and growth)[3]



Growth Context of Mobile Network

The size of the mobile network in Senegal and Cameroon has grown at a rate of 18.4% and 12.1% over the last year reaching a network size of 2,900 and 2090 sites respectively, as of March 2013.

The mobile network continues to grow in both Senegal and Cameroon driven by competition and capacity constraints.

1.2. Power and Telecoms: The Off-Grid network

The growth and expansion of mobile telecom networks depend on key support infrastructure including power and transportation. Power supply infrastructure plays a major role in running the mobile network with a benchmark network uptime of 99.98% in order to maintain the reliability and quality of services.

The key power sectors indicators and its impact on telecom operations in Senegal and Cameroon is studied in below sections.

1.2.1. Power Sector: Key Indicators and State of Power Infrastructure

The Key indicators representing the overall state of the power sector in Senegal and Cameroon on the next page.

2 Published reports from regulators – ART, Cameroon (www.art.cm) and ARTP, Senegal (www.artpsenegal.net)

3 GPM market research and analysis

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Table 1: Power Sector indicators – Senegal and Cameroon

	Senegal	Cameroon
Population (Million)	12.8	20.1
Installed Capacity MW	635[4]	1448[5]
Urban Electrification %	70[6]	90
Rural Electrification %	22	23

The State of Power infrastructure in Senegal

The situation of the power sector in Senegal is challenged by the low density of the electricity grid, insufficient regulatory frameworks and its over-reliance on imported fossil fuels to meet its energy demand. This high dependence on imported diesel makes Senegal a place where energy remains expensive, linked to the global fluctuations of oil prices. However subsidies exist in the energy sector, so that prices remain relatively low.

The absence of diversification of energy sources, especially for electricity generation is a key vulnerability factor. 90% of electricity is generated in thermal plants, with 10% by hydropower. Renewable energy power generation accounts for less than 1%[7].

Solar systems have been in use by SENELEC, the national utility, since 1983, to provide for rural electrification. In some parts of Senegal solar energy production helps to increase the level of rural electrification from 6% to more than 25%[8].

The State of Power infrastructure in Cameroon

While Cameroon possesses the second greatest hydroelectric potential in Africa, after the Democratic Republic of Congo, the country suffers from insufficient electricity supplies and the obsolescence of the transmission and distribution networks make electricity access highly unreliable – those who have access to power tend to experience cuts in supply as often as every three days[9].

The fact that Cameroon's three main transmission grids are isolated from one another and no exchange of available surpluses can be made between the grids[10] also adds to the lack of resilience of the nation grid network. For telecom operators, this is a serious challenge to their operations from urban to rural areas, as explained by Orange and MTN last year, while under regulatory pressure on the quality of their network coverage.[11]

There are also great disparities between cities and rural settlements. While urban connections are above other African countries' average, rural dwellers' access to electricity lags behind.

1.2.2. Power and Telecoms: The Off-Grid network and Grid reliability

The expansion and reach of commercial grid has fallen short of the ubiquitous reach of mobile networks in both Senegal and Cameroon resulting in mobile networks in the off-grid areas, primarily powered by diesel generators and other innovative alternatives including battery hybrids and green power.

The breakup of telecom tower sites in terms of their grid power connection status is presented below.

4 Lighting Africa – Senegal Policy Report Note 2010
5 Cameroon Energy Profile Reegle 2012
6 IRENA 2012
7 Senegal Energy Profile Reegle 2012
8 Senegal Energy Profile Reegle 2012
9 http://feowl.tumblr.com/post/22314629217/feowl-measures-the-lack-of-electricity-in-douala
10 Cameroon Energy Profile Reegle 2012
11 http://www.agenceecofin.com/operateurs/0106-5119-cameroun-pour-mtn-et-orange-leur-deficit-de-couverture-vient-surtout-des-delestages

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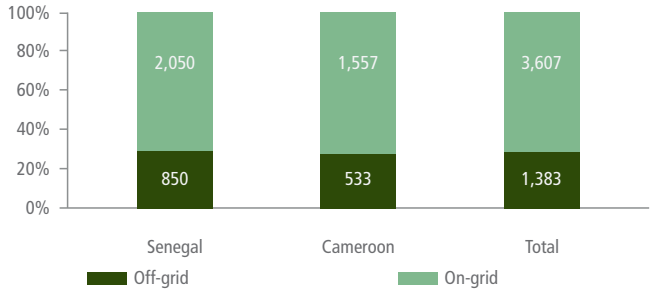
Figure 4: Sites by On/Off grid (numbers)[12]



Out of the total 2,900 sites in Senegal, 850 (~ 29%) are located in off-grid areas without grid power supply. Cameroon has 533 sites (over 25% of the network) falling in off-grid areas.

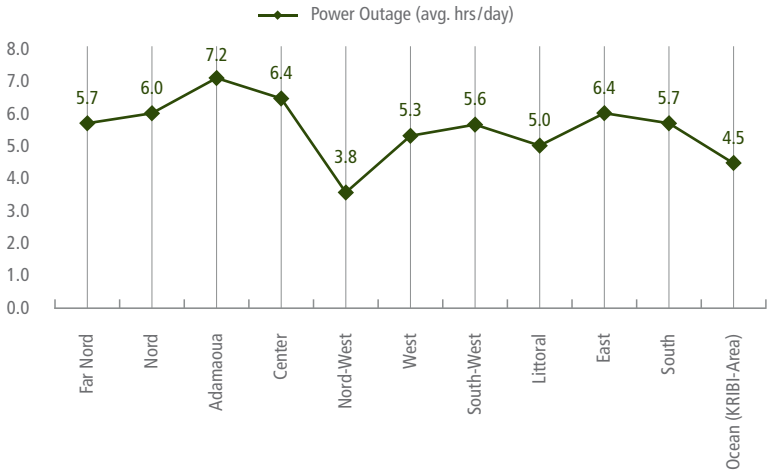
Cameroon and Senegal combined together have a total of 1,383 off-grid sites which accounts for about 28% of the total 4,990 sites in these two countries.

Grid Power Reliability

The grid power supply to the telecom sites in both Senegal and Cameroon is characterized by unscheduled outages ranging 4-12 hours on average depending on the region. Most of the sites rely on back up diesel generators during the outage of grid power, adding to the cost of running the network.

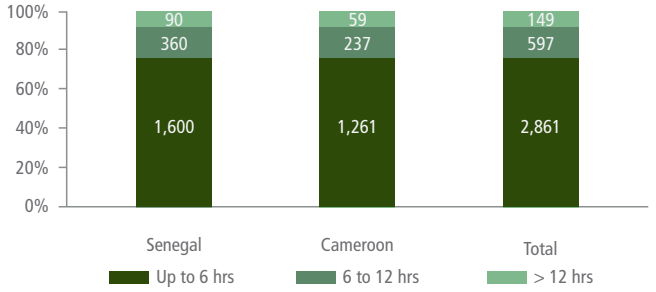
The region-wise average daily power outage for selected network of sites in Cameroon is illustrated below.

Figure 5: Power Outage Scenario by Region – Cameroon[13]



The number of on-grid sites along with average daily power outage scenario is presented below for both Senegal and Cameroon.

Figure 6: Sites by Grid Power Outage (On-grid)[14]



A total 746 (~21%) of the total 3,607 on-grid sites in Senegal and Cameroon have unreliable grid power supply with average power outages of more than 6 hours per day.

12 GPM market research and analysis
13 GPM market research and analysis – based on data from MNO stakeholders
14 GPM market research and analysis

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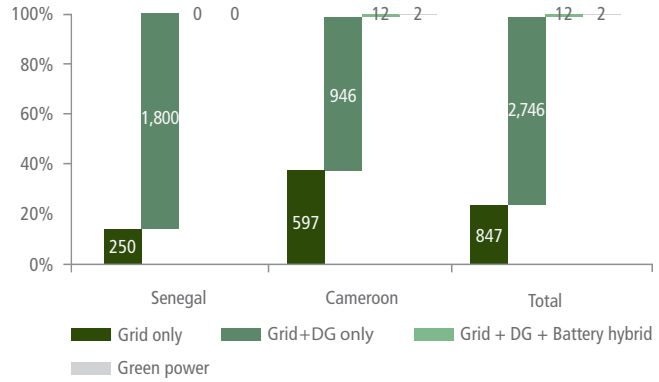
1.3. Powering Telecoms: Current Approach

In this section, GPM looks at the current approach to powering the network in Senegal and Cameroon. The breakup of sites by power solutions is presented below.

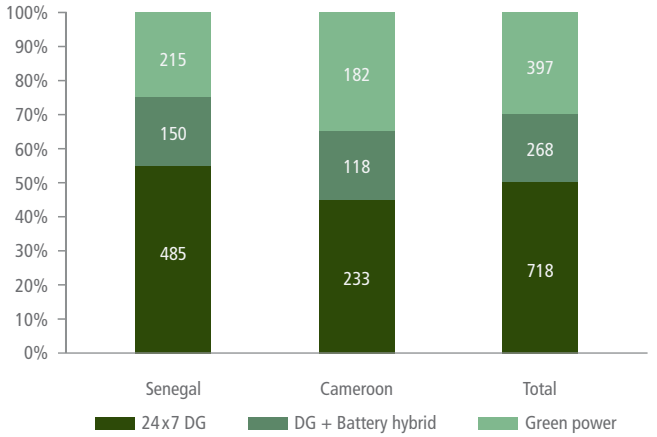
Over 76% of the on-grid sites are deployed with back up diesel generators whereas more than 23% of the on-grid sites are completely on grid power supply. Only 2 on-grid sites are deployed with green power solution. The below graph illustrates the break up sites by current deployed power solutions.

Figure 7: Sites by Power Solution Deployed (on-grid)[15]



The majority of off-grid sites (approx. 52%) are powered by 24x7 DG power solution and more than 19% are deployed with DG-battery hybrid power systems. The share of green power deployments stands close to 29% of the total off-grid sites. The corresponding break up by country and power systems is illustrated in the below figure.

Figure 8: Sites by Power Solution Deployed (off-grid)[15]



1.4. Powering Telecoms: The Overall Context

The current state of telecoms infrastructure along with the support infrastructure, including power infrastructure, has implications on the operations of the existing network as well as on the growth of the network to reach country-wide coverage.

The deteriorating quality and reduced availability of grid power supply to telecom sites has led to more reliance on diesel power for running the on-grid network. Grid extension has been a big challenge requiring an investment of approximately USD25,000 per site. The huge costs of grid extension, in addition to regular maintenance of the grid, and high mean time to repair grid faults has hindered operators from considering grid extension as a solution for powering off-grid sites.

Senegal and Cameroon have deployed green power solutions to a considerable number of off-grid sites thereby reducing the diesel OPEX at those sites. The operators have focused on implementing battery hybrid solutions at both off-grid and on-grid networks to further optimize the energy OPEX of running the network. However, the operators have been facing various operational challenges including lack of local vendor support, unavailability spares for green power deployments.

At more than 85% coverage, the majority of the +4.6 million uncovered population are living in rural and remote off-grid areas. The further deployment of green power in off-grid areas would require considerable investment in order to reduce diesel usage for powering the off-grid network.

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2. Industry and Regulations

2.1. Industry structure

The industry structure defined by the ownership of tower infrastructure and power systems is represented in the table below. In Senegal, both active and passive infrastructure (including tower and power assets) are owned and managed by MNOs. In Cameroon, on the contrary, the passive infrastructure – including tower and power assets – is owned and managed by tower companies.

Table 2: Industry Structure and Ownership[16]

	MNO/Anchor Tenant	Tower Owned/Managed	Power System Owner
Senegal	Expresso	Expresso	MNO
	Orange	Orange	MNO
	Tigo	Tigo	MNO
Cameroon	MTN	IHS Towers	Tower Co
	Orange	IHS Towers	Tower Co

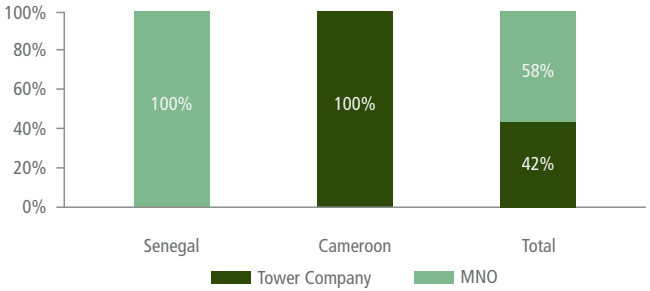
2.1.1. Tower Outsourcing Scenario

The tower outsourcing concept has picked up in Cameroon with the entry of IHS Towers, an Africa-focused Tower Company. IHS Towers now owns and manages the tower assets of MTN Cameroon and is under a management agreement with Orange to own and manage its passive tower infrastructure.

Senegal is yet to experience the benefits of tower outsourcing and all of the operators own their tower assets and manage them in partnership with O&M services partners.

The graph opposite illustrates the ownership structure of mobile towers between MNOs and Tower Companies.

Figure 9: Tower Ownership Structure: MNO vs. Tower Company[17]



2.2. Regulatory Environment

The regulatory framework and guidelines for promoting green power and improving electricity access is yet to be put into implementation in both Senegal and Cameroon. Both governments have established goals to improve electrification and include renewables as part of the energy mix.

The highlights from the policy framework and guidelines for Senegal and Cameroon are presented on the next page.[18]

16 GSMA GPM market research
17 GSMA GPM market research and analysis
18 Policy documents and published material as cited in the table

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Table 3: Green Regulations and Power Sector Vision – Senegal and Cameroon Green Regulations

	Green Regulations	Power sector vision
Senegal	■ A decree passed in August 2010 created a dedicated Minister of Renewable Energy, who is charged with improving the regulatory and legislative framework for renewable energy in the country. But despite statements by the Ministry of Energy that renewable energies should have a minimum share in electricity production of 15% in 2020, policy conditions for renewable energy are in their infancy in Senegal. ■ Feed-in tariff structures, as well as Power-Purchasing Agreements (PPAs) for renewable energies were introduced at the end of 2010 as part of the renewable energy agenda. However these tariffs proposed under the 2010 renewable energy law have not yet come into effect.	The Senegalese government's efforts are concentrated on the expansion of national capacity, with the involvement of IPPs, and of rural electrification. ■ SENELEC announced in 2011 plans to increase the installed capacity of Senegal by as much as 1,288 MW in the coming years. ■ The national rural electrification agency (ASER) plans to provide access to electricity for 3.8 million rural population, or 365,000 rural households before 2015, against 102,000 rural households in 2010.
Cameroon	Cameroon's development objectives under the Vision 2035 comprise significant investments in the energy sector, including renewable energies. The Cameroonian government is currently contemplating different options for improving the country's capacity to generate electricity, such as the construction of a new hydroelectric power plant.	The energy sector is considered a factor of growth, as Cameroon's hydroelectric potential ranks second-highest in Central Africa. The government has a long term power policy under the Energy Sector Development Plan (PDSE 2030). ■ By 2020, the Government aims to achieve a 48% countrywide electrification rate, a 75% electricity access rate and a 20% rural electrification rate. ■ Cameroon's Rural Electrification Master Plan (PDER) addresses the electrification of about 660 localities through the extension of the national grid as well as the development of a regional grid.

3. Powering Telecoms: Green Telecoms and the Size

In this section, GPM looks at green alternatives to power telecom tower sites and the potential size of the green power market for telecoms. The various green power choices are studied and analysed based on the country's context.

3.1. The Green Choices and Fit for Telecoms

The choice of green power technology for telecom application depends on the availability of resources, technology supply, commercial viability and market acceptance. The qualification of various green choices suitable for telecom application including solar, wind, biomass, fuel cell and pico-hydro is analysed on the next page.

3.1.1. Green Choice: Solar

Solar energy is one of the most ubiquitously available sources of clean energy and, as the most suitable for distributed power generation bringing power generation to where it is needed, it is adapted to applications such as telecoms. Unlike other sources of clean energy it is widely scalable owing to its modular technology to match future increase in load. However, solar technology presents challenges in terms of high upfront CAPEX and high space requirements for deploying the plant.

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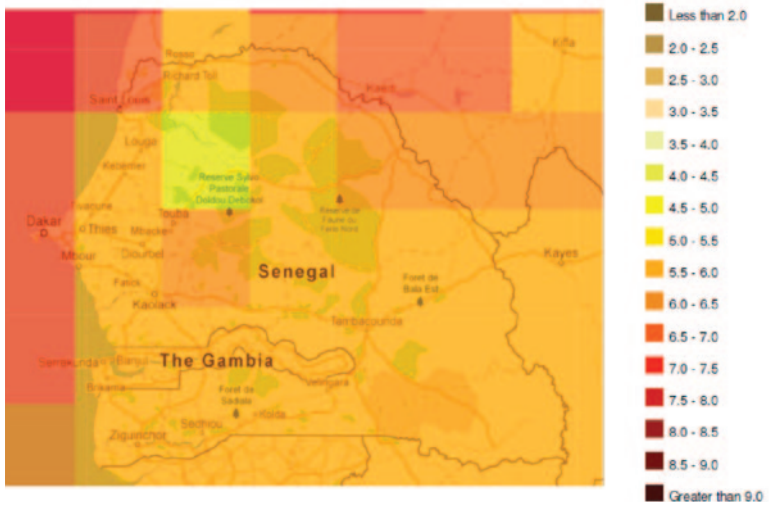
Context for Senegal

Highlights:

- Average solar radiation ranging from 4.0 to 5.0 kWh/sq. m/day.[19]
- An average of 3000 hours of sunshine every year[19]
- Solar power has been used by SENELEC, the national electric utility, in Rural Electrification.
- Contribution of solar power to total electricity consumption stands very low at 0.01%.[19]

Figure 10: Solar Radiation Map – Senegal



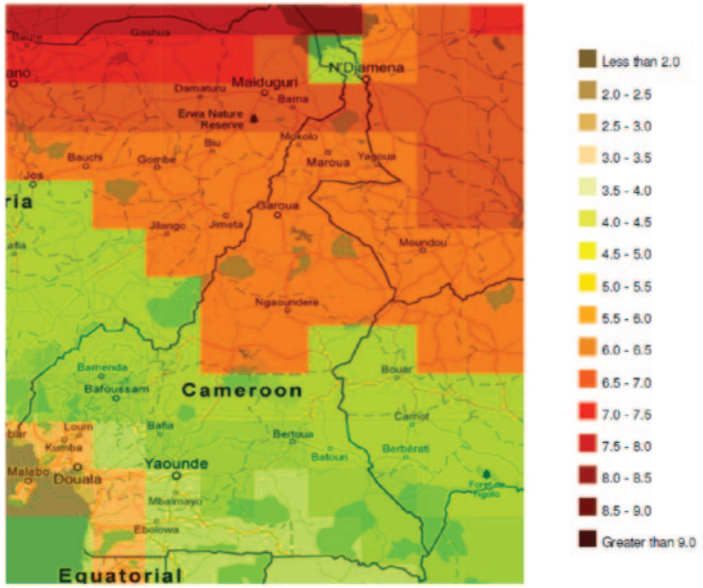
Source: maps.nrel.gov/swera

Context for Cameroon

Highlights:

- Average solar radiation ranging from 4.9 to 5.8 kWh/sq. m/day.[20]
- Solar power currently being used in distributed off-grid installations and majorly deployed to power the telecom towers.

Figure 11: Solar Radiation Map – Cameroon



Source: maps.nrel.gov/swera

19 Senegal Energy profile – Reegle
20 Cameroon Energy profile – Reegle

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Green Fit for Telecom: Availability vs. Acceptance

Country	Availability	Reliability	Market Acceptance	Supply Chain Readiness	Policy Framework
Senegal	Very Good	Good	Very Good	Good	Yes, but not specific to Telecom
Cameroon	Very Good	Good	Very Good	Good	Yes, but not specific to Telecom

Green Fit for Telecom: Potential vs. Adoption

Country	Stage of Adoption	Resource Potential	Barriers to Adoption	Risks of Adoption	Commercial Viability
Senegal	Commercial	High	■ Higher pricing of solar power systems leading to huge CAPEX requirements ■ Lack of regulatory support and clear guidelines for green power adoption	■ Operational risk in terms of local challenges of theft and breaking of solar panels	High
Cameroon	Commercial	High	■ Higher pricing of solar power systems leading to huge CAPEX requirement ■ High load in multi-tenant scenario for tower companies ■ Availability of local support for spare parts and Support from O&M partners for maintenance	■ Operational risk in terms of local challenges of theft and breaking of solar panels ■ Local support and availability of spares	High

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3.1.2. Green Choice: Wind

Wind is one of the traditional green energy resources and established as a cost effective source of green energy on megawatt (MW) scale deployments. Its adoption for small scale distributed energy generation has been hindered due to higher regular maintenance costs, low reliability due to variability in wind speed characteristics and risks of investment.

Context for Senegal

Highlights:

- The coastal areas of Senegal have good wind speeds compared to the inland areas.
- Average wind speeds ranging from 4.2 m/s in the southern coast to 5.8 m/s in the northern coast of Senegal.[21]
- Average wind speeds of 2-3 m/s in inland areas of Senegal.[21]
- Recent focus has been on megawatt scale deployments in the coastal regions by IPPs.

Figure 12: Wind Resource Map – Senegal

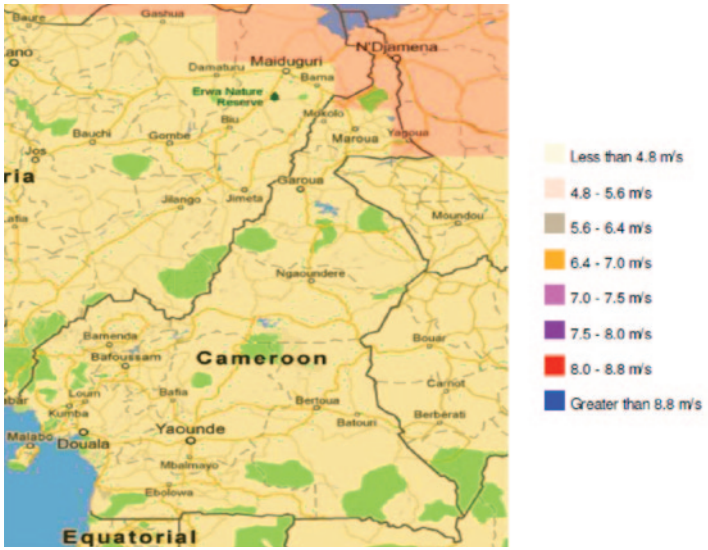
Source: maps.nrel.gov/swera

Context for Cameroon

Highlights:

- Overall, the wind resources in Cameroon do not present a good potential for deployments in telecoms except for some areas of the far north region where the average wind speeds are in the range of 4-5 m/s

Figure 13: Wind Resource Map – Cameroon



Source: maps.nrel.gov/swera

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Green Fit for Telecom: Availability vs. Acceptance

Country	Availability	Reliability	Market Acceptance	Supply Chain Readiness	Policy Framework
Senegal	Poor	Poor	Very Poor	Poor	No
Cameroon	Very Poor	Poor	Very Poor	Poor	No

Green Fit for Telecom: Potential vs. Adoption

Country	Stage of Adoption	Resource Potential	Barriers to Adoption	Risks of Adoption	Commercial Viability
Senegal	Pre-pilot	Low (Except Coastal region)	■ Low resource availability ■ Reliability of power generation	■ Low energy resource and unreliable wind speeds	Low
Cameroon	Pre-pilot	Low (Except Northern region)	■ Low resource availability ■ Reliability of power generation	■ Low energy resource ■ Unreliable wind speeds and change of wind direction by season	Low

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3.1.3. Green Choice: Biomass

The biomass technology is traditionally available and has been gaining adoption with innovative use of biomass options. The adoption of biomass for telecom application however, presents its own challenges in terms of operational complexity and scalability, supply integration and sustainability.

Context for Senegal and Cameroon

Cameroon has the third largest biomass potential in Sub-Saharan Africa with 3/4 of its territory covered by forests. Proper technology and a sustainable use of the country's tremendous biomass resources could help address some of the energy challenges rural off-grid population face.

Senegal has moderate biomass resources mainly used as firewood for household consumption. However, the lack of technology has resulted unsustainable as the use of biomass resources has been causing a deforestation of over 16 ha of forests. Biomass accounts for 42% of Senegal's final energy use.[22]

The market fit for biomass is presented below.

Green Fit for Telecom: Availability vs. Acceptance

Country	Availability	Reliability	Market Acceptance	Supply Chain Readiness	Policy Framework
Senegal	Poor	Good	Very Poor	Poor	No
Cameroon	Good	Good	Very Poor	Poor	No

Green Fit for Telecom: Potential vs. Adoption

Country	Stage of Adoption	Resource Potential	Barriers to Adoption	Risks of Adoption	Commercial Viability
Senegal	Pre-Pilot	Medium	■ Unavailability of vendors and technology adoption ■ Operational complexity and Supply challenges ■ Pre-pilot stage and unproven operational feasibility	■ Biomass supply and sustainability	Medium
Cameroon	Pre-Pilot	High	■ Unavailability of vendors and technology adoption ■ Operational complexity and Supply challenges ■ Pre-pilot stage and unproven operational feasibility	■ Biomass supply and sustainability	Medium

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3.1.4. Green Choice: Fuel Cell

Over the years, fuel cell technology has seen various innovations including the fuel types and generation technology. Fuel cells based on hydrogen are most popular and the cleanest type of fuel due to its 100% burning characteristics. However, its adoption is hindered due to high initial CAPEX, availability and supply of fuel and high replacement cost of stack (almost 25-30% of CAPEX). On-site hydrogen fuel generation is an alternative option to consider for countries without reliable fuel supply chain; however the technology and pilot demonstration haven't reached to telecom application in this region.

The hydrogen fuel supply chain is not yet established in both Senegal and Cameroon to make use of the fuel cell technology for distributed electricity generation suitable for telecom applications. It would require a considerable effort from the technology providers and vendors to develop the eco-system in order to establish the use of fuel cell for on-site power generation and back up applications in telecom sector.

The market wise fit for fuel cell is presented below.

Green Fit for Telecom: Availability vs. Acceptance

Country	Availability	Reliability	Market Acceptance	Supply Chain Readiness	Policy framework
Senegal	Poor	Good	Poor	Poor	No
Cameroon	Poor	Good	Poor	Poor	No

Green Fit for Telecom: Potential vs. Adoption

Country	Stage of Adoption	Resource Potential	Barriers to Adoption	Risks of Adoption	Commercial Viability
Senegal	Pre-Pilot	Low	■ Inhibition from using hydrogen fuel tanks in the premises due to perceived safety issues ■ High initial CAPEX and Fuel supply challenges ■ OPEX Savings not yet established	■ Reliability of fuel supply and replacement cost of fuel cells	Low
Cameroon	Pre-Pilot	Low	■ Inhibition from using hydrogen fuel tanks in the premises due to perceived safety issues ■ High initial CAPEX and Fuel supply challenges ■ OPEX Savings not yet established	■ Reliability of fuel supply and replacement cost of fuel cells	Low

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3.1.5. Green Choice: Hydro (Pico)

Hydro power is the most traditional form of clean energy however its adoption for small scale distributed power applications has been limited due to availability of technology and suppliers. Other challenges for telecom application include the availability of water body resources adjacent to or near to the site location. The CAPEX requirements and potential business case for telecom applications is yet to be known.

Cameroon has the second largest hydro-electric potential in Sub-Saharan Africa with a total estimated potential of 23 GW. The potential for micro-hydro up to 1MW is yet to be exploited despite an estimated 1.115 TWh of electricity generation potential present in Eastern and Western regions of Cameroon.[23]

The market fit for pico-hydro is presented below.

Green Fit for Telecom: Availability vs. Acceptance

Country	Availability	Reliability	Market Acceptance	Supply Chain Readiness	Policy framework
Senegal	Poor	Good	Very Poor	Very Poor	Yes, But not yet for small scale telecom applications
Cameroon	Good	Good	Very Poor	Very Poor	Yes, But not yet for small scale telecom applications

Green Fit: Potential vs. Adoption

Country	Stage of Adoption	Resource Potential	Barriers to Adoption	Risks of Adoption	Commercial Viability
Senegal	Pre-Pilot	Low	■ Low market awareness ■ Availability of water body close to tower locations ■ Cost of technology ■ Regulatory clearance	■ Operational risks associated with limited knowledge and readiness	Not Established
Cameroon	Pre-pilot	Medium	■ Low market awareness ■ Availability of water body close to tower locations ■ Cost of technology ■ Regulatory clearance	■ Operational risks associated with limited knowledge and readiness	Not Established

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3.1.6. Green Choice: Summary

The overall summary of green options and their level of suitability for telecoms in Senegal and Cameroon is presented below.

The choice of green technology would also depend on the availability of technology vendors along with local technical support. The MNOs and Tower Companies in both Senegal and Cameroon have a limited number of both vendor choices and local technical support for maintenance and repair.

Summary of Green Choices: Potential Choice for Telecoms in Senegal and Cameroon

	Solar	Wind	Biomass	Fuel Cell	Pico-Hydro
Senegal	High	Low	Low	Low	Low
Cameroon	High	Low	Medium	Low	Medium to Low

3.2. Green Telecoms: The Current Green Deployments

The MNOs in both Cameroon and Senegal have been in the forefront in terms of adopting green power alternatives for powering their networks.

Both the major operators in Cameroon, namely MTN and Orange have been driving the deployment of solar power systems for their network in order to reduce energy OPEX for running their off-grid network by reducing the dependence on diesel power. 182 off-grid sites in Cameroon are deployed with solar power systems accounting for approx. 34% of its total off-grid network of 533 sites. 2 sites in the on-grid network are deployed with grid-solar-DG hybrid power solution.

The green power adoption in Senegal is mostly driven by Sonatel-Orange while other major operators are yet to grow green power deployments at scale. 215 sites in Senegal are deployed with solar power systems accounting for approx. 25% its entire off-grid network of 850 sites.

3.3. Green Telecoms: The Opportunity and Potential Size

The off-grid network in both countries presents an excellent opportunity for converting them to green power sites. The graph below represents the network in terms of grid-connectivity and reliability grid power supply.

The majority of grid-connected sites have relatively good grid power supply with average daily power outages ranging between 4 and 12 hours in both Cameroon and Senegal. However, the grid power connectivity is restricted to major cities and towns.

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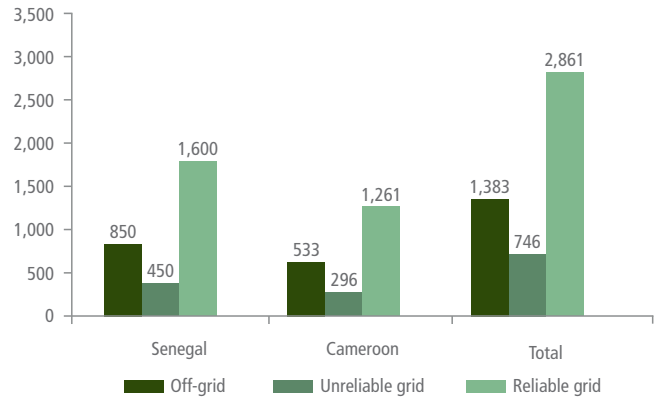
Figure 14: Break-up of sites by grid status (numbers, overall %)[24]



GPM estimates that, Cameroon and Senegal combined present an opportunity of 793 sites for green power deployments. This constitutes 10% of the unreliable-grid network and 52% of the off-grid network of sites. The respective green opportunity for both Senegal and Cameroon is illustrated below.

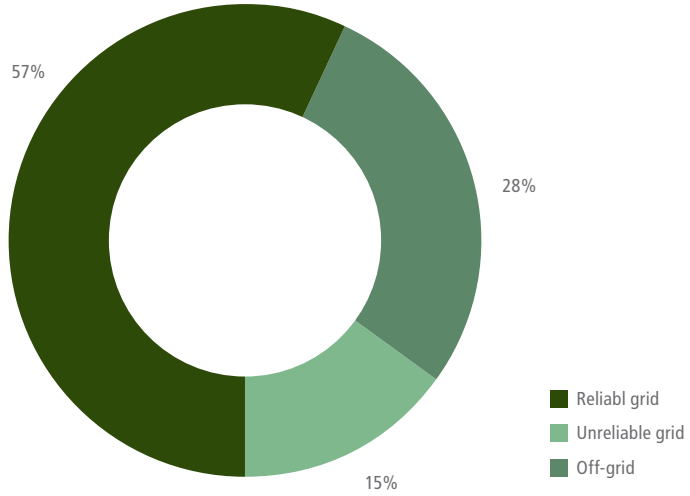
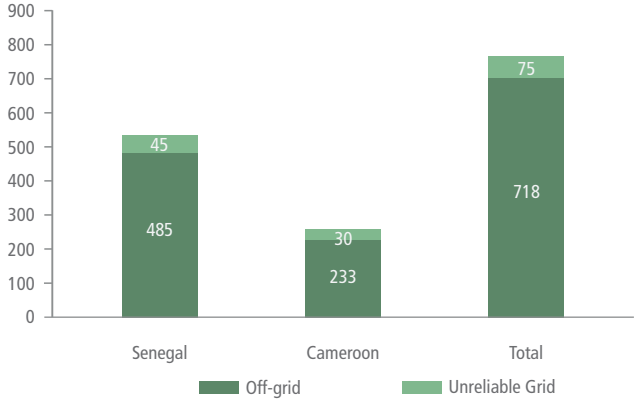


Figure 15: Green Power potential (No. of sites)[25]



The above estimates are based on current powering status of the network and site parameters including average load characteristics of the network.

3.3.1. OPEX Savings Potential

GPM estimates that the implementation of the green power alternatives for 793 potential sites would save around USD11.4 million in OPEX and reduce diesel consumption by 67% from current levels. The payback period would be around 2.8 years with an initial investment of approximately USD 41,000 per site.[21]

The estimate is based on sizing of the solar-hybrid power systems for the current load requirements considering an average DG run of 3 hours per day.

24 GSMA GPM market research and analysis
25 GPM Analysis based on market data

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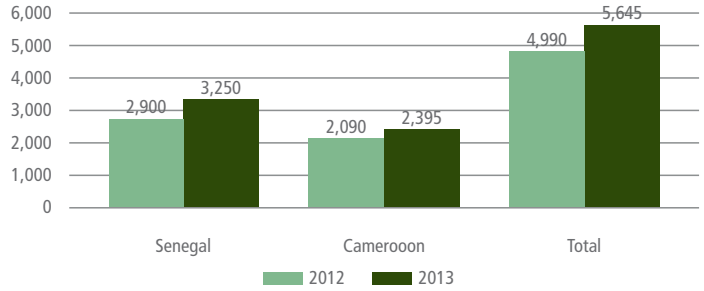
4. Powering Telecoms: The way forward

4.1. Growth forecast and Powering outlook

4.1.1. Short term

In the short term, the size of the mobile networks in both Senegal and Cameroon is expected to reach 5,465 sites, growing at 13.1% from the current level of 4,990 sites. The short term growth outlook for mobile network in both Senegal and Cameroon is presented below.

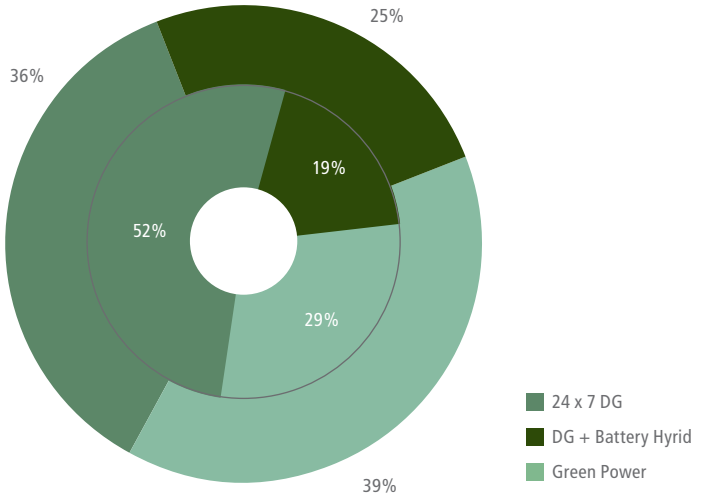
Figure 16: Growth (No. of sites) – short term



In the short term, operators and tower companies would look at implementing battery hybrid solutions at both on-grid and off-grid sites in order to reduce the dependence on diesel generator thus reducing the energy OPEX.

The opposite graph illustrates the short term trend in powering the off-grid sites in the region.

Figure 17: Powering Outlook – short term



Note: The inner ring of the graph represents the current scenario in 2012 and the outer ring represents the short term scenario for 2013.

In the short term, during the year 2013, the share of green power and DG-battery hybrid deployments is expected increase to 39% and 25% respectively from the current levels of 29% and 19%. The number of sites powered by 24x7 DG solutions would reduce to 36% from the current level of 52%.

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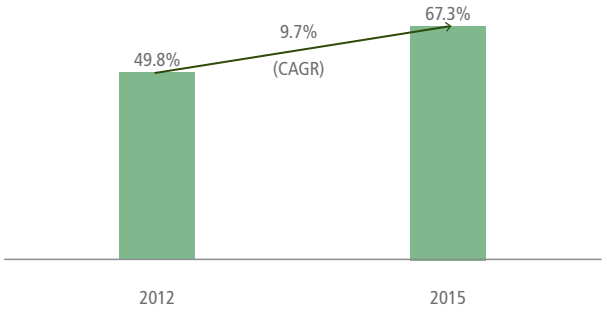
4.1.2. Long term

In the long term, the number of telecom tower sites is estimated to reach 6,589 sites by 2015 at a cumulative annual growth rate of 9.7%. This requires an additional of 1,599 sites to be deployed in both Senegal and Cameroon over the next three years.

Figure 18: Growth (No. of sites) – long term



The estimate is based on the long term market outlook for Senegal and Cameroon taking into account current penetration and coverage levels, network capacity and other demographic characteristics including population and density of population.

As a long term strategy, in addition to considering green power alternatives, MNOs and tower companies are focusing on optimizing the power requirements of the network through various energy efficiency initiatives including site load optimization, power system and network optimization. This is to ensure that both economic and environmental objectives are met through OPEX reduction and reduced CO_2 emissions.

4.2. Powering Telecoms: Future trends and Model innovations

In the following sections, GSMA highlights some of the future trends in the telecom infrastructure market and possible innovations driving the industry towards more sustainable and positive environmental impact.

4.2.1. Structural change: Leading to Tower Company

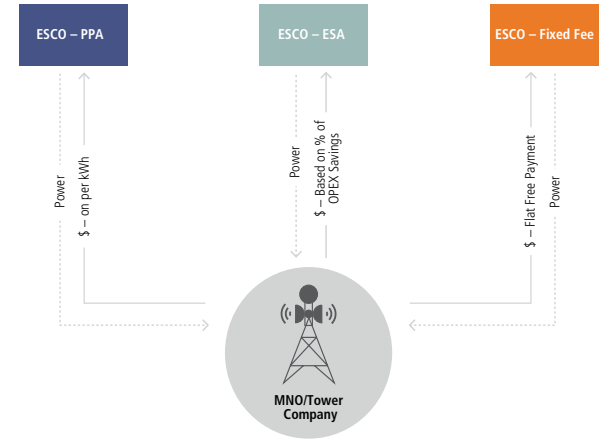
Cameroon is in the forefront adapting the tower outsourcing model with the recent entry Africa focused Tower Company, IHS Towers Africa. IHS Towers now owns and manages the tower assets of MTN and Orange, the two major MNOs in Cameroon. Tower sharing is expected to pick up in near future by expected expansion in network capacities and also, with expected entry of Cameroon's third GSM operator.

Senegal, on the other hand, has all its towers owned and managed by respective MNOs. The mobile industry is yet to see the entry of any major Africa focused Tower Companies.

4.2.2. Supply Model Innovation: Emergence of Energy Service Company (ESCO)

In the ESCO model, the energy service company would completely own onsite power generation and supply of power to the base station sites thus reducing the burden of deploying and managing the power plant which currently is the responsibility of the network operator or tower company.

Figure 19: 3rd party ESCO business models



PPA – Power Purchase Agreement
ESA – Energy Savings Agreement
Fixed Fee – Monthly Fixed payment

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Different business models exist including the fixed price model, power purchase agreement (PPA) model and energy service agreement model (ESA). However, of the three models, the PPA model is the most popular and simple in terms of managing the terms and SLAs. In the PPA model the ESCO provides energy on a per kWh basis based on an agreed PPA price.

The Revenue Opportunity for an ESCO model based on PPA

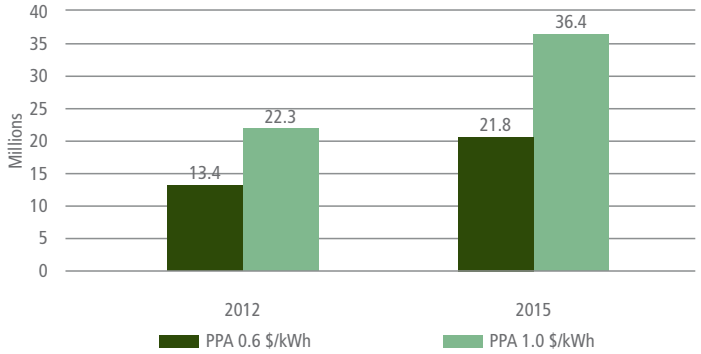
GPM estimates that a total of 905 sites would present potential opportunity for a 3rd party energy outsourcing model.[26] The estimate is based on the current powering scenario including off-grid and unreliable-grid network and its associated costs.

The corresponding market potential for an ESCO is USD13.4 million revenue generation every year at a PPA rate of USD0.6/kWh. The market potential only include the opportunity for providing power to the telecom tower and does not include the community power opportunity for the 3rd party energy service company.

The ESCO market revenue potential would grow to USD21.8 million per annum corresponding to over 1,525 potential sites by 2015.

The corresponding ESCO market potential would increase to USD22.3 million in 2012 and USD36.4 million by 2015 if the PPA rate is USD1.0 /kWh

Figure 20: Market Potential (Revenue) – 3rd party ESCO business model



Investment, Payback and IRR for an ESCO

The third party ESCO would be achieving an IRR of 25-31% for the investment and a payback period of 3-3.5 years based on the expected investment. The current investment required for an ESCO would be around USD45 million for the 905 potential sites as of 2012 and an additional investment of USD31 million over the next three years to realize the potential revenue opportunity by 2015.[26]

4.2.3. Services Innovation: Community Power

With the majority of the population living in areas without access to electricity, the ubiquitous mobile telecoms infrastructure presents excellent synergies in delivering energy services to the community while complementing the mobile services provided by the telecom operators.

The community power model based leveraging the mobile industry presents an excellent opportunity for a third party ESCO, providing a bigger market for energy services. In this model, the telecom site acts as an anchor load, whilst providing energy supply to the adjacent communities through charging based energy hubs or establishing mini-grids to supply energy to the communities.

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5. Conclusion

Cameroon and Senegal have achieved a good level of renewable energy deployments in the telecom industry led by the major MNOs. However, both the markets present an opportunity for further green deployments on existing off-grid and unreliable-grid network.

The future growth of network in off-grid regions will present a further opportunity for potential green deployments. There is a need for favourable regulatory environment to address some of the challenges for future green deployments in the industry.