



Case Study: Smart Grid Strategy for Grid Modernization

Client Profile



Energy & Electricity
Myanmar Supply Public

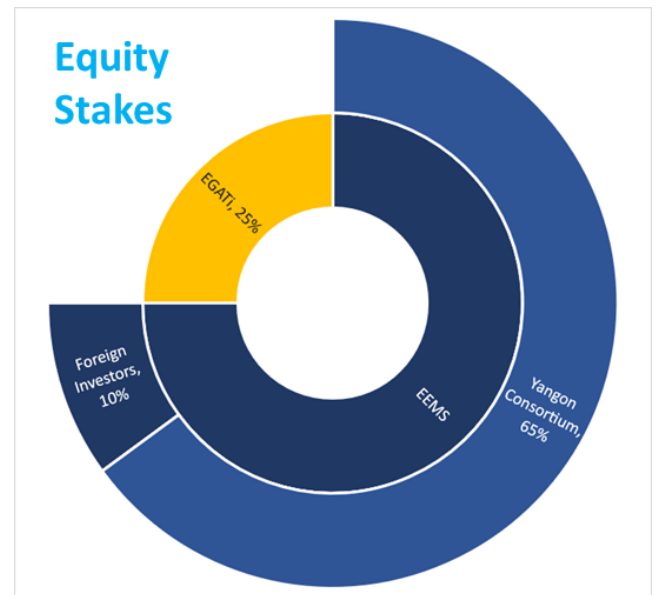


Company Limited (EEMS) is a consortium of distribution companies and EGAT International (EGATi), a wholly subsidiary of the Electricity Generating Authority of Thailand.



EEMS was formed to initially modernize Yangon's grid and serve as a model for Myanmar's growing economy. EEMS will introduce Smart Grid technologies and enable Yangon to become a Smart City. Immediate results include a stable distribution grid, improved service and IT systems that enable further improvements.

Ultimately, the vision is to enable Yangon to be the first Smart City in a modern and vibrant Myanmar. This aspiration is shared by private enterprises, government stakeholders, and investors.



Project Driver

Providing a reliable and stable source of power



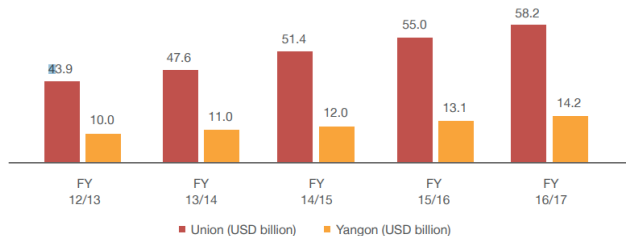
is an ongoing problem in Myanmar which projected economic growth will exacerbate. Over 40% of Myanmar's population lacks access to electricity from the power grid. In rural areas, where most people live, over two-thirds of households rely on candles, kerosene and batteries.

Yangon, Business Capital of Myanmar

Yangon was chosen as the launch point because it is Myanmar's business capital. Yangon is not only important as the home to the most influential and powerful leaders it is also a driver of the economy.

Major GDP Contribution

Yangon contributes US\$19.7 billion to Myanmar's GDP of US\$76 billion or 26% which is consistent with historical results as shown in the accompanying chart. It is believed even greater output is possible if the constraints to growth can be mitigated.



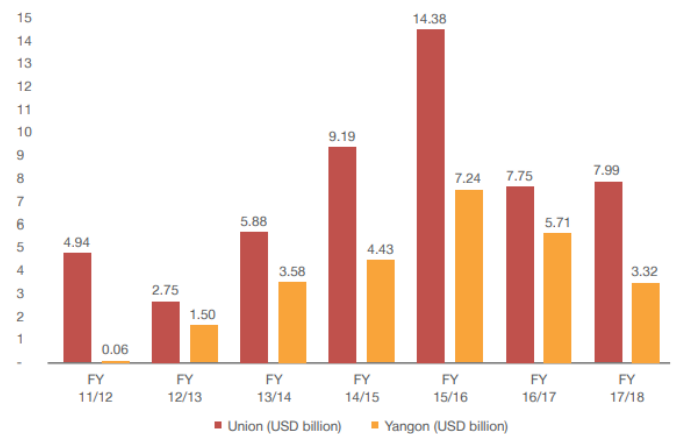
Yangon productivity is also high relative to the rest of Myanmar. On a per capita basis, Yangon contributes twice the national average. Yangon's GDP growth rate also averages in the 8-10% range compared to the national average in the 5-9% range.

Attractive for Foreign Direct Investment

The Myanmar Ministry of Investment and External Economic Relations (MIFER) described foreign direct investment (FDI) inflows during the first 10 months of 2020 as encouraging. The Myanmar Investment Commission (MIC) approved 219 new foreign projects in the country between October 2019 and July 2020, totaling US\$5 billion.

Most of these FDI initiatives were carried out in the power generation sector with other industries encompassing real estate, manufacturing and oil and gas. There is a pool of investors who have conducted due diligence in the power industry in Myanmar: Hong Kong, Singapore, Japan and China.

Yangon is the destination for roughly half of all foreign and local investments in Myanmar. Total investments in Yangon have averaged over US\$ 4 billion as shown in the historical chart below.



Source: DICA

Global Trading Destination

As Myanmar integrates into the Asian and global trading communities, it is developing the infrastructure to grow both imports and exports.

Yangon is the logistics hub of Myanmar with roughly 85% of the imports and exports flowing through its various seaports. 53% of the industrial estates (industrial parks) are located in Yangon. Supporting global trade has created transportation development initiatives.

Power Distribution Factors

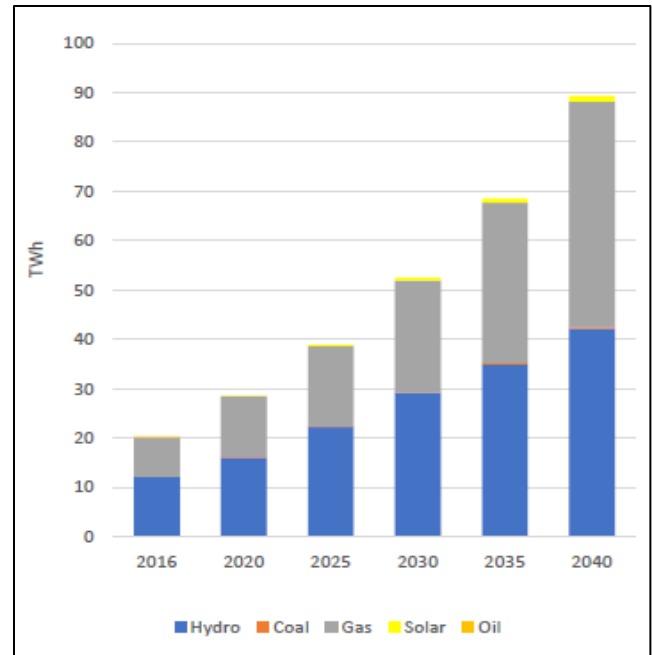
Yangon consumes almost half of the country's power supply but faces frequent and sustained power outages. The electrical grid suffers from significant power losses (both technical & non-technical losses) and upgrades are urgently needed to meet growing power demand and provide reliable service to all customer segments.

Yangon's aging transmission and distribution infrastructure severely limits the ability to onramp new generation sources. This results in dramatic power shortages which necessitates curtailment and planned shutdowns during peak periods.

Growth in Power Demand

Myanmar will require a more than quadrupling of its installed capacity to 23.6 gigawatts by 2030 (ADB-NEMP). The electrification rate increased 30% in 2013 and reached 54% in the middle of 2020. The Myanmar National Electrification Plan targets 75% electrification by 2025 and 100% by 2030, both of which are achievable. Yangon's electrification rate will itself increase from 78% in 2013 to 100% by the end of 2020.

The MOEE projected rapidly growing power generation as illustrated in the chart below.

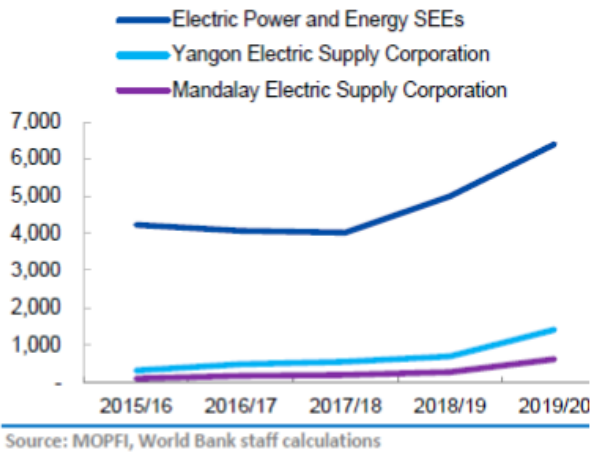


More Favorable Tariffs

The government increased the electricity tariff for the first time in five years in July 2019. Myanmar's electricity price was financially unsustainable with the lowest rates in ASEAN.

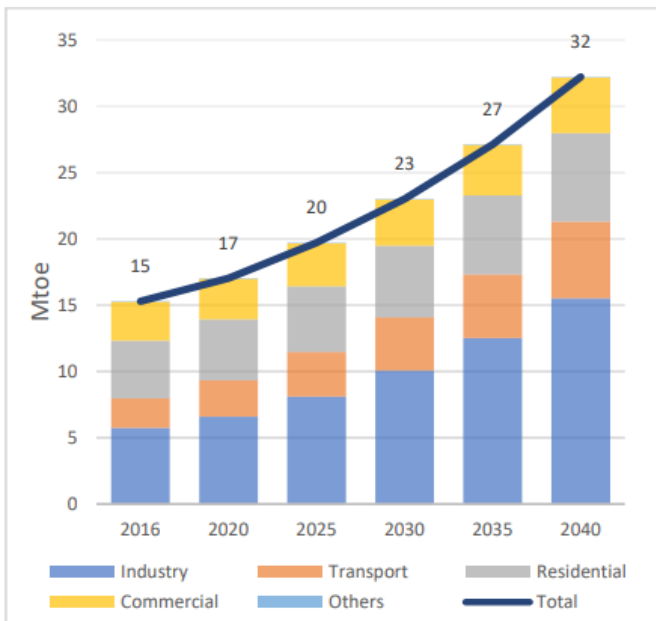
The tariff increase has eased the pressure on MOEE as well as on the state-owned energy service companies for both investment and power buying.

(billion kyat)



Rapidly Accelerating Consumption

Compounding existing issues is the rapid acceleration of demand for power. In June 2019, the World Bank stated “Myanmar needs to invest twice as much and implement projects three times faster, supported by higher electricity tariffs. Myanmar’s track record of strong economic growth and increased electrification has led to a growing demand for electricity.

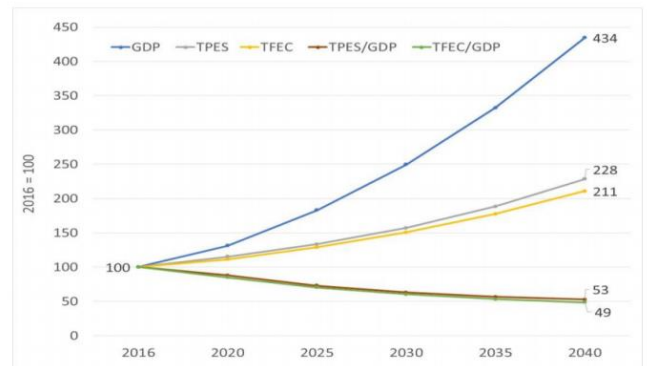


Mtoe = million tons of oil equivalent.

According to estimates, consumption will grow at an

average annual rate of 11 percent until 2030. Peak demand is expected to reach 8.6 gigawatts (GW) by 2025 and 23.6 GW by 2030, which is a significant increase from the current level of 3.6 GW. To cater to this demand, overall investment requirements are estimated to be around US\$2 billion per year, which is double the historic levels. By 2025, 5 GW of new generation capacity need be added, equivalent to roughly three times what was built over the same period in the past.”

Extrapolating forward, demand will dramatically exceed supply.



GDP = gross domestic product, TFEC = total final energy consumption, TPES = total primary energy supply.

Aging Infrastructure

More than 50% of the current Yangon distribution lines, transformers and meters have surpassed their 50-year life expectancy, having been built mostly in the 1950’s and 1960’s. Deteriorating infrastructure has led to increasing power outages with broader scope.

Power Quality

Yangon’s poor power quality metrics reflect the age and low level of maturity of the power grid. Outages are very frequent and compare very poorly to world

class: SAIFI (a universal measure of the frequency of outages per year) is 26.4 compared to 1.1 outages in North America, 0.992 in Bangkok. Similarly, SAIDI (a measure of average duration per year) is 30.3 compared to 1.5 hours in North America, 0.30736 hours in Bangkok.

In a survey, 97% of Small to Mid-sized Enterprises (SMEs) reported experiencing an outage in every month with each outage lasting 3.3 hours on average. Outages not only impact smaller business performance, but they also add capital and operational costs for businesses to function. 70% of SMEs report owning a private generator. Even worse, the World Bank reports that small firms suffer 13 outages in a typical month.

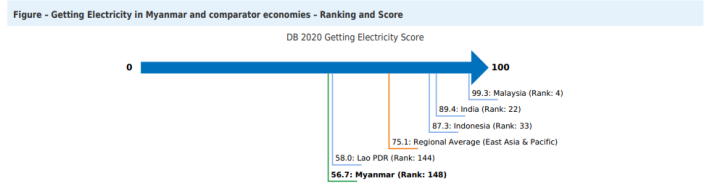
Downstream Damage

Outages and brownouts frequently damage equipment so there is a secondary cost to power quality problems. Additionally, momentary outages (less than 5 minutes in Myanmar) also cause damage to connected equipment. Furthermore, insufficient voltages are very common.

Service Connection

Even obtaining service is a challenge. 41% of surveyed SMEs were required to buy a transformer, leading to a high average cost of a new connection (US\$ 21,000). The average number of days to get a new connection is 48.5 days.

Overall, Myanmar ranks very low in the region for the ability to obtain a grid connection as shown below.



Project Overview

Actionable Strategies developed the Smart Grid strategy including benefits, risk, and financial projections. The firm developed the written proposal and presentation to the key stakeholders in Myanmar.

- ▶ Ministry of Electricity and Energy (MOEE)
- ▶ Electricity Supply Enterprise (ESE is part of the Ministry of Electricity)
- ▶ Yangon Electricity Supply Corporation (YESC is a state-owned enterprise)
- ▶ Mandalay Electricity Supply Corporation (MESOC is the other state-owned distribution company serving the second largest city in Myanmar)

Project Approval

These stakeholders approved the project and a Notice To Proceed was issued. MOEE was then asked to grant a new bankable Concession Agreement. This expanded distribution franchise would allow required financing to be obtained.



A meeting with Win Khine, Minister of MOEE, was scheduled for February 3, 2021 to formally approve the Concession Agreement.

Coup d'État

On February 1st, a coup d'état resulted in a takeover of Myanmar's government by a military junta run by the Tatmadaw (Myanmar's armed forces).



Project Finance

Bankable concession terms of 30 years will enable financing and implementation of the network upgrade and build-out in the distribution area. The initial project was focused on investments across 10 townships with an estimated implementation cost of \$200 million.

US DFC had committed to EEMS to provide full debt financing of \$200M and up to \$500M if the scope expanded.



Roadmap to a Smart City

The plan starts with ensuring the feasibility of the financial model and technical implementation. Once this is assured, investment funding can be used to incrementally enhance the grid. Modernization of aging equipment will eventually transition to implementation of Smart Grid technologies. An underlying foundation will be built for business process, IT, OT, communications and human capital. While distribution technology is essential, building sustainable business and operating models are the only way to ensure profitability and the ability to scale.

Inception

The first activity is a Feasibility Study which will ensure the business model and technical plan is sound. The FS will identify potential investors and provide them with the strategy, financial analysis and technical plan to encourage them to invest with confidence.

Modernization

Grid Modernization would occur directly from the detailed designs of the Inception phase. Implementation would focus on loss reduction by introducing new equipment and



automation in phases. Higher ROI efforts would occur earlier. Incremental deployment allows benefits to be realized earlier and grow over time.

Smart Grid

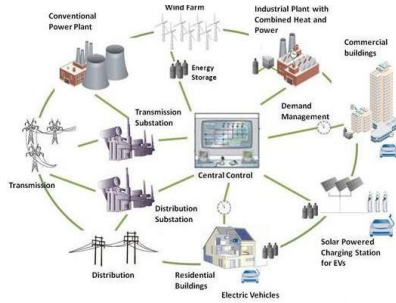
Smart Grid implementation will be a journey and not an event. The plan will implement

Smart Grid technologies over time. The phased plan will seek to achieve reasonable ROI while minimizing cost and risk.

The initial Smart Grid objective of improving power quality indices will evolve. The longer-term objective is to improve operational efficiency and service delivery through automation. While helping reduce operational costs, Smart Grid technologies also dramatically improve service delivery for individuals as well as commercial and industrial customers.

Key elements of the Smart Grid plan include:

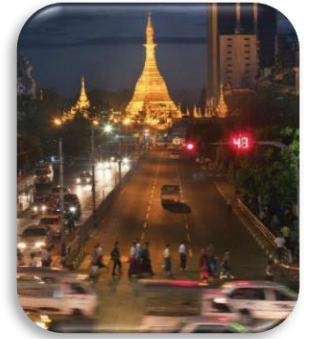
- ▶ Information and Communications Technologies (ICT) foundation
- ▶ Situational awareness capabilities including AMI to provide self-healing down to the household or business
- ▶ OMS (Outage Management System) and FLISR (Fault Location Isolation and Services Restoration) to reduce outage frequency and duration
- ▶ Customer visibility in near real-time via OMS (Outage Management System) and CRM (Customer Relationship Management)



- ▶ Implementation of a Customer Service Center
- ▶ Asset management to the extend useful life of equipment

Smart City Enablement

Smart City Enablement will allow Yangon to utilize Smart Grid technologies as part of a larger and holistic city-wide initiative. Because of the need for distributed intelligence, a network of sensors and more endpoint devices, grid expansion will be required.



Benefits Calculations

Grid modernization and Smart Grid technologies will provide benefits to Myanmar as a country and directly to businesses and citizens of Yangon.



Economic



Social



Environmental



Critical Infrastructure



Human Capacity

Economic Benefits

Economic growth and prosperity are directly linked with electricity consumption.

Per capita GDP

Per capita GDP increases with final energy consumption. Reducing outages will enable Yangon to fully realize the economic potential that is currently impacted by loss of electrical service. Greater electrification will drive logarithmic increases in output as experienced in other emerging markets. Improved output and productivity have a multiplier effect in the economy.

growth and higher GDP will create better wages for lower income level workers as they up-skill.

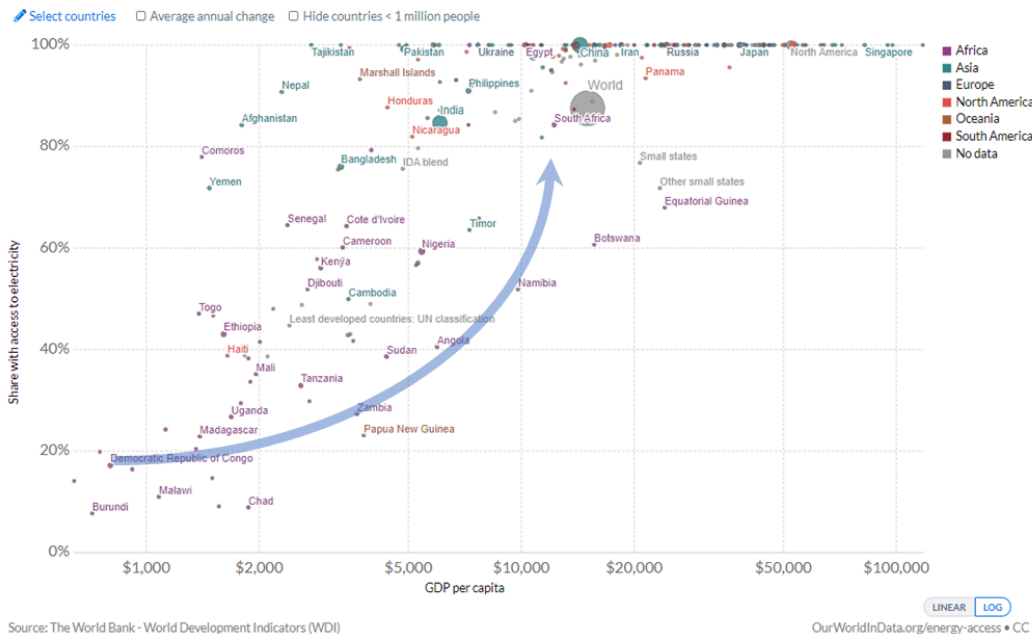
FDI benefits experienced by other ASEAN countries include knock-on benefits such as improved government revenues.

Poverty Reduction

Grid modernization will improve access to electricity. Electrification yields direct economic benefits because poverty reduction will be realized for those who previously lacked access to power. Poverty reduction is a proven outcome in other emerging markets around the world.

Access to electricity vs. GDP per capita, 2016

GDP per capita is adjusted for price differences between countries and inflation and measured in international-\$.
Our World in Data



Implementation of Smart Grid technologies will enable automation of many processes which lowers the cost of service delivery for both new and existing customers. This makes electricity more affordable for those in poverty.

Greater access to quality and reliable power will drive the growth of small to mid-sized enterprises (SMEs)

Foreign Direct Investment

Grid modernization will increase investor confidence and attract greater FDI flow into Yangon. The city has already attracted the majority of foreign investors in export-oriented industries. Increased industrial

and better job opportunities for many lower income earners. The growth of SMEs will create greater spending power which benefits workers, especially at the lower end of the spectrum. Poverty reduction will accelerate as modernization progresses.

Rural Development

Rural development will accelerate with government electrification plans. Rural communities account for 30% of gross domestic product and two-thirds of jobs. The Yangon service territory includes rural areas.

Electrification of rural areas has a dramatic effect in emerging markets such as Myanmar. Electrification in other markets has reduced rural isolation and opened access of rural people to markets, job opportunities, and services.

Cost Efficiency from Mobile Technologies

Modern technologies such as mobile communications can accelerate economic development. In other emerging markets they have been used to reduce transaction costs, facilitate banking and credit, enable government services, and provide entrepreneurial opportunities. Clearly mobile technology relies on reliable and ubiquitous power. Mobile computing has enabled citizens in emerging markets to gain access to technology-driven solutions at a lower cost than using traditional computers with the knock-on benefit of ubiquitous access.

Social Benefits

Universal access to electricity will dramatically impact education.

Education has direct social

benefits and also translates to economic benefits. Access to proper lighting is critical to enable students in primary and secondary education. Digital access



will continue to play a more important part of education at all levels which is not possible without reliable access to power.

Environmental Benefits

Environmental benefits range from incorporation of clean generation to reducing environmental impact at the point of consumption.



Greenhouse Gas Reduction

With distribution system losses of 15% of energy per year in the EEMS territory, significant waste exists in generating energy. Reducing system losses by 1% (approximately 35 GWh) would help reduce approximately 24,746 metric tons/year of carbon dioxide equivalent emission. This is the equivalent to reducing of the consumption of 2,784,562 gallons of gasoline.



Clean and Renewable Energy

Myanmar is blessed with abundant sunlight outside of the rainy season which makes solar power practical. Grid modernization will enable the integration of solar and other sustainable generation sources onto the grid as Distributed Energy Resources.

Hydropower, both large scale and small, have tremendous growth potential in Myanmar. Incorporating planned and potential hydropower sources can alleviate power shortages in a sustainable fashion.

Pollution Reduction

Reducing losses in the distribution grid reduces net pollution. With less input energy required to deliver power to customers, distribution companies reduce the generation required which reduces pollution upstream.

Pollution Elimination

An estimated 10-15% of Yangon's 7.35 million residents are considered 'unofficial'. They reside in informal settlements that lack modern cooking fuels and technologies. Instead, they use wood and charcoal for cooking. Electrification will reduce the pollution resulting from these cooking methods. Overall, 20.7% of Myanmar relies on clean cooking vs. 65.1% worldwide.

Many households without electricity resort to burning candles for lighting. Studies have identified numerous toxic chemicals released from burning candles that measure at harmful levels. Electrification will eliminate these toxic chemicals in many households.

Citizen / Customer Satisfaction

The citizens and businesses of Yangon are not satisfied with the current state of the Grid. Outages, power



cuts, safety, service times and installation costs are all major issues.

Grid Reliability

Yangon has yet to achieve a basic level of service with consistent delivery of power safely and reliably. This impacts individual citizens, businesses, and other institutions. There is universal displeasure with the state of the power grid which concerns government at all levels.

Safety

Yangon's aging infrastructure leads to many accidents each year, including fatalities. Injuries occur when workers are near power distribution equipment and lines. Many individual citizens are hurt due to downed power lines.

Critical Infrastructure

The power grid is part of any modern country's critical infrastructure. Grid



modernization ensures businesses and citizens have the greatest opportunities and quality of life.

Universal Energy Access

The project supports the government of Myanmar's universal energy access goal by 2030 as stipulated in the country's National Electrification Plan. While Yangon has a higher degree of electrification than other areas of the country, roughly 45% of households lack access to power. Electrification improves the quality of life of citizens and contributes other societal benefits as described below.

Power Quality

Power quality is problematic in Yangon with frequent outages that may have a



long duration. Stabilizing the grid will reduce power quality issues which yields incremental benefits to citizens and business that require a reliable source of power. For mission critical uses such as hospitals and certain types of business, off-grid capabilities can ensure uninterrupted power.

Resilient Infrastructure

The National Electrification Plan calls for off-grid resources necessitating support for Distributed Energy



Resources on the distribution grid. Mission critical uses can directly connect microgrids. This capability will also facilitate the incorporation of sustainable distributed generation.

One such example is distributed solar for both individual as well as commercial and industrial customers. Microgrids can provide a dedicated power supply to critical industrial like tire factories, steel mills, and molding factories which are extremely sensitive to power interruption. Myanmar can attract multinationals who are shifting their production facilities out from China but demand a reliable source of power.

Power Losses

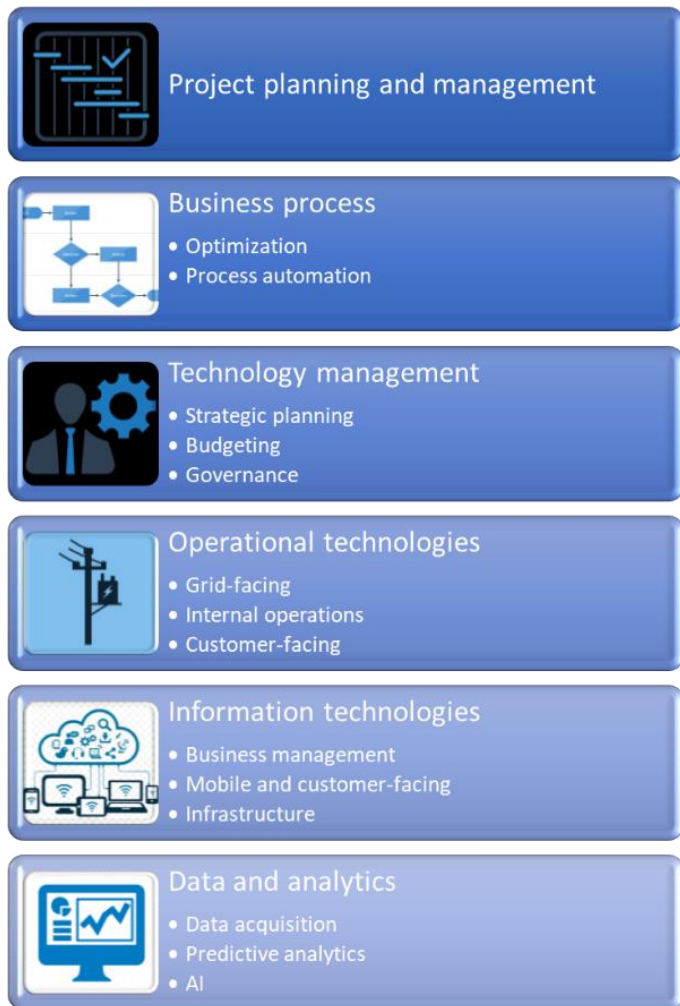
Power losses, both technical and non-technical, are an order of magnitude higher than found in modern power systems. Grid modernization will address both of these drags on the industry. Reduction in the cost structure can translate to more favorable tariffs which can benefit the economy as a whole.

Power Shortages

Power shortages are a persistent problem in Yangon and the rest of Myanmar. The dry summer season reduces the ability of hydropower generation to meet peak demand. This leads to load shedding (taking some consumers offline) and to unplanned blackouts. This is highly disruptive to commerce and has an impact on average citizens, half of whom have experienced the effects of power shortages.

Human Capacity Building

As a result of modernizing Yangon's grid through an increasingly mature set of Smart Grid technologies, Myanmar will build human capital skills and capabilities. Participation in the planning and implementation of Smart Grid projects will allow both leaders and workers to accumulate knowledge, experience, and proven approaches. These skill sets are in demand globally with project management and IT skills applicable across industries.



These skills generate higher wage jobs and are applicable across the power industry. The majority of the skills are useful in many other industries.

As more workers are trained and the maturity of the projects increases, these skills can be applied outside of Myanmar. Exported highly skilled labor is a strategic benefit realizable in the very near future based upon experiences in other emerging markets. EGAT in Thailand is a perfect example.

Alignment to Global and National Initiatives

Grid modernization directly aligns to several key global initiatives. The project supports Myanmar’s engagement in the global community and commitment to certain goals and targets.

UN Sustainable Development Goals

Myanmar has committed to the United Nations Sustainable Development Goal 7 which includes universal access to affordable, sustainable energy and substantially increasing the share of renewables in the final global energy mix by 2030.



Grid Modernization and deployment of Smart Grid technologies supports other UN Sustainable Development goals:

- ◆ Goal 8 – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- ◆ Goal 9 – Build resilient infrastructure, promote sustainable industrialization and foster innovation
- ◆ Goal 11 – Make cities and human settlements inclusive, safe, resilient and sustainable

- ◆ Goal 13 – Take urgent action to combat climate change and its impacts

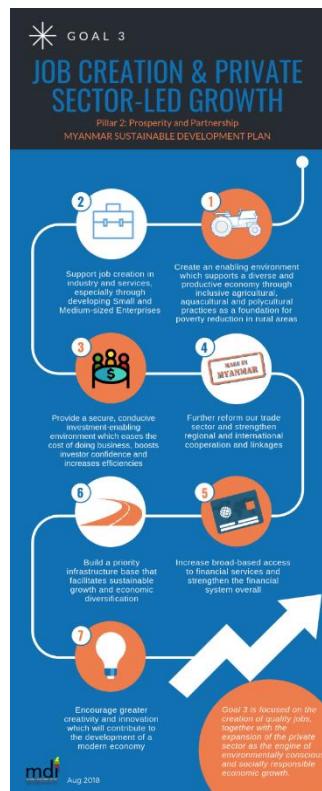
Myanmar’s Sustainable Development Plan

Similar to the UN’s SDGs, Myanmar has a Sustainable Development Plan for 2018-2030. This project directly supports key objectives in the plan.



Under Pillar 2, Goal 3, Strategy 3.6: Build a priority infrastructure base that facilitates sustainable growth and economic diversification

- 3.6.1 Identify priority infrastructure projects, with a focus on job creation, to be developed together with viable and appropriate financing.



Under Pillar 3, Goal 5, Strategy 5.4: Provide affordable and reliable energy to populations and industries via an appropriate energy generation mix

- 5.4.5 Promote energy generation and distribution efficiency and conservation in industry, commercial, household, and public sector use



UN Paris Climate Accord

Myanmar is also committed to the goals of the UN Paris Climate Agreement, which is to limit global average temperature increase to 1.5°C and to make financial flows consistent with a pathway towards low greenhouse gas (GHG) development.



Post-Coup Status

Modernizing power grids across Myanmar and using Yangon as a model for Smart Cities showed great promise. Should Myanmar transition back to civilian rule, the project will be pursued again. The people at EEMS have remained safe and hope for a return to democracy.