Powering Myanmar’s future
A White Paper on joint opportunities to ensure sustainable access to energy for all
Introduction

Figure 1. Location of hydro and thermal power plants

As of November 2018, Myanmar has an installed power generation capacity of 5,607 MW according to the Myanmar Ministry of Electricity and Energy (MoEE), largely composed of a total of 47 hydro, gas-fired and coal-fired power plants. Since 2010, the installed capacity has increased by approximately 60%. While the number of hydro power plants remained relatively stable, gas fired power plants have largely increased with installed gas-fired power generation capacities almost being tripled since 2010. The current generation is 19,914 GWh and the share of state-owned and private generation is currently about 50/50. A clear path of liberalizing the sector – over 90% of power generation was state-owned in 2008 – is a positive sign for a dynamic growth in power generation capacities.

Besides the general lack of power generation capacities and an old, underdeveloped grid (also see below), Myanmar faces large variations in load demand: while the maximum peak load demand is currently standing at 3,320 MW the off-peak load is only about half of this amount. Another fluctuation challenge is represented by seasonality: while power generation (especially through hydro power) is much higher during monsoon season, the long and hot summers always face a significant lack of reliable electricity supply, also in major cities. Therefore, according to the Electric Power Generation Enterprise (EPGE), the government currently negotiates with the operator of the Shwe gas field in Rakhine State, to increase Myanmar’s share of the production (currently 20%, while 80% is sold to the China National Petroleum Company) during summer time.

**Domestic supply and the export challenge**

Electricity supply and demand in Myanmar are far from matching at this stage. Short-, mid- and long-term supply strategies are needed, e.g. in the form of electricity or LNG imports, additional oil and gas explorations and new energy resources not yet included in Myanmar’s energy mix.

Myanmar has some of the largest offshore reserves of natural gas in Southeast Asia. The export of natural gas is one of the country’s major earners of foreign currency and ranks number 3 on the list of top export commodities, after garment and agricultural products.

According to information from the MoEE, Myanmar’s inland natural gas capacities amount to rather small volumes of 50 million cubic feet/day (mmcfd). The much larger, existing offshore gas reserves are the Shwe field in Rakhine State, as well as the Yetagun, Yadana and Zawtika fields south of Yangon.

Yetagun exports all its production to Thailand (250 mmcfd) while Zawtika exports 250 mmcfd of its total production of 350 mmcfd to Thailand. The largest field, Yadana, exports 650 mmcfd of its total 850 mmcfd production to Thailand and provides 200 mmcfd for domestic use. Currently, there are three gas pipelines to export natural gas to Thailand. Their lengths range from 250 km to 470 km and they connect Ratchaburi near Bangkok with the Yadana, Yetagun and Zawtika gas fields in Southern Myanmar.

The daily production of Shwe field is 500 mmcfd, of which 400 mmcfd are exported to China, as mentioned above. In 2013, a gas pipeline from the Shwe gas field (annual capacity: 12 bcm of natural gas) and in 2017 a crude oil pipeline (annual capacity: 12 million tons of crude oil) near Kyaukphyu in Rakhine State started operations. The pipelines grant China direct access to the Gulf of Bengal without the need to pass through the Strait of Malacca. The pipelines terminate in Yunnan province where China will build additional refineries. The pipeline project is jointly implemented by China National Petroleum Corporation (CNPC) as the majority stakeholder and state-owned Myanmar Oil and Gas Enterprise (MOGE). The next enhancement step is already agreed: China’s CITIC will build and operate a deep-sea port and special economic zone in Kyaukphyu, that shall be connected to China by a new railroad.

Production rates of certain fields (e.g. Yadana and Yetagun) will start to decline from 2020 (also see figure 6) and so Myanmar has started to explore and develop new gas fields. As part of this, another bidding round for field exploration concessions is scheduled to start in 2019.

Amongst the ongoing explorations, the most promising results are seen in Block A-6. However, it will most likely take until at least 2023-24 until A-6 will start commercial production. The possible production is currently being assessed. It can reasonably be anticipated that there will be a shortage of domestic gas for a certain period in the foreseeable future, at least until a sufficient amount of natural gas is again produced from new fields. Importing LNG may therefore be a valid and viable solution to overcome temporary shortages as well as for long term demand (see below).

Balancing the needs of the country is a major task of the MoEE. While natural gas contributes substantially to Myanmar’s export revenues (at least 20%) and provides an eagerly required foreign currency inflow, Myanmar also faces the challenge and need to substantially expand its power generation capacities to meet increasing energy demands at home. To address this problem, Myanmar is currently reviewing possibilities to improve the power generation capacities with a mix of thermal, hydro and renewable power plants as well as buying additional electricity from neighboring countries, such as Laos, India or China. According to MoEE, at least 1,000 MW each could be purchased from India and China respectively, discussions and even feasibility studies have commenced. Such cross-border trading of power requires also the construction of (500 kV) transmission lines that can transport the electricity from overseas generation plants to the load centers in Myanmar. The Myanmar government at the same time paints a long-term picture which shows utilization of these new transmission connections for cross-border power trading in both directions.

**Downtown Yangon**

Source: Delegation of German Industry and Commerce in Myanmar
Cross border gas (oil) exports
Cross border electricity trading (under consideration)

Figure 2. Energy export and import (estimate)
Sources: EPGE (2018), MOGE (2018)
Increasing demand with domestic growth

In the future, the demand for energy in Myanmar will grow even further. In this regard, partnerships e.g. in the form of IPPs, may be the most time- and cost-effective solution to reliably generate and provide electricity. For IPPs to get implemented, reliable legal and financial framework conditions from the Myanmar government side are key.

Domestic energy demand and consumption are constantly increasing. Between 2011 and 2017, the energy demand in Myanmar tripled while power generation capacities did not even double over the same period. Demand is expected to continue tripling over the next 12 years and reach 9,100 MW to 14,542 MW by 2030 (depending on the scenario). At the same time, MoEE seeks to increase power generation capacity drastically to 16,830 MW by 2030-31. These scenarios assume a 100% electrification objective for 2030 as well as certain economic and industrial growth levels.

Currently, Myanmar can only provide power to a fraction of its population. As of late 2018, 42% of the population had access to electricity (grid-connected and off-grid combined).

In 2016, JICA developed a first Energy Master Plan. According to this Master Plan, the minimum installed power generation capacity by 2030 will need to be 23,594 MW. This amount would represent almost a fivefold increase from today. In late 2018, the Myanmar government presented an updated, more moderate demand increase that foresees an installed capacity of 16,830 MW for 2030, consisting of hydro, thermal, wind and solar power.
Since August 2018, energy development is integrated into the overarching, cross-sectoral Myanmar Sustainable Development Plan (2018-2030), MSDP, that shall combine all existing master-plans for the country. Strategy 5.4 under this plan outlines how the Myanmar government plans to provide affordable and reliable energy to populations and industries via an appropriate energy generation mix, in which renewables shall play a more significant role than in the past. A Renewable Energy Law is currently at drafting stage. In the context of the MSDP, the Myanmar government aims at creating a database (also referred to as Project Bank). This Project Bank shall include all projects being identified as essential by the different ministries in order to achieve the ambitious 2030 goals. Based on this, the government will also decide which stakeholders can take the lead on implementing these projects and about the business- and financing scheme, i.e. project implementation through a PPP structure, an ODA loan, etc.

The overarching target is 100% electrification in 2030. In order to achieve full electrification by 2030, Myanmar will need to expand and diversify its power generation. According to Myanmar-based energy experts, coal is going to play a more minor role than initially expected. At the same time, gas (incl. LNG imports), domestic hydro power and renewable energies are expected to play a larger role. Domestic as well as international power generation companies will need to cooperate hand in hand with the Myanmar government to achieve this goal and effectively mix Myanmar’s power for the future.

Gas – a preferred option with future potential

With Myanmar being blessed with an abundance of oil and gas resources that have and may further attract substantial amounts of FDI, gas is likely to keep representing a major share in Myanmar’s energy mix.

For its short to midterm energy supply strategy, the Myanmar government focuses on gas-fired power plants while hydropower constitutes the major power generation capacity to be added over the longer run. At the end of January 2018, four thermal (gas) power plant projects with a total generation capacity of approximately 3,000 MW received a Notice to Proceed (NTP). Additionally, two hydropower projects (Shweli-3 and Deedoke) also received a NTP, so that the current pipeline of projects covers approximately 4,000 MW of additional power to be installed within the next years. As new gas fields will be explored and LNG imported, gas will remain also a major contributor to clean energy in Myanmar.

One major challenge that Myanmar will face with regards to expanding gas-fired power generation capacities is the domestic availability of natural gas. While the new A-6 block is currently

Cheap coal unpopular

Coal can supply electricity relatively cheaply and quickly, but due to its negative environmental impacts it is rather unpopular in Myanmar at this stage.

Myanmar is not richly endowed with natural coal resources and the coal available in e.g. Shan State or Sagaing Region is of poor quality. Hence, in order to develop clean and highly efficient coal-fired power plants in Myanmar, coal would need to be, at least partially, imported. While coal could represent a relatively fast solution in achieving Myanmar’s energy supply ambitions for 2030, its social acceptance due to environmental aspects is very low. Residents have repeatedly demonstrated against the erection of coal-fired power plants in their area. Besides, it is difficult to find proper financing options for coal-fired power plants. If technology develops in a way that can make coal cleaner while still affordable, its acceptance in Myanmar may increase.

Mixing Myanmar’s power for the future

As stated above, Myanmar’s energy mix for 2030 shall be much more diversified than the current mix. In this regard, certain challenges remain and opportunities arise.
explored and new blocks are soon going to be tendered for exploration, their timeline and specific exploration outcomes are yet unknown which makes LNG imports a viable bridging solution as well as an attractive addition to the energy mix. Additionally, LNG is worth considering against the background of Myanmar’s ambition to go for a clean energy mix.

Over the past decade, the oil and gas sector has developed into Myanmar’s number one sector for foreign direct investment (FDI). The oil and gas sector accounts for 30% of the total FDI volume in Myanmar. FDI will also be needed to undergo further exploration activities. With the recently announced intention to make conditions more favorable for FDI (e.g. by lifting the requirement to form a JV with a local partner), MoEE’s expectations for a high participation of foreign companies in the announced tender of 31 blocks (18 onshore and 13 offshore) for oil and gas production are high. There are currently 53 onshore blocks and 51 offshore blocks in Myanmar. Out of these, exploration and production activities are currently being conducted at 35 onshore and 38 offshore blocks.
Hydro power – a long-term bet

Having an enormous power generation potential in Myanmar, hydro power shall be developed as a, if not the, major pillar to power the country in the future. Meanwhile, socio-environmental concerns with regard to the sustainability of dams and hydro power projects need to be reviewed carefully and included in the planning.

The potential for hydro power projects in Myanmar is tremendous, but social and environmental concerns remain, and a number of larger hydro power projects are located in areas that are currently prone to conflict. In order to develop hydro power as a sustainable solution for Myanmar, it may be worthwhile to consider small to mid-size hydro projects that can be replicated country-wide on a broader scale.

Over the long run, the Myanmar government plans to establish hydro power as a key pillar of a sustainable electrification strategy and sees potential for over 40 GW to be generated through hydro power. For 2030, MoEE expects a total of roughly 10 GW from hydro power plants, concrete plans exist for approximately 1,500 MW (see figure 1) with much more being in the pipeline. All hydro power capacities combined amount to approximately 3,000 MW at the moment.

It is currently expected that hydro power projects will now follow gas-fired power plants as the next big sector to address in the context of advancing Myanmar’s power supply.

One prominent hydro power project in this regard in Shweli-3 in Northern Shan State (also see figure 1). Its proposed size is 671 MW and the government already completed 11% of the site. The construction of Shweli-3 will also require the project developer to build 300 km high-voltage transmission lines that connect the plant to the national grid. The anticipated investment amounts to USD 1 billion. French EDF (Electricité de France), which signed a Memorandum of Understanding on this project with the government in December 2015, received a Notice to Proceed at Shweli-3 in September 2018. In August 2018, the MoEE also issued a Notice to Proceed to Andritz, Shwe Taung and Kansai Group for the Deedoke hydropower project in Mandalay Region. Additional projects are in the pipeline.

Renewables to play a bigger role

Solar and wind are gaining popularity in Myanmar and their fix place in the energy mix. To establish renewables as a key component of Myanmar’s power generation landscape, legal frameworks and price structures would need to be modernized further.

Wind and geothermal but particularly biomass and solar energy have significant potential in Myanmar. Even floating solar is considered as a power supply source by the Myanmar government, but these projects are technically demanding and have not been piloted yet. Biomass is already used on a small scale. However, these installations have a large potential to be upgraded and introduced across the entire industry. Of all renewable energy projects, solar PV is currently developed the furthest in Myanmar. A 50 MW PV plant is currently under construction and other projects are planned. Regarding wind power, the government signed an agreement on the first larger installation of 30 MW in Chaungthar (Ayeyarwaddy Region) with China’s Three Gorges Corporation.

As with all other power generation projects, feed-in tariffs have to be directly negotiated with the government. Regarding renewables and their fluctuations, the government fears incompatibility with the grid although a recent USDTA study forecasted that an optimized grid could possibly handle up to 20% penetration level from renewables. Since renewable energies are cost competitive and quick to develop, they represent a viable element in powering the country. To establish renewables as a reliable source of power, they will need to involve storage systems and ideally also modern grid control.

Need for a modern grid

Transmission tackled

The grid is generally underdeveloped, with 500 kV lines only starting to exist. In the past, power transmission has been relatively inefficient and demonstrated high transmission losses. Over the last two to three years, clear improvements could have been witnessed and further improvement through cooperation projects launched with international investors and governments is expected.

In the past decades, previous government investments in the transmission and distribution grids were kept at a minimum. Hence today Myanmar’s power grid is far beyond state-of-the-art technology, as well as unstable and insufficient. Transmission losses accounted for 20% in the financial year 2013-14, while recent years’ improvement activities lead to a reduction of losses. However, with the right measures this can still be improved a lot further. Therefore, the grid upgrade and expansion are key of the government’s 2030 electrification strategy.

As of 2017, Myanmar had 221 transmission lines accounting for a total length of about 7,000 miles. So far, Myanmar’s transmission system only operates on 66 kV, 132 kV and 230 kV voltage levels.

66 kV lines can be fairly long in Myanmar. 132 kV lines are used for connecting power plants to the national grid and are mainly found in the central transmission zone. 230 kV lines are currently the main system, running in a north-south corridor in central Myanmar and connect big consumption areas, such as Yangon. The Yangon area relies heavily on imports from other areas, particularly the northern part of Myanmar as the main source for hydro power.

A 500 kV line from Meiktila to Yangon is currently being built respectively tendered with financial support from bilateral development cooperation (Korea, Japan, Serbia) and will also include the construction of four substations funded by JICA (Meiktila, Taungoo, Phayargyi, Hlaingtayar). As mentioned above, in the longer run and wake of power imports from India and China, additional 500 kV lines may get constructed towards the Northeast and Northwest. Furthermore, the construction of new power plants can also involve the construction of new high voltage transmission lines.

The 230 kV lines are constructed in cooperation with foreign companies (e.g. from Korea (230 kV, Kolan to Keng Tan) and China (230 kV, Ohntaw to Nabar)) and the construction is structured as deferred payment (over approximately 10 years). In Myanmar, high voltage lines can only be owned and operated by the national government. The government agency in charge of high voltage transmission lines is the Department of Electric Power Transmission and System Control (DPTSC) under the MoEE.

Apart from an expansion and upgrade of transmission lines, Myanmar’s power grid also needs substations with smart equipment and modern communication technologies that are able to regulate feed-in fluctuations and allow for a 24/7 nation-wide balancing of power supply and demand.
Figure 8. Existing power grid and under construction projects
Source: MoEE (2018)
More substations for a smart grid

Not only does the grid need to be expanded but it also needs to be modernized. This will include further substations which ideally can enhance a smart grid, if Myanmar decides to opt for smart solutions as a grid-stabilizing mechanism.

As of 2017, there are 277 substations. An additional 38 substations are planned to stabilize and enhance the grid. A substation expansion will also be a prerequisite to be able to handle the additional 10 GW in the grid. The Yangon area is currently operating with 10 substations (230 and 66 kV lines). Four new stations are planned for Yangon as part of the construction of the 500 kV lines. The circle of 230 kV lines will then almost be closed, with the only missing link still existing between the Ahlone and the Thida substation.

Any addition or replacement of substations shall consider future requirements of communication, smart grid and IoT. In other words, to make the grid stable, reliable and ready for the future, a drastic modernization and grid optimization program needs to be rolled out, based on a comprehensive network and grid study.

Distribution – the bottleneck

Distribution plays a major role in bringing electricity to the people. Initial grid upgrade efforts have been focusing on transmission but should not leave distribution out of sight. Increasing private sector engagement, e.g. through mini-grid operators, may represent a viable solution to electrify more remote and non-grid-connected areas.

In September 2018, Myanmar President U Win Myint asked Parliament to approve a USD 298.9 million loan from the Asian Development Bank (ADB) to be used to improve electricity transmission and distribution in Yangon, Ayeyarwady, Tanintharyi and Bago regions and Mon, Karen, and Rakhine states (2019-2025). As part of this ADB loan, Myanmar also plans to introduce a computerized electricity management and bill-collection system.

The grid-connected distribution network (lines and transformers) in Myanmar is operated by locally represented government entities (YESC for Yangon, MESC for Mandalay, ESE for the rest of the country). Private sector providers offer distribution e.g. in the form of mini-grids in off-grid areas, e.g. in Dawei, Myawaddy, Hpa-An, Ye, Tachilek, Muse etc. Foreign companies are currently not allowed to operate in this sector but an investment of up to 35% in local mini-grid operators is possible since the introduction of the new Companies Law in 2018. Despite this opening towards FDI, the hurdle of receiving payments in local currency, and facing foreign exchange risks in this regard, still hinders foreign companies to properly invest in these systems.

By 2030, the Myanmar government plans to increase the total line length of the distribution network from approximately 9,000 km at the moment to approximately 25,000 km. The largest increase is planned for 0.4 kV lines (from approximately 4,000 km to over 13,000 km).

To tackle all the grid challenges and tasks described above in a money- and time-efficient and -effective manner, a comprehensive grid study would be highly beneficial. It could serve as a data-driven basis when deciding on how to balance and optimize power generation and power flow while keeping the costs low and make timelines predictable.
Achieving full coverage by 2030 – four core activities to consider

To provide access to energy for all of Myanmar by 2030, substantial investments will be required. The estimated investment size depends on the different case scenarios, a total investment size of 25 billion USD is an average estimate. The installation of additional power generation capacities may cost around 10 billion USD. The upgrade and expansion of the grid is likely going to be more expensive (approximately 15 billion USD). Only a small fraction (we currently estimate approximately 5%) of these investments may be done with support from international organizations (foremost ODA grants and loans). Hence, a close cooperation between the government and private investors, Myanmar as well as international, will be needed to create frameworks that are viable for investors, operators and of course the Myanmar people and companies.

1) Providing access to energy for all through a socially-sustainable tariff increase

The average subsidy per kWh in Myanmar is currently 22 MMK (0.015 USD). On average, the government buys one kWh for 92 MMK (0.06 USD) and sells it for 70 MMK (0.046 USD) to the end user. This results in every additional unit of power produced creating a larger hole in the government budget. In view of Myanmar’s ambitious energy expansion plans this is not sustainable. We therefore recommend reassessing the tariff structure, eliminating subsidies and creating a new pricing system that, however, needs to be socially sustainable and does not negatively affect households below the poverty line. Ultimately, such a move would also benefit the households below the poverty line which mostly live in rural areas, as these are currently the ones that often do not have any access to electricity yet or need to run expensive diesel generators. Eliminating subsidies would immediately lead to a larger national budget available for expanding the electricity supply to rural areas which then in turn would also improve the livelihoods of poorer households which tend to rather live in rural areas. Since higher tariffs typically encourage people to save energy, there will ultimately also be a positive impact on the environment through reduced energy consumption.

2) Creating a transparent and enabling legal framework

Approval and decision processes are still complicated and time consuming, however, progress is underway. In 2017, the national government granted full-decision making power to the states and regions concerning new power projects of a size of up to 30 MW, as long as the project is not connected to the national grid.

Model agreements with separate versions for renewable and thermal projects had been developed previously with support from USTDA. However, according to industry experts, these templates are not commonly used. The reference project for bankable PPAs is typically the Myanmar gas-fired power plant (negotiated by Singaporean Sembcorp with support from the International Finance Corporation), which may not fit to all projects though. A preparation and consequent use of standard templates could help to create a more transparent and stable investment environment supporting particularly FDI in the power sector. This will go hand in hand with creating sustainable financial models for the government as well as the investors, minimizing risks for both parties and attract eagerly needed foreign direct investments.

The cheapest energy unit is the one which does not need to be generated. A legal framework which drives the creation of energy-efficient building standards in combination with incentives for eliminating peak loads by shifting loads to non-peak times will lead to less needed generation and therefore less needed investments.

3) Enhancing the grid to handle sustainable power

Myanmar is one of the countries which have signed the Paris agreement on CO2 reduction. The latest developments in Myanmar’s power sector show an increasing interest from the government in renewable energies. As outlined above, Myanmar’s power mix of the future is certainly going to be more diversified than it is today, no matter which scenario is actually going to get implemented. Along with a more diversified energy mix, the volatility of power generation and different loading patterns bring additional challenges, which the expanding grid will need to be able to balance in order to avoid frequent power cuts.

There are various mechanisms that allow to balance and stabilize the grid for a diversified energy mix, ranging from batteries and storage systems, FACTS to ensure the power quality and stability to smart grid solutions. Particularly power quality and smart systems will be required to improve grid reliability and the balancing of supply and demand which in return is the basis for any investment in major infrastructure projects. Myanmar has the big advantage to leapfrog in this field. Foreign companies with their experience and expertise can help and support Myanmar on its way into this new digital era.

4) Succeeding on the last mile by optimizing distribution

While transmission lines are already in the focus of reforms, the distribution system - the last mile to the end-user - is still to be upgraded and extended. For this, clear planning in view of the different end user profiles will be needed, based on extensive data collection, e.g. through smart equipment, surveys and experienced modeling. An extensive and comprehensive planning of the transmission and distribution network with the target to create the most effective and advanced smart system, requires a time investment but is a guarantor for the most optimized and effective solution. Money and time spent here will pay back in form of major savings in the future without compromising on reliability. Investing in highest quality standards and equipment ensures readiness for the future, for sustainable and organic growth and most of all for the next generations to come. Key here will be to work hand in hand together with foreign investors on a PPP basis in a fair and responsible way that encompasses social, environmental and financial sustainability.

To conclude, it should be highlighted again that 100% access to energy in Myanmar by 2030 is challenging but possible. This objective can be reached by intensifying and prioritizing planning and creating a framework that enables Myanmar and international companies to effectively join forces with the government for the benefit of Myanmar.
In 2030, Myanmar shall have a modern power grid that provides electricity to the majority of its expected future population of 60 million people. The remainder shall be covered with reliable and affordable off-grid solutions. The development of Myanmar’s future energy system will be supported by economic growth rates which are expected to remain high, with an average annual GDP growth of approximately 7%. Currently, 42% of the population have access to electricity. The grid needs upgrade and expansion in order to reach the entire country and reduce power cuts to a minimum.

Due to a low number of power plants that can only provide electricity to a fraction of the population, cities are currently the only areas regularly powered while the countryside needs to rely on small renewable energy solutions, expensive diesel generators or no access to power at all.

This White Paper aims at sharing the experiences which were gained in Myanmar over the past years and summarizes the recommendations that could be drawn from this. To power Myanmar’s future effectively, a socially, technically and financially sustainable approach will be necessary and leapfrogging potentials in view of smart, digitally interconnected solutions are worth considering.

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