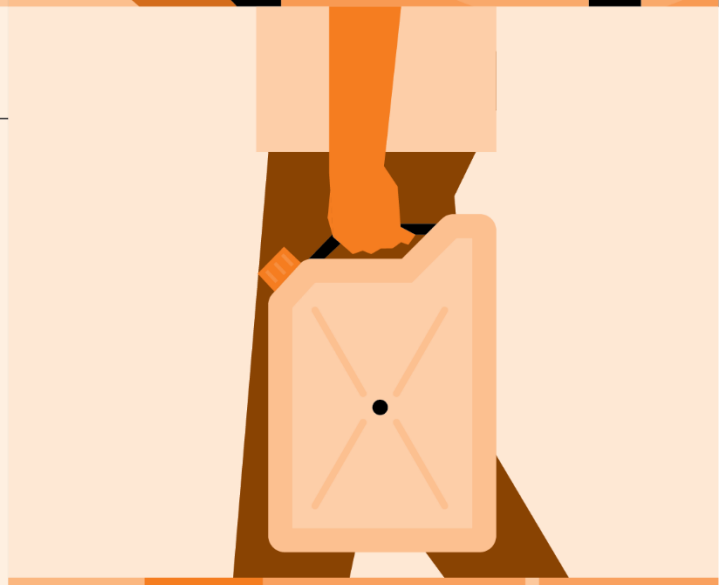
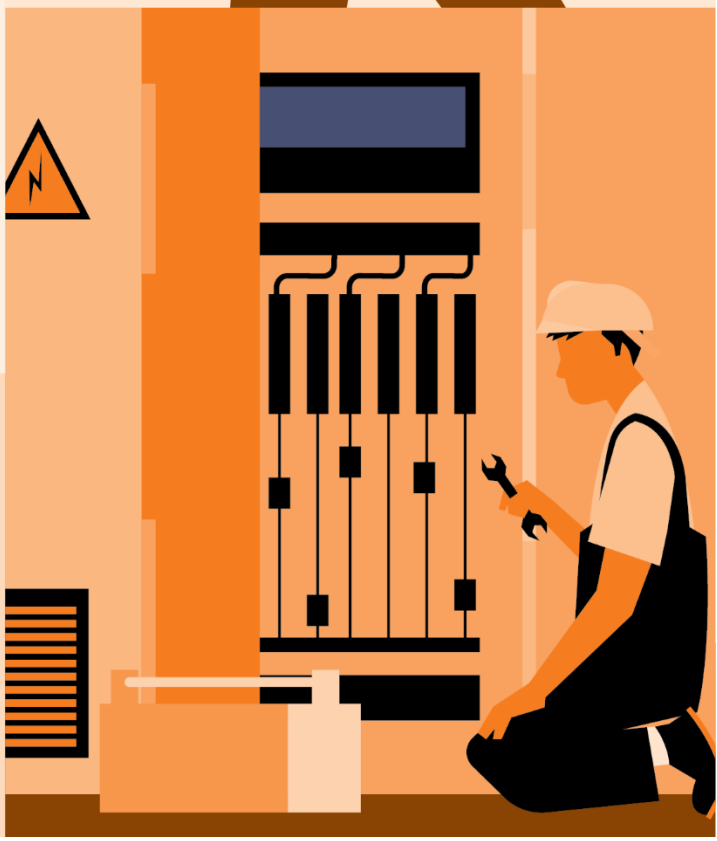
JUNE 2024

Myanmar Energy Sector Update

Energy Poverty Amid Plenty





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Preface and Acknowledgements

Increasing the power supply-demand gap remains the major challenge to securing reliable electricity services in Myanmar. This report presents the recent dynamics in both on-grid and off-grid electricity generation to understand the complexities related to the performance of the power sector in Myanmar.

The report was prepared by a team comprising Myoe Myint (Senior Energy Specialist), Joonkyung Seong (Senior Energy Specialist), Adwoa Asantewaa (Energy Economist), May Oo Mon (Program Assistant) and Sadig Aliyev (Program Leader for Infrastructure) under the guidance of Jie Tang (Practice Manager, Energy), Mariam J. Sherman (Country Director) and Sudeshna Ghosh Banerjee (Regional Director, Infrastructure). The team appreciates Smart Power Myanmar for their valuable contribution towards the mini-grids section. The report was prepared as part of the Myanmar Infrastructure Monitoring and relies on data from various sources, including the private sector and third parties, as well as open-source data and news that were analyzed and cross-checked as part of the monitoring work.

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Context

Myanmar is endowed with abundant primary energy resources. Its hydropower potential is estimated at more than 100,000 megawatts (MW) in its river systems including four basins of Ayeyarwady, Chindwin, Thanlwin, and Sittaung. The installed hydropower capacity, however, is only 3,262 MW (2023), illustrating the huge potential to be harnessed that could, in the long term, not only meet domestic demand but also become a green energy source for the region. Myanmar is also a hydrocarbon-rich country; the potential reserves of crude oil, natural gas, and coal are 15,220 million barrels, 93.698 trillion cubic feet, and 711 million metric tons, respectively, according to the official statistics. Proven oil reserves are estimated at 50 million barrels, and gas reserves at around 10 trillion cubic feet. Conditions for renewable energy are favorable too. Myanmar is in the "sunbelt" with the highest solar potential reaching 6.6 kilowatt-hours per square meter (kWh/m^2) per day on a horizontal surface in the dry zone (Mandalay, Sagaing, and Magway regions). [1] Myanmar thus has greater energy generation potential and more options for meeting its needs than most countries in the region.

The electricity sector in Myanmar is currently grappling with a critical situation marked by severe supply constraints and significant unmet demand. Many of the challenges in the power sector are structural, fundamental, and linked with political instability, conflict, and macroeconomic conditions.[2] The industrial sector, in particular, is bearing the brunt of the shortage of grid electricity, with the existing sources of electricity supply deteriorating rapidly. This is due to a combination of factors, including aging power plants with obsolete technology, a shortage of natural gas, damaged national grids, lack of spare parts, manpower shortage, departure of foreign investors, inappropriate policies, and weak sector management. The electricity sector requires substantial investments to maintain its existing power generation and transmission capability. However, financial investments are not likely to result in efficient production and utilization of resources unless policy reforms are implemented, which are notable in modernization with technology acquisition, adequate electricity pricing, and financial management of the sector.

During the period 2015-2021, the electricity sector of Myanmar was on a steady development pathway, with a fast-expanding power generation base, relying on natural gas, hydropower, and solar to meet fast-growing electricity demands. The annual averages of power output were on a clear upward trajectory from 15,965 to 23,643 Giga Watts hour (GWh) between FY2015/16 and FY2020/21, with the increase of total installed generation capacity from 5,125 to 6,830 Mega Watts (MW) over the same period.[3] Aiming to increase renewable solar energy significantly, a major solar tender was launched in May 2020 for 30 solar power plants to be constructed throughout the country; only one of those was completed since the military takeover in 2021, and the other 29 were canceled.

Shortly after reaching a historic operational capacity (peak load) of 3,997 MW in May 2021, there has been a steep decline in power production with the departure of foreign investors

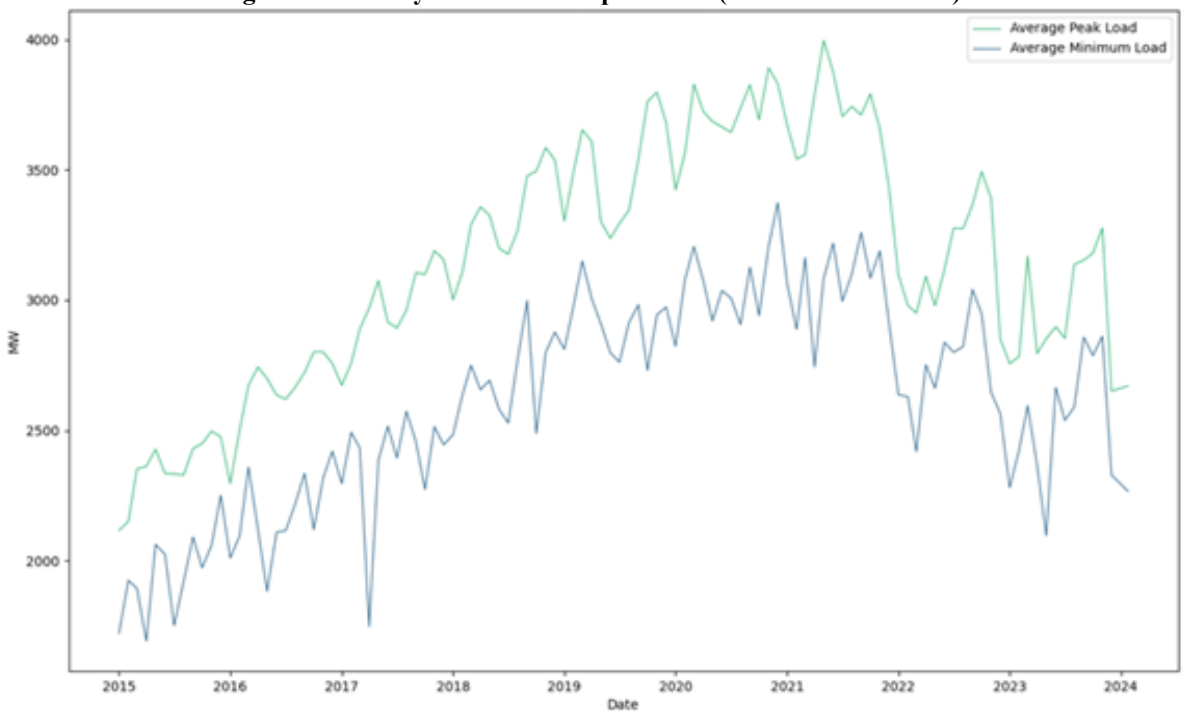
[1] World Bank, Myanmar: Energy Infrastructure Assessment, June 2019.

[2] World Bank, In the Dark: Power Sector Challenges in Myanmar, August 2023

[3] Central Statistical Organization: Myanmar Statistical Yearbook 2023.

from the energy sector. The operational generation capacity drastically declined from the highest peak load to its FY2015/16 level in early 2024. Furthermore, the gap between the minimum and maximum energy levels has also narrowed (Figure 1); this gap widened in 2020 but is now tightening again, representing a loss of flexibility in the grid and the fact that consumer demand is outstripping capacity. By October 2021, it was clear that Myanmar was facing a deep energy crisis, and efforts to remedy this with (small) solar energy plants in 2022 were insufficient. The situation has further deteriorated by the persistent depreciation of the Myanmar Kyat and the dwindling foreign exchange reserves of the country for importation of fuel (LNG) and spare parts.

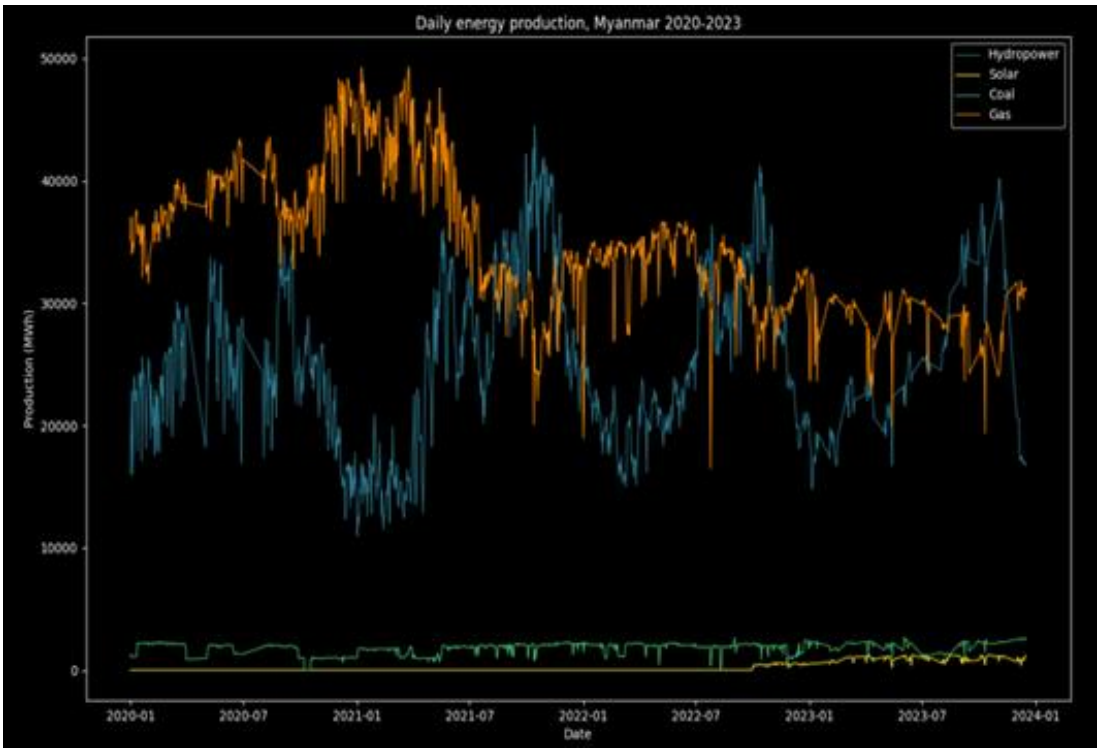
Figure 1: Monthly minimum and peak load (Jan 2015 - Jan 2024)



Source: World Bank staff estimates.

The current energy crisis in Myanmar has been worsening since its historic peak load in May 2021. The operational capacity keeps on declining with significant drop in 2022 and 2023. The operational capacity in early 2024 is so low as it was in 2015, meaning that years of progress has effectively been undone. If power generation data is disaggregated by fuel type, the earlier increase in gas-fired power (in 2019 and 2020) has by now been fully reversed or cancelled out, and the Myanmar power landscape has switched back to a hydro-dominated model (Figure 2). Gas-driven generation has seen a "double dip" – i.e., an initial steep decline in mid-to-late 2021 when major players (such as LNG to power project) withdrew, a slight recovery in early 2022, and then a continued decline in late 2022 and throughout 2023. The 2023 drop in gas-driven generation is particularly concerning, given the crucial role gas production has played in Myanmar historically, and the absence of a substitute generation source for the moment.

Figure 2: Daily Electricity Production by Fuel Type (2020-2024)



Source: World Bank staff estimates.

As of 2024, Myanmar's power system relies heavily on hydropower plants. In particular, the national grid relies on electricity supply from Yeywa hydropower plant (790 MW) and Shweli (400 MW allocated for Myanmar), the most consistently generating electricity. Several hydropower dams are producing intermittently. There is a stock of mid-to-large dams that produce relatively consistently (except when there's a conflict), but many of the small-to-mid-sized dams are not producing even when they are most needed. Zaungtu, Zawgyi2, Myogyi, and Kinda, as examples, do not produce electricity consistently. Seasonality likely plays a role, but other factors, including maintenance problems or water management issues, may be at play.

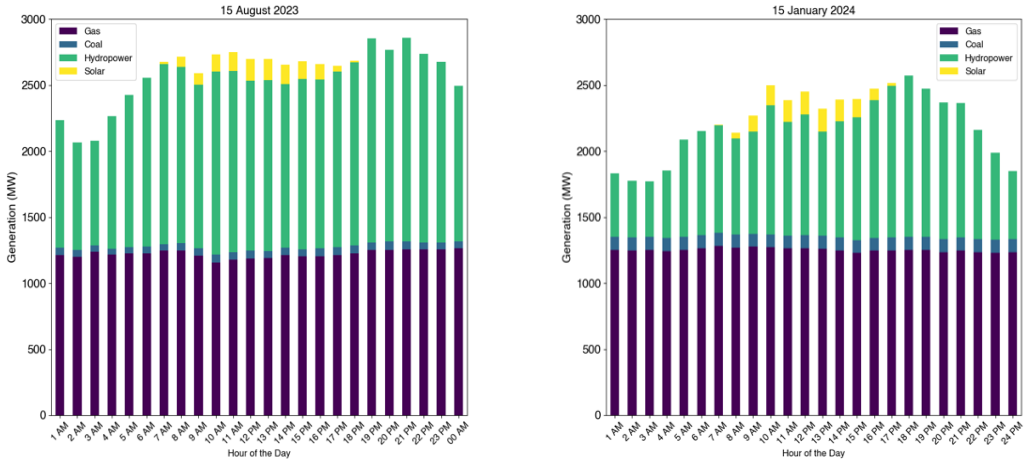
Solar plants contribute a relatively small amount of electricity to the national grid, representing a marginal fraction of the electricity supply in Myanmar. There are only six solar plants in the country – one built before the 2021 military takeover and another five built thereafter. These plants are too small to meet the demands of the power grid. Myanmar solar plants usually start generating at 7 am in the dry season, reach their peak capacity by 11 am, and produce until 6 pm. During the monsoon, plant capacity reaches around noon, and production plummets after 5pm, on average. The small yellow line in the far-right bottom corner of Figure 2 represents the very small solar production in Myanmar. There are also two small coal plants, that have been producing electricity at a stable level (green line in Figure 2).

The sudden surge in utilization of hydroelectric power plants causes safety concerns as it has entailed using older dams more intensely than before. It increases wear and tear (fissures, cracks, vibrating turbines, etc.). Hydroelectric power production fluctuates a lot, with the

difference in seasons, and this has caused issues as the administration has tried to compensate for the loss of gas-based energy production with hydro. This reverses the pre-2021 trend of increasing investment in gas-based energy production and reducing reliance on hydroelectric power plants. Gas-based energy production is not recovering and continues to be in gradual decline because of the halt on import of LNG, less domestic gas production, and prioritization of exporting gas to neighboring countries.

Despite significant changes in the generation landscape, the rules for power dispatch remain the same. The baseload is supplied by thermal (gas and coal) power plants, while the daytime load is complemented by hydropower and solar. The following charts show the load curves for selected typical days for the monsoon season (August 15, 2023) and dry season (January 15, 2024). The gas base load is stable at 1220 MW, but there is a significant drop in the hydropower generation in January. Compared to load curves before 2021, these recent charts have less defined peaks. The difference between peak hours and mid-day is almost non-existent.

Figure 3: Hourly Load Curve (monsoon vs. dry season)



Source: World Bank staff estimates.

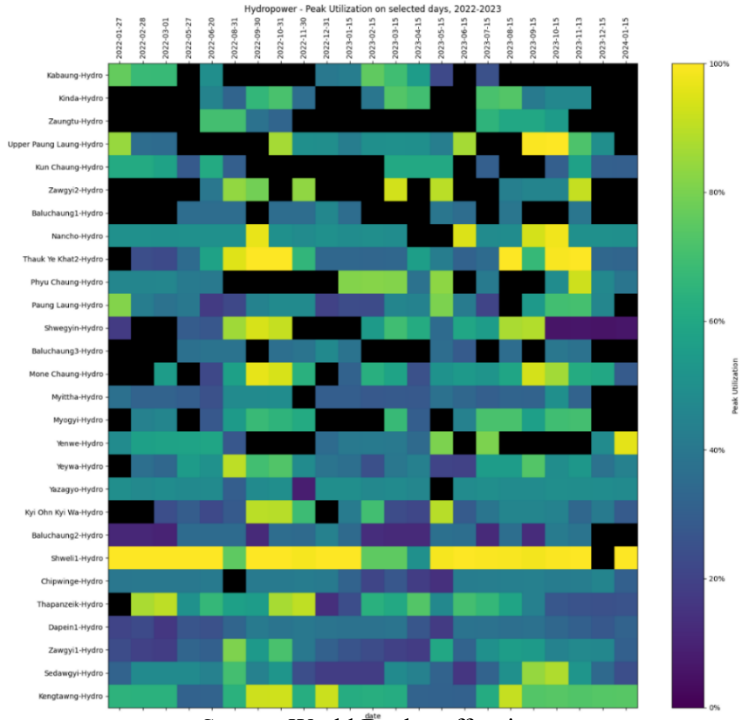
Hydropower Plants

Electricity generation by hydropower plants increased to 9,070 GWh in 2022/23 from 8,370 GWh in 2020/21, although installed capacity remains the same at 3,262 MW[4]. Hydropower plants located in non-conflict affected areas can be considered over-exploited as armed clashes impact both plant operation and power evacuation. Three hydropower plants of Baluchaung cascade (total 243 MW) have been significantly affected by conflicts. The first destruction of power lines in these areas was as early as 2021 – soon after the military coup. Electricity from the Baluchaung cascade power plants supplied Nay Pyi Taw. During active conflict, transmission lines connecting these plants to the national grid system were destroyed and access to the site by engineers for necessary maintenance and operation is challenging. Baluchaung 1 and 3 are not producing electricity at all, while Baluchaung 2 produces occasionally, likely for local demand.

[4] Central Statistical Organization, Myanmar Statistical Yearbook 2023

The largest hydropower plant, Yeywa (790 MW), is steadily operating at around 40-60 percent of installed capacity. There are concerns that the incidents near the Yeywa plant area could spread out and impact normal plant operations. Moreover, some technical issues might limit the plant to operate at half of its capacity. Shweli 1, located near China border in northern Shan State, is one of the most crucial power plants as it consistently generates power at its capacity. Armed conflicts have flared up near the dam since late 2023. This hydropower plant is currently in an area controlled by ethnic armed groups. Shweli 1, with a total installed capacity of 600 MW, has been remotely operated from the Chinese side. According to the power purchase agreement, the power plant exports 200 MW to China and allocates 400 MW to feed into the national grid.

Figure 4: Peak Utilization of Hydropower Plants on Selected Days



Source: World Bank staff estimates.

Medium and small hydropower plants are functioning intermittently or not operating reliably. These hydropower plants include, but are not limited to, Zaungtu (20 MW), Kinda (56 MW), Zawgyi 2 (12 MW), Myittha (40 MW), Myo Gyi (30 MW), Kabaung (30 MW), and Upper Paung Laung (140 MW). Although the reason behind intermittent production is not disclosed, interviews with industry experts revealed that most staff from many of these power plants were relocated to nearby towns such as Taunggyi for safety reasons. The decline of electricity generation by these hydropower plants is significant as they operate 806 MW capacity on the randomly selected days of 14 and 16 December 2023. In normal operation, December would usually be the highest production time by hydropower plants, with the reservoir still full of water from the rainy season, by taking advantage of high generating efficiency as much as possible.

Water management of hydroelectric dams returns to normal. Several dams appear to have been emptied in 2020-2021 (Zawgyi-2, Myogyi, Zaungtu, Kinda, Thapanzeik) due to major maintenance works. Hydropower was over-solicited in late 2021 and early 2022, causing a steep

decline in water levels early in the dry season. That led to critically low reservoir levels during the dry season. Water levels in 2022-2023 followed smoother patterns, marking a return to the traditional approach to water management, as well as rationing.

Hydropower generation capacity addition will continue to be challenging. Completion and commissioning of hydropower plants under construction is delayed due to active armed conflicts and constrained budgets. The status of key projects under construction or development are below:

- **Upper Yeywa (280 MW) in northern Shan**, the largest hydropower plant under construction, was expected to be commissioned by the end of 2024. With closer proximity to active armed conflict zones, the construction of Upper Yeywa has already been impacted several times, including in 2019, when transporting materials was difficult due to safety concerns. According to satellite imagery, some construction is happening, including a high-voltage power line in place. However, overall progress appears slow, with no evidence of a reservoir being filled or of high dam walls being in place.
- **Upper Kengtawng (51 MW) in southern Shan**, with 80 percent complete in 2023, is expected to be commissioned by 2025, subject to construction being able to continue in this remote part of Shan. This plant will be in addition to the existing Kengtawng (54 MW) hydropower plant completed in March 2009. This hydropower plant is very remote, far from urban centers. Satellite imagery shows the construction progress, including a high dam wall and preparations for the turbine where water will flow.
- **The development of Namtu (210 MW) in northern Shan** is progressing slowly, as the project is very close to an active conflict area. Although satellite imagery provides limited evidence of construction progress, signs of activity at the dam site include the widening of the access road, new buildings, and some heavy machinery. Construction remains at a preliminary stage.
- **Construction progress of Thahtay (111 MW) in Rakhine** is minimal, as per satellite imagery, and there is no evidence of electrical components being installed. The recent active armed conflicts in the area are likely to delay construction works.
- **No progress is observed for Hatgyi (1,390 MW),** which was originally planned to export 90 percent of electricity to Thailand and 10 percent for domestic utilization. The project area is currently under control by ethnic armed groups, and local communities have been historically against this project.
- **Little progress is observed in the development of other new projects,** such as Ban Chaung (23 MW), Ma Yun (33 MW), and Sar Ya Wa (49 MW), and revitalized hydropower projects, such as Shweli 3.

Gas Power Plants

Electricity generation by gas power plants decreased from 12,607 GWh in FY2020/21 to 11,468 GWh in FY2022/23, and it further declined to 5,189 GWh in the first half of FY2023/24.[5] The average plant factor for gas plants in Myanmar was 19 percent in 2022, declining to 17 percent in 2023. The decline in electricity generation came from i) a reduction in available generation capacity and ii) a reduction in gas supply to power plants. Figure 5 highlights the peak utilization of gas-based power plants for producing electricity. The peak utilization measures the peak on a given day divided by installed capacity; if a plant has low peak utilization, it means that only a fraction of its capacity is being used. The plant factor is the actual energy produced divided by the potential maximum. If a plant has a high plant factor, it means that it is generating substantial power or "meeting its potential.".

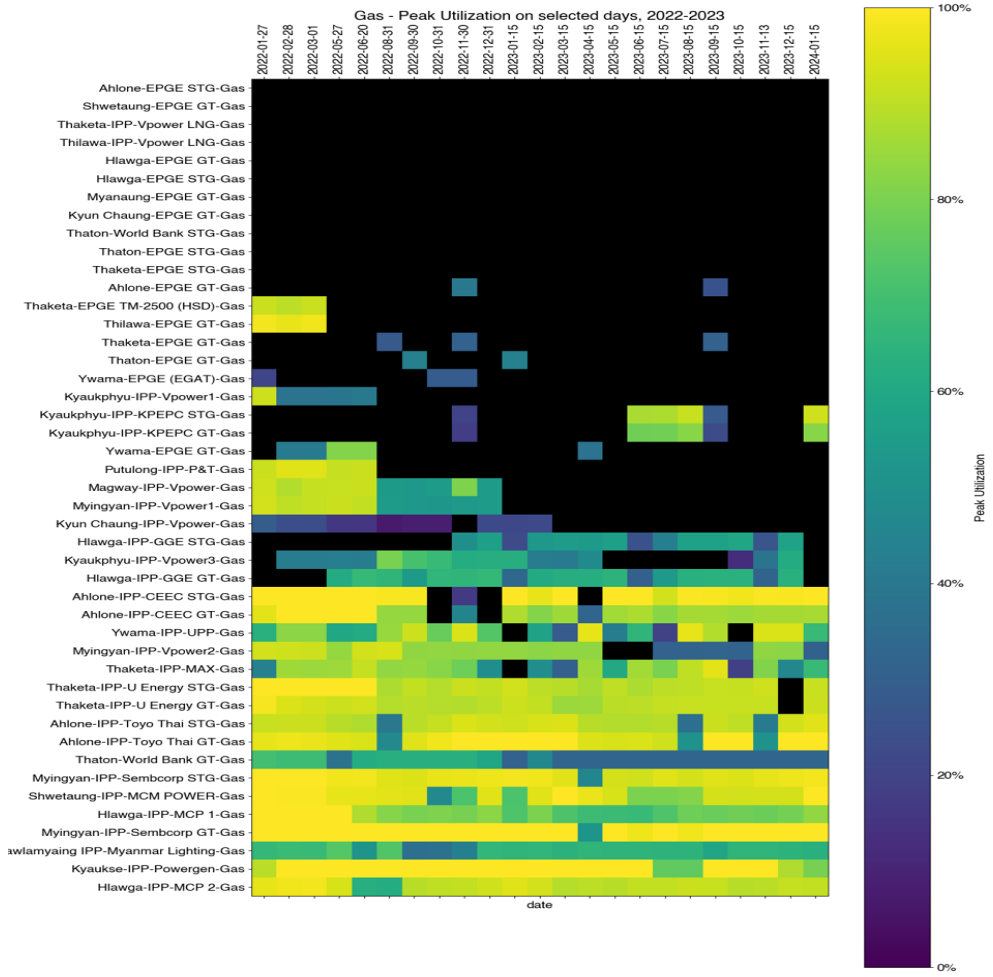
Available generation capacity was reduced by 1,200 MW, driven by the withdrawal of the biggest foreign investor in gas power plants. VPower (Hong Kong-based) entered the Myanmar power market in 2015. It was operating about a third of available gas capacity in 2021. VPower switched off two LNG power plants in Thilawa (350 MW) and Thaketa (400 MW) in July 2021, citing the currency depreciation, dwindling foreign exchange reserves, and high LNG prices in the global market. VPower ceased four of its five gas power plants in Myanmar from 1,310 MW of installed capacity in early 2021 to only 109 MW in 2023. The withdrawal of VPower has been a key factor in the drop in Myanmar's gas-based generation and the overall power supply in the country.

The commissioning of a new 135 MW combined cycle gas turbine (CCGT) power plant in Kyauk Phyu is affected by limited technical support by manufacturers due to international sanctions. The construction of a new power plant by PowerChina was delayed because the original turbine manufacturer could not provide essential technical support and spare parts during commissioning. As shown in Figure 5, Kyauk Phyu IPP operated for a few months, from June to September 2023, before it stopped and started again in January 2024. Lack of technical support and shortage of essential spare parts significantly impact the operation of state-owned power plants, such as a relatively new Thaton CCGT power plant, but also private IPPs, such as Mawlamyaing IPP power plant and Hlawga IPP power plant.

Almost all state-owned gas power plants are idling, while privately owned plants generate electricity in varying degrees. The state-owned plants remain functional, but utilization of these plants is minimized due to the rationing of natural gas due to a decline in natural gas production. Privately owned gas power plants are prioritized because state-owned gas plants are more run-down and less efficient with significant gas leaks. Furthermore, many power purchase agreements (PPA) between private developers and the ministry include a "take-or-pay" clause, meaning that the government is contractually obligated to purchase energy if it is available, even if it is not needed at that time.

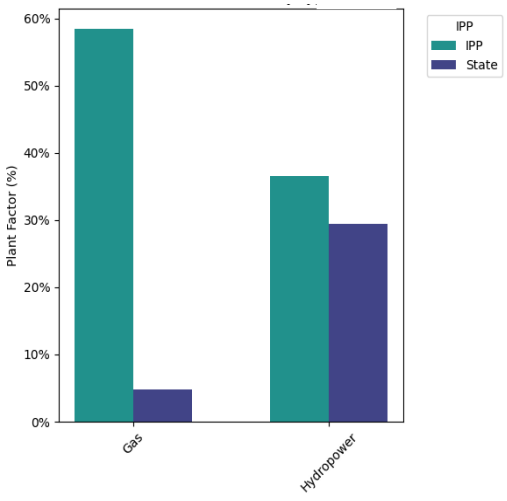
[5] Central Statistical Organization, Quarterly Statistics Bulletin, 2023-2024 (Q2)

Figure 5: Peak Utilization of Gas Power Plants on Selected Days



Source: World Bank staff estimates.

Figure 6: Plant Factor by Fuel Type



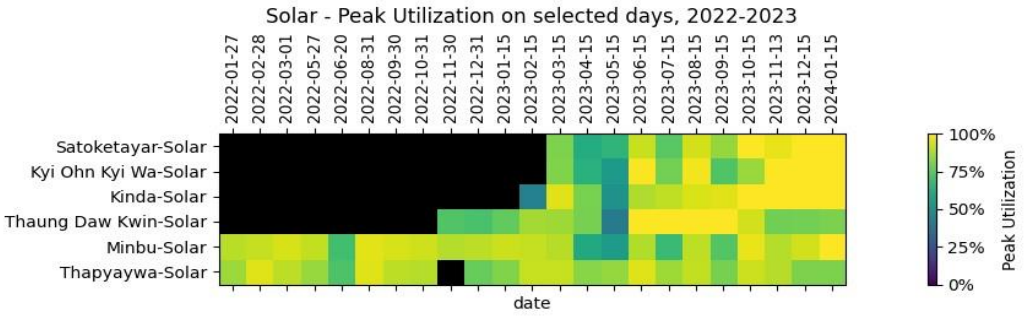
Source: World Bank staff estimates.

Solar PV and Wind

All six grid-connected solar power plants in Myanmar with a combined capacity of 182 MW have been operating normally. Compared to gas power plants, solar power plants generate electricity with no major disruptions at peak potential (100 percent - yellow) or near it quite frequently (Figure 7). The first grid-connected solar plant in Minbu (40 MW) in Magway Region started producing in 2019 and has been producing electricity but not at full capacity due to technical constraints. Thapyaywa solar plant (30 MW), commissioned in December 2021, and Taung Daw Kwin (20 MW), commissioned in November 2022, have been producing at levels somewhat below capacity due to technical constraints. Kinda (30 MW), developed by PowerChina and commissioned in February 2023, utilized the Kinda hydropower plant's substation and transmission lines. Satoketayar (30 MW) and Kyi Ohn Kyi Wa (30 MW) solar plants, developed by PowerChina and commissioned in March 2023, are cogenerating with two existing hydropower plants using the existing transmission infrastructure. These three solar plants have often produced at or exceeded their maximum contracted capacity.

Despite the effort for rapid solar PV deployment through three rounds of IPP tenders, for a total capacity of up to 2,150 MW, only 142 MW has been commissioned. The first public tender for developing 30 grid-connected solar power plants for 1,060 MW was launched in 2020, of which 29 were awarded, but only one was built at Thapyaywa by local developer Asia World. In the wake of the military coup, winning bidders of 28 sites delayed implementation, and these tender results were later canceled. The second tender for up to 480 MW was launched in June 2021 for 12 sites[6], of which only one project has been commissioned at Taung Daw Kwin[7] by the same local developer Asia World. There is no evidence at this stage that the remaining 11 projects are proceeding. Another tender for the development of grid-connected solar power plants at six sites for 610 MW in total was launched in 2022[8], of which five sites were awarded to PowerChina and three sites are now in operating[9].

Figure 7: Peak Utilization of Grid-connected Solar Power Plants on Selected Days



Source: World Bank staff estimates.

[6] https://www.vdb-loi.com/mm_publications/myanmar-issues-new-solar-tender-for-240-480-mw/
[7] https://www.pv-magazine.com/2023/01/09/myanmar-switches-on-20-mw-of-solar/
[8] https://www.moep.gov.mm/en/userfile/Newspaper_for_PV_04.pdf
[9] https://www.moi.gov.mm/moi:eng/news/12101

While a feed-in tariff for rooftop solar PV was introduced in 2023, it is not expected to contribute effectively to the scale-up of distributed renewable energy. A feed-in tariff of 85 Kyat per kWh in Nay Pyi Taw and Yangon was announced in March and April 2023, respectively, guaranteeing a price to buy excess solar electricity produced by rooftop solar PV systems to incentivize industrial zones/ factories to install rooftop solar and sell additional power produced back into the grid. Given currency depreciation, the cost of production may be well above the announced feed-in tariff, and thus, it may not encourage new commercial and industrial rooftop solar projects.

Feasibility studies for three wind farms in Rakhine were commenced in January 2023 by a China-Myanmar JV company, with the first wind farm in Gwa to be built in two phases of 50 MW each, followed by the second in Ann (150 MW) and the third in Thandwe (110 MW). The wind speeds have been measured in these sites with the expectation of commissioning in 2025. The ramping up of violence in Rakhine since November 2023 will likely affect construction, particularly in Ann and Thandwe. Eight additional MOUs for wind farms were signed in 2023 for sites in Rakhine and Ayerawaddy. If built, their combined capacity would be 1,230 MW.

Power Imports

Aiming for regional interconnection, Myanmar has been pursuing with neighboring countries for power imports, but little progress has been observed so far. In 2023, the authority and Electricité du Laos extended a 2018 MOU until 2028 to build a 230 KV interconnection between the two countries. Under the agreement, Laos would sell 600 MW to Myanmar starting in 2026. The line would first be built from the border to Tachileik and onward to Keng Tung by the end of 2024. The Keng Tung-Meiktila section will be finished by 2026. Laos has an oversupply of hydroelectricity during the monsoon season, and Myanmar could absorb some of it. However, the interconnection would pass through territory currently controlled by ethnic armed organizations. The success of the project, therefore, depends on their consent.

The Chinese and Myanmar transmission grids are already connected at several points at medium voltages (Kokang and Wa Self-Administered Zones, Muse), and through two export-oriented dams (Shweli-1 and Dapein-1). However, there is no high-voltage line currently capable of sending large amounts of electricity from Yunnan into Myanmar's national grid. China and Myanmar have discussed a grid interconnection for several years. In 2019, the government planned two 1000 MW interconnections with China. Since the military coup of 2021, progress has been slow but remains a top diplomatic priority. In 2023, the military authorities planned for a 230 KV interconnection between Ruili, Yunnan, and Muse, Northern Shan. This area is currently at the center of the armed conflict; thus, the current conditions prevent any construction.

India has attempted to advance a regional grid interconnection project through the Bay of Bengal Initiative for Multisectoral Technical and Economic Cooperation (BIMSTEC). In February 2024, BIMSTEC members met to discuss regional interconnection. However, the transmission line route goes through an area not controlled by the authorities, and thus, it is highly unlikely to move forward in the near future.

Off-grid mini-grids

Myanmar's off-grid electrification sector has been deteriorating due to an overlapping multitude of crises. Fuel prices have tripled since the 2021 military takeover, burdening mini-grid operators and deteriorating service delivery. Mini-grid operation is also affected by the shortage of skilled labor. Therefore, households and businesses in off-grid communities have been experiencing power shortages and disruptions in economic activities. The sustainability of most mini-grids is diminished by electricity theft, departure of trained personnel, currency depreciation, fuel price spikes, inflation, high operation and maintenance costs, limited access to finance, and the inability of vulnerable households to pay for connection fees.

The Myanmar National Electrification Plan, endorsed in 2015, was the Government's ambitious programmatic action plan to electrify 7.2 million households to achieve universal electricity access by 2030. The National Electrification Project (NEP)[10], financed by the World Bank, was a major contribution to the first phase of Myanmar's National Electrification Plan. Off-grid component of NEP supported the development of (i) 73 mini-grids serving 22,500 households; (ii) solar home systems for 421,000 households; (iii) electricity connections for 15,800 rural health clinics, schools, and other community buildings; and (iv) installation of 52,000 public streetlights. Some of these mini-grids developed under the NEP were negatively affected by armed clashes between military and resistance forces. Many of the NEP mini-grids are now suffering from insufficient resources and capacity.

Among 93 NEP mini-grids surveyed, only 43 located in Ayeyarwaddy and Thanintharyi are accessible, while the remaining mini-grids are partially or not accessible due to worsening security conditions. These inaccessible mini-grids are in the active conflict-affected areas of Sagaing, Rakhine, Shan, and Kayah State. Limited internet access and not functioning mobile phone networks effectively make monitoring mini-grid operations in these areas more difficult.

NEP mini-grids demonstrate their ability to provide a reliable power supply and prove resilience amid complex crises. Out of the responses available for 93 mini-grids, 89 mini-grids (95 percent) continued operations, and only four mini-grids have entirely ceased operations. 29 mini-grids are providing 24 hours of electricity, 14 mini-grids are providing 16-24 hours of electricity, and 20 mini-grids are providing a minimum of 8-16 hours of electricity. Higher electricity demand, higher operation costs due to diesel prices, and lower battery health are major reasons for reducing electricity supply hours. Most load shedding happens during the nighttime, typically from 9 pm to 5 am. It is notable that a large share of mini-grids provides a reliable power supply for more than 16 hours or even 24 hours a day, better than the grid.

Although a third of households are not connected yet to the mini-grids, demand for electricity has reached up to the maximum capacity of the mini-grids. Existing customers utilize more mini-grid electricity as an affordable energy source because tariffs were fixed prior to the political crisis and currency inflation. Out of a total of 27,323 households within the service area of 93

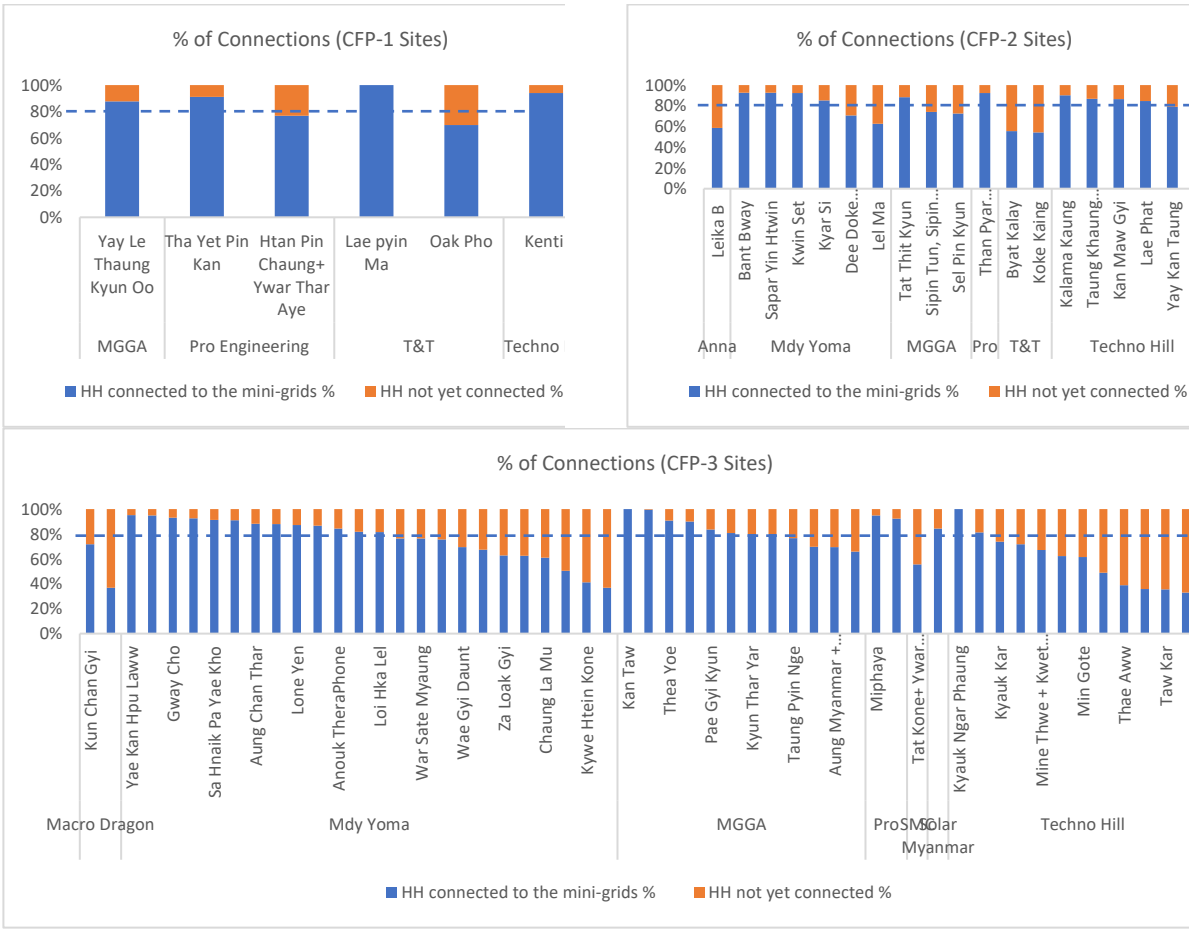
[10] The project implementation was paused following the military takeover in February 2021 and subsequently closed in September 2021

mini-grids, 18,128 (66 percent) households are connected to the electricity, whereas 9,434 households are waiting to connect. About half of the mini-grids have connection rates of 80 percent or above, while nine mini-grids have connection rates of less than 50 percent. According to the developers, the existing solar PV generation and battery storage capacity is insufficient and needs expansion to meet increased demand and connect households without access to electricity.

The currently fixed electricity tariffs can no longer cover the operation cost of a mini-grid. During NEP implementation, the tariff was designed so that revenue would cover O&M cost, battery replacement, and recovery of private capital investment. However, the currency depreciation (over 300 percent since February 2021) and inflation puts mini-grid operators in a difficult financial position. Furthermore, a triple increase in diesel prices since 2021 impacts developers who cannot adjust fixed tariff schemes, making it difficult to sustain their operations. These mini-grids were supposed to be handed over to the village communities after some years of operation, but it is not clear how the transfer will take place and how the community can sustainably operate the mini-grids.

The increasing cost of service, coupled with fixed electricity tariffs, leads to financial difficulties for mini-grid operators. Since the villages were connected to the mini-grids three to five years ago, household electricity demand has gradually increased through additional kitchen appliances and electrical equipment for income-generating activities. Incremental demand beyond the original design of the mini-grids is supplied mostly by diesel generators. The higher the electricity demand, the greater the financial loss of the mini-grids operator because fixed electricity tariff no longer reflects the cost of electricity service, particularly with surging fuel costs.

Figure 8: Mini-grids Connection Rates



Source: World Bank survey on NEP mini-grids data.

Conclusion

Myanmar has been encountering energy poverty, while electricity production is a fraction of its abundant primary energy resources. Electricity consumption in Myanmar is at 308 kWh per capita in 2022/23[11], which is about a third of the average per capita electric power consumption in lower-middle-income countries. Worsening multiple crises across the country negatively impacts the electricity supply, as the generation capacity has declined after a historic high in May 2021.

Shortage of electricity supply has been impacting the states and regions in different ways and at different levels of severity. The electricity supply situation is catastrophic in conflict-affected areas, and full-day power cuts were observed in Chin, Rakhine, and Kayah States. In 2023, power supply significantly deteriorated in Ayeyarwaddy, Sagaing, and Mandalay, while electricity availability in Yangon, Bago, and Magway was poor. Although the electricity supply in Nay Pyi

[11] Central Statistical Organization, Myanmar Statistical Yearbook 2023

Taw remains the most consistent and reliable, load shedding is practiced in residential areas. The industrial sector is bearing the brunt of the shortage of grid electricity, with less than two hours of electricity supply per day, because priority is given to residential consumers than industrial zones throughout the country.

Mini-grids developed in the past demonstrate resilience, as 95 percent of NEP mini-grids continue supplying electricity to rural communities while the off-grid electrification sector has deteriorated. Although the majority of mini-grids provide a reliable power supply better than the national grid, there is a need for long-term sustainability to be an alternative to the unreliable grid system. The fixed electricity tariffs throughout the concession period led to the worsening financial viability of the mini-grid operators as the cost of service has been increasing with high inflation. Additional investment is needed to expand solar PV panels, battery storage capacity, and distribution networks to meet increased demand and connect households without access to electricity.

Many of the challenges in the power sector are structural, fundamental, and linked with political instability, conflict, and macroeconomic conditions. Intensified armed conflicts spreading across various geographic areas are expected to prevent all attempts at increasing power supply, such as resuming the operation of abandoned hydropower plants, repairing damaged transmission lines, and constructing new grid-connected solar plants in dry zones. In the absence of capital-intensive upstream exploration activities and drilling new wells to compensate for declining production, the existing domestic supply of natural gas is expected to be lower than the current level in the coming years. It will result in lower electricity generation by gas-based power plants in the foreseeable future. Myanmar's power sector, both on-grid and off-grid, requires not only significant investments but also policy reforms for financial viability to maintain, at least, its existing capability of electricity supply.

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