IFC International Finance Corporation World Bank Group

GSMA Green Power for Mobile

In partnership with the Netherlands

Tower Power Africa: Energy Challenges and Opportunities for the Mobile Industry in Africa

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Glossary:

MNO: Mobile network operator or mobile operator

Tower Company (Tower Co): A company that manages a part or the entire assets of a telecom tower.

ESCO: Energy Service Company that provides end-end energy services and supplies power to telecom towers and/or community and businesses on a agreed pricing and business model.

Mobile Coverage: Coverage (of population or land) by mobile network signal

Mobile (unique) Subscribers: Number of people having subscribed to atelast one mobile service or connection

Mobile Connections: Number of active connections (including mulptiple SIMs per user)

CAPEX Model: Mobile Operator or Tower Company invests CAPEX of their own to rollout the renewable solution.

OPEX Model: An ESCO invests CAPEX to generator power at site level and sells power to MNO or Tower Co

Tenancy Ratio: A tenancy ratio is expressed as a fraction of the total number of operators sharing towers/total number of sites present.

Site: Mobile tower site or Mobile base station site

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

Bad-grid/Unreliable grid: Sites with power outages in excess of 6 hours per day on an average

Grid: Electricity Utility Grid

DG: Diesel Generator

IRR: Internal Rate of Return is the Rate of Return of an Investment.

OPEX: Operational Expenditure

CAPEX: Capital Expenditure

ROI: Return on Investment

kWh/ MWh / GWh / TWh: Kilo Watt Hour / Mega Watt Hour / Giga Watt Hour / Tera Watt Hour

GW / MW: Giga Watt / Mega Watt

PV: Photo voltaic

CSP: Concentrated Solar PV

RE: Renewable energy

Green Power: Power produced from any renewable energy technology such as Solar, Wind, Fuel cell etc.

GHG: Green House Gas (CO2)

CAGR: Cumulative Annual Growth Rate

ARPU: Average Revenue per User of mobile services

PPA: Power Purchase Agreement

FIT: Feed-in Tariff offered by power utilities for grid connected or mini-grid power projects

Executive Summary

The mobile telecommunications industry in Africa is in a transitional phase with changing industry structure and dynamics. Africa currently has over 800 million mobile connections and nearly 450 million unique subscribers. The coverage of mobile network has varying range from 10% to 99% across countries in Africa with an average of 70% mobile coverage.

Despite the huge growth and potential future opportunity, the mobile industry in Africa faces many challenges – both infrastructural and operational.

1. The mobile operators face challenges to power their existing networks, both off-grid and on-grid, because of unreliable power supply and heavy reliance on expensive diesel power to power up their existing networks.
2. The mobile operators face infrastructure challenges to expand mobile coverage to uncovered population (majority of which live in rural and remote areas without access to grid electricity and road infrastructure) owing to higher operational costs and poor ROI.

The mobile networks in Africa have grown beyond the reach of grid electricity and mobile operators have deployed a significant part of their tower infrastructure in areas without any access to grid electricity infrastructure. According to GSMA analysis and estimates, Sub-Saharan Africa has a total of over 240,000 towers across countries providing mobile coverage to 70% of the region's population. The size of the tower portfolio is expected to grow to over 325,000 towers by 2020. Majority of telecom tower sites in Africa are deployed in either off-grid areas or problematic grid areas with unreliable power supply. Africa currently has an estimated 145,000 off-grid sites which is expected to grow to 189,000 sites by 2020. The number of bad-grid sites is expected to grow from 84,000 in 2014 to over 100,000 sites by year 2020.

Energy costs constitute a major chunk of network OPEX for mobile operators in Africa. For a typical tower site in Africa, the share of energy costs is as high as 40% of the overall network OPEX. An off-grid site consumes nearly 13,000 liters of diesel every year, at an average annual energy OPEX of over US$ 21,000 and adds nearly 35 metric tons of CO2 emissions to the environment. An unreliable-grid site consumes around 6,700 liters of diesel and produces 18 metric tons of CO2 emissions to the environment. Further to the above costs of diesel power, there is an additional 10-15% cost due to diesel pilferage which is very common practice in many countries across Africa.

A 60-70% reduction in CO2 emissions by way of adopting green power alternatives for telecom towers would result in an annual OPEX savings of nearly US 17,000 per site and would require an initial investment of US$ 42,000 per site with an ROI of over 35% and payback of less than 3 years. This presents a huge opportunity for mobile operators and investors to positively look into green power as a viable alternative to power mobile telecom networks.

Africa has huge renewable energy resource potential to be exploited especially owing to its tremendous hydro, solar, wind and bioenergy resources across the continent. However, with its imminent challenges, the mobile industry in

Africa is far from capitalizing on its tremendous potential presented by green power alternatives. Africa currently has a total of less than 4,000 sites deployed with green power alternatives.

Limited investment capital, dearth of sustainable business models, lack of impetus from government and regulators, limited collaborative efforts within the industry have handicapped the scaling of green power alternatives in telecoms across Africa. The changing industry structure has also greatly impacted the pace of green adoption over the past few years.

A crucial driver of the conversion to greener alternatives will be Energy Service Companies (ESCOs) that provide energy to towers owned by Mobile Network Operators (MNOs) and dedicated Tower Companies (Tower Cos). Many MNOs across Africa are in the process of selling of their tower assets, including the energy infrastructure. This trend, brought on by a strong imperative to cut network deployment and operating costs, is expected to intensify in the future.

Introduction

Africa, with a population of over 1.1 billion, is home to over 800 million mobile connections and nearly 450 million unique subscribers.[1] Sub-Saharan Africa alone accounts for 75% of the unique subscribers in the continent. However, the population coverage of mobile networks in Africa stands at an average of 70%; leaving around 300 million people without access to mobile communications infrastructure. The coverage of mobile network has varying range from 10% to nearly 99% across countries in Africa. Within the context of achieving universal access to mobile communications, Africa presents a significant growth opportunity for the mobile industry over the coming years.

However, the mobile industry in Africa faces many challenges – both infrastructural and operational, to operate the mobile networks in a cost effective manner. The abysmal grid electricity infrastructure is one of the major challenges in running the networks and adds a significant cost to operations. Africa has one of the lowest electrification rates in the world with only 43% of the population having access to grid electricity, leaving over 600 million people without access to electricity.[2] In addition, wherever there is access to grid electricity infrastructure, the supply of electricity is highly unreliable with frequent and long outages.

Regardless of the challenges faced, the mobile networks in Africa have grown beyond the reach of grid electricity and mobile operators have deployed a significant part of their tower infrastructure in areas without any access to grid electricity infrastructure. Limited grid electricity infrastructure combined with inadequate electricity supply capacities has forced mobile operators to rely on alternative power sources such as diesel generators to power up their networks – both on-grid and off-grid.

The reliance on diesel based power alternatives has hugely increased the cost of operations for their existing networks due to the higher cost of diesel power, the regular maintenance of power equipment and diesel generators. This has greatly impacted the ROI of existing network investments for operators in the region and also hindered MNOs to expand their networks into rural and remote areas.

Therefore, the infrastructural challenges for MNOs in Africa two fold – one, to cost effectively power their existing network and two, to cost effectively expand network coverage to population currently without access mobile communications infrastructure. In addition to the infrastructure challenges, MNOs also face many operational challenges including the theft of diesel, equipment vandalism and site security.

The poor supporting infrastructure and the operational complexities across Africa have hugely impacted the OPEX of mobile networks and hence, the cost of services for the end users. Cost-effective energy alternatives and reduced risks of operations have a great implication for increasing the coverage and subscriptions across countries in Africa.

[1] GSMA Intelligence
[2] IEA – Access to Electricity database 2013

Mobile operators in Africa have focused on addressing the energy challenges by adopting alternative renewable energy sources, such as solar, wind, biomass and fuel cell, in order to reduce the cost of energy as well as to address some of the operational challenges in powering their tower sites. However, the adoption of green power alternatives has not reached the possible potential scale due to many reasons including the changing industry landscape, unfavourable regulatory environment, inadequate funding and limited technical resources.

Given the huge opportunity for growth and the imminent challenges, the report tries to bring clear understanding of the current state of mobile and energy infrastructure in Africa and to identify possible alternatives for cost-effectively powering mobile networks in Africa. In the following sections, the report also looks at the changing industry structure as well as regulations and their impact on scaling the adoption of green energy in powering telecoms infrastructure and therefore, improving access to mobile communications across the continent. The geographical scope of this report is limited to Africa and majorly Sub-Saharan Africa.

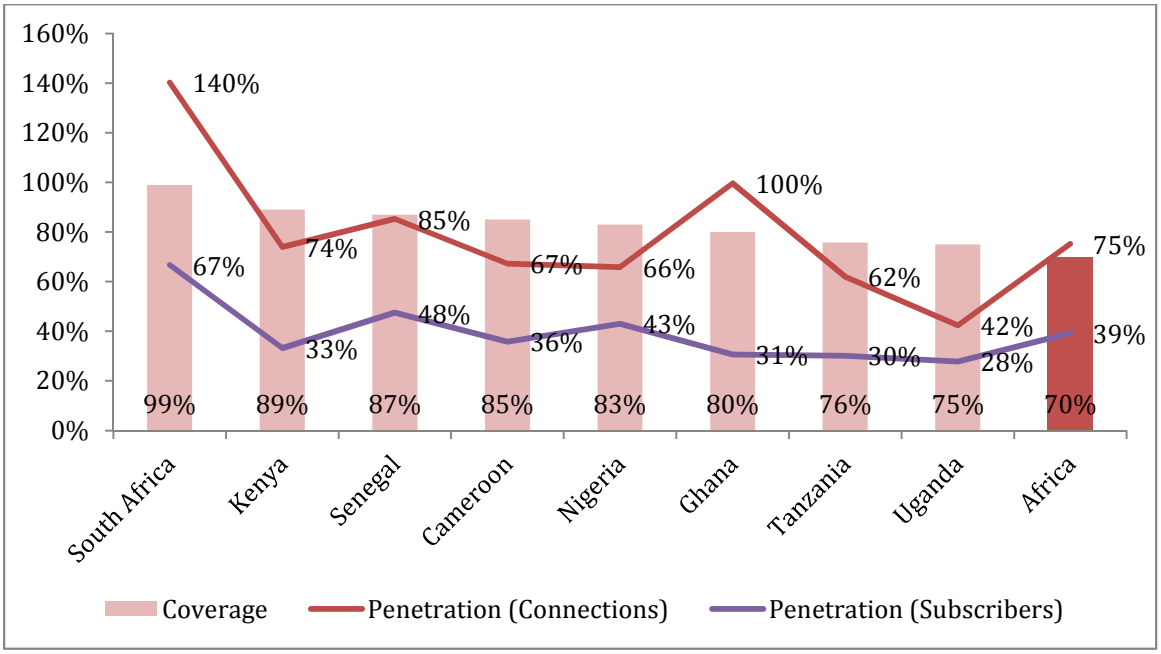
Industry Context: Mobile Networks Growth in Africa

Mobile Network Coverage and Subscriber Growth

Mobile networks in Africa have grown beyond the limited reach of other basic supporting infrastructure such as grid electricity and road transport. MNOs in the region have invested significantly in expanding network coverage to reach an average of 70% of the population across countries in Africa. This is a tremendous growth from the coverage level of 37% in 2009.[3] The average mobile network coverage (2G) across Africa is expected to reach to approximately 85% by year 2019.[4]

However, with nearly 450 million unique subscribers and a subscriber penetration of less than 40%, Africa has one of the lowest mobile subscription levels in the developing world. The low subscription levels can be attributed various factors including demographic, economic and regional. The higher cost of services in Africa is one of the factors affecting the subscriptions in semi-urban and rural areas despite presence of mobile network coverage.

Figure 1: Mobile Coverage and Subscriber Penetration



Nigeria is the largest market by mobile connections and unique subscribers in Sub-Saharan Africa followed by South Africa and Kenya. South Africa leads in mobile network coverage with 99% of its population having access to mobile network signals.

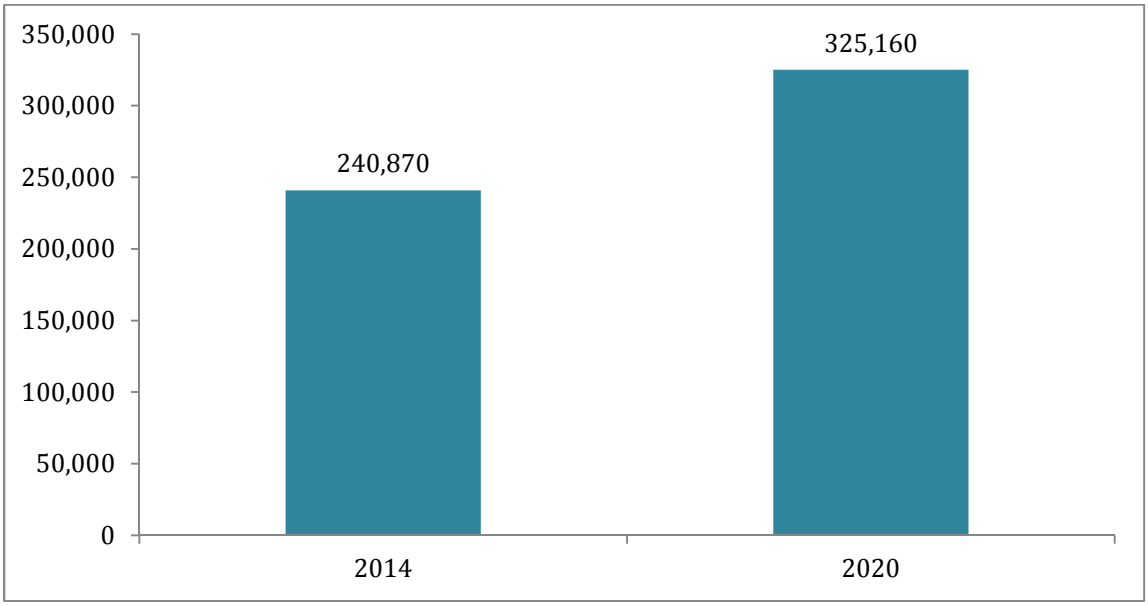
[3] GSMA Intelligence Analysis
[4] Ericsson Mobility Report 2014

Expansion of mobile network coverage will require a huge investment in network infrastructure including both active network equipment and passive tower infrastructure. Passive infrastructure, including tower and power, forms a major chunk of investment in expanding the mobile networks. In addition to the huge CAPEX investment in networks, the costs of operations remain very high in African countries, especially owing to the higher costs of providing energy to the base station sites.

Size of Mobile Networks (No. of Tower sites) and Growth

The size of the mobile network (number of tower sites) has tremendously grown to support the growth in coverage levels across the region. According to GSMA analysis and estimates, Sub-Saharan Africa has a total of over 240,000 towers across countries providing mobile coverage to 70% of the region's population. The size of the tower portfolio is expected to grow to over 325,000 towers by 2020.

Figure 2: Size of Mobile Networks in Sub-Saharan Africa (Number of Towers)

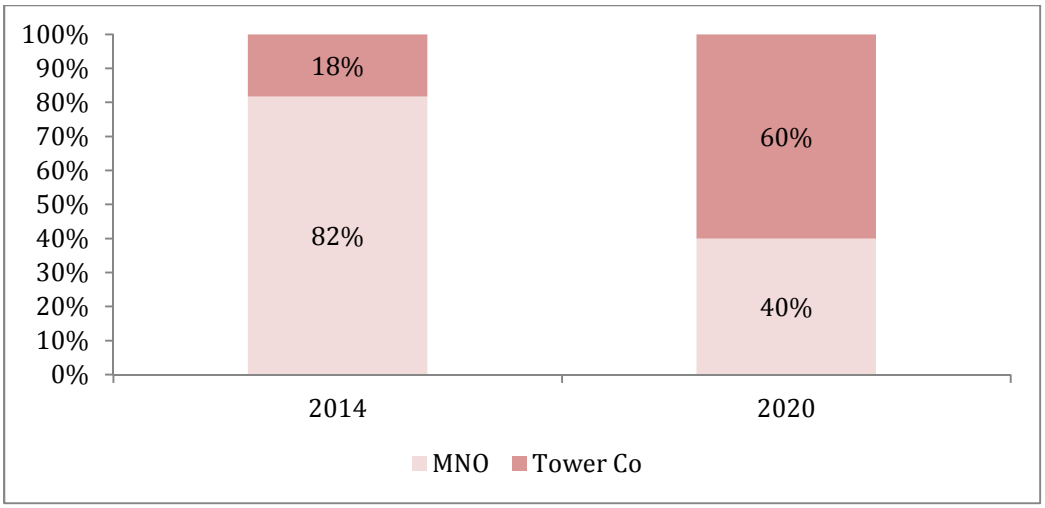


South Africa leads the table with more than 35,000 towers, followed by Nigeria with more than 30,000 towers.

Industry Structure and Changing Tower Ownership

The telecom tower industry in Africa is dominated by MNOs owning majority the towers. However, with the recent aggressive focus of Tower Companies in Africa has been leading to majority tower portfolios being transferred to Tower Companies as ownership or management contracts.

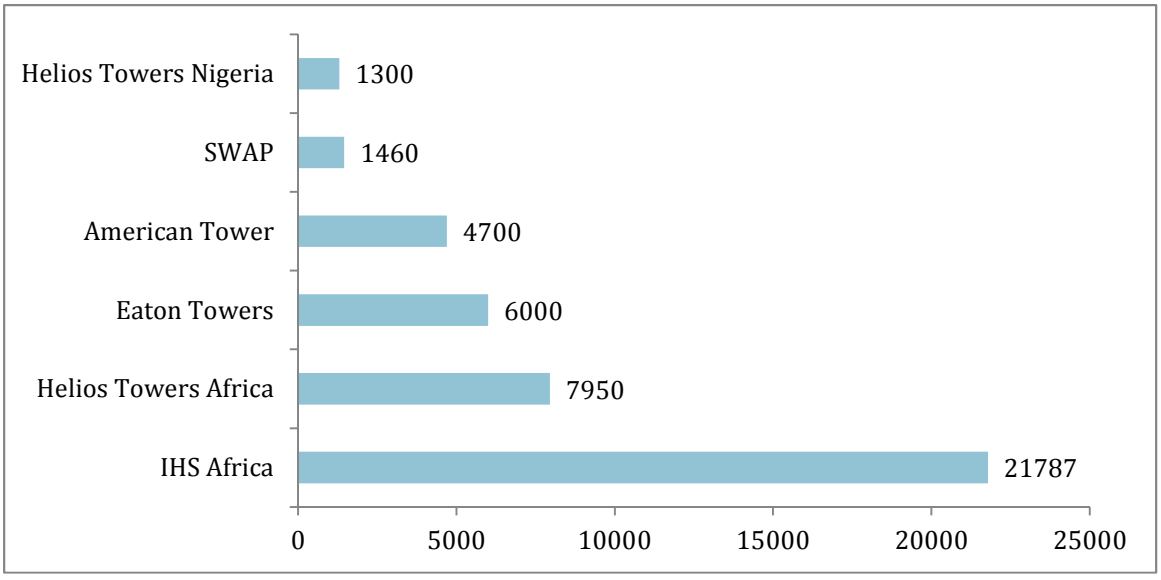
Figure 3: Tower Co share of total Tower Portfolio



Tower-sharing is more nascent in the African continent. Less than 20% of the current tower estate or about 44,000 towers are owned and operated by Tower Cos. But, change is likely to occur rapidly. According to industry estimates, additional 20,000-25,000 towers in Africa are likely to transfer from MNO-captive to Tower Co-owned and operated, by the end of 2014, increasing their share across Africa to almost 30%.

With many of the MNOs looking at offloading their tower assets, the ownership of towers by Tower Companies is expected to reach to 60% of the total towers by 2020. The major Tower Cos and their tower portfolio is illustrated below.

Figure 4: Major Tower Cos and their Tower Portfolio



IHS Africa leads the Africa Tower Co industry with over 20,000 towers under its portfolio owing to the recent deals with MTN and Etisalat in Nigeria. Helios Towers stands second with about 9,000 towers across Africa and Nigeria. Other

major Tower Cos include Eaton Towers (6,000 towers), American Tower Company (4,700 towers) and SWAP technologies (about 1500 towers). There is also an emergence small local Tower Cos across the continent, such examples being Tower Co of Madagascar, TASC in Middle East, Frontier Tower Solutions in Burundi, Infratel in South Africa.

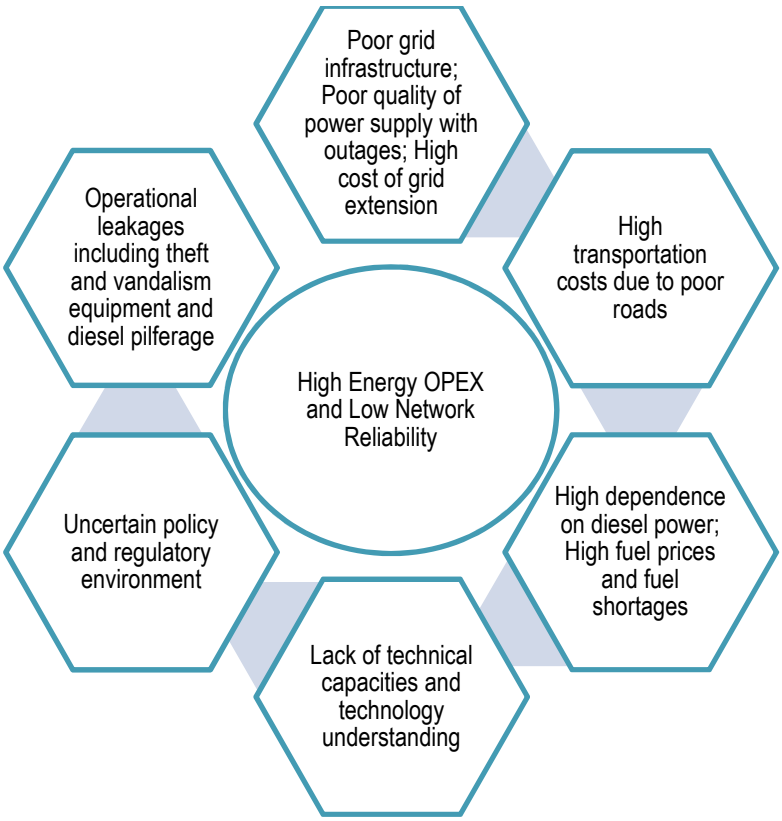
Operations Context and Challenges to Growth

Mobile Operators in Africa face many challenges to operate and run their mobile networks with expected benchmark uptime of 99.95%. In the recent years, there have been many instances of penalties being imposed by the regulators for poor service availability and deterioration in QoS. Majority of network downtime events are essentially attributed to failures in power supply to the site equipment.

Majority of the sites in Africa have diesel generators as backup power source which require regular maintenance visits. Site accessibility is a big challenge due to poor road infrastructure and difficult geographic terrains including mountainous regions. Grid connection costs are very high due to the costs involved in extending the grid infrastructure to most difficult site locations.

The overall operational context for MNOs is illustrated below.

Figure 5: Operational Context of Mobile Networks



Challenges for Operations and Growth of Mobile Networks in Africa

The key challenges faced by MNOs and Tower Cos in powering and operating their mobile networks in Africa are highlighted below.

Infrastructure and Operational challenges leading to Higher OPEX

- Poor or lack of grid electricity infrastructure increases energy OPEX of a site
- Limited or no road access infrastructure increase O&M costs of sites
- Higher cost of security and monitoring systems to protect assets and infrastructure to prevent diesel theft, equipment theft and vandalism of site equipment
- Lack of local skilled technical resources increases the costs operations

Business Challenges leading to poor economic viability

- High cost of network maintenance and operations including high cost energy for existing networks (especially in semi-urban and rural areas) leads to higher cost per subscriber and hence affects the affordability of services and lower subscriber penetration
- Low income levels and poor revenue potential in rural and remote regions affects the ROI and business case for mobile operators and hence hinders the expansion of mobile networks which require high CAPEX and OPEX

General technical Challenges

- Lower economies of scale (in terms subscribers per site) for network assets due to dispersed communities and lower density of population in rural regions of Africa
- Lack of local skilled technical resources increases the operational burden on operators in Africa
- Limited awareness and expertise on renewable energy technology is a challenge for operators across Africa
- Availability of committed local partners is a challenge which affects the efficiency of operations as well as the success of green power initiatives of operators
- Other challenges include site security, theft and vandalism of equipment, and diesel theft by local communities affect the reliability and predictability of network operations

Energy and Power Sector: Current State and Challenges in Africa

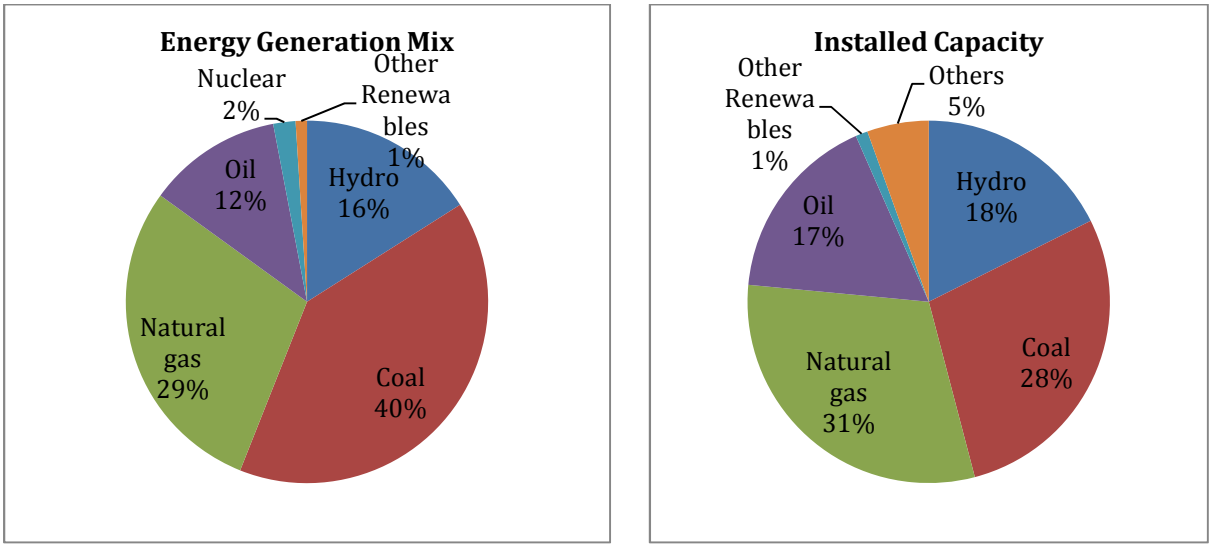
Despite tremendous resource potential, the power sector in Africa is characterized by insufficient generation capacities, inadequate transmission and distribution infrastructure, poor quality of power supply, and high reliance on fossil fuel based power generation. The main obstacle to the increase in electricity generation capacity is the high cost of producing electricity. Reducing the cost of generating electricity could significantly improve the overall energy supply in Africa.

Renewable energy could play a major role in optimizing the energy mix and improve access to electricity across Africa. In the following sections we take a look at the current state of energy supply infrastructure and underlying challenges affecting socio-economic growth across the region.

Current state of Energy Supply and Consumption

Africa currently has 147 GW of installed capacity, a level comparable to the capacity China installs in one or two years. Africa's annual power generation stands at 664 TWh of which Sub-Saharan Africa (excluding South Africa) accounts only for 145 TWh of annual generation.[5]

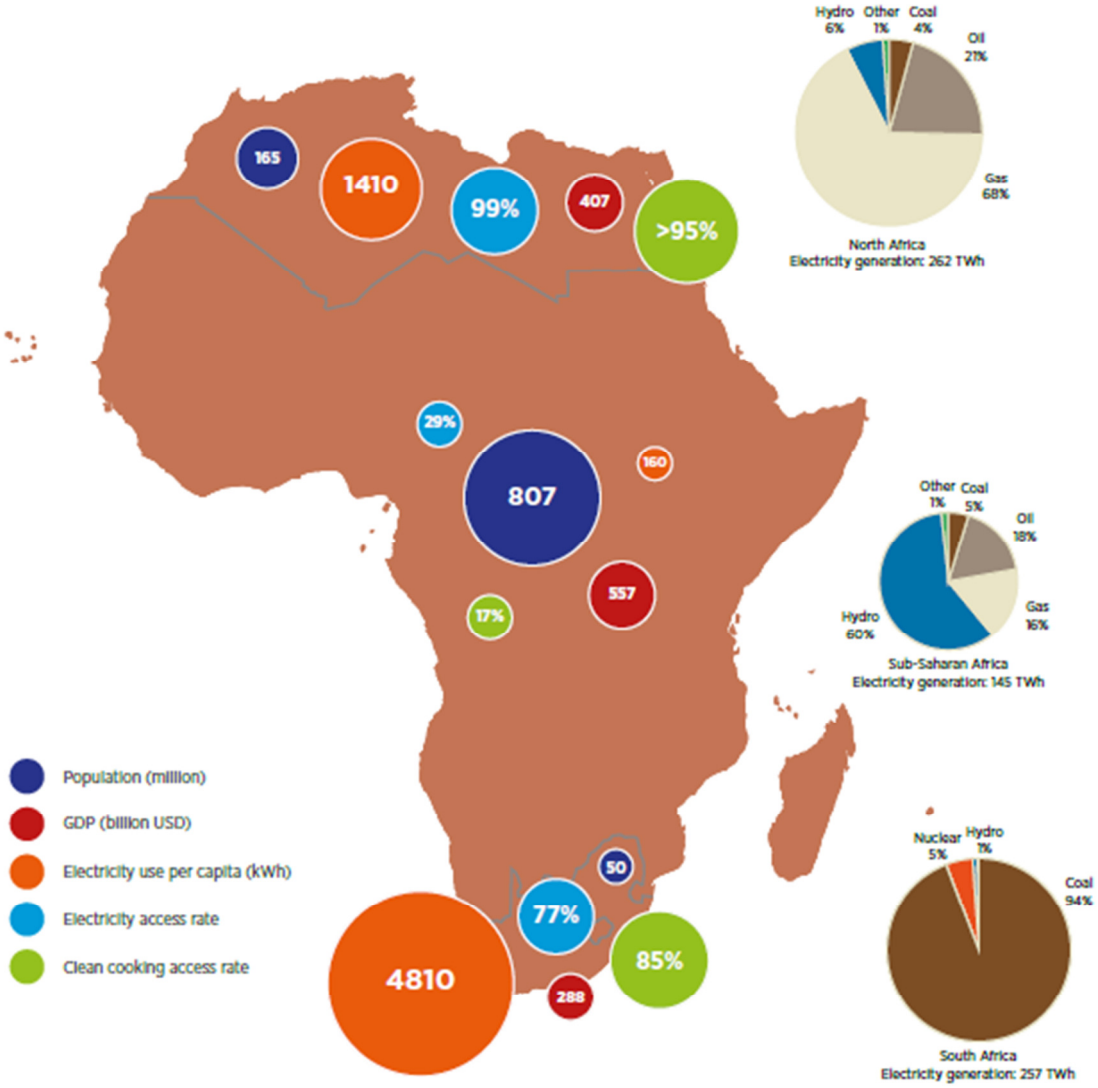
Figure 6: Power Generation Mix and Installed Capacity



At 28 MW per million installed capacity, Africa has one of the lowest average per capita electricity consumption in the world at 620 kWh per year. Average per capita electricity consumption in sub-Saharan Africa (excluding South Africa) is just 153 kWh per year. This is one-fourth of the consumption in India and just 6% of the global average.

[5] IRENA – Prospects for the African Power Sector

Figure 7: Electricity Generation, Access and Consumption in Perspective across Africa



Source: IRENA analysis (adapted)

To meet its growing demand Africa has an urgent need to raise the level of investment in its power sector. The continent will need to add around 250 GW of capacity between now and 2030 to meet demand growth. This will require capacity additions to double to around 7 GW a year in the short-term and to quadruple by 2030.[6]

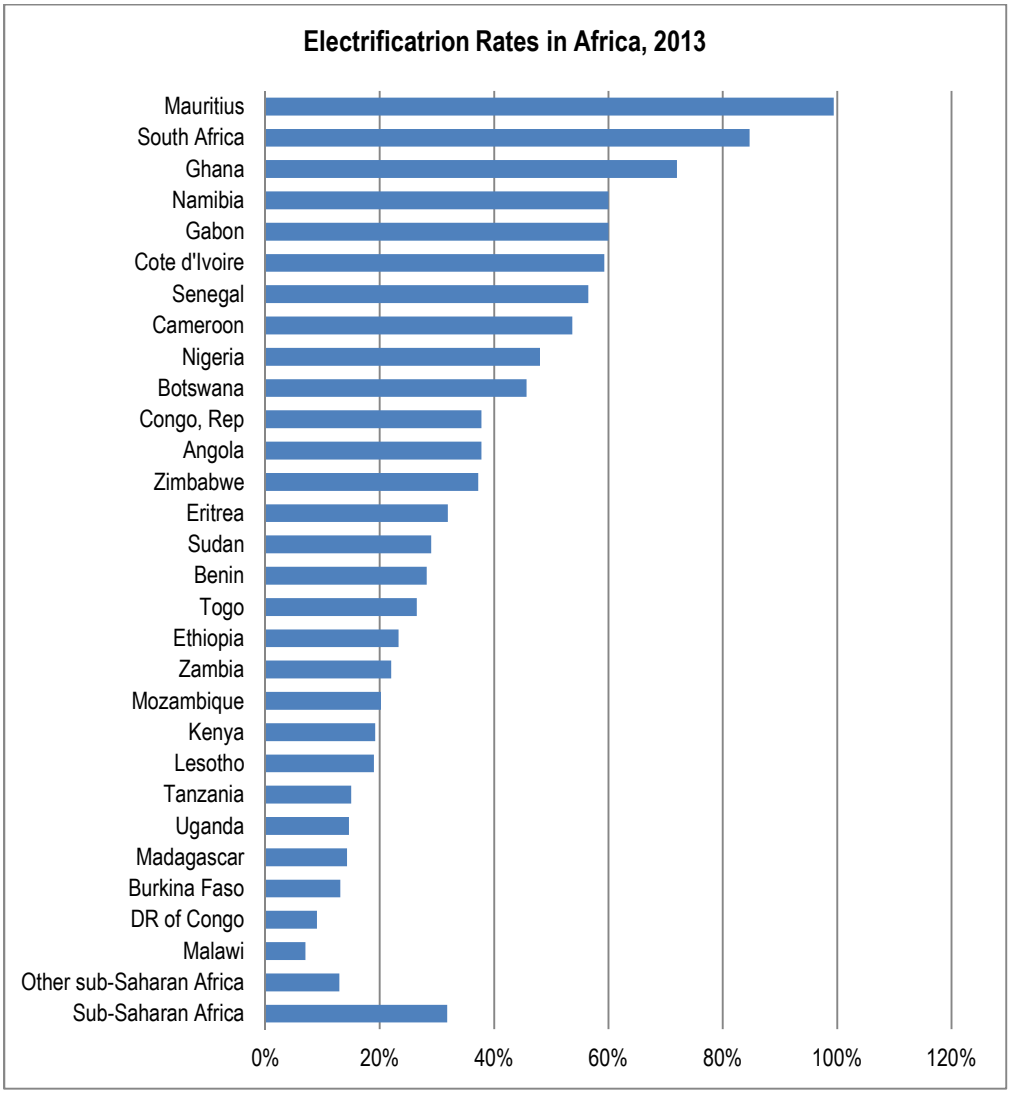
The magnitude of the investments required is such that governments will need public-private partnerships in order to scale up investment in generation capacity. Africa needs favourable business environment and robust policy framework to attract the level of private investment required to install the additional 250 GW by 2030.

[6] IRENA – Prospects for the African Power Sector

Electricity Infrastructure and Challenges

Nearly 600 million people in Africa lack access to electricity. The grid electrification rate in Africa stands at 43% of its population. The urban electrification is at 70% while only 28% of the rural population has access to grid electricity.

Figure 8: Electrification rates in Africa[7]



Electricity blackouts occur on a daily basis in many African countries. Faced with this situation, people and enterprises often have to rely on expensive diesel power generation to meet their electricity needs, costing some African economies between 1% and 5% of GDP annually.

Access to electricity is hindered by the limited reach of grid infrastructure across African countries. Grid expansion is often costly and requires considerable investments alongside additions generation capacities. In order to improve

[7] IEA – Energy Outlook database, 2013

access to electricity in utility driven centralized approach, Africa needs huge investments in expanding grid infrastructure to reach at least major towns and rural dwellings. In addition, the dispersed nature of rural communities presents huge geographic challenges to achieve universal electricity access by 2030. Therefore, there is a need for a mixed approach to pursue distributed generation based on isolated mini-grids to improve and accelerate access to electricity and modern energy.

Figure 9: Transmission and Distribution Grid Infrastructure in Africa

Source: IRENA, World Infrastructure Report (World Bank)

Being a diverse and large continent, Africa faces unique challenges in addressing its energy needs, especially due to unevenly distributed energy resources (both fossil and renewable) across the continent. Countries with rich fossil fuel resource as well those which currently import fossil fuel for their energy needs, are faced with similar choices as to sustainably develop their future energy mix in order to reap the benefits of socio-economic and environmental sustainability.

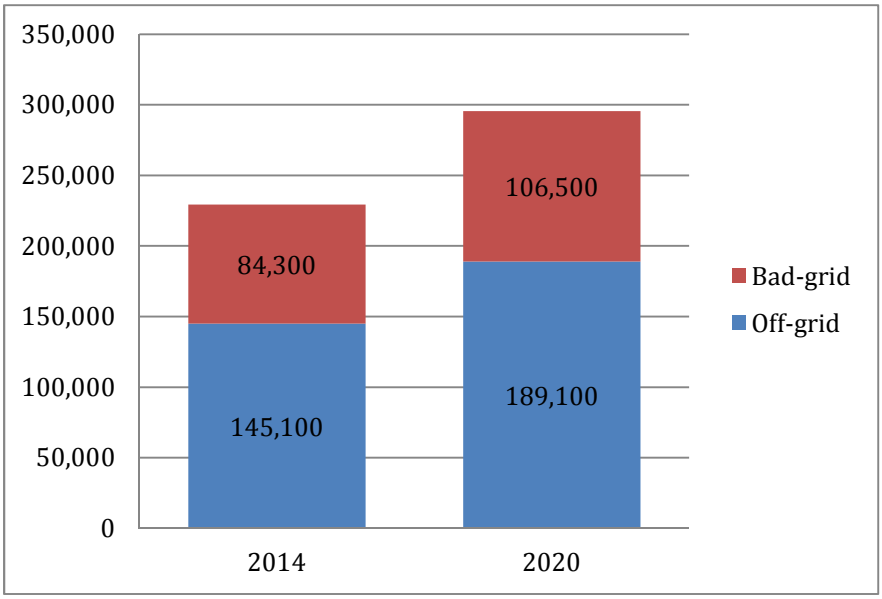
Energy as a challenge: Cost of Powering Mobile Networks in Africa

Grid Infrastructure and Growth in Off-grid and Unreliable-grid Network of Sites

The limited reach of grid infrastructure and inadequate power generation capacities has greatly affected the availability and quality of electricity supply to mobile network sites; and therefore, impacted the configuration and geographic spread of mobile networks in Africa.

Majority of telecom tower sites in Africa are deployed in either off-grid areas or problematic grid areas with unreliable power supply. The below figure illustrates the number of towers by off-grid and unreliable-grid conditions.

Figure 10: Tower Sites by Off-grid and Unreliable-grid



Africa currently has an estimated 145,000 off-grid sites which is expected to grow to 189,000 sites by 2020. Similarly, the number of bad-grid sites is expected to grow from 84,000 in 2014 to over 100,000 sites by year 2020.

The growth in mobile networks has tremendously outpaced the expansion of grid infrastructure across countries in Africa. This has led to many of the tower sites being deployed in off-grid areas leading to a large number of existing off-grid sites. Energy provision planning was traditionally ignored by the network expansion teams during the aggressive network rollout phases, and hence mobile operators, for very long, have been deploying the traditional diesel based power system for powering the off-grid sites.

In addition to the limited reach grid infrastructure and its snail-paced expansion, the inadequate existing power generation capacities and slow capacity additions over the years have further widened the demand-supply gap and have adversely affected the availability (with more frequent/long power cuts) as well as quality of power supply (with low/unusable voltages). This has forced mobile operators to deploy backup power sources such as batteries and diesel

generators, even at grid-connected sites, in order to provide power during outages and poor quality of power supply conditions.

The Real Cost of Grid Electricity in Africa

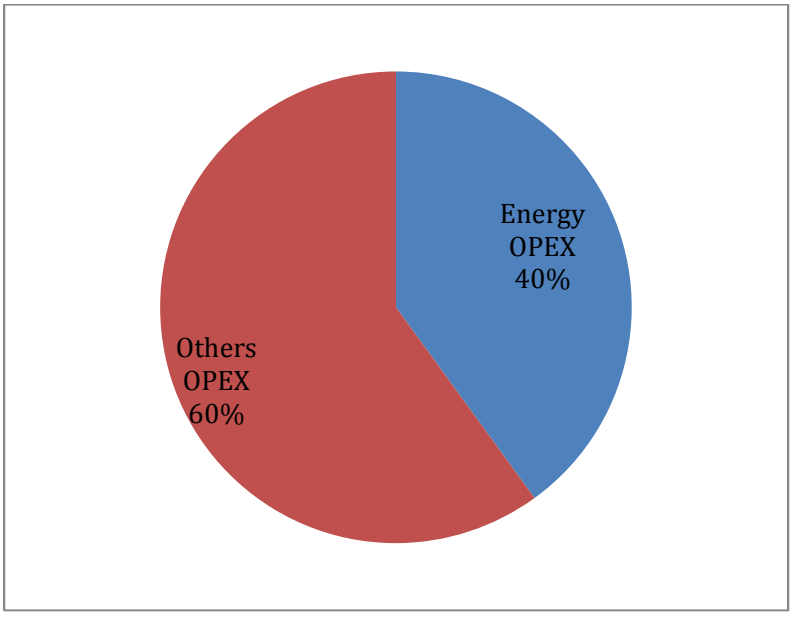
The poor quality and leakages in the transmission and distribution infrastructure has adversely impacted the availability and quality of grid power supply which in turn has a significant effect on the real cost of grid electricity supplied to the end users including telecom sites.

Our estimates show that, poor quality (such as phase losses and low/fluctuating voltages) of incoming power supply can add anywhere from 5% to 10% to the overall costs of grid electricity. There have been many instances of equipment burnouts at telecom sites due to fluctuating voltage conditions beyond the standards specified by the utilities. This has increased the maintenance costs due to unforeseen replacements of the burnt power system components with new ones.

Cost of Powering Mobile Networks

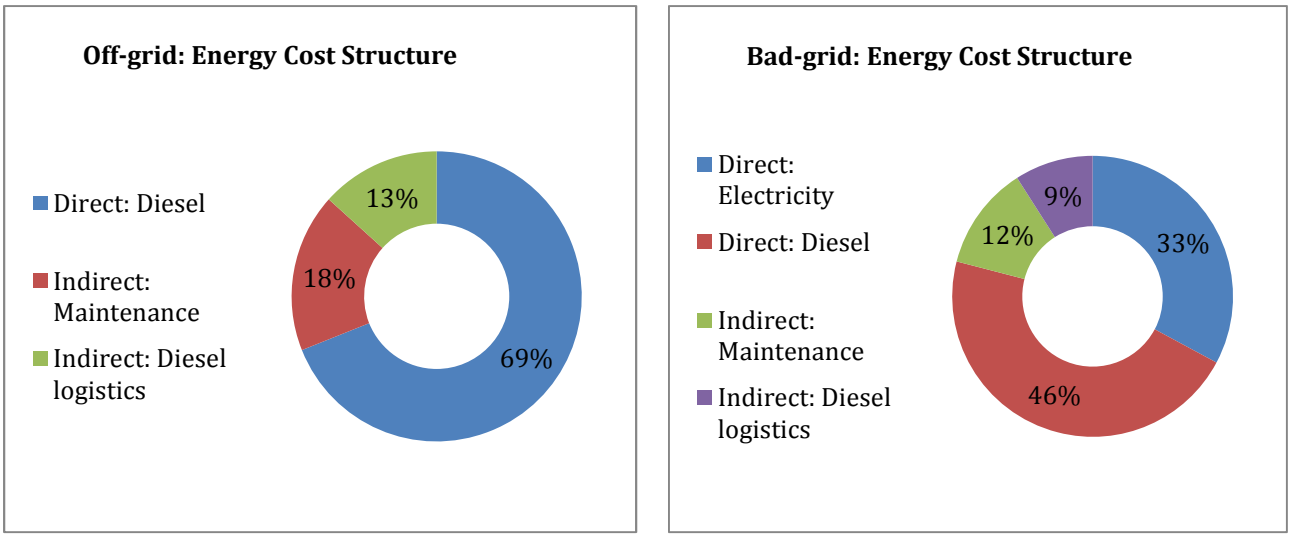
Energy costs constitute a major chunk of network OPEX for mobile operators in Africa. The limited reach of grid, availability and reliability of electricity supply plays major role in the cost of powering telecom tower sites. For a typical tower site in Africa, the share of energy costs is as high as 40% of the overall network OPEX.

Figure 11: Share of Energy costs in overall network OPEX



The cost of energy depends on the type of alternative power source deployed at the site. In many cases, mobile operators have relied on diesel based power solutions, as both primary and backup source, for powering both off-grid as well as unreliable-grid sites.

Figure 12: Cost of Powering Tower Sites (Off-grid)



An off-grid site consumes nearly 13,000 liters of diesel every year, at an average annual energy OPEX of over US$ 21,000 and adds nearly 35 metric tons of CO2 emissions to the environment. An unreliable-grid site consumes around 6,700 liters of diesel and produces 18 metric tons of CO2 emissions to the environment.

Further to the above mentioned costs of diesel power, there is an additional 10-15% cost due to diesel pilferage which is very common practice in many countries across Africa.

In summary, the higher cost of powering mobile networks in Africa, owing to poor grid electricity scenario and overdependence diesel based power systems, has significantly impacted the cost of services to the end users and hence mobile operators are confronted with poor business case for the expansion of mobile networks to low-income rural areas.

Renewable Energy in Africa: As an alternative for Powering Mobile Networks

Given the challenging energy supply and grid infrastructure in Africa, it is essential to look at alternative ways of meeting the energy demand, especially through exploiting renewable energy resources across the continent. This section tries to identify the resource potential in terms various renewable energy options and related policy framework and supporting regulatory scenario across Africa to promote the use of sustainable renewable energy sources to meet the growing power demand across user segments including the telecom industry.

Renewable Resources and Potential in Africa

Africa has huge renewable energy resource potential to be exploited especially owing to its tremendous hydro, solar, wind and bioenergy resources across the continent. The table below illustrates the practical realizable potential of various renewable resources across regions in Africa.

Table 1: Renewable Resource Potential (TWh) in Africa – by regions

(in 00's TWh)	CSP	PV	Wind	Hydro	Biomass	Geothermal
Central Africa	299	616	120	1,057	1,572	
Eastern Africa	1,758	2,195	1,443	578	642	88
Northern Africa	935	1,090	1,014	78	257	
Southern Africa	1,500	1,628	852	26	96	
Western Africa	227	1,038	394	105	64	
Total Africa	4,719	6,567	3,823	1,844	2,631	88

Solar PV has the highest potential at 656,700 TWh followed by CSP (Concentrated Solar PV) at 471,900 TWh per year. In terms of the regions, Eastern Africa has the highest potential of renewable resources followed by Southern Africa. Eastern Africa is the only region with a great potential for geothermal energy.

However, currently only less than 2% of the renewable resources (excluding hydro) are exploited for electricity generation across Africa. This presents a huge untapped potential for large scale renewable power projects as well as small scale mini-grids and off-grid power systems.

Solar is one of the most ubiquitously available sources of clean energy and the most suitable for distributed power generation bringing power generation to where it is needed, thus suits for 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.

The exploitation of solar energy for telecom applications has reached the stage of commercial adoption; however, it is far from becoming the mainstream technology for scaled adoption for powering telecom base station sites.

The adoption of wind turbines 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. It has been adopted in combination with other green technologies such as solar for telecom applications where there is a good potential for OPEX savings. However, its adoption has not gone beyond the pilot stage.

Hydro power is the most traditional form of clean energy available for large scale power generation and its adoption so far at small scale distributed generation has been limited due to availability of technology and suppliers. The 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 evaluated.

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, is presented with its own challenges in terms of operational complexity and scalability, supply integration and sustainability.

Fuel Cell technology has been recently gaining momentum in telecom power applications and has been supported with increased efforts from solution providers to build the fuel supply chain and logistics to support the smooth and reliable operations. However, the high cost of technology has been a barrier to its adoption at a larger scale.

Policy and Regulations for promoting Renewable Energy

Renewables are the way forward for Africa, and have the potential to power the whole of the continent. But policy certainty and regulation will be crucial for the industry to attract investment and grow. Policy and regulatory uncertainty has long been a hindering block for the flow of private investments into renewable energy across Africa. There is a strong need for coordinated efforts from relevant ministries to overcome the uncertainties and provide favourable policy and regulatory environment to attract more investments in renewable energy projects in order to improve access to electricity.

The highlights of policy and targets for select countries in Africa are presented below. **Appendix D** gives a detailed view of various acts and policy directives across the continent with target statements for renewable energy focus.

Table 2: Renewable Policy – guidelines, targets and incentives across select African countries

Country	Policy	Guidelines	Targets	Incentives
Kenya	Least Cost Power Development Plan 2011-31 Feed-in tariffs for Renewable Energy Resource Generated Electricity 2008 Energy Act 2006	2008 FIT(Feed-in tariff), modified and expanded in 2010, including geothermal, wind, solar, small-hydro, biomass, biogas	Renewable energy installed capacity by 2031 - Geothermal: 5.5 GW by 2031; Wind: 3 GW; Solar PV: 0.5 GW; Small hydro: 0.3 GW The transmission development plan indicates the need to develop approximately 10,345 Kms of new lines	Investment Tax exemption
Ghana	New Renewable Energy Law	Feed-in tariff PV solar grants to electricity end users	10% RE share in electricity generation by 2020 30% penetration of RE electricity in rural electrification by 2020	Total import duty exemption on RE equipment
Nigeria	Renewable Energy Master Plan	Fiscal and market incentives to support RE deployment Design of further tax credits, capital incentives and preferential loan opportunities for renewable energy projects	To increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030. Renewable electricity would then account for 10% of Nigerian total energy consumption by 2025. Targets higher electrification rates, from 42% in 2005 to 60% in 2015 and 75% by 2025	Short-term moratorium on import duties

Tanzania	Scaling up Renewable Energy Programme (SREP) 2013 2010 Electricity rules (feed-in tariff) Tanzania Energy Development Access Programme (TEDAP)	Standardized PPA for wind, hydro, PV and cogeneration below 10 MW Feed-in tariff for mini-grids, large scale RE generation	To catalyse the generation of about 100 MW from renewable energy 700 GWh from geothermal and 178 GWh from off grid renewables	PV equipment exemption from VAT and income duties TEPAD Solar PV/kWh grants
Uganda	Renewable Energy Policy 2007-17	RE Feed-in tariff Solar subsidy programme Global Energy Transfer Feed-in Tariff (GET FIT) Programe Uganda	61% RE share gross final energy consumption by 2017 To fast-track a portfolio of up to 15 small-scale RE generation projects (1MW-20MW)	From 2007, 45% subsidy - increased from 14% - on all solar power equipment
Senegal	Law on Renewable Energies and Biofuels		15% RE share in primary energy mix by 2012	Total tax exemption for any RE-related device
South Africa	Renewable Energy Independent Power Producer Programme (REIPPP) Renewable Energy Feed-in Tariff (REFIT) Free Basic Alternative Energy Policy	Feed-in tariff for renewable energy projects Development of renewable energy as part of sustainability programme	10% of electricity generation capacity from RE by 2030 Target of 1 million solar water heaters to be installed by 2030	Free electricity (including RE) for rural population Subsidies for renewable energy
Madagascar	Decentralized Rural Electrification Program 2008 Reform of Electricity Sector, Madagascar 1999	Opening up electric power generation, transmission and distribution to private sector competition	Decentralized Rural Electrification Program to improve the rate of access to electricity in rural areas by prioritizing the deployment of renewable resources.	
Ethiopia	Growth and Transformation Plan (GTP) 20011-15	To provide sufficient and reliable power sources at all time for economic and social development	To increase the generating renewable energy capacity (including hydro) from 2000 MW to 8 GW - 10 GW by the end of 2015.	

Policy guidelines and regulatory support play a major role in overall adoption and growth of renewable energy. Many countries in Africa are at the early stage of developing policy and regulatory guidelines for promoting the use of renewable energy to meet the growing demand for electricity and increasing access to modern energy.

The mobile industry has grown to a level as one of the biggest consumers of electricity and diesel in Africa. The adoption of green power will reduce the costs of energy as well as reduce the negative impact of diesel power on the environment. The mobile operators in Africa has to a certain extent have implemented green power alternatives to power their existing networks, however, the scale of deployments is far from reaching its true potential. The requirement of huge CAPEX and the lack of local technical resources are amongst the major barriers to green power adoption in telecoms in Africa.

There is strong need for policy and regulatory intervention to positively complement the industry efforts to scale the adoption of renewable energy alternatives. The industry would need encouraging fiscal incentives, technical capacity building and favourable policy guidelines to cost effectively adopt renewable alternatives to power their existing networks and further expand mobile coverage and access to communication services to rural and remote populations across African continent.

Renewable energy alternatives for Powering Mobile Networks

Suitability and Feasibility for Telecom Power

The overall summary of green options and their level of suitability for telecom power applications in Africa is presented below. The adoption of green technology would depend on the availability of technology, vendors along with local technical support and market acceptance.

Table 3: Green Alternatives: Fit for Telecom Power Deployments

	Solar	Wind	Biomass	Fuel Cell	Micro-Hydro
Resource Potential	High	Low to medium	Medium	Medium	Low to Medium
Technology Availability	High	Medium	Medium	Medium	Low to Medium
Market Acceptance and Commercial viability	High	Low to medium	Low	Low	Low
Supply chain readiness	High	Medium	Low	Medium	Low
Stage of Adoption	Commercial	Pilot/Early Commercial	Evaluation/ Pre-pilot	Pilot/Early commercial	Evaluation/ Pre-pilot

A sample Solar-DG hybrid solution is considered to demonstrate the feasibility of green power design and business case based on CAPEX model. Consider an existing off-grid site with a DC load of 1 kW and running on 10 KVA DG for 16 hours a day. Other key commercial parameters for the design are assumed as below.

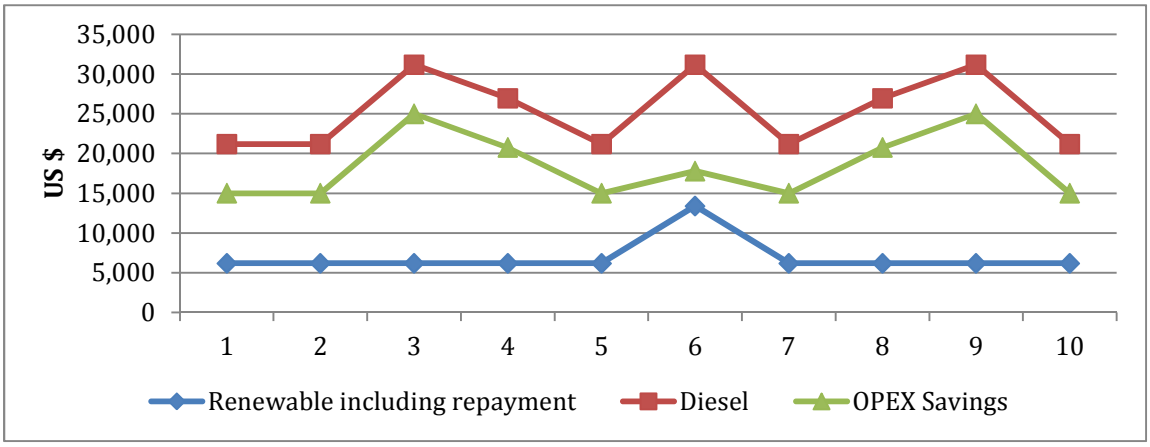
- Diesel price (delivered): 1.5 US$/Ltr
- DG fuel consumption: 2 L/hr
- PV Solar cost: 400 US$ for 250W panel

The design model suggests a solar solution of 5.5 kW with 600 Ah battery, 6 kW converter and existing diesel generator. The business case and OPEX savings schedule for the above solution is illustrated below.

Figure 13: Business Case and Feasibility of sample green power system

Payback period (years)	1.70
ROI	59%
IRR	57%
NPV	$51,215
Discount Rate	18.0%

Figure 14: Cash flow Comparison and OPEX savings



The OPEX savings schedule above illustrates the comparison of the base case diesel power scenario with the green power design and associated OPEX savings realizable with the green power alternative over the 10 year business case.

Similarly, other green technology solutions can be evaluated for their financial feasibility in comparison to the base case diesel power scenario and then, based on the technical feasibility, the green technology can be deployed at the site. The following sections present the current state of green power adoption across Africa and the associated barriers currently faced by the industry.

The green opportunity

As discussed in the previous sections, the mobile industry in Africa currently has an estimated 145,000 off-grid sites. Each off-grid site in Africa consumes nearly 13,000 liters of diesel every year, at an average annual energy OPEX of over US$ 21,000 and adds nearly 35 metric tons of CO2 emissions to the environment.

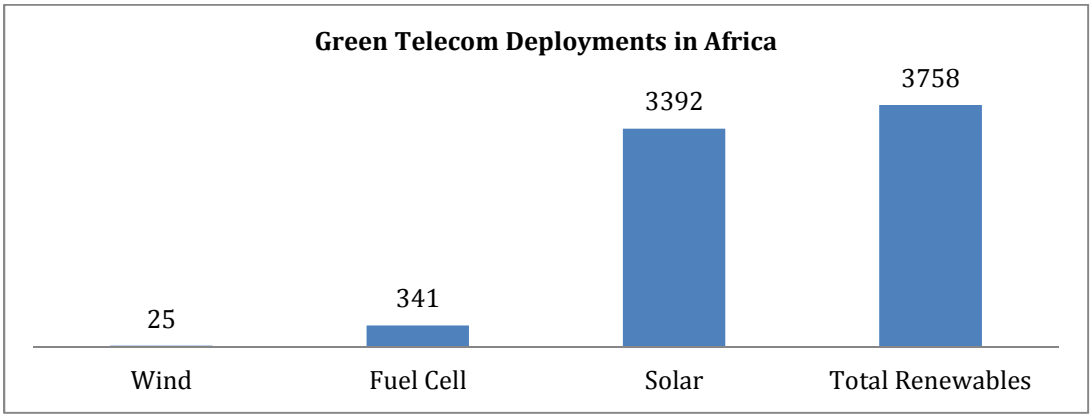
A target of 60-70% reduction in CO2 emissions by way of adopting green power alternatives for telecom towers would result in an annual OPEX savings of over US 17,000 per site. This would require an initial investment of approximately US$ 42,000 per site with a payback of less than 3 years and ROI of over 35%.

This presents a huge opportunity for mobile operators and investors to positively look into green power as a viable alternative to power mobile telecom networks.

Current state of green adoption

The green deployments in Africa have not reached expected potential scale possible for green power adoption in telecom industry. The figure below presents the current deployments of green power across mobile networks in Africa by various technology options.

Figure 15: Green Power deployments in Africa[8]



Africa currently has a total of less than 4,000 sites (almost all of them off-grid sites) deployed with green power alternatives. This accounts for less than 3% of the total off-grid sites in Africa as against global average of 13%.

Solar is the most widely deployed green power technology with over 3300 deployments, accounting for nearly 90% of total green deployments. Solar is the only technology that has reached a stage commercial adoption across markets in Africa. On the contrast, the deployment of wind turbine solutions has not gone beyond the pilot stage and has lost the trust of MNOs and Tower Cos due to unreliability, high maintenance costs and risks of operations.

[8] GPM deployment tracker

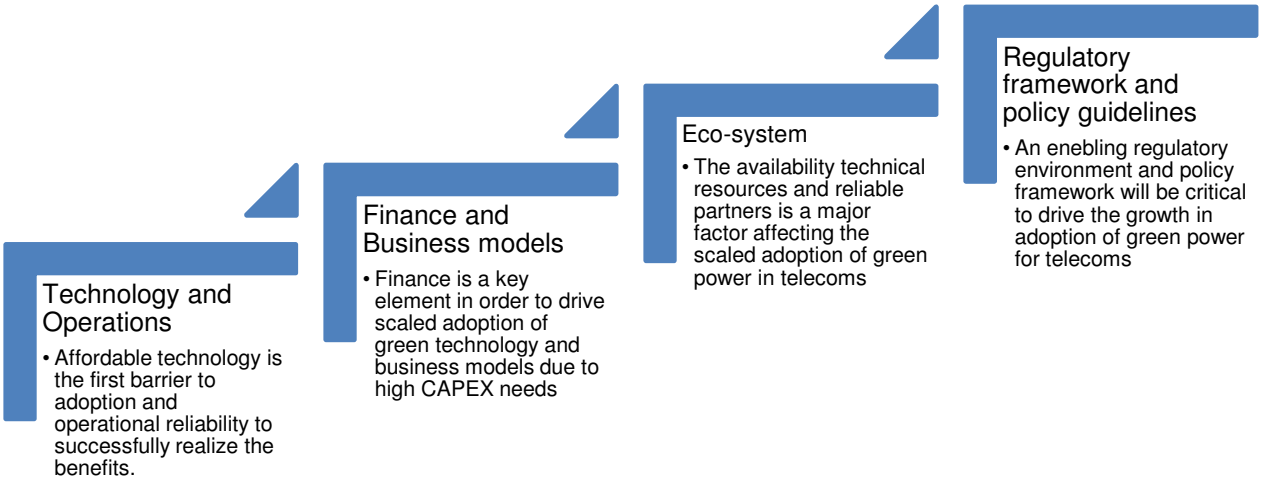
Recent developments in fuel cell technology and further supply chain integrations have helped technology providers to make inroads to deploy more than 300 fuel cell solutions across off-grid and unreliable grid sites in Africa. The technology providers and the solution integrators are strongly focusing on establishing the fuel supply eco-system by building fuel generation capacities along with supply operations in order to support the growth of fuel cell deployments in the region.

Barriers to green adoption

Africa its imminent challenges in power supply infrastructure is far from capitalizing on its tremendous potential presented by green power alternatives to provide sustainable power to industry and communities across the country. Limited investment capital, dearth of sustainable business models, lack of impetus from government and regulators, limited collaborative efforts within the industry have handicapped the scaling of green power alternatives in telecoms across Africa. The changing industry structure has also greatly impacted the pace of green adoption over the past few years.

There is a need to overcome these barriers by systematic intervention in order to catalyze and drive the growth of green power alternatives across the country. Some of key barriers to green power adoption is presented below.

Figure 16: Key barriers to green power adoption in Telecoms



Key barriers and challenges to green adoption are listed below.

- Financial
    - Funding choices in addition to internal budgets
    - Limited knowledge and support from commercial banks to finance green deployments
    - Proven business models for off-loading the funding requirement
- Operational
    - Reliability of technology and vendors
    - Theft, vandalism of equipment

  - Lack of committed support from partners at ground level
- Technology
  - Availability and cost of technology
  - Limited skills on technology selection and right solution dimensioning
  - Technical support post deployment
- Eco-system
  - Availability reliable operational partners and technology vendors
  - Local knowledge and technical support
  - Regulatory support and policy guidelines to drive the green adoption

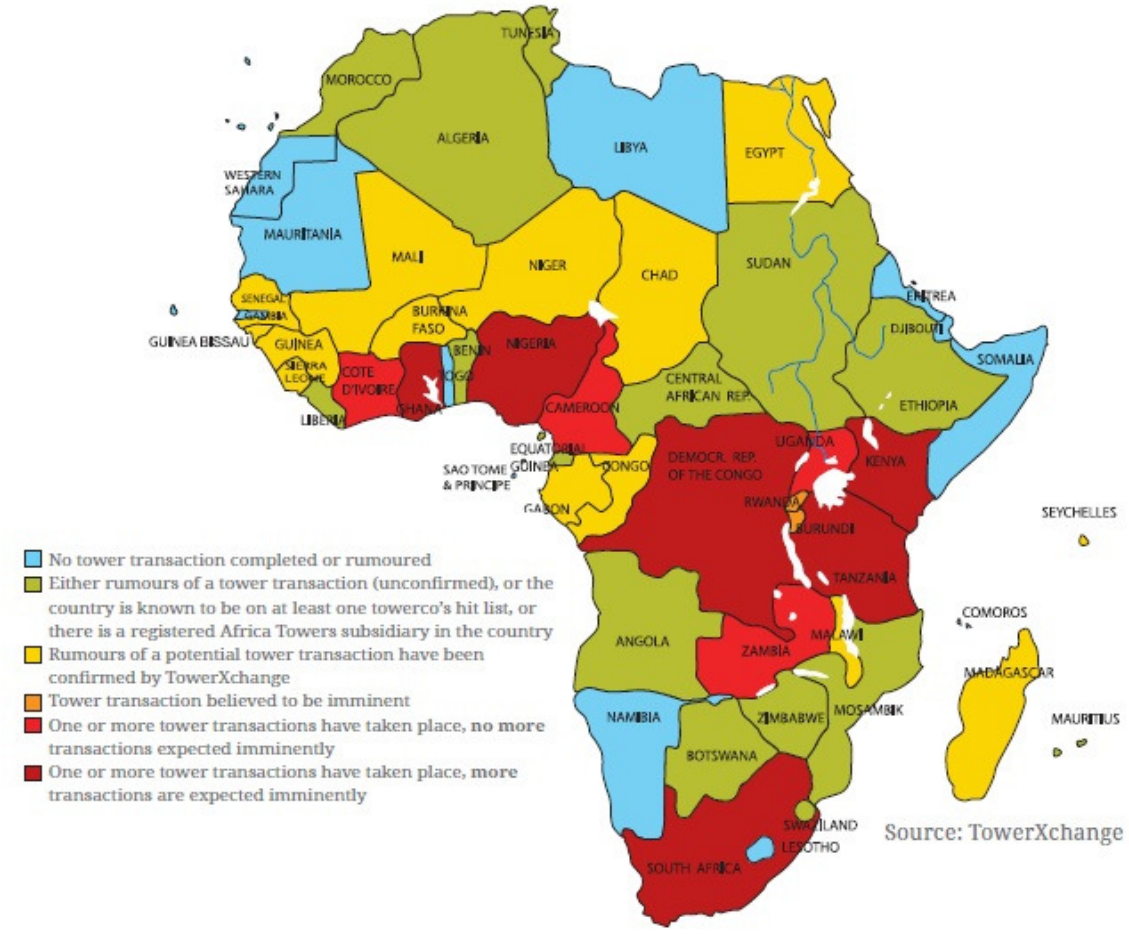
The industry trends, opportunities and the way forward to overcome the industry barriers to green adoption are discussed in the following section.

Industry Trends and Opportunities: Future of Powering Mobile Networks in Africa

The Emerging Tower Co model

Over the past two years, African mobile industry has witnessed many deals in transfer of tower assets from MNOs to Tower Companies across countries. The tower ownership structure has been tilting towards focused Tower Cos owning majority of the tower assets in many of the African markets. The Big Four Tower Cos – IHS Towers Africa, HTA (Helios Towers Africa), ATC (American Tower Co) and Eaton Towers, are achieving scale in Africa as a result of recent deal closures with MNOs across countries. Their diversified portfolio across countries along with deals across multiple MNOs has reduced the country and operator specific risks and has positioned them to attract bigger investments over the years to come.

Figure 17: Growth in Tower Co model (by country, deals etc.)

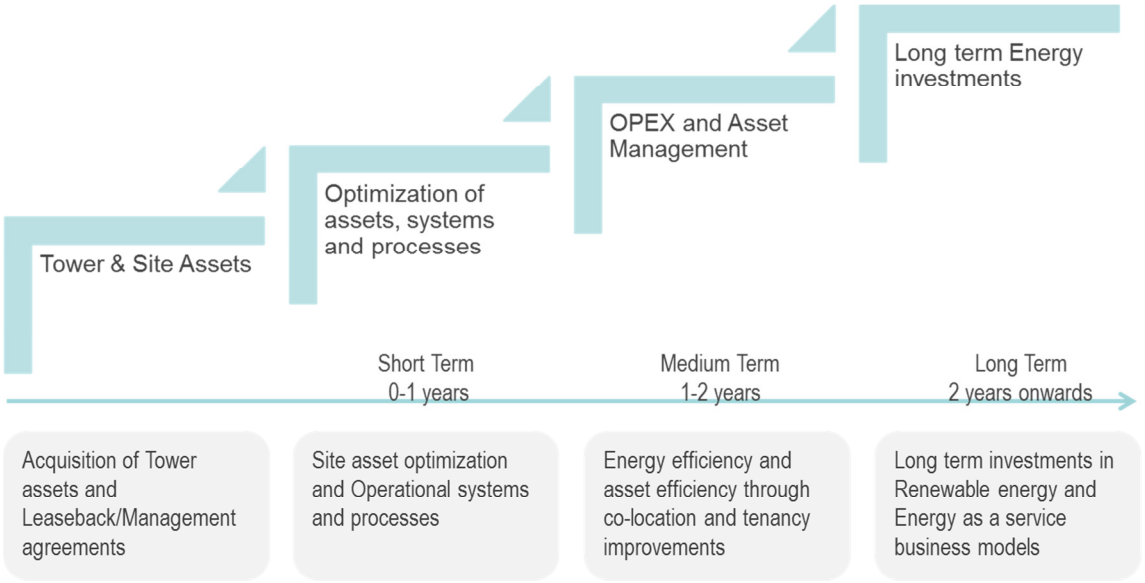


Source: TowerXchange

The big Tower Cos are expected to continue their acquisitions across markets and operators over the next year focusing on big markets and big portfolio deals. This will pave way for some small local Tower Cos to emerge in smaller markets such as Burundi, Madagascar etc.

The emergence of Tower Co model in Africa has tremendously impacted the adoption of green power alternatives for powering mobile networks. The impact has been mainly due to the transitional phase further delaying the investment decisions to invest in green power.

Figure 18: Phases of Investment in Energy by a Tower Co (Post-acquisition) and the Impact on Green Energy investment



The different phases following the tower acquisitions and specific focus of Tower Cos in each phase are described below. In the initial phase, Tower Cos would focus on optimizing existing assets and implementing systems and processes to enable them better manage site operations and assets going forward.

In the medium term, the focus will shift towards improving OPEX performance by implementing energy efficiency initiatives and strategies to improve asset utilization by way of tenancy increments and co-location management. Successful implementation of initiatives in this phase will pave the way for more strategic initiatives in the next phase.

Short term (0-1 year)	Assets • Refurbishment of site assets and equipment • Asset optimization (e.g. passive/free cooling at indoor sites, deep cycle batteries, power equipment capacity planning) Operations • Deploy site management and remote monitoring systems

	• Implement access control systems and processes Cost and partner control • Maximize grid power utilization to reduce energy bills • Evaluate O&M contractor and re-align new processes and systems to improve adherence to the KPIs
Medium term (1-2 years)	OPEX and Asset management • Energy efficiency and optimum utilization • Power system optimization and planning for future tenancy growth • Asset efficiency and co-location management
Long term (2 years+)	Strategic focus • Investment in alternative energy including renewable energy • Energy management and new energy business model • New business lines (e.g. community power)

Tower Cos will take about 1-2 years to stabilize operations and bring efficiency in order to focus on more longer term initiatives such as investing in green power alternatives to reduce dependence on diesel and reducing OPEX. In the long term Tower Cos can take a strategic view at evaluating various renewable energy options as well as energy business models in order to capture maximum value from their existing Tower and Energy operations.

Impact on Green Adoption

The emergence of Tower Co model over the past few years has had a great impact on the pace of green adoption across Africa. The adoption of green power for telecoms in Africa has been growing slower than expected due to delays and postponement of investments by both MNOs and Tower Cos. The delay from MNOs has been due to the planned tower sales to Tower Cos, and the delay from Tower Cos in green investments has been due to the time taken for stabilization of Tower Co operations post acquisition.

Further, the uncertainty in tower sale decisions and long duration of tower deal closures has impacted the prioritizing of investments into CAPEX intensive green power alternatives. Owing to uncertainties in decision making, many green power initiatives of MNOs have not progressed beyond pilot stages.

However, in the near term, as the Tower Cos gain scale and stabilize operations, there will be an increased focus on energy operations and OPEX reduction so as to achieve competiveness and capture market share by offering attractive pricing to tenants. Given the slow paced grid expansion in many parts of Africa, Tower Cos in the region would look at long term energy investment options to achieve sustainability and cost efficiency.

As quoted by one of the leading Tower Cos in Africa – "any investment towards greener/efficient solutions are based on positive return over 24 months with a hurdle rate of 25% IRR. We calculate Total Cost of Ownership over five years and the OPEX over a five year period must not be more than double the initial purchase cost."[9]

Further, the transfer of tower assets will bring specific focus on energy and cost reduction to achieve competitiveness. Future expansion of networks will require Tower Cos to build and deploy tower assets in rural and remote areas without access to grid electricity. Tower Cos expanding their assets to rural areas would need to look at renewable energy as an alternative to diesel based power solutions to be able cost effectively serve the MNO tenants' requirements.

Overall, in the short term, there will be a slower focus on renewable energy alternatives for powering telecom tower assets. However, going forward (in the medium to long term), Tower Cos are expected to have stronger focus on energy efficiency and renewable energy alternatives to reduce dependence diesel power and to reduce OPEX in order to stay competitive in the market.

Energy Outsourcing prospects in Africa

Despite a lot of discussion around energy outsourcing (Energy Service Co – ESCO) model in mobile industry, there hasn't been any successful adoption of the model due to various reasons. An ESCO is a local utility, responsible for passive energy infrastructure providing energy as a service to mobile network operators. While doing so, the ESCO may adopt both renewable as well as non-renewable energy sources in order to be efficient and cost effectively provide energy to mobile networks and local communities around.

The successful adoption of ESCO model will highly depend on the ability of an ESCO to own the assets and to win the confidence of MNOs and Tower Cos. To achieve this, the ESCO would need to firstly, create a clear value proposition which is attractive for both MNOs and the business, and secondly, demonstrate it through pilots for a reasonable number of sites. Some MNOs felt that big ESCO should come into play with a capability of deploying large numbers in the range of 500-1000 sites to demonstrate the business model and credibility of an ESCO to deploy at scale. The ESCO would also need to clearly demonstrate a path of adoption for the MNOs and showcase the ability to bring down the cost of operations as close as possible to the ideal scenario of grid power.

Africa is far from successfully demonstrating a successful business model with realizable benefits all the stakeholders and the required reliability to sustainably provide energy services to MNOs and Tower Cos in the region. This will require a strong collaboration amongst the stakeholders including MNOs, TowerCos, ESCOs, and investors in order to try, test and build the best practices and establish right model for ESCO business for scaled adoption.

A detailed view at various ESCO business models along with their pros and cons is presented in **Appendix B**.

[9] TowerXchange Presentation at GPM Nigeria Working Group 2014

Outlook and Future Prospects

The growth of ESCOs will be a crucial driver for the conversion to green and renewable energy alternatives providing energy to MNOs and dedicated Tower Cos. MNOs will find it difficult to lead the transition efforts for the following three reasons:

- **MNOs are focused on selling off all tower infrastructures:** As explained above, many MNOs across the world, especially in Asia and Africa, are in the process of selling of their tower assets, including the energy infrastructure, to third-party structures. This trend, brought on by a strong imperative to cut network deployment and operating costs, is expected to intensify in the next six years.
- **High degree of customization/complexity at the tower level:** In a rapidly evolving tower energy landscape that requires a high degree of customization across multiple tower sites and geographies, as well as specific technical expertise, MNOs are not best-positioned to drive energy efficiency. Moreover, MNOs have an incentive to reduce complexity of non-revenue generating operations like power, in order to focus on revenue-generating parts of their business, which primarily revolve around servicing customers. They are reluctant to embrace green and renewable energy solutions that add to operational complexity, even though they may help to reduce costs in the long term.
- **Financing priorities:** MNOs place a priority on network expansion and technology upgrade of active equipment. With a limited pool of CAPEX, MNOs will always favor investments in active radio equipment over investments in energy solutions. Therefore they tend to ignore the very real cost-saving potential of green and renewable energy solutions, especially as their expectation of payback—three to four years—is quite long by industry standards. ESCOs are better placed to invest in long-term assets and amortize them over time in order to reap the full benefits of reduced costs.

Drivers for the green transition

Banking and finance support: Commercially attractive financing mechanisms are a must, given the high CAPEX requirements. Key needs include:[10]

- Low collateral requirements based on long-term contracts with MNOs and TowerCos who are well-capitalized and therefore considered creditworthy
- Construction financing
- Longer repayment timelines of at least 7 years, etc.

MNOs and TowerCos could help support the emergence of this type of financing segment offering a clear perspective on their energy outsourcing plans (e.g. 1000 sites over 2 years). This would not only likely attract larger players to enter into the sector (e.g. Caterpillar, Cummins Power), but also allow smaller IESCOs to organize their scale up with “bankable” contracts.

[10] “IFC Energy Service Company Market Analysis”, IFC (June 2011).

Very importantly, commercial lenders at the local level require greater access to information and training to overcome their lack of awareness on the savings potential of the projects, which typically results in higher interest rates and capital costs.

Entry of large ESCO players: Thus far it appears that the telecom tower energy market has passed below the radar of the large, global power sector companies. These large players will bring the ability to scale aggressively through their enhanced asset bases, existing relationships with commercial lenders and focus on innovation and product development.

Conducive policy and regulatory environment: Local policymakers and regulatory bodies require training and policy development assistance on key issues such as the deployment of renewable-energy certificates (RECs) for green energy use at telecom towers, elimination of diesel subsidies, and tax and tariff rebates in order to incentivize renewable energy use at telecom towers.

Market intelligence and knowledge sharing: Greater data collection and effective information sharing is another important intervention that can help accelerate the market. In particular, there is a need to disseminate key financial information that would assist in making risk and return judgements for those looking to invest in or execute energy provision for off-grid and bad-grid telecom towers.

Conclusion

Africa presents a huge potential for the mobile industry to adopt greener alternatives to address the energy challenges currently present across the continent. Limited investment capital, dearth of sustainable business models, lack of impetus from government and regulators, limited collaborative efforts within the industry have handicapped the scaling of green power alternatives in telecoms across Africa. The changing industry structure has also greatly impacted the pace of green adoption over the past few years.

There is a need for systematic intervention in order to catalyze and drive the growth of green power alternatives across the continent. A collaborative approach by the industry with a supporting investment and regulatory environment could drive the adoption of cost effective green technology to address the existing energy challenges as well as further grow the networks to cover the remaining 30% of the population currently without access to mobile communication services.

About the GSMA Association
The GSMA represents the interests of mobile operators worldwide. Spanning more than 220 countries, the GSMA unites nearly 800 of the world's mobile operators with 250 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organizations in industry sectors such as financial services, healthcare, media, transport and utilities. The GSMA also produces industry-leading events such as Mobile World Congress and Mobile Asia Expo.

For more information, please visit the GSMA corporate website at www.gsma.com. Follow the GSMA on Twitter: @GSMA.

About Mobile for Development - Serving the underserved through mobile
Mobile for Development 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 and economic impact and stimulate the development of scalable, life-enhancing mobile services.

For more information, please visit the Mobile for Development website at http://www.gsma.com/mobilefordevelopment/. Connect with us on Twitter @GSMAM4D

About the GSMA Green Power for Mobile Programme
Green Power for Mobile works to extend the coverage, reduce the cost and minimize the environmental impact of mobile networks by championing renewable energy.

Whilst it continues to serve mobile network operators globally, the programme will place key focus on a number of target markets in Africa and Asia including Indonesia, Bangladesh, Pakistan, Afghanistan, Nigeria, Ghana, Kenya, Tanzania, Uganda, Senegal and Cameroon. With Project Managers based in each of these regions, GPM is well positioned to engage with the industry and address the requirements of these markets.

For more information on the GSMA's Green Power for Mobile Programme, please contact us on greenpower@gsma.com

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

Appendix A: Infrastructure Sharing and Outsourcing

The infrastructure sharing here means a passive sharing. The passive sharing is usually defined as the sharing space or physical supporting infrastructure, which does not require active telecom equipment. For infrastructure outsourcing will discuss outsourcing mechanism with a Tower Company (Tower Co).

Infrastructure Sharing

The main driver for MNOs to co-locate sites is to reduce the acquisition and build time for new sites and to increase the chances of cost effectively and rapidly gaining new subscribers. And another strategic rationale decision for engaging in infrastructure sharing differs between countries. Some reasons behind this activity are as follows:

- In developing markets, it will help to reduce time and cost from a site acquisition process and may give MNO a new un-served coverage to cover
- In mature markets, infrastructure may reduce operational cost for a new site on congested location
- If the sharing includes active sharing network equipment, it will give a fast implementation to reduce MNO's network issue in certain area/location

Infrastructure sharing mainly focuses on commercial consideration rather than regulatory mandates. Network sharing may take many forms ranging from passive sharing of cell site and masts to sharing of radio access network (RAN) and other active elements such as network roaming and the core.

Site Sharing Concept

The main reason of site sharing is because of commercial condition rather than regulatory impulse. The site-sharing concept is based on followings reasons:

- In the early phases of network development, infrastructure sharing is most commonly practice between MNOs, which are used to facilitate quick network roll-out, at a lower cost
- In the networks mature, MNOs will focus from deployment to service satisfaction, so MNOs will concentrate to reduce the operational cost with reducing their quality of service to their subscribers

Figure 23: Infrastructure Sharing (Shared Compound)

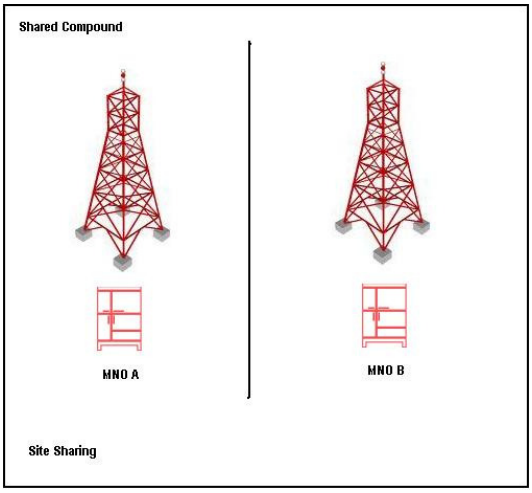
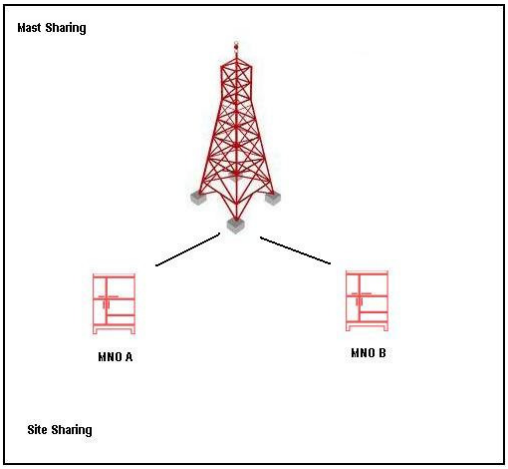


Figure 24: Infrastructure Sharing (Mast Sharing)



Passive infrastructure sharing requires the consideration of many technical, practical and logistical factors. MNO must consider items such as load bearing capacity of tower, azimuth angle of different service providers, tilt of the antenna, and height of the antenna, before agree to conduct infrastructure sharing.

Site Sharing Mechanism

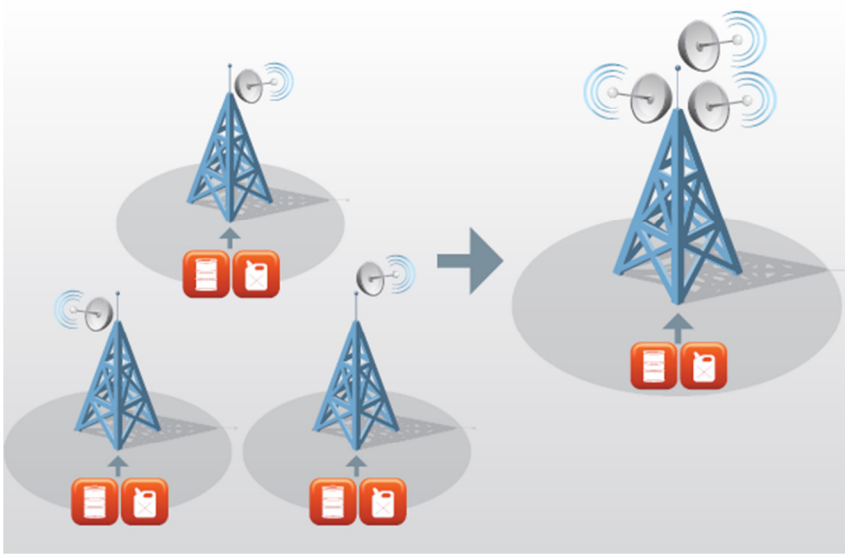
The site sharing involves co-location of sites between MNOs. MNOs will share the same physical compound and tower but install separate antennas, cabinet, backhaul and power system. But sometimes, they may decide to share support equipment, including shelters, power supply and air conditioning.

The mechanism of site sharing is not easy as practical condition, because MNOs usually will have one on one agreement for this site sharing mechanism. If MNO counterpart has no right candidate to choose, it may delay roll out progress of the other MNO.

Infrastructure Outsourcing

Ascertaining legal ownership of sites in towns is one of the reasons why most of MNO will outsource its tower to a Tower Co. In urban areas, sites are often located and constructed on rooftops and other high structures. As there is a limited place to choose and it makes MNO may have a little choice rather than go for site sharing option.

Figure 25: Infrastructure Sharing/Outsourcing Evolution



In rural areas, construction costs such as power suppliers and access roads constitute a significant percentage of the total site build costs. In such cases, to reduce individual CAPEX investment and ROI (Return of Investment), MNO will shift a risk to Tower Co.

Site Leasing Concept

On infrastructure outsourcing, Tower Co will bear all investment cost by providing compound and tower for MNO. Tower Co will take the infrastructure maintenance cost with agreed Service Level Agreement (SLA) from MNO. Tower Co provides project management as follows:

- Site hunting and site acquisition
- Material testing and soil investigating
- Non-destructive testing
- Tower design
- Site management

- Quality audit services
- Technical support and maintenance

As a return, MNO will give a fee to Tower Co for their services.

Site Leasing Mechanism

One of benefit from infrastructure outsourcing, MNO does not need to consider of many technical and logistical factors. MNO just needs to prepare frequency band to minimize interference from other equipment that have been installed. Tower Co will prepare tower strengthen and supporting material according to the agreement.

At the end, infrastructure sharing or outsourcing will bring a positive outcome includes:

- Optimization of scarce resources and positive environmental impacts
- Decrease an investment duplication in both capital and operational expenditure
- MNO will be able to cover underserve area with minimum investment
- Able to reduce network issue by fast implementation in congested location

These impacts will give a reduction in wholesale and retail prices for mobile services, because of cost efficiency on deploying a network.

Appendix B: Energy Outsourcing

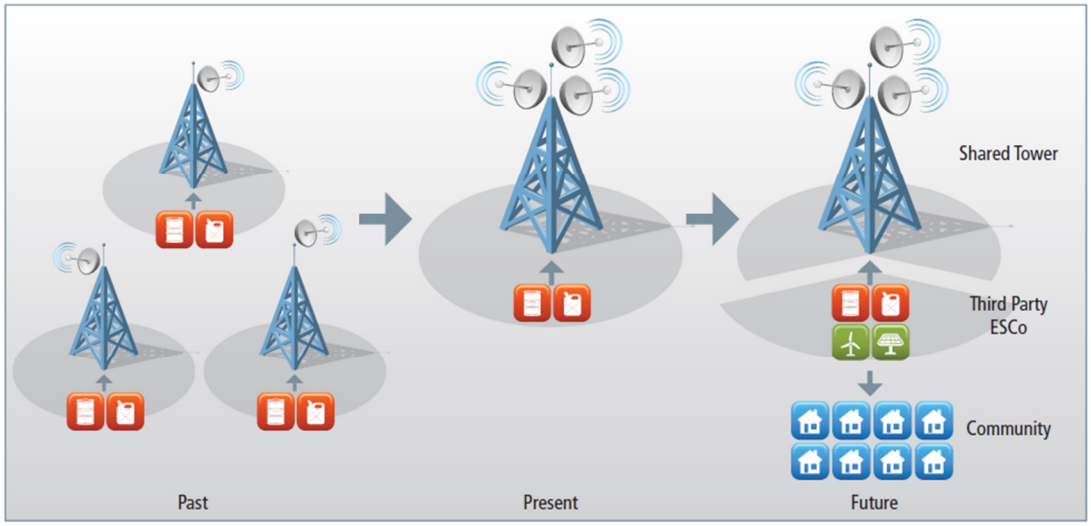
Energy Outsourcing Concept

MNOs will not only need infrastructure to bring its service to customer. MNOs also need a power to operate their base station. National operators often have to cover large geographic regions and install thousands of sites to provide the services required of them both from a commercial and a legal point of view.

MNOs have to keep their network running on a continuous basis 24 hours a day and 365 days a year, regardless of utilization. Demand for service may drop to zero during night time hours on certain sites but MNOs have no option to switch the site off during these hours as they cannot predict subscriber movement.

As a function of their size and operating requirements, networks consume large quantities of power with the entire associated carbon footprint. This is a growing an opportunity to any company who can provide energy and at the same time reducing environmental impact.

Figure 26: Energy Outsourcing Evolution



Energy Service Company or ESCo will take the responsibilities by handling power system investment and daily operational activities for MNOs in exchange for a fee. ESCo will provide energy to power up base station as anchor tenant and community surrounding as an optional, so MNOs will concentrate on their main target for giving the best services to their subscriber.

In following section will discuss about a green energy outsourcing business model.

Energy Procurement Business Models

In energy procurement, MNO can choose to two different business models on purchasing a green technology solution based on a financing scheme.

- In-house or CAPEX Model
- Outsourcing or OPEX Model

CAPEX Model

The CAPEX Model is the most popular on purchasing power solution in the telecom industry, but its trend has shifted to the other business model because of investment capital pressure during acquiring new assets for the network. The main reason to implement this business model is to achieve significant OPEX saving for company, with consideration of acceptable ROI.

MNO will play important role for this model, by choosing the right a green technology solution and partner. On scalability for CAPEX Model will depend on capital support from MNO to implement their design.

OPEX Model

In Africa, where the grid availability is unreliable or even no grid at all, ESCo can play an important role to help MNO to expand the network. The ESCo will bear all the cost of power system investment and maintaining equipment. This concept is recognized as energy outsourcing or OPEX Model.

There are 3 business models those are usually used in the telecom industry:

- A Power Purchase Agreement (PPA) Model: the MNO will buy energy based on a per kilowatt hour (kWh) rate with minimum agreed price and consumption
- A Monthly Flat Fee Model: this model establishes a certain OPEX cost for the MNO based on agreed price month and the ESCO will provide the power requirement based on agreement
- An Energy Saving Agreement (ESA) Model: this model calculates a saving difference between before and after implementing a green solution

Power Purchase Agreement (PPA) Model

The PPA model is the most practical one on energy outsourcing business model. The MNO will buy the energy from ESCo based on kilowatt-hour price and with a minimum agreed price. The MNO will not involve on investment and maintenance parts, because ESCo will provide those services.

Flat Fee Model

The Flat Fee Model is a monthly fixed price rate that has been agreed between MNO and ESCo. The most crucial part from this model is a financial risk for ESCo from diesel fluctuation that might impact of business case. The other impact might come from inflation that will impact on daily operational cost and wage.

Energy Saving Model

In this model, the MNO and the ESCo will calculate the saving difference before and after the implementation of green solution, and then the saving will be split for both parties. Some issues might come from this business model such as:

- Actual identification for current OPEX consumption for each particular site
- A dispute of saving might come after the green solution deployment if there is no proper monitoring system installed

This energy saving business model brings its own complication with regards to its calculation method on energy saving result between MNO and ESCo. This method might not applicable for a new network such as in Africa.

Appendix C: Community Power from Mobile Infrastructure

Telecom network and community are two parts that cannot be separated. Tower has been built to give mobile service to population surround that particular coverage location. Community will get the benefit by connected with their family or business through mobile network.

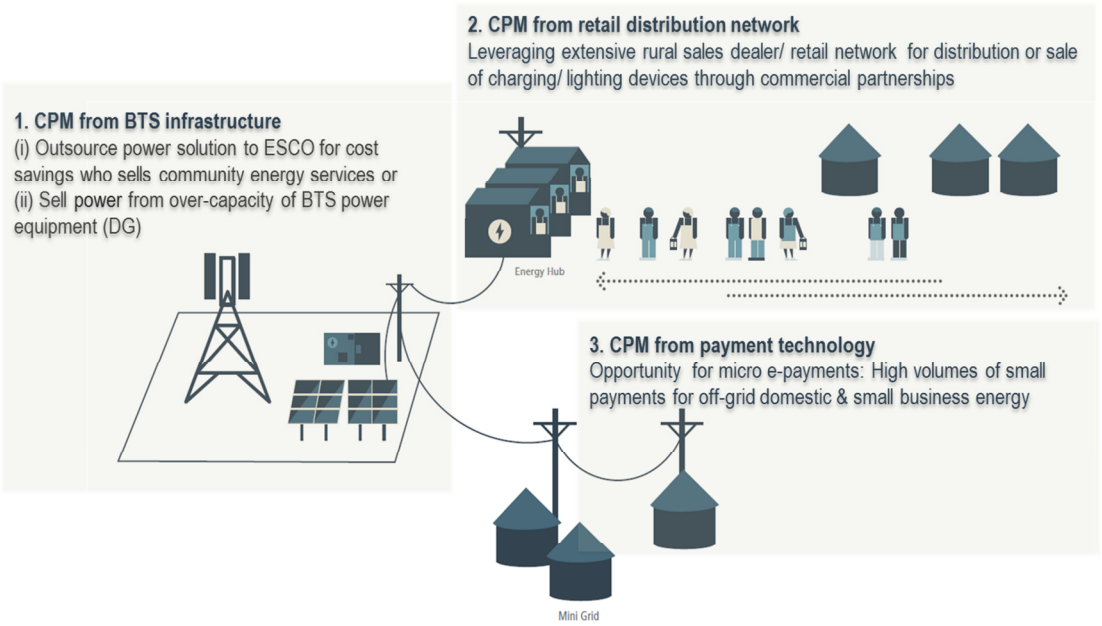
But sometimes, community doesn't have a grid connection while tower/base station is running and working 24 hours a day. It has generated some issue for MNO or Tower Co. GSMA through Mobile Enabled Community Services (MECS) has tried to find a solution for underserved community by optimizing mobile network channels.

Community Service Concept

In 2013, it is about 1.3 billion people has no access to energy and 783 million without access to improved water resources. MECS has estimated that 411 million have access to the mobile network before they have access to energy and 165 million people have access to the mobile network before they have access to improved water source[11].

The GSMA sees an opportunity for the mobile industry to help solve these challenges in emerging markets. The main reason is mobile network coverage has reached to people who have no access to energy and water. The MNO and TowerCo through, their infrastructure, distribution channel or mobile payment technology can offer to increase an access of energy and water to underserved community.

Figure 27: Community Power from Mobile - Models



[11] Mobile Enabled Community Services Research – www.gsma.com

Opportunity and Challenges

Energy and water issues have raised a new opportunity for MNO, TowerCo or ESCo. Some opportunity for community inclusion as follows:

- Mobile infrastructure – leveraging the presence of telecom towers to support rural electrification efforts
- MNO distribution channel and mobile money agent, expanding the footprint and generate a new revenue from value added services
- TowerCo/ESCO, build long term relationship with community surround and reduce vandalism
- Create a new opportunity by selling an energy to underserved population

The one of challenges for Africa is no clear regulation for ESCO to sell their energy to community. ESCO/TowerCo needs to deal with every district authority to get permit and license for selling the energy.

Benefits for MNO/Tower Company

The benefit for providing energy access to community as follows:

- Tower Co/ ESCO will get additional revenue by selling the energy to house surrounding the tower
- By sharing power to community, it can reduce any vandalism from community
- It can be part of CSR from MNO/Tower Co by proving an excess of energy from site
- Leveraging mobile platform to access energy and water services
- Tower Co/ESCO secure long term partnership with anchor tenant and increase its financial sustainability

Appendix D: Renewable Policy and Targets across Africa

Country	Policy Directives and Acts	Year	Policy Status	Policy Type	Policy Target
Algeria	Renewable Energy and Energy Efficiency Development Plan 2011-2030	2011 (February)	In Force	Policy Support, Strategic planning	Multiple RE Sources, Multiple RE Sources, All, Multiple RE Sources, Power, Multiple RE Sources, Heating, Multiple RE Sources, Cooling, Solar, Solar, Solar photovoltaic, Solar Thermal
Algeria	Renewable Energy National Fund	2009	In Force	Policy Support, Insitutional creation, Economic Instruments, Fiscal/financial incentives	Multiple RE Sources, Multiple RE Sources, All
Algeria	Law 04-92 on the Diversification of Power Generation Costs (REFIT)	2004	In Force	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Multiple RE Sources, Multiple RE Sources, All, Multiple RE Sources, Power
Algeria	Law 04-90 on Renewable Energy Promotion in the Framework of Sustainable Development	2004	In Force	Regulatory Instruments, Codes and standards, Policy Support, Insitutional creation, Research, Development and Deployment (RD&D), Research programme , Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Research, Development and Deployment (RD&D), Research, Development and Deployment (RD&D), Research programme , Technology development	Wind, Bioenergy, Biomass for power, Geothermal, Hydropower, Multiple RE Sources, Power, Solar, Bioenergy
Algeria	Law 99-09 on the Management of Energy	1999	In Force	Policy Support, Strategic planning, Policy Support, Insitutional creation	Multiple RE Sources
Botswana	10th National Development Plan 2009-2016 (NDP10)	2009	In Force	Policy Support, Strategic planning	Multiple RE Sources, Multiple RE Sources, All
Botswana	PV System Pilot Projects	2002	Ended	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion	Solar, Solar photovoltaic
Botswana	National Photovoltaic Rural Electrification Programme	1997	In Force	Economic Instruments, Direct investment, Infrastructure investments, Economic Instruments, Fiscal/financial incentives, Loans	Solar Thermal, Solar, Solar photovoltaic
Botswana	Botswana Energy Master Plan	1996 (reviewed 2003)	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Policy Support, Strategic planning, Research, Development and Deployment (RD&D), Research programme , Technology development	Solar, Solar photovoltaic, Multiple RE Sources, Power, Solar
Burkina Faso	Sectorial Policy of Energy	2013 (Oct)	In Force	Policy Support, Policy Support, Strategic planning	Multiple RE Sources, Multiple RE Sources, All
Burkina Faso	Law of finance 2013 relative to the deletion of customs charges on equipments and material of solar energy	2013 (Jan)	In Force	Economic Instruments, Economic Instruments, Fiscal/financial incentives, Economic Instruments, Fiscal/financial incentives, Tax relief	Solar, Solar Thermal, Solar Thermal, Solar heat, Solar Thermal, Solar thermal electricity (STE), Solar, Solar photovoltaic
Burkina Faso	Law 053-2012 on	2013 (Feb	In Force	Policy Support, Regulatory	Multiple RE Sources

	general regulation of the electricity sub sector	7th)		Instruments	
Burkina Faso	National White Paper for 2020	2008 (Jan)	In Force	Policy Support, Strategic planning	Multiple RE Sources, Solar
Burkina Faso	Decree 2000-628 on the Letter of Energy Sector Development Policy	2000 (Dec 30th)	Superseded	Policy Support, Regulatory Instruments	Bioenergy, Biomass for heat, Bioenergy, Biomass for power
Democratic Republic of the Congo	Diversification of Energy enterprises to Increase resilience to Climate Changes		In Force	Regulatory Instruments, Auditing	Multiple RE Sources, All
Egypt	Egyptian Solar Plan	2012 (July)	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Strategic planning, Regulatory Instruments, Other mandatory requirements	Multiple RE Sources, Power, Wind, Solar
Egypt	New National Renewable Energy Strategy	2008 (February)	In Force	Regulatory Instruments, Other mandatory requirements, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Strategic planning	Wind, Multiple RE Sources, Power
Estonia	GIS: Extended use of renewable energy sources for the generation of energy and reconstruction of district heating networks I, II	2010 (March 4th)	In Force	Economic Instruments, Direct investment, Funds to sub-national governments	Bioenergy, Biomass for power
Estonia	National Renewable Energy Action Plan (NREAP)	2010 (January 1st)	In Force	Policy Support, Strategic planning, Policy Support	Multiple RE Sources, Multiple RE Sources, All, Multiple RE Sources, CHP, Multiple RE Sources, Cooling, Multiple RE Sources, Heating, Multiple RE Sources, Power
Estonia	GIS: Supporting investments of the enterprises for the application of wind energy in electricity generation	2010 (January 1st)	Ended	Economic Instruments, Direct investment, Infrastructure investments	Wind, Wind, Onshore, Wind, Offshore
Estonia	Wider use of renewable energy sources in energy production	2009 (March 24th)	In Force	Economic Instruments, Direct investment, Infrastructure investments	Multiple RE Sources, CHP, Multiple RE Sources, Heating
Estonia	National Development Plan of the Energy Sector until 2020	2009 (June 15th)	In Force	Policy Support, Strategic planning, Research, Development and Deployment (RD&D)	Multiple RE Sources, All
Estonia	National Energy Technology Development Plan	2008 (June 1st)	In Force	Research, Development and Deployment (RD&D), Research programme	Multiple RE Sources, All
Estonia	Electricity Market Act 2007	2007	In Force	Regulatory Instruments, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums, Regulatory Instruments, Other mandatory requirements	Wind, Bioenergy, Biomass for power, Hydropower, Multiple RE Sources, All
Estonia	Long-term development plan for the fuel and energy sector to 2015	2004	Ended	Policy Support, Strategic planning	Multiple RE Sources
Estonia	Electricity Market Act 2003	2003 (amended	Superseded	Regulatory Instruments, Economic Instruments, Fiscal/financial	Wind, Bioenergy, Biomass for power, Hydropower, Multiple RE Sources, Power

		2004)		incentives, Feed-in tariffs/premiums	
Estonia	Green Energy (Roheline Energia)	2001	Ended	Voluntary Approaches, Negotiated Agreements (Public-private sector), Economic Instruments, Market-based instruments, Green certificates	Wind
Estonia	2nd National Energy Efficiency Target Programme	2000	Superseded	Economic Instruments, Direct investment, Infrastructure investments, Policy Support	Bioenergy, Biomass for heat
Ghana	National Electrification Scheme	2007-2020	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Research, Development and Deployment (RD&D), Research programme	Wind, Onshore, Bioenergy, Biomass for power, Multiple RE Sources, Power, Solar, Wind
Ghana	Ghana Energy Development and Access Project (GEDAP)	2007	In Force	Economic Instruments, Fiscal/financial incentives, Loans, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Fiscal/financial incentives, Tax relief	Wind, Solar, Solar photovoltaic
Ghana	Strategic National Energy Plan (SNEP) 2006-2020	2006	In Force	Policy Support, Strategic planning	Multiple RE Sources, Power, Multiple RE Sources, Heating
Ghana	Renewable Energy Services Programme (RESPRO)	1999	In Force	Economic Instruments, Direct investment, Infrastructure investments	Solar, Solar photovoltaic
Ghana	Tax and duty exemptions	1998	In Force	Economic Instruments, Fiscal/financial incentives, Tax relief, Economic Instruments, Fiscal/financial incentives, Taxes	Wind
Kenya	Solar water heating regulations	2012 (April)	In Force	Regulatory Instruments, Other mandatory requirements, Regulatory Instruments	Solar Thermal
Kenya	Revised Feed-in-Tariffs for Renewable Energy	2010	In Force	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Wind, Onshore, Bioenergy, Biofuels for transport, Bioenergy, Biomass for heat, Geothermal, Heat, Geothermal, Power, Hydropower, Solar, Solar photovoltaic
Kenya	Energy Regulation 1009 on Biodiesel Licensing	2009	In Force	Regulatory Instruments, Other mandatory requirements	Bioenergy, Biofuels for transport
Kenya	Feed-in tariffs for Renewable Energy Resource Generated Electricity	2008	Superseded	Regulatory Instruments, Other mandatory requirements, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Wind, Bioenergy, Biomass for power, Hydropower, Bioenergy, Co-firing with fossil fuels
Kenya	Energy Regulatory Commission established	2007 (July)	In Force	Information and Education, Information provision, Policy Support, Policy Support, Insitutional creation, Policy Support, Strategic planning, Regulatory Instruments, Codes and standards, Research, Development and Deployment (RD&D)	Multiple RE Sources
Kenya	Energy Act 12 of 2006	2006	In Force	Research, Development and Deployment (RD&D), Demonstration project, Economic Instruments, Fiscal/financial incentives, Tax relief, Policy Support, Policy Support, Insitutional creation, Research, Development and Deployment (RD&D)	Multiple RE Sources, Power, Bioenergy, Biofuels for transport, Bioenergy, Biomass for heat, Multiple RE Sources, Heating

Kenya	The National Energy		Planned	Policy Support, Strategic planning, Policy Support	Multiple RE Sources
Libya	Law No. 426 establishing the Renewable Energy Authority of Libya (REAOL)	2007	In Force	Regulatory Instruments	Wind, Solar Thermal, Solar, Wind, Onshore
Madagascar	Decentralised Rural Electrification Program	2008	In Force	Policy Support, Strategic planning, Voluntary Approaches, Negotiated Agreements (Public-private sector), Voluntary Approaches, Public Voluntary Schemes, Economic Instruments, Market-based instruments, GHG emissions trading, Economic Instruments, Market-based instruments, Green certificates, Economic Instruments, Market-based instruments, White certificates	Hydropower, Bioenergy, Biomass for power, Solar, Solar photovoltaic, Wind, Onshore
Madagascar	Reform of Electricity Sector in Madagascar	1999	In Force	Policy Support, Insitutional creation, Policy Support, Strategic planning	
Mali	Action Plan for Renewable Energy Promotion in Mali	2007	In Force	Policy Support, Policy Support, Strategic planning	Multiple RE Sources
Mali	National Programme to Popularise the Jatropha Plant (PVEPP)	2004	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Information and Education, Advice/Aid in Implementation, Information and Education, Information provision, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Fiscal/financial incentives, Loans	Bioenergy, Biomass for power, Bioenergy, Biofuels for transport
Mali	New and Renewable Energy Project for the Advancement of Women (PENRAF)	1996 (expanded 2001, 2003)	In Force	Economic Instruments, Direct investment, Information and Education, Information provision	Solar, Bioenergy, Biomass for power
Mali	Rural Electrification by Solar Energy	1996	In Force	Policy Support, Policy Support, Strategic planning	Solar, Solar photovoltaic, Solar, Multiple RE Sources
Mauritius	Small Scale Distributed Generation (SSDG) (Feed-in tariff/Net metering scheme)	2010 (last amended 2012)	In Force	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Wind, Hydropower, Solar, Solar photovoltaic, Solar, Multiple RE Sources, Power
Mauritius	Grid code for Small Scale Distributed Generation (SSDG)	2010 (Dec 9th)	In Force	Policy Support	
Mauritius	Maurice Ile Durable (MID)	2009 (last updated 2013)	In Force	Policy Support, Strategic planning	Multiple RE Sources, Multiple RE Sources, All, Multiple RE Sources, Power
Morocco	National Agency for the Development of Renewable Energy and Energy Efficiency 16.09	2010	In Force	Policy Support, Insitutional creation	Multiple RE Sources
Morocco	National Integrated Project for Solar Electricity Production and National Agency for Solar Energy	2010	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Policy Support, Insitutional creation, Policy Support, Economic Instruments, Direct	Solar

				investment, Infrastructure investments	
Morocco	Moroccan Agency for Solar Energy "MASEN" (Law 57.09)	2009 (Oct 1st)	In Force	Policy Support, Insitutional creation	Solar, Solar photovoltaic, Commercial, Solar Thermal, Solar thermal electricity (STE)
Morocco	Renewable Energy Development Law 13.09	2009	In Force	Regulatory Instruments, Policy Support, Strategic planning	Wind, Solar, Solar photovoltaic, Solar Thermal, Solar thermal electricity (STE)
Morocco	Law of self-generation (Law 16.08)	2008 (June 30th)	In Force	Policy Support, Insitutional creation, Voluntary Approaches, Unilateral Commitments (Private sector)	Multiple RE Sources, All, Hydropower, Bioenergy
Nigeria	Nigeria Renewable Energy Master Plan	2011	In Force	Economic Instruments, Direct investment, Infrastructure investments, Economic Instruments, Fiscal/financial incentives, Tax relief, Policy Support, Strategic planning	Wind, Bioenergy, Biomass for power, Solar, Solar photovoltaic, Hydropower, Multiple RE Sources
Senegal	Renewable Energy Law	2010 (December)	In Force	Regulatory Instruments, Regulatory Instruments, Codes and standards, Sectoral standards, Policy Support	Multiple RE Sources, Multiple RE Sources, Power, Multiple RE Sources, All
Senegal	Senegalese National Biogas Programme Phase I	2009	In Force	Economic Instruments, Direct investment, Infrastructure investments, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Insitutional creation	Bioenergy, Biomass for power, Bioenergy, Biomass for heat
Senegal	2007-2012 Special Programme for Biofuels	2007	In Force	Economic Instruments, Direct investment, Infrastructure investments, Policy Support, Insitutional creation	Bioenergy, Biomass for power, Bioenergy, Bioenergy, Biofuels for transport
Senegal	Program for the promotion of renewable energies, rural electrification and sustainable supply in domestic fuel (PERACOD)	2004-2015	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies	Solar, Multiple RE Sources, Multiple RE Sources, All
Seychelles	Energy Act	2012	Planned	Regulatory Instruments	Solar, Wind, Hydropower, Multiple RE Sources
Seychelles	Energy Policy for the Republic of Seychelles 2010-2030	2011	In Force	Policy Support, Policy Support, Strategic planning	
Seychelles	Tax exemptions for renewable energy equipment	2010	In Force	Economic Instruments, Fiscal/financial incentives, Taxes	Multiple RE Sources
Seychelles	Grid-connected Rooftop Photovoltaic Systems project 2010-2014	2010	In Force	Economic Instruments, Direct investment, Infrastructure investments	Solar, Solar photovoltaic
Seychelles	Seychelles Energy Commission established	2009	In Force	Policy Support, Insitutional creation	Multiple RE Sources
Seychelles	Energy Security Steering Committee established	2008	Ended	Policy Support, Strategic planning, Policy Support, Insitutional creation	Multiple RE Sources
Seychelles	Seychelles Energy Policy	1999	Superseded	Policy Support, Insitutional creation	Multiple RE Sources
South Africa	Regulations Regarding the Mandatory Blending of Bio-fuels with Petrol and Diesel	2012 August 23rd	In Force	Regulatory Instruments	Bioenergy, Bioenergy, Biofuels for transport, Bioenergy, Biofuels for transport, Biodiesel, Bioenergy, Biofuels for transport, Bioethanol
South Africa	Renewable Energy Independent Power	2011	In Force	Policy Support, Economic Instruments, Fiscal/financial	Multiple RE Sources, Wind, Onshore, Solar, Solar photovoltaic, Solar Thermal, Bioenergy,

	Producer Programme (REIPPP)			incentives, Feed-in tariffs/premiums, Economic Instruments	Biomass for heat, Bioenergy, Biomass for power, Bioenergy, Co-firing with fossil fuels, Bioenergy, Bioenergy, Biofuels for transport, Hydropower
South Africa	Integrated Resource Electricity Plan 2010 – 2030	2011	In Force	Policy Support, Strategic planning, Regulatory Instruments	Multiple RE Sources, Multiple RE Sources, All
South Africa	Renewable Energy Feed-in Tariff (REFIT)	2009 (modified 2011)	Ended	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Wind, Bioenergy, Biomass for power, Bioenergy, Hydropower, Solar, Solar Thermal
South Africa	Integrated Resource Plan for Electricity (IRP)	2009	In Force	Policy Support, Strategic planning, Policy Support	Multiple RE Sources, Multiple RE Sources, All, Solar Thermal, Solar heat
South Africa	National Energy act (No 34 of 2008)	2008 (November 24th)\n	In Force	Policy Support, Strategic planning, Policy Support	Multiple RE Sources
South Africa	Vision, Strategic Direction and Framework for Climate Policy	2008	In Force	Regulatory Instruments, Information and Education, Economic Instruments, Fiscal/financial incentives, Taxes, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Policy Support, Strategic planning, Regulatory Instruments, Obligation schemes , Regulatory Instruments, Monitoring	Multiple RE Sources, Power
South Africa	Solar Traffic Lights	2008	Planned	Economic Instruments, Direct investment, Infrastructure investments	Solar, Solar photovoltaic
South Africa	Eskom Solar Water Heating Rebate Programme	2008	In Force	Economic Instruments, Fiscal/financial incentives, Tax relief	Solar Thermal
South Africa	Free Basic Alternative Energy Policy (Household Energy Support)	2007 (April 2nd)\n	Unknown	Regulatory Instruments, Policy Support, Economic Instruments, Direct investment, Infrastructure investments	Multiple RE Sources
South Africa	India-Brazil-South Africa Declaration on Clean Energy	2007	In Force	Voluntary Approaches, Public Voluntary Schemes, Voluntary Approaches	Multiple RE Sources
South Africa	Biofuels Industrial Strategy	2007	In Force	Economic Instruments, Fiscal/financial incentives, Tax relief	Bioenergy, Biofuels for transport
South Africa	Renewable energy subsidies - DME	2005	Ended	Policy Support, Economic Instruments, Fiscal/financial incentives, Tax relief, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Fiscal/financial incentives, Loans	Multiple RE Sources
South Africa	Energy Development Corporation (EDC) Projects	2004	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Economic Instruments, Fiscal/financial incentives, Grants and subsidies	Multiple RE Sources
South Africa	White Paper on Renewable Energy	2003	In Force	Policy Support, Strategic planning	Multiple RE Sources
South Africa	Integrated Energy Plan for the Republic of South Africa	2003	In Force	Policy Support, Strategic planning, Policy Support	Multiple RE Sources
South Africa	Integrated National	2001	In Force	Economic Instruments, Direct	Solar

	Electrification Programme			investment, Infrastructure investments, Economic Instruments, Fiscal/financial incentives, Grants and subsidies	
Tunisia	The Decree on connection and access of renewable electricity to the national grid	2011	In Force	Policy Support, Regulatory Instruments, Codes and standards	Multiple RE Sources, Bioenergy, Wind, Solar
Tunisia	Tax exemptions for the import of renewable energy and energy efficiency equipment materials (Decree 2010/1521)	2010	In Force	Policy Support, Strategic planning, Regulatory Instruments, Codes and standards, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums, Economic Instruments, Fiscal/financial incentives, Tax relief	Multiple RE Sources, CHP, Multiple RE Sources, Cooling, Multiple RE Sources, Heating, Multiple RE Sources, Renewable heat pumps , Wind
Tunisia	Tunisian Solar Plan (PST) 2010-2016	2009	In Force	Voluntary Approaches, Negotiated Agreements (Public-private sector), Policy Support, Policy Support, Insitutional creation, Policy Support, Strategic planning, Economic Instruments, Direct investment, Infrastructure investments, Voluntary Approaches, Unilateral Commitments (Private sector)	Wind, Onshore, Solar, Solar, Solar photovoltaic, Solar Thermal, Wind
Tunisia	Decree 2009/362 on Renewable Energy and Energy Efficiency Premiums	2009	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies	Solar Thermal, Multiple RE Sources, Multiple RE Sources, Heating, Multiple RE Sources, Power, Solar
Tunisia	Law 2009-7 on Energy Efficiency: Renewable Energy Provisions	2009	In Force	Regulatory Instruments, Codes and standards, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Policy Support, Insitutional creation, Regulatory Instruments, Monitoring, Regulatory Instruments, Auditing, Regulatory Instruments	Multiple RE Sources, All, Multiple RE Sources
Tunisia	Decree on rules of selling renewable electricity to the Tunisian Company of Electricity and Gas (STEG)	2009	In Force	Policy Support, Regulatory Instruments, Economic Instruments, Regulatory Instruments, Codes and standards	Multiple RE Sources, All, Bioenergy, Solar, Solar photovoltaic, Wind
Tunisia	National Energy Efficiency Program 2008-2011: Renewable Energy Provisions	2008	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Information and Education, Information provision, Economic Instruments, Direct investment, Funds to sub-national governments, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Policy Support, Strategic planning, Research, Development and Deployment (RD&D), Research programme , Technology development	Wind, Onshore, Bioenergy, Biomass for heat, Bioenergy, Biomass for power, Solar, Solar photovoltaic
Tunisia	National Energy Efficiency and Renewable Energy Programme 2008-2011	2007	In Force	Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Economic Instruments, Fiscal/financial incentives, Grants and	Wind, Bioenergy, Solar, Solar photovoltaic

				subsidies, Policy Support, Strategic planning	
Tunisia	PROSOL Tertiary: Incentives for commercial solar water heaters	2007	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Information and Education, Advice/Aid in Implementation, Information and Education, Information provision	Solar Thermal
Tunisia	Law 2005-82 on Energy Efficiency Fund (FNME)	2006	In Force	Economic Instruments, Direct investment, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support, Insitutional creation	Multiple RE Sources, Power, Multiple RE Sources, Multiple RE Sources, All, Multiple RE Sources, CHP, Multiple RE Sources, Heating
Tunisia	PROSOL Residentiel: Incentives for solar water heaters	2005	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support	Solar Thermal
Tunisia	Law and Decree on Energy Conservation and Renewable Energy	2005	In Force	Policy Support, Strategic planning	Multiple RE Sources
Tunisia	Law 2004-72 on Energy Efficiency: Renewable Energy Provisions	2004	Superseded	Regulatory Instruments, Monitoring, Policy Support, Policy Support, Insitutional creation, Policy Support, Strategic planning, Research, Development and Deployment (RD&D), Research, Development and Deployment (RD&D), Research programme , Technology deployment and diffusion, Research, Development and Deployment (RD&D), Research programme , Technology development, Regulatory Instruments, Other mandatory requirements	Wind, Onshore, Bioenergy, Biomass for heat, Geothermal, Geothermal, Power, Hydropower, Solar, Solar Thermal, Wind
Tunisia	Tax exemptions for the import of renewable energy and energy efficiency equipment materials (Decree 95/744)	1995	Superseded	Policy Support, Strategic planning, Regulatory Instruments, Codes and standards, Economic Instruments, Fiscal/financial incentives, Tax relief	Multiple RE Sources, CHP, Multiple RE Sources, Cooling, Multiple RE Sources, Heating, Multiple RE Sources, Renewable heat pumps , Wind
Uganda	Renewable Energy feed-in tariff	2011 (last amended 2012 Nov)	In Force	Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Wind, Bioenergy, Bioenergy, Biomass for power, Geothermal, Geothermal, Power, Hydropower, Solar, Solar photovoltaic
Uganda	Solar Power Subsidy	2007	In Force	Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Fiscal/financial incentives	Solar, Solar photovoltaic, Solar
Uganda	Renewable Energy Policy 2007-2017	2007	In Force	Regulatory Instruments, Information and Education, Information provision, Economic Instruments, Fiscal/financial incentives, Tax relief, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Direct investment, Infrastructure investments	Solar Thermal, Bioenergy, Biofuels for transport, Bioenergy, Biomass for heat, Bioenergy, Biomass for power, Geothermal, Geothermal, Power, Hydropower, Multiple RE Sources, Heating, Multiple RE Sources, Power
Uganda	Energy for Rural Transformation (ERT)	2002 (July 1st)	Ended	Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Market-based instruments, GHG emissions trading, Information and Education, Professional training and qualification, Policy Support, Insitutional creation,	Solar Thermal, Bioenergy, Biomass for power, Multiple RE Sources, Power, Solar, Solar photovoltaic, Solar, Solar photovoltaic, Off-grid

				Regulatory Instruments, Auditing, Regulatory Instruments, Codes and standards, Product standards, Regulatory Instruments, Monitoring	
Uganda	Energy for Rural Transformation Program Pase II and III	2002	In Force	Economic Instruments, Direct investment, Infrastructure investments, Information and Education, Advice/Aid in Implementation, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Economic Instruments, Fiscal/financial incentives, Loans, Policy Support, Insitutional creation, Policy Support, Strategic planning	Solar Thermal, Bioenergy, Biomass for power, Multiple RE Sources, Power, Solar, Solar photovoltaic
Uganda	Hydro and CHP Feed-in-Tariff	2000 (modifeid 2010)	In Force	Economic Instruments, Fiscal/financial incentives, Taxes, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Multiple RE Sources, CHP, Hydropower
United Republic of Tanzania	2010 Electricity rules (Feed-in tariff)	2010	In Force	Policy Support, Economic Instruments, Fiscal/financial incentives, Feed-in tariffs/premiums	Multiple RE Sources, Power, Multiple RE Sources, Multiple RE Sources, Heating
United Republic of Tanzania	Tanzanian Energy Development Access Programme (TEDAP)	2008	In Force	Economic Instruments, Direct investment, Infrastructure investments, Economic Instruments, Fiscal/financial incentives, Grants and subsidies, Policy Support	Solar, Solar photovoltaic, Multiple RE Sources, Multiple RE Sources, Power
Zimbabwe	Energy Regulatory Act	2011	In Force	Policy Support	Multiple RE Sources
Zimbabwe	Rural Electrification Fund Act	2002	In Force	Policy Support, Strategic planning, Economic Instruments, Direct investment, Infrastructure investments	Multiple RE Sources
Zimbabwe	National Electricity Act	2002	In Force	Policy Support, Policy Support, Strategic planning, Policy Support, Insitutional creation	Multiple RE Sources

Source: IRENA