IFC International Finance Corporation World Bank Group

GSMA

Green Power for Mobile

In partnership with the Netherlands

SIZING THE OPPORTUNITY: GREEN TELECOMS IN MYANMAR

GREEN POWER FOR MOBILE MARKET ANALYSIS

Contents

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Objective

The Green Power for Mobile Market Analysis report for Myanmar aims at providing market insights and highlight opportunities for telecom operators in the green power sector.

The objectives of the report are to analyse the state of the telecom market and how networks are currently being powered in order to provide the readers with an understanding of the potential of alternative energy solutions, in particular green power. The report looks at various elements, including the industry structure, the regulatory environment and the current state of power within the telecom infrastructure, influencing the potential for green power solutions.

The report presents the current size of the market and takes a look at the future of green power for mobile as well as future trends, providing an overview of the potential market opportunity for 3rd party outsourced energy model.

Approach

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

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.

ESCOs: An energy service company that provides turnkey or end-to-end GPM solutions to an operator for off-grid telecom BTS.

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

OPEX Model: A Renewable ESCO invests CAPEX to generator power at site level and sells power to Mobile Operator or Tower Company.

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

Off-grid site: Telecom Base Station Site which is NOT connected to the commercial Grid power supply

On-grid site: Telecom Base Station Site which is connected to the commercial Grid power supply

DG: Diesel Generator

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

CAGR: Cumulative Annual Growth Rate

ARPU: Average Revenue per User of mobile services

PPA: Power Purchase Agreement

Executive Summary

Myanmar, with a population of nearly 60 million, is considered one of the last frontiers for growth in Asian region with immense business potential in various segments including energy, telecommunications and infrastructure to name a few. Myanmar, a green field telecommunications market, has been the focus of many international players for the last two years. The government has recently awarded two new mobile telecommunications licenses to international mobile operators, namely Ooredoo and Telenor, to bring competition and efficiencies in order increase access to affordable communications services to the people of Myanmar, and drive towards achieving universal access to mobile communications.

Until recently, the telecommunications industry in Myanmar has been a monopoly run by the Myanmar Posts and Telecommunications (MPT) – the state-owned incumbent operator, providing fixed and wireless communications services in the country. With a current subscriber base of 5.44 million, the mobile penetration in Myanmar has been the lowest in the region at only less than 10% of the population having access to mobile services.

With the entry of Ooredoo and Telenor, the subscriber base is expected to grow to 22 million increasing the penetration to approximately 40% by 2017. Similarly, the mobile network coverage of population is expected to grow from current level of 12% to 70% by 2017. To achieve this growth in coverage and penetration levels, the MNOs need considerable investments in expanding the mobile network to reach the uncovered population so far. Based on the current plans, the mobile network is expected grow from current 1,800 sites to 7,600 sites by 2015 and further to 17,300 sites by 2017.

However, the MNOs face many infrastructure challenges to achieve the aggressive network rollout targets. Of the many challenges, electricity supply and grid infrastructure remain the biggest challenges to rollout the network. Currently, the grid power infrastructure reaches only 29% of the population in Myanmar and the per capita power consumption is amongst the lowest in the region at 160 kWh per year. Power outages and blackouts are very common and frequent due to shortages in power generation capacities. Site acquisition and abysmal transport infrastructure are other major challenges affecting the rollout of mobile networks in Myanmar.

Given the context of shortages in power supply, poor grid and transport infrastructure, the MNOs need to rely on diesel based power sources to power up their network at 99.95% benchmark uptime. Limited reach of grid power infrastructure will lead to majority of the telecom sites being deployed in off-grid areas. GPM estimates that the number of off-grid sites in Myanmar will grow from current 540 sites to 2,850 sites by 2015. A corresponding growth in unreliable-grid sites is from 450 sites to 2,043 sites by 2015. In the short term, the MNOs are looking at utilizing battery hybrid technics to reduce the dependence on diesel generators and save on energy OPEX.

GPM analyses the use and feasibility of alternative green power technologies to power up telecom sites and thereby reducing the OPEX and dependence on diesel generators. GPM estimates that, by 2017, the potential green power for telecom opportunity will reach an approximately 9,990 sites. The adoption of green power at these sites would fetch an annual OPEX savings of US $137 million every year by 2017. With an investment of US $388.5 million, the payback period is less than 3 years.

Given the huge CAPEX requirements and challenges in energy provision, the MNOs could look at outsourcing the energy provision to a 3rd party Energy Service Company (ESCO). With the energy outsourcing, MNOs can realize a saving of US$ 79 million in OPEX every year by 2017. For an ESCO, the market potential would reach to annual revenue of US$ 157 million per year and would require an investment of US$ 466 million by 2017.

In summary, Myanmar presents a huge opportunity for MNOs/Tower Cos and the ESCOs to work towards deploying green power alternatives for powering telecom sites in order to save in energy OPEX and address the infrastructural challenges present in Myanmar and achieve the rollout targets and growth.

Myanmar: A new emerging economy

Myanmar (Burma), a country of nearly 60 million[1] people and one of the world's most diverse countries with a rich history, a wealth of cultural and religious traditions, is considered Asia's last frontier with huge potential for growth and international trade. Post ethnic-war era, with the developing political and economic reforms, Myanmar is emerging as an inexorable investment destination for governments and private sector in Asia and beyond.

Myanmar, with a total land area of 676,578 sq. km, is the second largest country in Southeast Asia endowed with fertile tropical deltas in the south and a rugged landscape in the Himalayan foothills of the north. It shares borders to the north and northeast with the People's Republic of China, to the east and southeast with Lao People's Democratic Republic (Lao PDR) and Thailand, and to the west and northwest with Bangladesh and India.

Figure 1: Myanmar and Its Regions

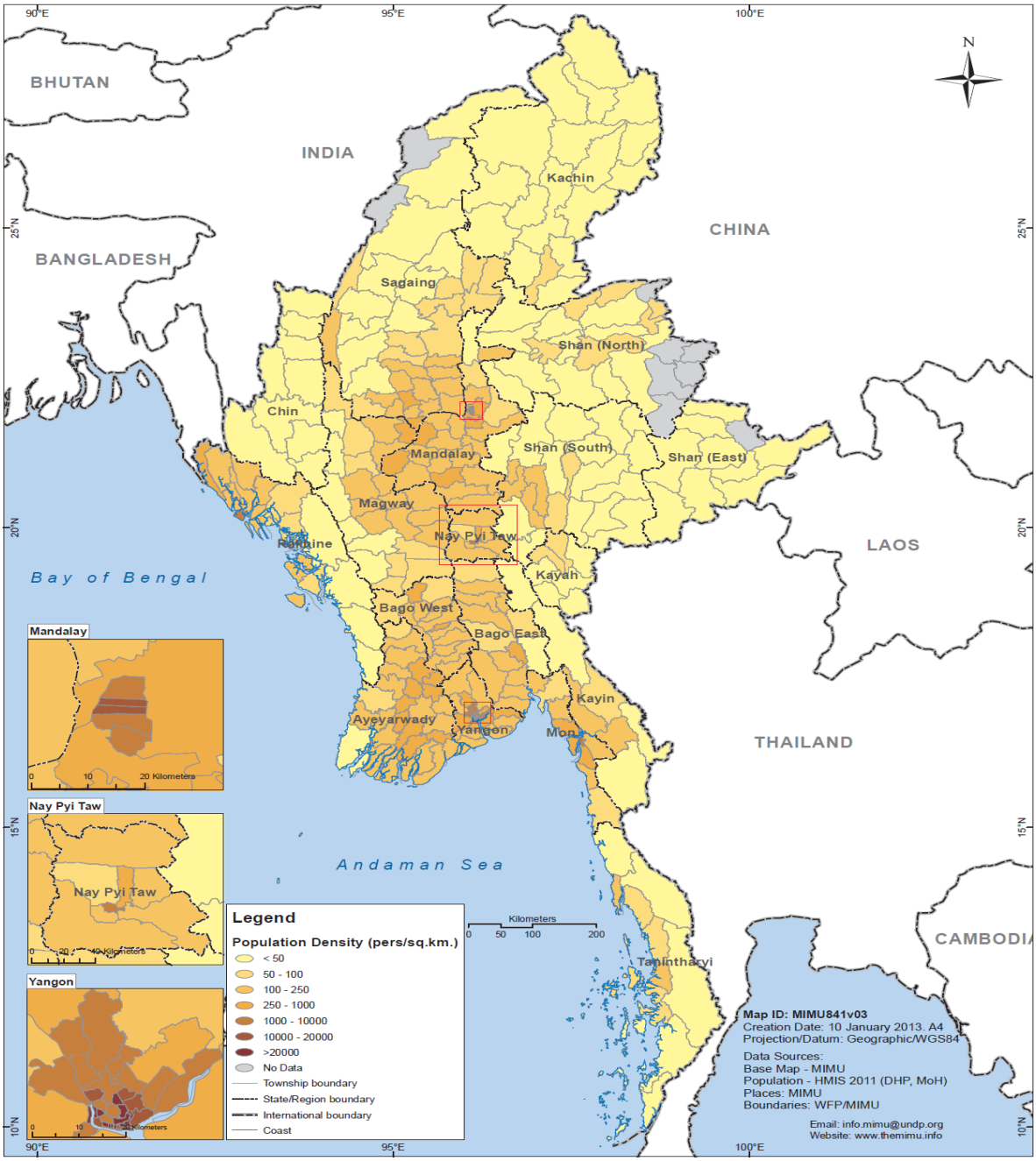
[1] Myanmar in Transition – Asian Development Bank (ADB) report

[2] Asian Development Bank, Country report - Myanmar

Myanmar is divided into seven/divisions (*taing*) and seven states (*pyi-nè*), classified by ethnic composition. The seven regions are Ayeyarwady Division, Bago Division, Magway Division, Mandalay Division, Sagaing Division, Taninthary Division and Yangon Division; the seven states are Chin State, Kachin State, Kayin State, Mon State Rakhine State and Shan State. Each states and divisions have their representation in Lower House in legislative.

Myanmar is rich in natural resources including arable land, forests, minerals, natural gas, and freshwater and marine resources and has a 2,800 km coastline which provides access to sea routes and deep-sea ports enabling potential international trades.

Figure 2: Myanmar – Population Density Map



Source: MIMU, ***Myanmar Information Management Unit***

Economic Strength of Myanmar

The economy is dominated by agriculture and farm-related activities which account for 36% of gross domestic product (GDP) employing 60%–70% of people in the country.[2] As a developing country, Myanmar is trying to accelerate its development among the neighboring countries. Myanmar with all economic challenges during the past has shown consistent GDP growth year by year. GDP per Capita has reached 848,325 MMK (Myanmar Kyat) in 2012 or around 878.18 in USD.

Table 1: GDP growth - Myanmar [3]

	2009	2010	2011	2012
GDP per capita (Kyat)	573,212	665,386	767,492	848,325
GDP Growth (%)	10.60	9.60	5.60	7.60

The economic growth rate is largely due to strong export earning driven by sales of natural commodities. Rice agriculture is main revenue stream for Myanmar. Myanmar has exported varies of variety rice to neighboring country such as Thailand. On the other hand Oil and Gas haven't been exploited much in the country. The country is a major natural gas exporter, other exports include oil, teak and precious and non-ferrous metals. The precious stones such as sapphires, pearls, jades and rubies have main driven for export. The mountainous Mogok area is recognized as 'Valley of Rubies' in the country.

Ongoing Reforms and Developments in Myanmar

Myanmar, with recent positive political and economic outlook, has shown substantial interest in extracting the country's natural resource wealth, and with the help of international organizations such as the World Bank and Asian Development Bank (ADB), it has started focusing on developing large-scale infrastructure projects to establish strategic corridors to connect the country to the wider economic region.

The first time in more than half a century, Myanmar is poised to achieve far-reaching economic growth with a positive investment scenario. While regional and international investment could potentially foster economic growth and improve livelihoods, the country has yet to develop the institutional and governance capacity to manage the expected windfall.

After decades of relative isolation, the new government is in the process of liberalising the economy and implementing reforms to attract foreign investment. The international community has shown great interest, fuelling

[2] Asian Development Bank, Country report - Myanmar

[3] BIMSTEC – www.bimstec.org

the onset of a gold rush, with Myanmar being portrayed as "probably the best investment opportunity in the world right now".[4]

Myanmar, as Asia's final resource frontier, has prominently enticed the interest of foreign investors. The approval of the Foreign Investment Law (FIL) in November 2012 has paved the way for attracting foreign investments in various sectors including infrastructure, telecommunications, energy and manufacturing. The FIL allows for up to 100 per cent foreign ownership with the exception of special restrictions in sectors such as agriculture, livestock breeding and fisheries etc. The Myanmar Investment Commission (MIC) is the agency that approves investments in restricted sectors.

Some of the key recent reforms and developments in Myanmar's economy include –

- Parliament approved the Foreign Investment Law (FIL) to allow for up to 100 per cent foreign ownership, but with special restrictions in some sectors, such as agriculture, livestock breeding and fisheries.
- Opening up the telecommunications sector for the development of telecommunications infrastructure to grow access to mobile communications in an effective and affordable way. Recent award of telecommunications licenses to two international mobile network operators; And the New Telecommunications Law to strengthen the focus and drive towards universal access to communications
- Reorganization of ministries to focus on rural economic infrastructure development – recent focus on rural electrification and support rural economic activity
- Drafting a New Energy Law developing energy sustainability and promoting renewable energy for rural electrification and with a focus on infrastructure and capacity development with potential for strategic international trade

Myanmar is now very positive about opening its market to international investors. It has been indicated by giving two national mobile operator licenses to Ooredoo and Telenor, also for the other sectors. These changes will bring signification impact to the economic development of the country and welfare of the citizens.

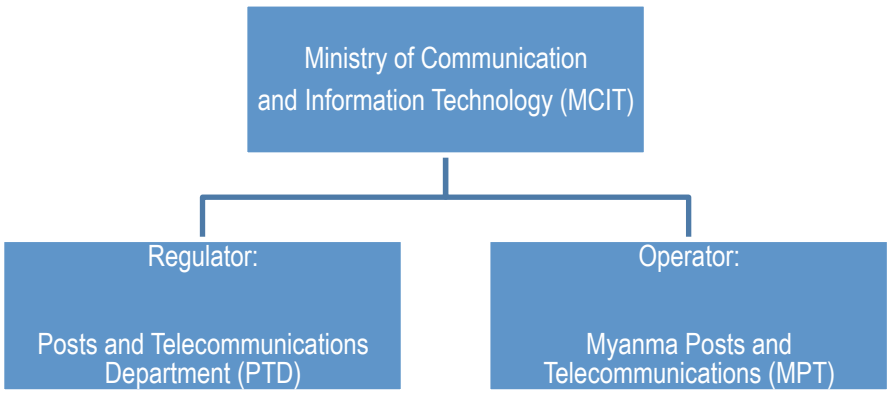
In this report, we critically look at the telecommunications sector – the infrastructure and growth outlook and its imminent challenges as well the way forward in the context of current developments in the country.

[4] "Staggering fortunes' possible in Myanmar: Rogers", Myanmar Times, July 2012

Myanmar: A Greenfield Telecommunications Market

Until recently, the telecommunications industry in Myanmar has been essentially a government monopoly with the state-owned operator, Myanmar Post and Telecommunications (MPT), deploying and managing the fixed and mobile telecommunications services in the country. MPT operates as a mobile and fixed telecom network operator under the Ministry of Communication and Information Technology (MCIT) with the Posts and Telecommunications Department (PTD) acting as the regulator.

Figure 3: Institutional Structure of MCIT



Previously, the telecommunications sector was under the Ministry of Communication, Posts and Telegraphs (MCPT). The MCPT has been managing the communications industry in Myanmar from the media sector to the telecommunication sector. The main responsibilities of MCPT in telecommunication industry in Myanmar as follows:

- Arranging public communication service for Myanmar's people
- Establishing communication centers and routers with standard requirement
- Issuing licenses for all communication industry
- Collecting licenses fee from the stakeholders
- Monitoring communication services according Laws, Rules and Regulations
- Managing radio frequency resources
- Monitoring standard and quality of communication services in the country

With the new structure, both MPT (the government operator) and PTD (the regulator) will fall under the purview of Ministry of Communication and Information Technology (MCIT).

The government has played an important role in both media and telecommunication sectors by owning majority stakes in the key sector companies. In the telecommunications sector, the government has a majority stake in MPT, which runs the fixed and wireless networks in the country as the government owned telecom operator. The government also owns a majority stake in another key organization Yatanaporn Teleport Co (YTP) which is the only internet services provider along with MPT. In addition, the government plays a key dominating role in media sector with a very few private players and opposition party organizations.

The monopoly of the state-owned telecom services is expected to end with the recent developments in granting new mobile telecom licenses to two new international private mobile operators. Both the new mobile operators are expected to launch their services mid of this year.

The government currently is drafting and finalizing a new Telecommunications Law, in an attempt to increase access to telecommunications in the country and to establish a fair playing field to all the telecom operators including the incumbent state-owned operator and the two new private players. However, there are many unresolved matter that must be addressed if Myanmar wants to be successful in delivering the much needed communication services to the country. Especially on followings:

- The split of Ministry as regulatory and enterprise company
- Finalizing key regulations law for telecommunication sector
- Managing frequency allocation for each players in telecommunication sector

The government is working with international organizations and industry bodies to address the current issues and provide clear regulatory framework and guidelines in order to achieve its goal of universal access to telecommunications at a faster pace.

New Telecommunication Law and Objectives

Until this document has been released, a new telecommunication law has not been in place for the industry. In this process, PTD will be responsible for providing advice to the Ministry and carrying out regulatory in the sector.

The interventions could be on following aspects:

- Encourage private sector participant to improve current regulation
- Develop future national plans and policies
- Financial development on subsidies, taxes or grants
- Define Universal Service Obligations (USO) to encompass broadband services
- Redirect Universal Service Fund (USF) to enable rural or uncovered areas in the country

The most important a key reform in Telecommunication Law will be the decision as to how to structure the market. As the present, most of towers, backhaul infrastructure and international gateways are owned by the government.

Current state of Mobile Telecom Industry in Myanmar

Myanmar is one of the last untapped telecommunication markets in the world. The first wireless network was launched in 1999 based on Code Division Multiple Access (CDMA) Technology. Then Global System for Mobile communication (GSM) has been introduced in 2002 and 3G network was commercially launched in 2008.

For many years, MCIT (or MCPT previously) has acted as Myanmar's telecommunication regulator and owns the primary telecommunication operator, MPT. Currently, MPT is the only GSM mobile operator in the country that serves 2G and 3G networks for Myanmar.

The mobile telecommunications market in Myanmar is significantly underdeveloped. While MPT has been the country's telecom operator deploying and managing both mobile and fixed networks, YTP has been leading as an ISP in Myanmar deploying and operating WiMAX services commercially.

Mobile roaming services in Myanmar are very limited. MPT has limited number of roaming partners and has no Short Message Service (SMS) Hub to connect MPT's customers with operators around the globe.

At the current level of network deployments, only three major cities are covered by wireless mobile networks including regions around Yangon, Nay Phi Taw and Mandalay. There are about 14,000 kilometers of fiber in Myanmar and around 1,800 mobile telecom towers across the country. The government owns most of telecom infrastructure.

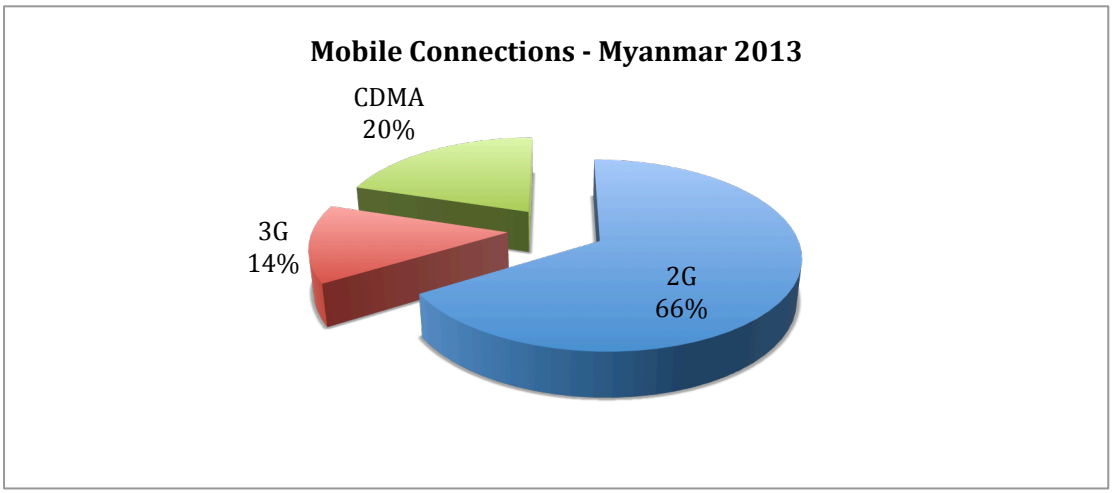
The cost of new connections has been a huge barrier in accessing mobile telecom services in Myanmar. In fact, SIM cards are priced around USD 150-200 in the market (and it used to be about USD 500-600 a few years ago) and it will go higher in black market.

With the award of new licenses to private mobile operators, Ooredoo and Telenor, The situation will change very soon as both the new operators are expected to launch their services by as early as June 2014. Additionally, a microwave frequency issue might become a problem for two new operators to achieve their on-air target within this year.

Connections and Penetration: Current Status and Future Growth Outlook

According to MCPT, the current number of connection is 5.44 million connections or 10.3% of penetration level[5]. 2G user is about 66% or 3.62 million from total connection, 14% or 0.74 million is 3G users and the remaining 20% is using CDMA technology. Yangon and Mandalay are two regions with the highest number of connection is the country, with approximate is 1.795 million connections[6].

Figure 4: Current Mobile Connections in Myanmar



The number of mobile penetration may increase if the cost of acquiring SIM card and telecom infrastructure issues can be eliminated. Because Myanmar's mobile penetration is the lowest compared to its neighbouring countries.

On fixed telecommunication lines, Myanmar has about 1% penetration or 604.5 thousand lines. The dispersion of fixed telephone infrastructure is biased toward larger cities such as Yangon and Nay Phi Taw. Most villages in rural areas remain without fixed line service.

The market will grow with the arrival of two new MNOs. In coming 2-3 years, the new MNOs will try to catch with the current incumbent market leader, MPT. With the aggressive growth targets set forth by the new operators, a number of towers will accrue rapidly in the country.

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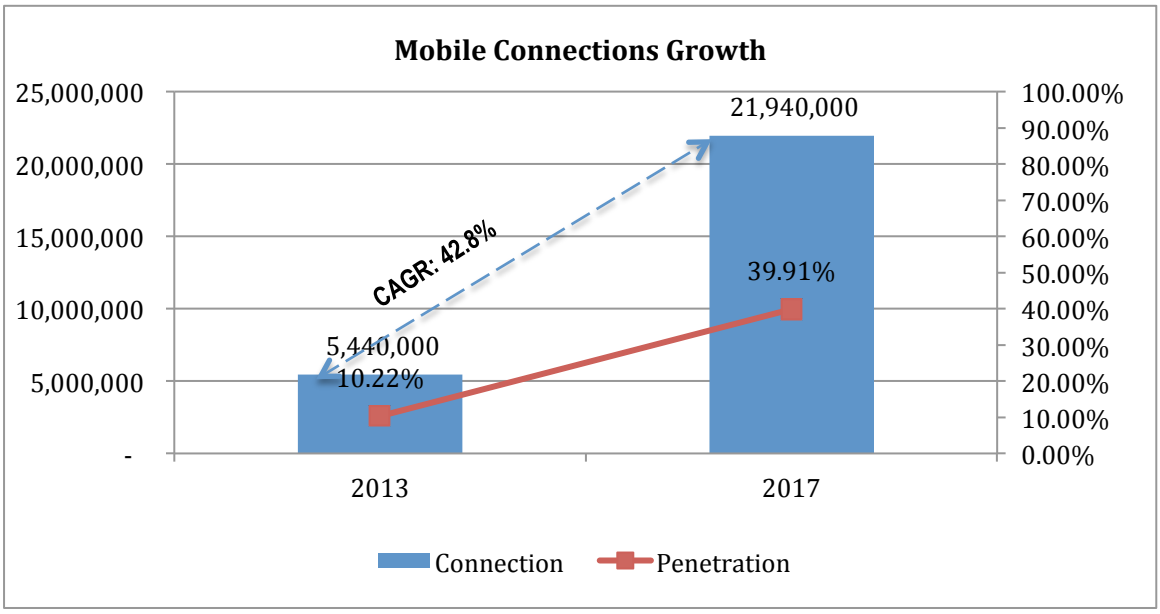
[5] Estimated penetration level based on a population estimate of 53 million (MCPT – www.mcpt.gov.mm)

[6] MCPT – www.mcpt.gov.mm

GPM estimates by 2017 the number of mobile connections will reach 21.9 million, growing at a CAGR of 43%. The mobile penetration level will grow to approximately 40% from the current level of over 10%.[7]

Figure 5: Growth in Connections and Penetration



Mobile Coverage and Network Deployments: Current status and Growth Outlook

GPM has identified that currently around 1,800 tower sites have been deployed in Myanmar by the incumbent operator, MPT. The current network covers only the major highways and cities of Yangon, Nay Pyi Taw and parts of Mandalay region. The mobile network coverage levels are expected to grow rapidly with the arrival of two new mobile operators in the country. The Ministry of Communication and Information Technology (MCIT) of Myanmar has set forth a mandate for MNOs to increase coverage to 95% by 2020 with interim target coverage of 70% by 2017.

The two new mobile operators, Ooredoo and Telenor, have mandatory coverage requirements due to license obligations and have set aggressive coverage targets to capture market share and new subscriber base. Based on current plans, the two operators are expected to deploy 4,700 sites by 2015. The incumbent operator is planning to deploy additional 500 sites in 2014 and additional 600 sites each over next two years.[8]

Given the above rollout plans by the three MNOs in Myanmar, the outlook for network growth and the corresponding growth in mobile coverage are illustrated below. The population coverage is expected to almost double reaching over 30% population coverage by 2015 from the current coverage level of 12%.

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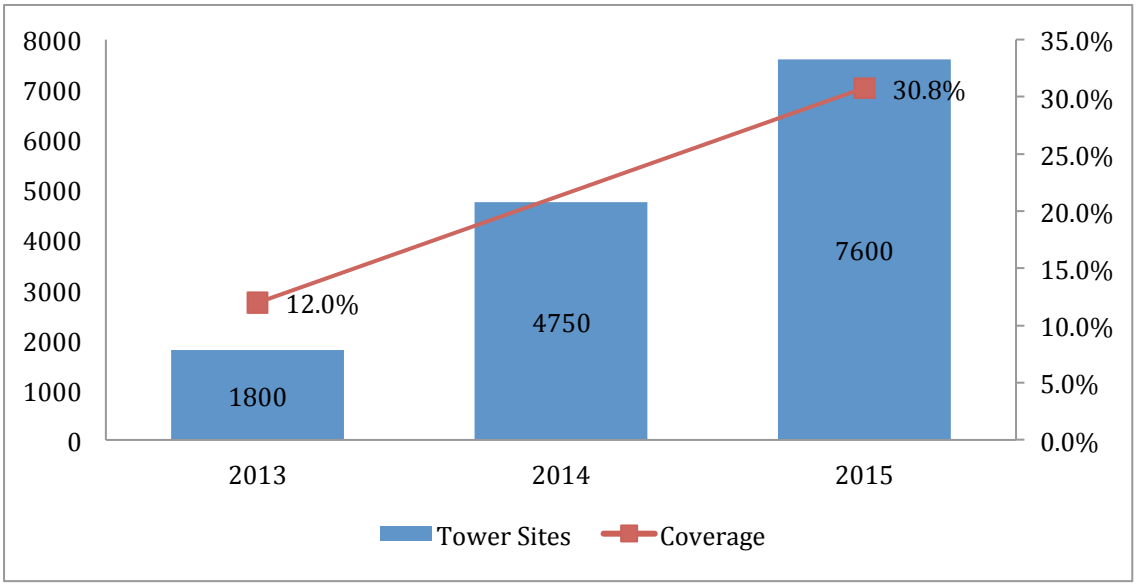
[7] GPM Research and Analysis, GSMA Wireless Intelligence

[8] Industry Insights - GPM Research and Analysis

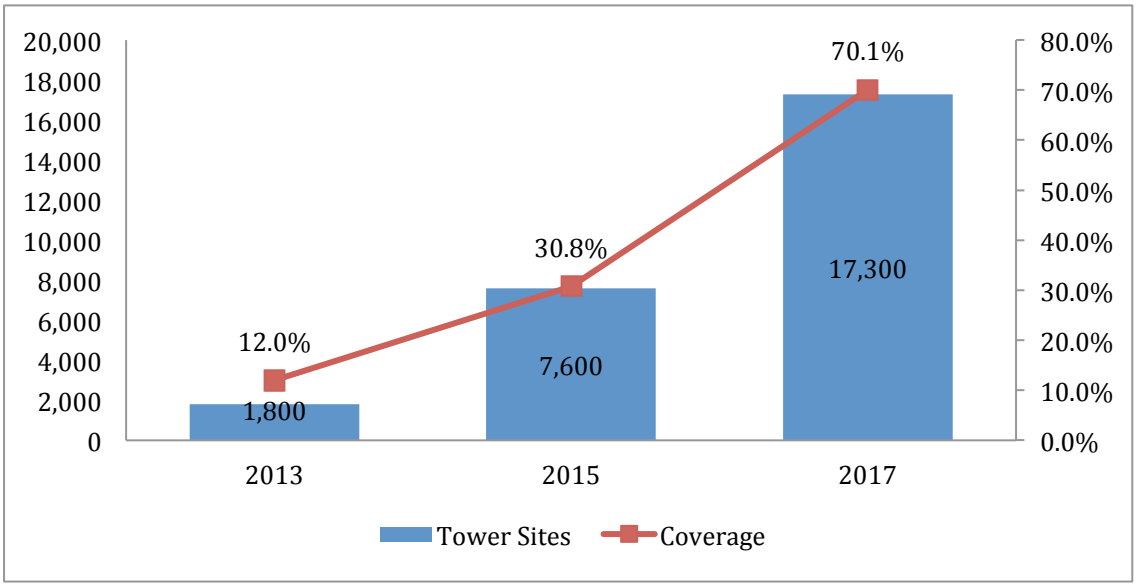
Figure 6: Growth in Network and Coverage – Short Term (by 2015)[9]



In the medium term, by 2017, the mobile operators are targeting to cover more than 70% of the population in the country. GPM estimates that to reach the targeted coverage level, mobile operators would need to deploy a total 17,300 sites by 2017.

The medium-term network growth and the corresponding growth in mobile coverage are illustrated below.

Figure 7: Growth in Network and Coverage – Medium Term (by 2017)[10]



[9] GPM Research and Analysis

[10] GPM Research and Analysis

Industry Structure and Deployments Models

The current approach to network deployment is mainly through Tower Company model allowing faster deployment cycles to meet the aggressive targets and to achieve cost efficiencies by sharing passive network infrastructure with other mobile operators.

The concept of site sharing and tower outsourcing is presented in detail in **Appendix A**.

The incumbent government operators, MPT and YTP, in line with their current rollout programs are looking at bringing foreign investments to catch up with the two private operators. However, with the directive from MCIT to reduce duplication of site rollouts, they would be considering co-locating some of their sites with other operators on the existing sites built up by the tower companies.

Currently, there are four Tower Companies operating in Myanmar, namely, Apollo Towers, Irrawwady Green Towers (IGT), Myanmar Tower Company (MTC) and Pan Asia Towers (PAT). Telenor is engaged with Apollo and IGT for their initial rollout programs while Ooredoo is engaging MTC and PAT for the initial network rollouts. The current industry structure and the engagement by rollout programs are illustrated in the below diagram.

Figure 8: Industry Structure and MNO-Tower Co engagements

	Apollo	IGT	MTC	PAT	MPT/YTP
MPT					√
Ooredoo			√	√	
Telenor	√	√			
YTP					√

The ownership of tower and power assets varies with the deployment model adopted by the operators. Both the new operators, Ooredoo and Telenor, are considering an outsourced model of sharing passive tower infrastructure as well as the power infrastructure in the long run. However, the model differs in the aspect of power outsourcing based on the structure of the power provision arrangement.

Ooredoo in the first phase of network rollout is adopting a mixed model of leased tower and space combined with in-house (CAPEX) power system deployment. Whereas Telenor is deploying its network on leased tower and

space combined with outsourced power. However, the diesel consumption and electricity bills are a passed through to Telenor by the Tower Companies.

Network Deployment and Challenges

The telecom market is thriving in Myanmar with all its infrastructure and operational challenges affecting the rollout plans. MNOs needs to deal with a new telecommunication law, spectrum issue and power availability during their network construction. At the same time, MNOs also need to focus on seizing a new customer and increase their market penetration.

Poor infrastructure, site acquisition and power availability remain main challenges during a site construction and rollout process.

Table 2: Mobile network deployment - Challenges and Opportunities[11]

	Challenges	Opportunities/Solutions
Infrastructure	Under-developed transport infrastructure means challenging inland logistics	Secure local partner and use limited weight equipment loads including light weight towers
	Limited reach of grid power infrastructure and power supply shortages	Hybrid and renewable energy solutions with deep cycle batteries
	Lack of rural electrification	Community power model with Telecom Towers as anchor tenant
Rollout and Site acquisition	Limited telecoms construction experience of local contractors	Expat management trains local resources
	Difficulty co-ordinating rollout of shared infrastructure across four MNOs and four Tower Cos	Progressive MCIT strongly discourages tower builds at duplicate sites
	Monsoon rains	Robust fleet
	Site acquisition – lease ownership often unclear, lease holders reluctant to sign	Local and expat site hunters working very hard to overcome the challenges
	Ownership of land prohibited	Long term leases for foreign companies with an investment permit
	Unable to access religious and agricultural real estate	Access to the significant amount of land owned by government
Regulatory	Anticipated import complexities and taxes	Vendors report that taxes are reasonable, with efficient handling and warehousing through the

[11] Revised from TowerXchange Journal, Issue 8

		main port. Special taxation for telecom and associated equipment to support faster rollouts.
	Telecommunications Law, including definition of terms of Network Facilities Provider License, not yet passed	Government has issued temporary licenses
Political and Economic	Unrest, particularly in Northern region	Continuing efforts to maintain a ceasefire
	Immature local banking and insurance industry	Foreign banks able to enter Myanmar after they join the ASEAN Economic Community single market in 2016. Small, state-dominated Myanmar insurance market being liberalised
	Some sanctions remain in place, some individuals are on US and other black lists	Check the ownership of local partners

With poor electricity supply and limited grid infrastructure posing huge challenges, the operators might need to look at alternative solutions to power up their base stations. The following section discusses in detail the situation of power supply and grid infrastructure in Myanmar and its implications on the mobile telecom industry.

Power and Infrastructure: A barrier to Mobile network growth in Myanmar

The deployment and growth of mobile networks is highly dependent on the existing power and road infrastructure. Mobile operators in Myanmar face a huge infrastructure challenges to support the planned deployments and growth of mobile networks in future.

The current state of Power Supply and Grid Infrastructure in Myanmar

Very low levels of Electricity Access

Myanmar is one of the least electrified country in the South East Asian region with a meager 29% of the country's 60 million population having access to grid electricity as of July 2013.[12] The rural electrification in Myanmar stands at 25.54% as of 2013 according to the data published by Ministry of Electric Power (MOEP) of Myanmar. Yangon, the most populated region of the country has the highest electrification rate of 67% followed by Nay Pyi Taw, the capital at 54% and Mandalay region at 31% electrification.[13]

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[12] Ministry of Electric Power, Myanmar

[13] Myanmar Energy Sector Initial assessment 2012, Asian Development Bank

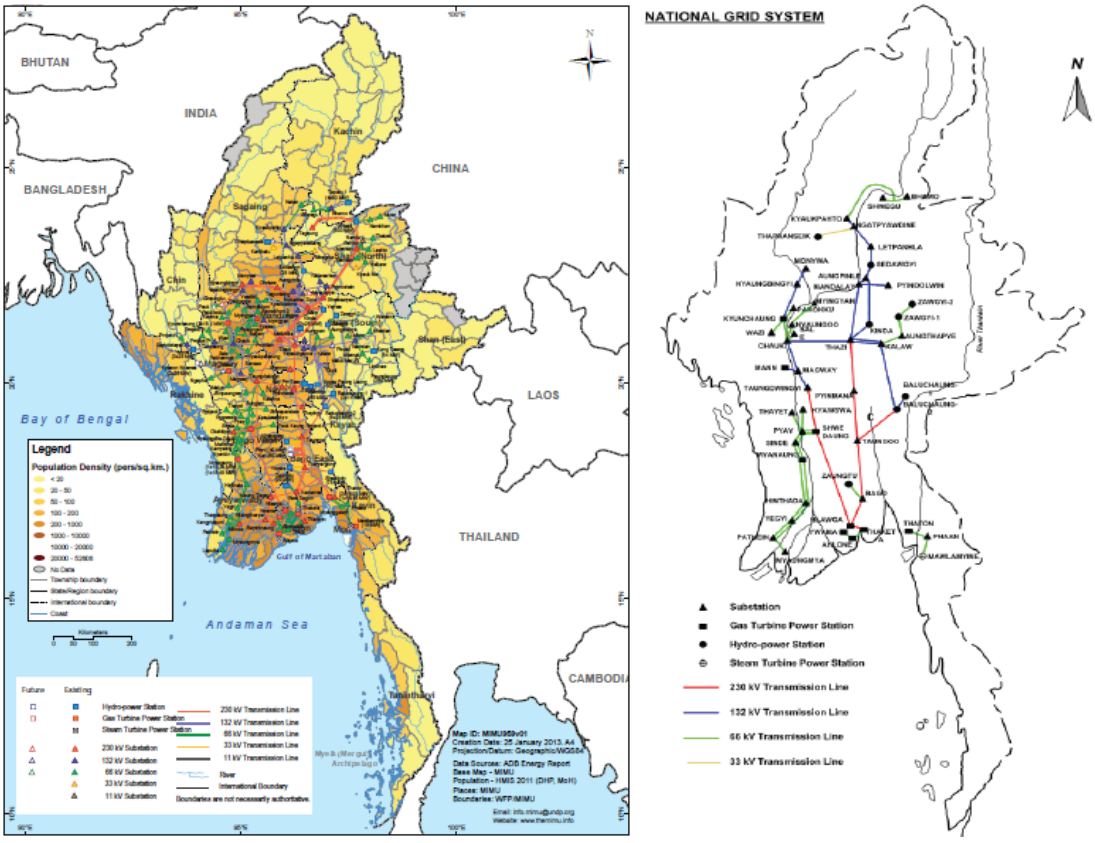
Limited reach of Grid infrastructure in Myanmar

The reach of central electricity grid is very limited with the transmission and distribution (T&D) network reaching only the main cities and region in the country. Myanmar's power grid is experiencing significant load shedding during the dry season of up to 400–500 MW. Privately operated diesel generators are a common sight in urban Myanmar for coping with scheduled and un-scheduled black-outs that occur particularly outside the rainy season. The country's very low electrification ratio of 29% indicates that grid-extension has mainly been an industry supply and export oriented process so far.

MEPE is responsible for the development and implementation of transmission network, and there are two distribution enterprises operating the power distribution systems in the country. The Yangon City Electricity Supply Board (YESB) is responsible for the supply of electricity to consumers in Yangon City. The Electricity Supply Enterprise (ESE) covers the rest of the country comprising 13 states and regions, including off-grid generation and distribution.

It was reported that technical and non-technical losses of the transmission and distribution system were as high as 30% in 2003 and reduced to 27% in 2011. These high losses and low electrification ratio will require improvement of transmission and distribution network in Myanmar.

Figure 9: Existing Power Grid and Population density, Myanmar



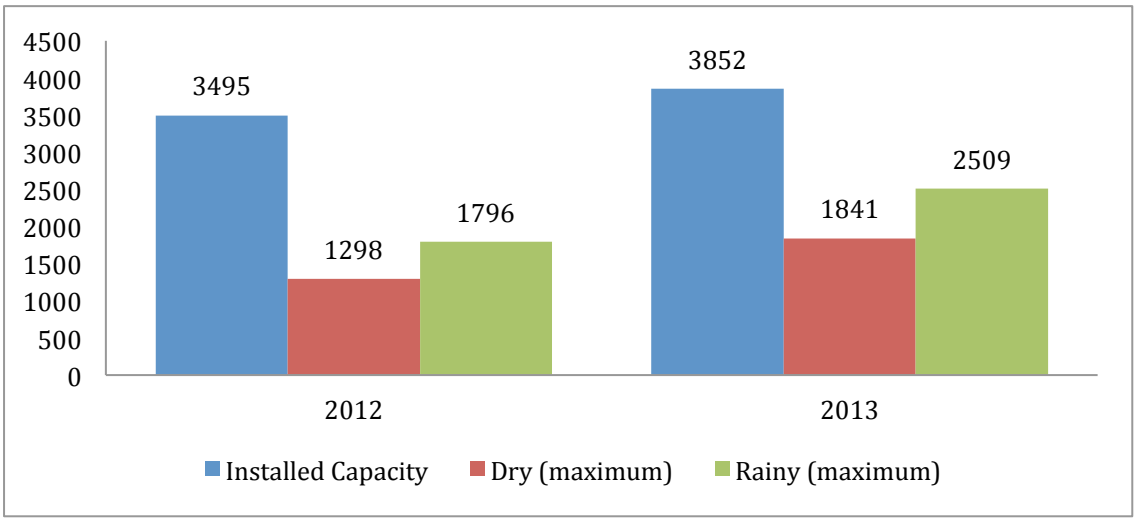
*Source: MOEP (Ministry of Electric Power) and MIMU, **Myanmar Information Management Unit***

Shortages in Electricity Supply

As of 2012, the total installed power generation capacity in Myanmar is 3,896 MW. Power generation mix in Myanmar is dominated by Large to small scale hydropower plants contributing around 2,780 MW (67%), followed by Gas-fired power plants contributing 996MW (29%) of the total power generation capacity. There are around 20 hydropower plants with capacities ranging from 12 MW to 790 MW.

However, majority of this installed capacity is underutilized due to seasonal factors and poor maintenance of generation equipment. In 2012, the maximum power supply in Myanmar is 1,298 MW and 1,796 MW during the dry and rainy seasons respectively. The maximum power generation vis-à-vis the installed capacity is shown below.

Figure 10: Installed Generation Capacity vs. Output Power Supply[14]

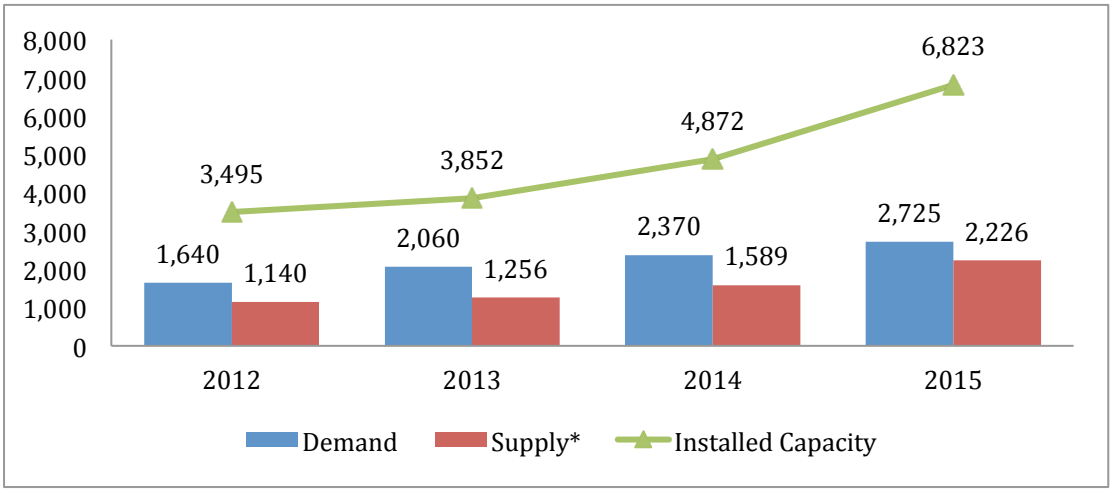


The current capacity utilization of power plants in Myanmar is less than 50% and it has impacted the per capita power consumption in the country which stands at average of 160 kWh as of 2012. Based on the current power generation levels, Myanmar is confronted with a severe shortage in power supply due to ever increasing demand for grid electricity.

Currently, the overall shortage in power generation is approximately 500 MW during peak time managed by scheduled load shedding and blackouts to reduce the load. The projected demand based on regular growth scenario is presented below.

[14] Ministry of Electric Power (MOEP)

Figure 11: Demand vs. Supply (Grid power)



Due to huge supply-demand gap, the power supply in Myanmar is very intermittent. According to the ADB initial power sector assessment report for Myanmar, it is observed that during the dry season, neighbourhoods in the lower socioeconomic areas of Yangon receive as little as one hour of power per day, while those in wealthier districts receive six hours followed by 12 hours off.

Over the last four years, electricity production has increased at an annual growth rate of 14.7%, from 6,622 million kilowatt-hours (kWh) in 2008-09 to an estimated 10,000 kWh in 2011-12. However, despite the higher 2011-12 output, estimated consumption in Myanmar is only about 160 kWh per capita, compared with 250 kWh per capita in Bangladesh (in 2009).[15]

Planned investments focusing primarily on hydroelectricity will only add 617 MW of capacity, amounting to a growth rate of less than 5% per year. Growth in demand, however, is expected to be double or triple this rate, pointing to a severe deficit in production. Even if electricity output doubled every five years (a 15% annual rate, similar to Vietnam's), it would take five years just to meet today's needs. In that time, demand would have grown by 12% a year.[16]

[15] Energy Sector Initial Assessment, ADB 2012

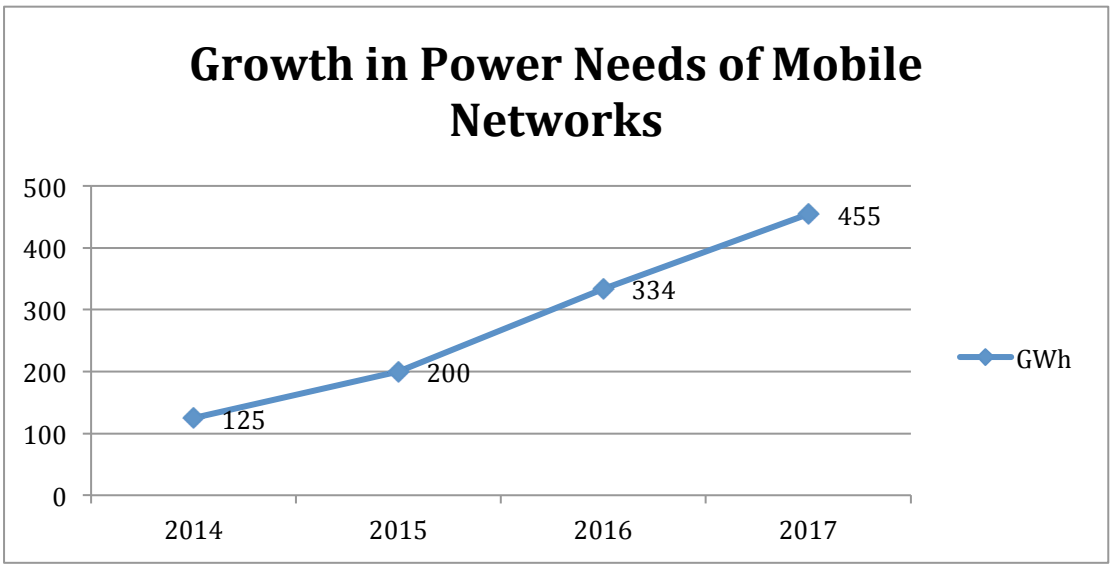
[16] Ibid

Growing Mobile Telecom Networks and the Impact on Power Requirements

Mobile industry in Myanmar is expected to become one of key power consumer with huge power requirements based on the current network rollout plans. The mobile industry requires additional 159 MW of power generation capacity on top of currently installed and planned. The power requirement from mobile industry is expected to grow to more than 455 GWh by 2017.[17]

The power demand from mobile telecom industry is illustrated below.

Figure 12: Power Demand from Mobile Networks



Given the context of poor grid power infrastructure and power supply shortages, it is expected that the mobile industry will face huge challenges in powering up the existing and planned network rollouts. The growing consumer demand as well as the additional demand from mobile industry would worsen the power supply situation leading to frequent blackouts and deterioration in the quality of power supply. The mobile operators would have to resort to depending diesel based power back up solutions to power up their networks. Appropriate power planning would be very crucial for mobile operators in order to address these challenges in order to meet the rollout targets as well as remain cost effective.

The Off-grid Mobile Network and dependence on Diesel Power

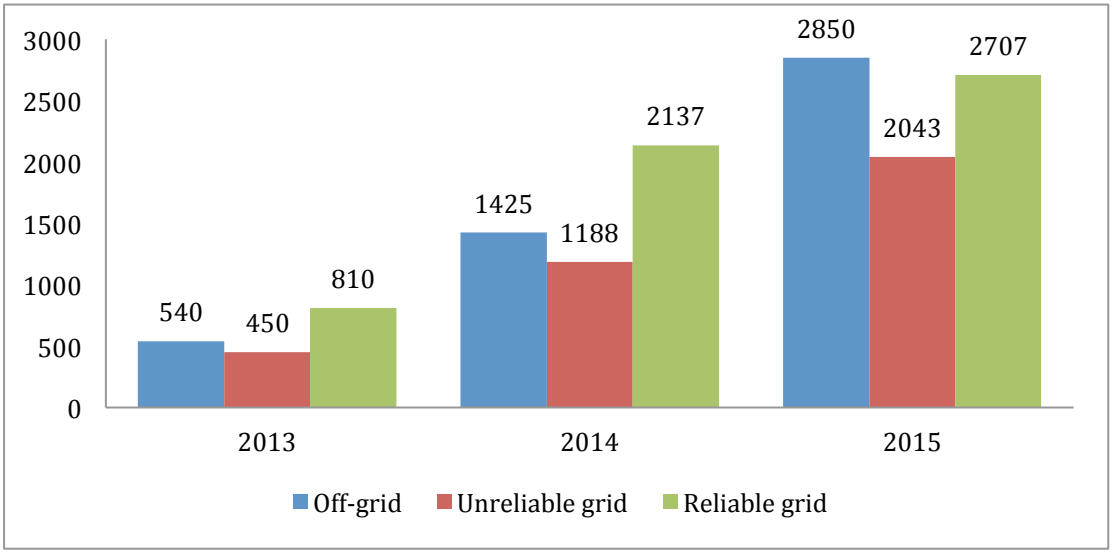
As discussed above, the limited reach of the grid infrastructure in Myanmar presents a huge challenge for mobile operators in terms of powering up the existing and planned network of telecom sites. Given the limited reach of the power grid in Myanmar, majority of the telecom tower sites are being deployed in the off-grid areas. In addition, the

[17] GPM Research and Analysis

availability grid power supply is a concern due to shortages generation capacities and ever increasing demand from both consumers as well as the industry. This will lead to large chunk of grid-connected telecom sites being supplied with unreliable grid power with frequent and long outages.

The below figure illustrates the break-up by various categories of power supply situation in Myanmar and the size of the off-grid and unreliable-grid network of telecom sites in Myanmar.

Figure 13: The size of the off-grid and unreliable-grid network[18]



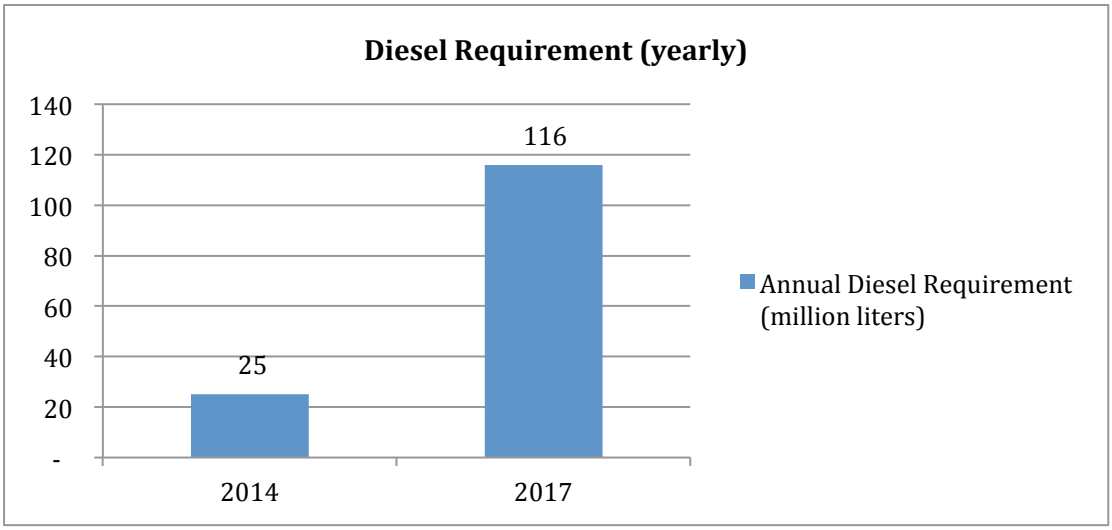
As shown above, the off-grid network in Myanmar is expected grow from 540 sites in 2013 to 2850 sites by 2015 based on current network rollout plans by mobile operators. The unreliable-grid sites are expected grow from 450 to 2,043 sites during the same period.

Within the context of current grid power supply scenario, mobile operators are forced to rely on diesel power for powering up these off-grid and unreliable-grid network of sites. The mobile operators are looking at battery hybrid solutions to reduce the dependence diesel by reducing the overall diesel generator run time by battery cycling technics.

Based on current powering approach, GPM estimates that, the annual diesel requirement would grow from 25 million liters in 2014 to 116 million liters by 2017 to power up the entire network of off-grid and unreliable grid sites. The corresponding CO2 emissions would be 67,370 tonnes and 310,676 tonnes in 2014 and 2017 respectively.

[18] GPM Research and Analysis

Figure 14: Diesel requirement (by Current Approach)



Given the above context, providing power to a telecom base station is not easy task, it will require an effort to put right design to minimize CAPEX and optimize OPEX for an MNO in Myanmar. The MNO is able to implement DG hybrid solution by optimizing battery life cycle but it might create another issue leading to fuel theft and pilferage which always comes as a huge operational challenge for mobile network operators.

A green technology can be an alternative energy solution for MNO to reduce its dependency on diesel and overcome the challenges related grid power. The green power alternatives such as Solar, Wind, Micro Hydro, Bio-Fuel/Bio-Gas or Fuel Cell can be the best choice for MNO. The next section will discuss about the green technology that can be fit for telecom sector.

Renewable Energy Alternatives for Powering Telecoms in Myanmar

Myanmar has abundant renewable energy resources, especially hydropower and biomass. The country also has other potential renewable energy resources including wind, solar, and other types of clean energy. As of now, except for hydropower (which is being developed and utilized on a commercial scale), all other renewable energy resources remain under research and in development or pilot stages. The Ministry of Energy has specific policy focus and guidelines for promoting wider use of new and renewable sources of energy for addressing electrification challenges in Myanmar. The Ministry of Science and Technology (MOST) is responsible for related research and development, and ensuring that the deployment of renewable energy technologies addresses the basic energy requirements of rural households and the agriculture sector. The Ministry of Electric Power (MOEP) supports general rural electrification programs in the country.

Table 3: Energy Sources and Potential in Myanmar[19]

Crude Oil (Offshore & Onshore)	609.39 MMBBL

[19] Presentations of Ministry of Electric Power(MOEP), Myanmar

(Proven + Probable)	
Natural Gas (Offshore & Onshore) (Proven+ Probable)	166.13 TSCF
Hydro	108,00 MW
Coal	711 Million Metric Tons
Biomass	52.5 % of total land area covered with forest potential available annual sustainable yield of woodfuel-19.12 Million Cubic Ton
Wind	365.1 TWH per year Coastal strip of 2832 Km with South-westerly wind -9 months North-easterly wind-3 months
Solar Power	51973.8 TWH per year
Geothermal	93 Locations

Renewable Energy Alternatives

1. Solar

Solar energy presents a great opportunity for decentralized and grid-connected power generation. The average solar radiation in Myanmar is more than 5 kWh per sq.m per day during the dry season. Solar radiation in Myanmar varies from 2.3-3.2 kWh/m2/day in the extreme north and south regions while majority of the Myanmar including the central region have good solar radiation ranging from 3.6-5.2 kWh/m2/day.

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 is at very early stages in Myanmar. Government and private sector organizations have been promoting and piloting solar PV systems for rural electrification applications.

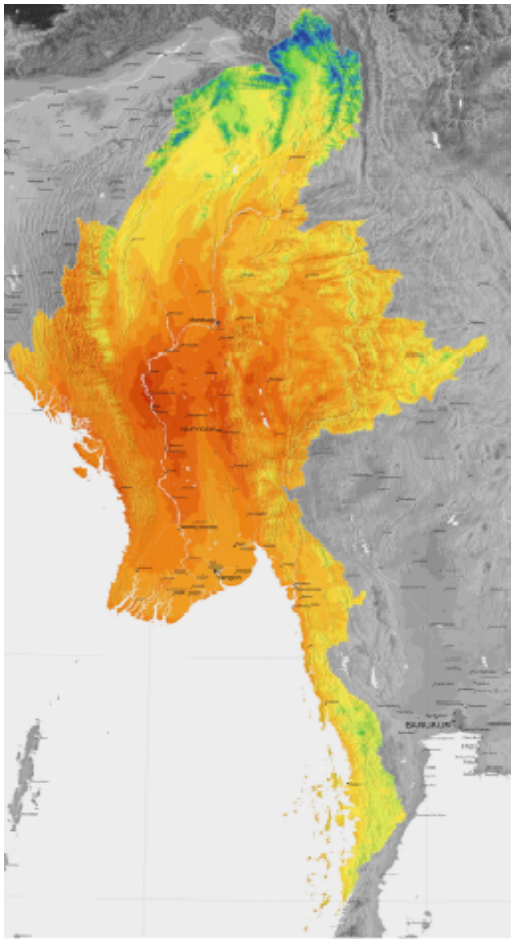
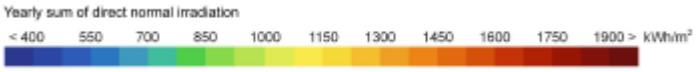


Figure 15: Solar Radiation (DNI) in Myanmar



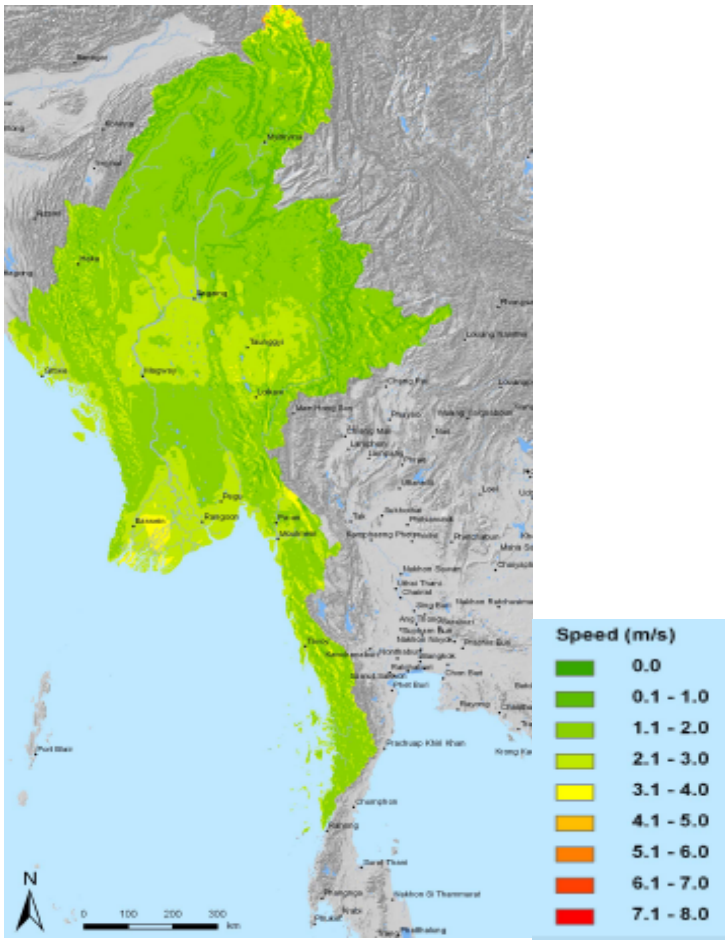
2. Wind

Potential wind energy of Myanmar is around 365.1 TWH (Terra Watt Hour) per year. Promising areas to harness wind energy are in three regions, namely Hilly Regions of Chin and Shan states, Coastal regions in the south and western part of the country and central part of Myanmar. Wind speeds in Myanmar are very low ranging from 1-3 m/s in most parts of the country. However some coastal pockets in the southern part of Myanmar have wind speeds in the range of 3-4 m/s.

In Myanmar, the use of wind energy is at the very initial stage. Due to expensive initial cost, wind energy is implemented only as an experimental and research phase. Only a very few small wind generators are used in lower part of the country. Readymade wind generator of **around 300-600 W** capacity are available in private market and mostly are imported from China. Due to the high upfront CAPEX requirement, lack of technical expertise and lack of clear wind resource assessments, the utilization of wind energy needs to be implemented in cooperation with foreign participants under technology transfer and financial assistance programs.

General observation shows that wind power potential in Myanmar is relatively low and irregular. There is a considerable measure of stagnant period which occur even in generally windy areas.

Figure 16: Wind Speed Map - Myanmar



3. Biomass

Myanmar has approximately 52.5% of its total land area covered with forests and a potential available annual sustainable yield of over 19 Million Cubic Ton of wood fuel. In addition, millions of tons of crop residues, such as rice husks, are produced year round in Myanmar due to the continuous cultivation of various crops. Further, many millions of tons of animal waste (particularly cattle excreta) are produced every year. In light of this extensive biomass energy potential, the government has started to actively promote its use for rural electrification and primary energy needs.

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.

4. Fuel-cell

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

The fuel cell technology is very new to the Myanmar market and needs to be developed in partnership with local organizations and research institutes in order to build the human and technical capacities to deploy and sustainably manage the fuel cell systems for distributed power generation. The fuel supply chain for hydrogen fuel cell applications has to be built from scratch in order to prove a business case and feasibility for distributed power generation applications such as telecom power systems. It would require a considerable effort from the technology providers and vendors to develop the eco-system in order to establish the use of fuel cell for on-site power generation and back up applications in telecom sector.

5. Micro-hydro

Myanmar's hydro power potential is estimated to be more than 100,000 MW. However, the potential for micro-hydro power plants with capacities ranging from 5kW to 1MW is yet to be exploited. It is estimated that approximately 36,000 units[20] (5kw capacity) of micro-hydro power plants can be installed in Myanmar. However

[20] New Energy and Industrial Technology Development Organization (NEDO), Japan

the exploitation of small hydro power will need a thorough study evaluating the feasibility and locations for long term rural electrification as well as agriculture and commercial applications.

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

Overall Fit of Renewable Energy Options for Telecom Power Deployments

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

Table 4: Green Alternatives: Fit for Telecom Power Deployments

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

Challenges for Renewable Energy Adoption in Myanmar

While Myanmar has abundant renewable energy resources, harnessing them is hampered by several factors:

- Lack of a fully transparent institutional and legal framework to support exploration, development, and deployment;
- Lack of policy guidelines with necessary support and incentives for the development of renewable energy in rural electrification and other commercial applications such as Telecom Power.

- Limited financial capital to support research and development, market-based investment programs, and development of physical infrastructures;
- Lack of human resource capacity; and
- Subsidized power and petroleum prices, which make it difficult for wind and solar energy alternatives to compete.

Establishment of a more supportive environment for development of Myanmar's renewable energy resources should include the following:

More clear information on the resource potential: Currently, there is no clear information about availability of renewable resources in Myanmar. An extensive study and data collection activity has to be performed by the local meteorological department or ministry of energy with the support from international organizations. This will help in accurately to assessing the potential for renewable energy and its applications for various segments including rural electrification and commercial deployments in Telecom.

Improved inter-ministerial cooperation and coordination: The coordination between ministries including the ministry of electric power (MOEP) and the ministry of information and communication technology (MICT) is essential to understand the power requirements of the Telecom Industry and to smoothen support for the growth the mobile telecom networks in the country.

Other aspects include of supporting the growth of renewable energy adoption include –

- Promotion of private sector participation at various levels in the energy supply chain
- Clarification of government policy regarding renewable energy
- Technology dissemination and capacity building

Green power adoption in Telecom Industry

The adoption of green power in telecoms would depend on various factors such as -

- How fast the grid infrastructure grows
- How fast power generation projects take off
- Quality of grid power supply
- Policy guidelines for renewables in Telecom

In the following section, a detailed analysis of the potential opportunity for green power adoption in telecom is presented.

Green Telecom Opportunity: Market Size and Business Models

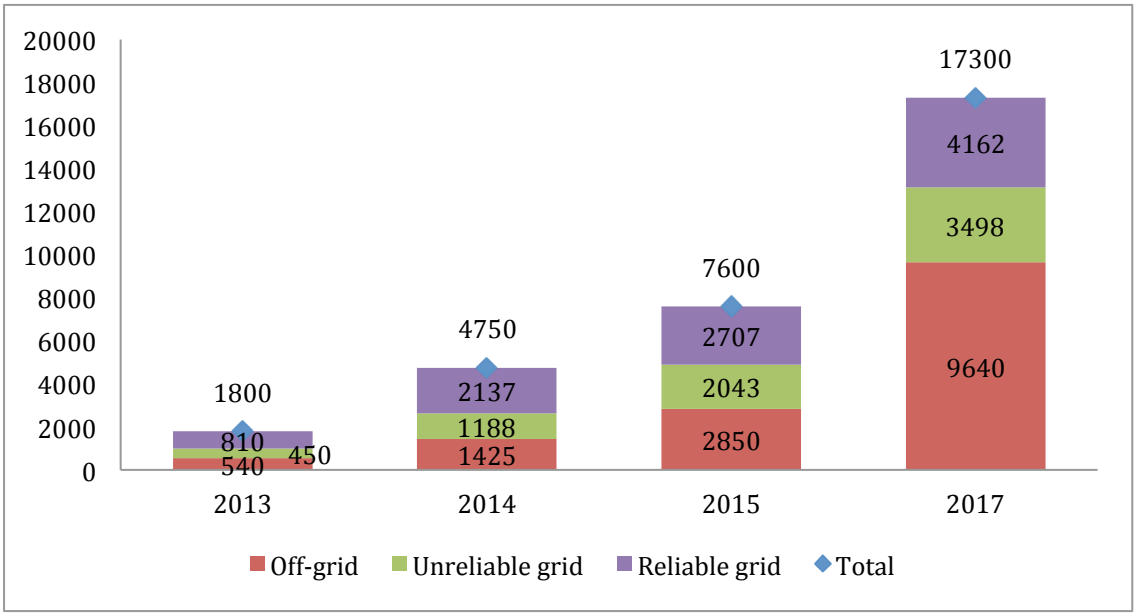
In the context of above sections, GPM attempts to identify the potential opportunity in deploying green alternatives for powering up telecom sites. The exploitation green power for telecom depends on various factors including the resource availability, technology landscape and feasible investment scenario for MNOs and Tower Companies. Most importantly, the size of market and potential for OPEX savings would drive MNOs or Tower Cos and the technology vendors to focus on promoting green power for telecoms.

In the following sections, we analyze the market size, potential opportunity and appropriate business models to capture the potential green telecom opportunity in Myanmar.

Market Size and Opportunity for Green Telecom in Myanmar

As presented in previous sections, MNOs or Tower Cos in Myanmar would need to depend heavily diesel power to power up the existing and planned network of off-grid and unreliable-grid telecom sites. The below diagram illustrates the size of the network by various power categories.

Figure 17: Size of the Network – Off-grid, Unreliable-grid, Reliable-grid (by 2017)

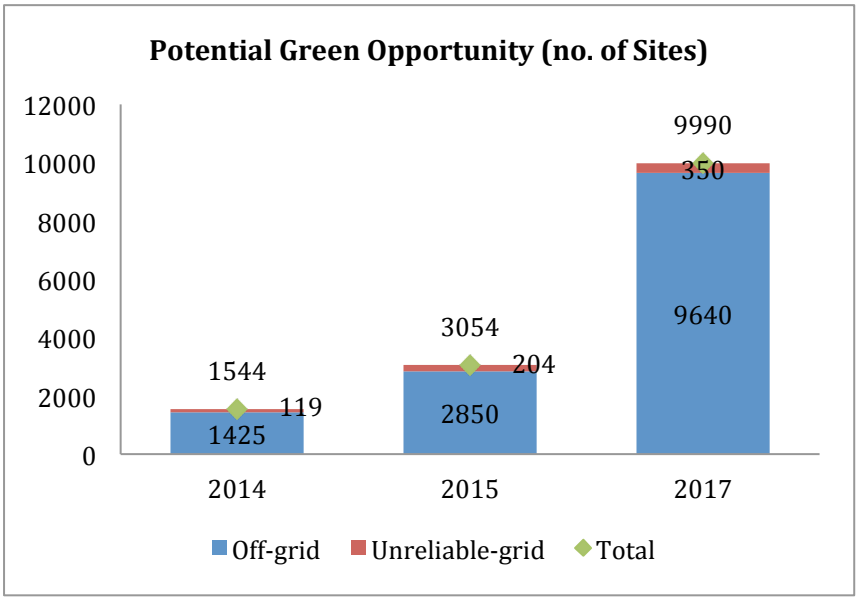


GPM estimates that, based on current powering approach, the MNOs or Tower Cos in Myanmar would require 25 million liters of diesel in 2014 and the diesel consumption would grow to 116 million liters by 2017.

In order to save energy OPEX and reduce emissions, the MNOs or Tower Cos need to adopt alternative green power solutions to power up their networks. GPM estimates that a total 1,544 sites are feasible and present a potential opportunity for MNOs and Tower Cos to deploy green power alternatives.

The potential opportunity would grow from 1,544 sites in 2014 to 9,990 sites in 2017.

Figure 18: Size of Green Power Opportunity (no. of sites)



The above estimates are based on various network parameters including the expected site load per tenant, expected tenancy ratio, and other deployment related parameters such as space availability for solar etc.

In the next section, an analysis and estimate of the market potential in terms of revenue or OPEX savings and the associated investment requirements as well as the return are presented.

Business Model choices and Market Potential

The investment and returns will depend on the type of business model adopted for deploying green power solutions for telecom sites. The two prominent models in the industry – the CAPEX model and the OPEX model are presented below along with the potential investments and returns associated.

A.) MNO or Tower Co led In-house Model (CAPEX Model)

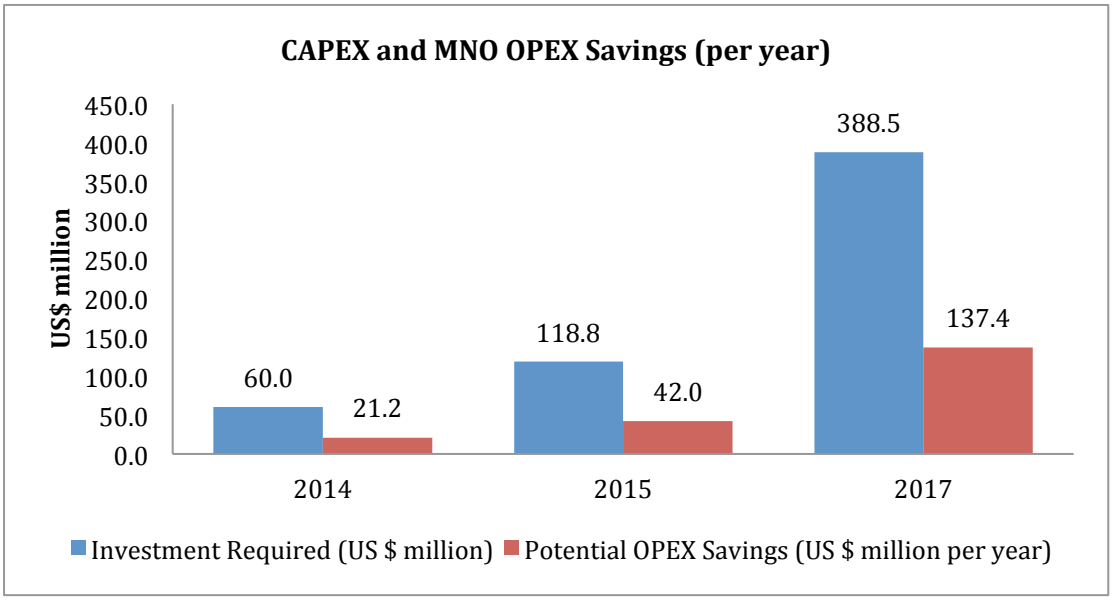
In this model, the MNO or Tower Co invests, owns and operates the green power system and realizes the benefit OPEX savings over the investment horizon. The MNO or Tower Co's decision to invest would depend on various parameters including CAPEX requirement or availability of funds, payback period or return on investment and the OPEX savings potential compared to the existing diesel based powering approach.

The potential opportunity for MNOs or Tower Cos in the CAPEX based green power investment model is presented below.

Table 5: CAPEX model: Green power Opportunity and Benefits

	2014	2015	2017
Potential number of sites	1544	3054	9990
Investment Required (US $ million)	60.0	118.8	388.5
Potential OPEX Savings (US $ million per year)	21.2	42.0	137.4
Savings in Diesel Consumption (million liters per year)	11.8	23.3	76.1
CO2 emission reduction (Tonnes per year)	31,527	62,359	203,985

Figure 19: Green Power - CAPEX and OPEX Savings for MNOs



In order to capture this potential opportunity, GPM estimates that the MNOs and Tower Companies would require an investment of US$388 million by 2017. The investments would have a payback period of 2.83 years at an annual OPEX savings of over US $137 million by 2017. By investing in green power MNOs and Tower Cos would be reducing their diesel consumption by 76 million liters (approximately 83% of consumption for a diesel based solution) and reduce CO2 emissions by 203,895 tons every year by 2017.

In Myanmar this model can be applicable to investments made by MPT (the incumbent government operator) or the first phase of rollout planned by Ooredoo (which owns the power assets in the first phase) and the tower companies, IGT and Apollo, who are responsible for both power and tower infrastructure rollout for Telenor. However, the CAPEX based model for green power investments by Tower Cos would also largely depend on the contractual agreement between the Tower Co and the MNO with regards to power provision. For example, Telenor has a pass through agreement for diesel and electricity costs with both the Tower Companies. This kind of agreement may not provide motivation for Tower Cos to invest in green power alternatives.

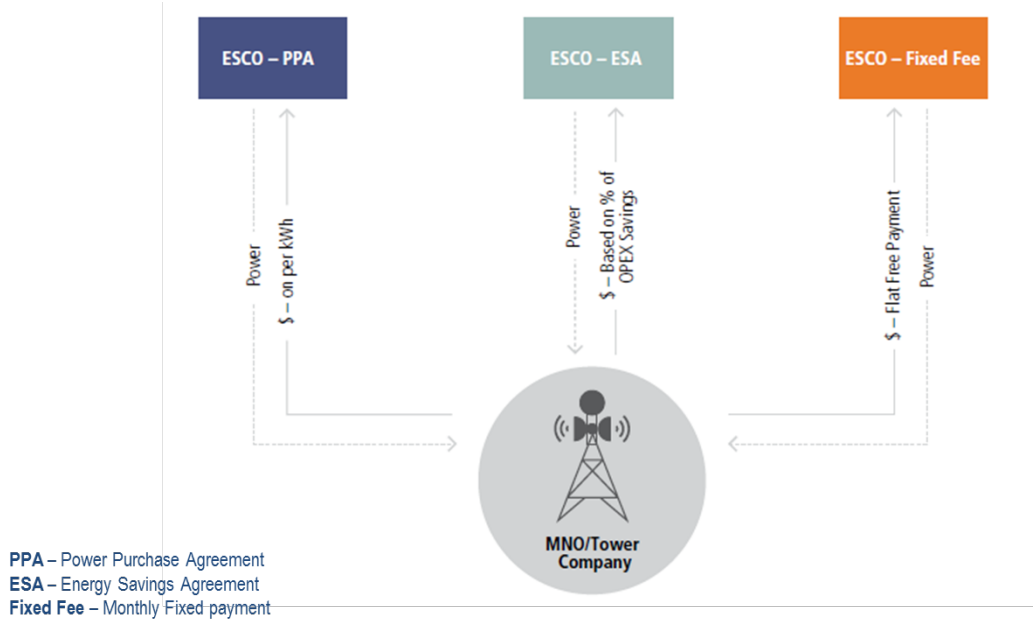
B.) 3rd Party led Outsourced Model (ESCO model or OPEX model)

In the 3rd party outsourced model or the ESCO model or the OPEX model, the MNO or Tower Co outsources the energy provision aspect of telecom network operations to a 3rd party organization which specializes in energy business and has sufficient investment capital as well as operational expertise to provide uninterruptible power supply to telecom sites.

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

Different business models exist including the fixed price model, power purchase agreement (PPA) model and energy service agreement model (ESA). Of the three models, the PPA model and the Fixed Price Model are the most popular and simple in terms of managing the contractual obligations and SLAs.

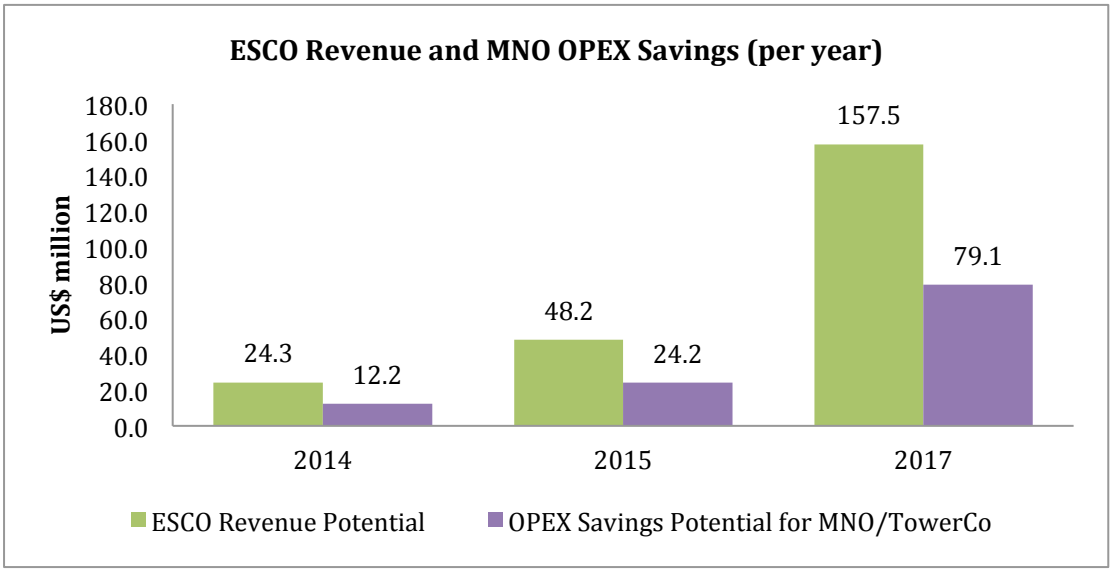
Figure 20: 3rd party ESCO business models



The MNO or Tower Co pays for the energy consumed based on various contractual models illustrated above. The various pricing models for an ESCO are described in detail in Appendix B.

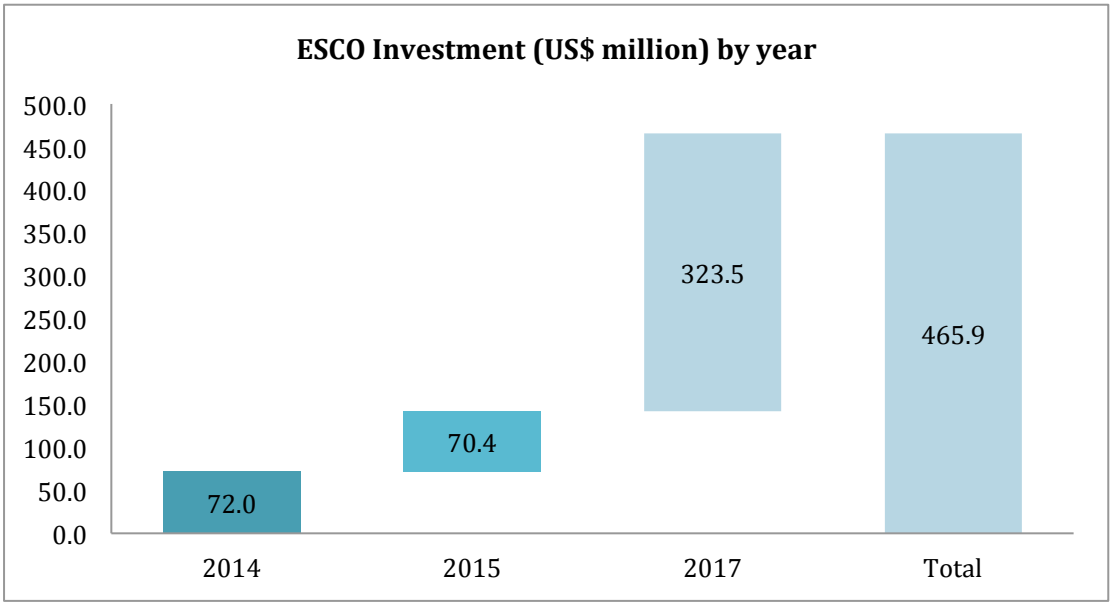
The potential opportunity for an ESCO is presented below.

Figure 21: ESCO Revenue Potential and MNO OPEX Saving Opportunity



The ESCO is presented with potential revenue opportunity of US$ 157 million and this would require an investment of US$ 465 million by 2017. The estimates are based on an expected internal rate of return of minimum 25% for an ESCO and a debt-equity ratio of 70% by 30%.

Figure 22: Investment schedule for an ESCO (by 2017)



Given the above investments and returns, the ESCO would be looking at a payback period of 2.6 years and a PPA rate of US$ 0.72 per kWh. The MNO would get an immediate benefit of US$ 12 million in energy OPEX by outsourcing it to an ESCO and the OPEX savings would grow to US$ 79 million by 2017.

The Current Business Model Approach and Future Outlook

Currently, the CAPEX based approach is predominant in Myanmar by both MNOs and Tower Companies. The incumbent government operator, MPT, has been deploying tower and power assets on the CAPEX model. MPT has so far deployed green power at around 200 sites on the CAPEX model and would continue its approach with this model.

Ooredoo, one of the two new operators, has adopted a mixed deployment model during the first phase of network rollout. The tower assets are owned by the Tower Company (MTC in this case) and leased back to Ooredoo on tower lease agreement, whereas the power assets are owned by Ooredoo (MNO led CAPEX model). In the second phase of rollouts given to PAT (its second partner Tower Company), Ooredoo is looking at completely outsourcing their power provision to Tower Company.

On the other hand, Telenor, the second new operator, has outsourced both tower and power ownership to the Tower Companies (IGT and Apollo towers in this case). However, the power outsourcing is partial OPEX model

where the diesel consumption and electricity costs are a pass through. In this case, both the Tower Cos would be investing and owning the power assets (Tower Co lead CAPEX model).

However, the 3rd party led OPEX model (ESCO model) is currently being evaluated by the Tower Companies, especially PAT, and is expected to take off once a credible partner with a proven energy investment and management track record is finalized.

The 3rd party led ESCO model would provide an opportunity to focus on community power models with Tower Co as an anchor tenant. With a very low electrification rate, Myanmar presents an excellent opportunity to leverage the growing telecom tower infrastructure to provide energy to surrounding communities. With the recent focus on rural electrification, led by various government programs, the 3rd-party Energy Service Companies (ESCOs) are better positioned to take on the Tower-led community power model where they provide power to a telecom tower as an anchor tenant and as well provide access to affordable energy services to the communities. The detailed concept of community power model leveraging telecom assets is presented in detail in Appendix C.

Conclusion

Myanmar is a green field telecommunications market with huge potential for growth. However, it is presented with various infrastructure challenges including limited grid and power supply, poor transport etc. Power provision is very crucial for deploying and operating the mobile networks in a cost effective manner. To achieve a cost-effective network deployment in Myanmar, the MNOs and Tower Companies have look beyond diesel based power solutions and consider alternatives such as green power and energy efficiency. The benefits of investing in green power are established and there are various business models in energy provision which can leveraged to reduce the risks associated with energy investments and operations.

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)

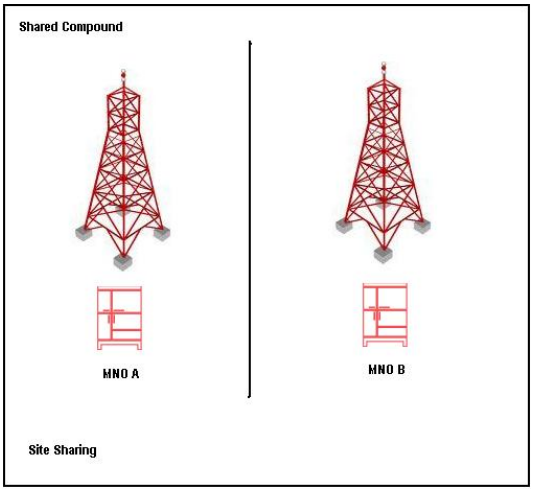
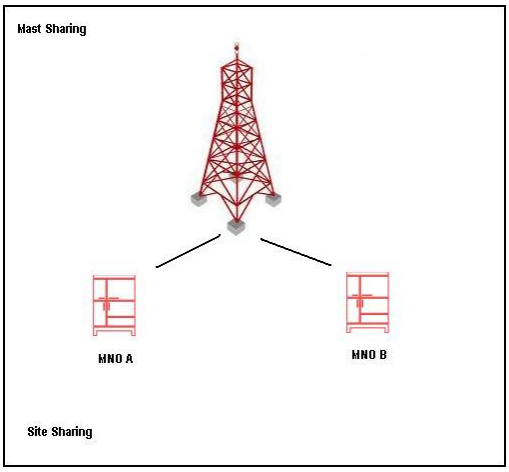


Figure 24: Infrastructure Sharing (Mast Sharing)



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

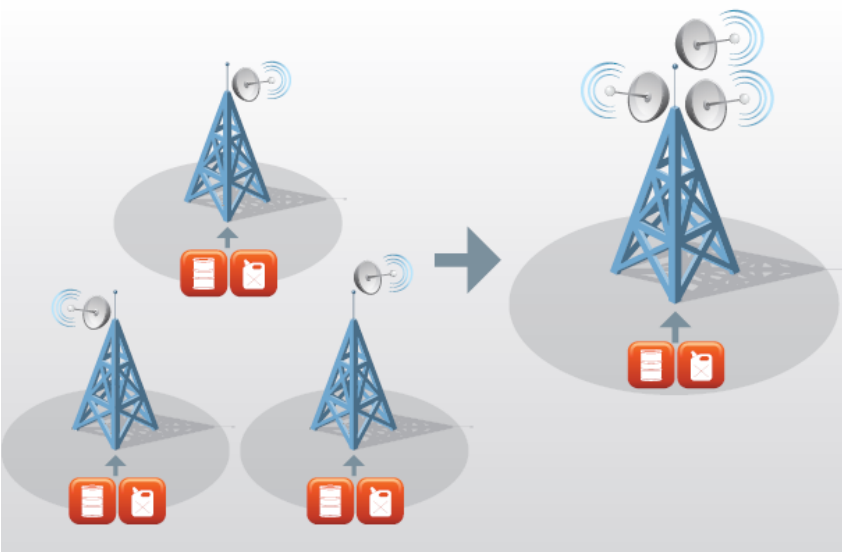
The site sharing involves co-location of sites between MNOs. MNOs will share the same physical compound and tower but install separate antennas, cabinet, backhaul and power system. But sometimes, they may decide to share support equipment, including shelters, power supply and air conditioning.

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

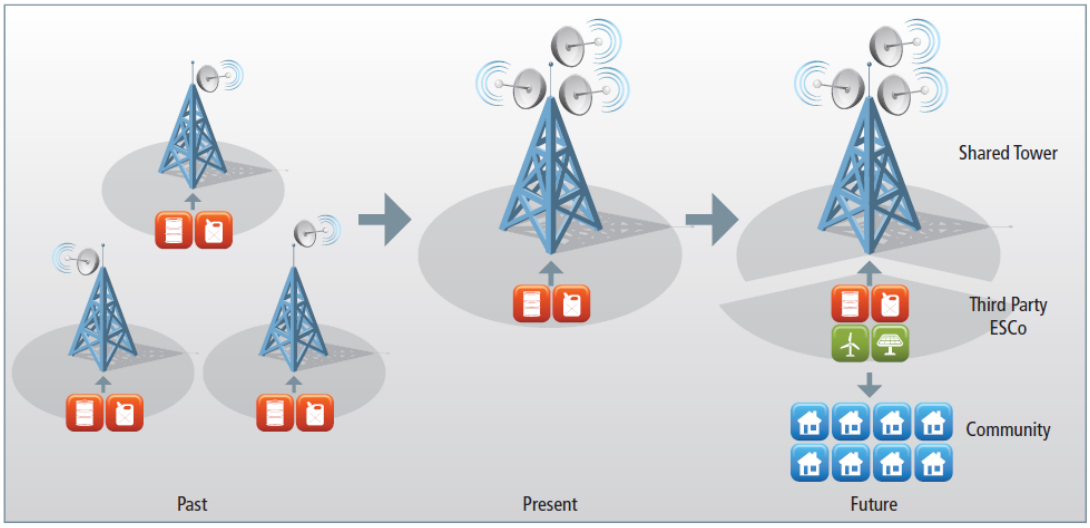
Energy Outsourcing Concept

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 Myanmar, 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 Myanmar.

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.

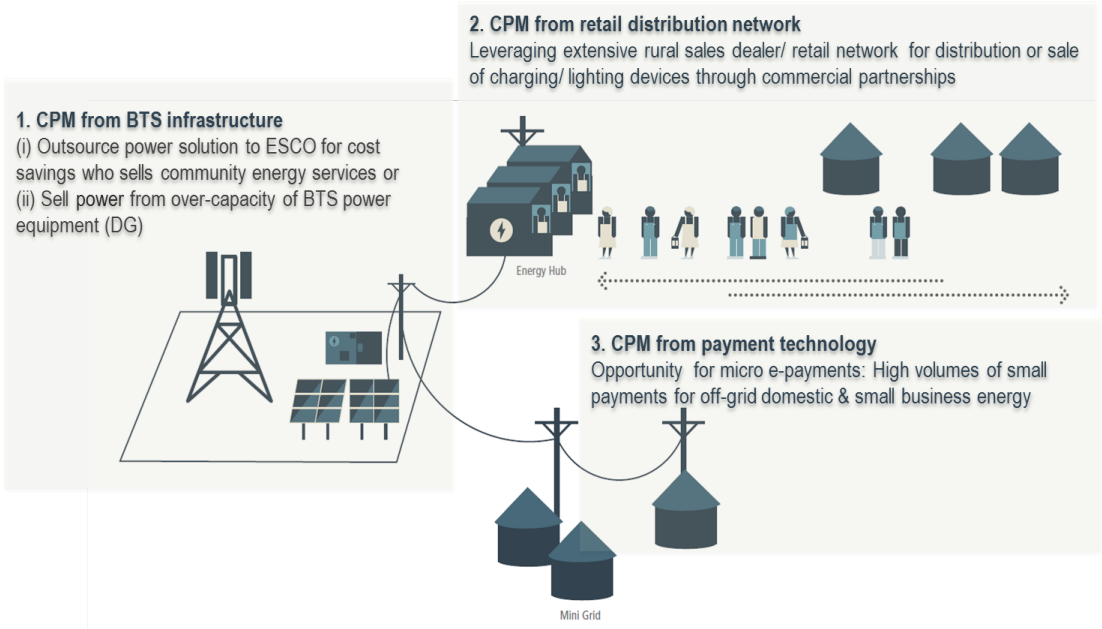
But sometimes, community doesn't have a grid connection while tower/base station is running and working 24 hours a day. It has generated some issue for MNO or TowerCo. GSMA through Mobile Enabled Community Services (MECS) has tried to find a solution for underserved community by optimizing mobile network 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[21].

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



[21] MECS 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 Myanmar 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:

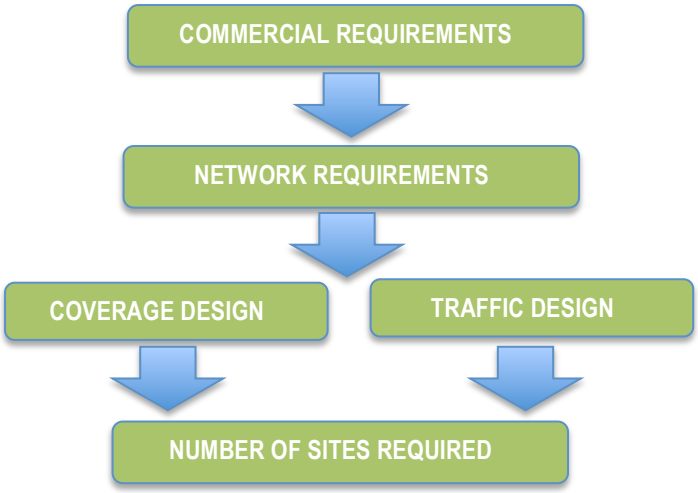
- Tower Co/ ESCO will get additional revenue by selling the energy to house surrounding the tower
- By sharing power to community, it can reduce any vandalism from community
- It can be part of CSR from MNO/Tower Co by proving an excess of energy from site
- Leveraging mobile platform to access energy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

Appendix D: Coverage Analysis and Tower Growth – Methodology Overview

Mobile network deployment/implementation may vary from one MNO to the other. MNO will see site planning from multiple angles and corporate's strategy. But it will aim a same goal, which is to cover more people and generate more revenue with optimized number of sites in the network. Following is the aspects that can be considered on designing the network:

- Frequency plan for radio network and transmission design
- Addressable target area based on corporate's strategy
- Services target for each areas/locations
- Traffic estimation for each areas

Figure 28: Network Dimensioning Flow

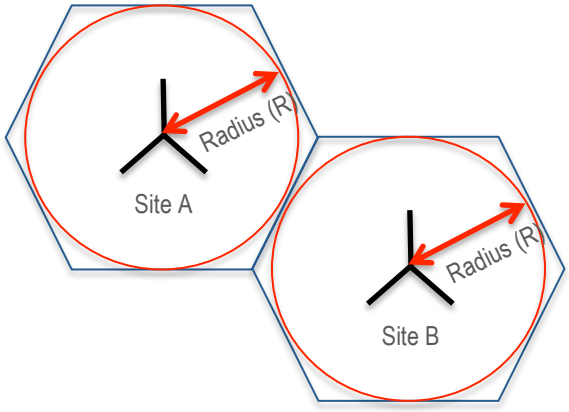


Coverage Analysis

MNOs in Myanmar have targeted to cover about 75% from total land size in Myanmar. In this section, GPM will try to provide a coverage analysis based on land coverage (without considering traffic demand or population coverage) in certain region across the country.

Myanmar has around 678,578 square kilometers land area that need to be covered by BTS signal. A basic assumption is every site will have 3 cells with average per cell can cover 3-5 km radius. Figure below gives how each cell will cover certain area.

Figure 29: Site Coverage Concept



Site A with coverage area can be counted as circle mass area. If R is 3 kilometers (or coverage area approximately 28.26 sq. km), to cover total area of the country it needs to have around 24,012 sites.

Table 6: Total Sites Based on Coverage Analysis

Land Size (sq. km)	Max Cell Coverage (km)	Area covered per site (sq. km)	Total Sites
678,578.00	5	78.5	**8,645**
678,578.00	3	28.26	**24,012**

The coverage analysis factors may vary from one MNO to the other. Some key elements those can impact to cell coverage distance such as antenna type or antenna tilt design.

However, the site estimates by land coverage method do not take into account the capacity requirements which affect the maximum possible subscribers per cell site for reasonable QoS (Quality of Service) mandates. The traffic analysis provides a better understanding on the subscribers and coverage in order to provide a better estimate of number of cell sites required.

Traffic Analysis

Designing the network will be tricky on initial setup, because it will not reach the maximum level of traffic occupancy at the beginning of implementation. A traffic analysis with all basic assumption is needed to during an engineering process. During network planning/engineering, an appropriate Grade of Service (GoS), Call Blocking, Quality of Service (QoS), Call Drop Rate and Coverage are key factors to get number of sites for the network.

Because network planning is a multi-discipline task where the competing requirements are balanced and the network planning changes through the life of a network indeed.

The traffic analysis is usually is related with population coverage in certain area of service. A number of sites will be calculated with the estimation of traffic growth of that particular location. Myanmar has about 60 million people with mobile penetration below 10%; providing an opportunity for new MNO to penetrate the market. Myanmar has a mandate to cover 95% of the population by 2020.

The below analysis considers a basic assumption that population will concentrate in one region without any consideration of population spreading and a GoS of 2%. The result will be higher when the calculation is based on region-wise in-depth capacity considerations.

Table 7: Traffic Analysis (Coverage) Assumptions

Assumption		Unit
Spectrum	5	Mhz
Carrier Available	25	Channel
Carrier per sector	2	Carrier
TCH per sector	15	Time slot
GoS 2%	9	Erl
Mins per month	120	Min
Days per month	30	Days
BH	5	Hrs
Erl per Sub	0.013	Erl
No of sector/sites	3	Sectors
BTS Capacity	27	Erl
Erl Max Subs/BTS	2,025	Subs
Myanmar Population	60,000,000	
Target Subs (Coverage)	57,000,000	95%
No of BTS	**28,148**	

Table 8: Number of Sites Based on Traffic Analysis (Sample Scenario)

Target Coverage	Coverage (population)	No of Cell Sites	No. of sites (with Tenancy= 1.2)
30%	18,000,000	8,889	7,407
70%	42,000,000	20,740	17,283
95%	57,000,000	28,148	23,456

MNO usually uses these methods to implement its sites. The traffic analysis will be used on high-density population area whereas the coverage analysis is used for road coverage or remote rural area.