ENSY 5100 PROJECT 1: HYDROPOWER STATUS REPORT IN MYANMAR

Submitted by

Shwe Myat Myo Oo

M.S. Energy Systems Candidate

Northeastern University

Contents

1. INTRODUCTION

Myanmar is the second largest nation in southeast Asia after Indonesia with a diverse population of approximately 53.37 million people. Although the country has a rich and storied national and cultural history, the modern state of Burma (as it was known during its formation) came into existence after gaining independence from the United Kingdom in 1948. Since then, modern Myanmar has faced significant regime changes and internal strife—from 1962 to 2011, Myanmar was under the governance of several military regimes that have negatively impacted the country in many ways, and the country is currently involved in one of the world's longest-running civil wars. These events have significantly affected the state's ability to fully take advantage of its strategic geopolitical position and abundant natural resources (especially renewable energy resources), thus contributing to Myanmar remaining one of the most economically challenged nations in southeast Asia despite extensive reforms by the current governing administration to mitigate the issue.

As is shown in Figure 1, the country slopes downward in elevation from north to south and the central lowlands are surrounded by steep mountain ranges. The major rivers in Myanmar are the Ayeyarwaddy, Salween, Chindwin and the Sittaung. The Ayeyarwaddy, in particular, is known as the 'lifeline of the nation' due to its versatility for transportation, water supply, irrigation, maintaining biodiversity, and fishing. All four rivers are significant sources of hydropower, and are essential to Myanmar's economic well-being since Myanmar is an agriculturally dominated country where over 65% of the population live in rural areas, working in the agricultural sector. In addition, the Mekong river delineates the border between present-day Myanmar and Laos.

There is significant potential for development of Myanmar's energy infrastructure, given that only 39% of the country's households currently have access to grid electricity and many renewable energy resources are currently underutilized. Hydropower development throughout the entire size category spectrum for both grid and off-grid usage will be a major step towards developing such infrastructure to ensure future energy security in Myanmar.

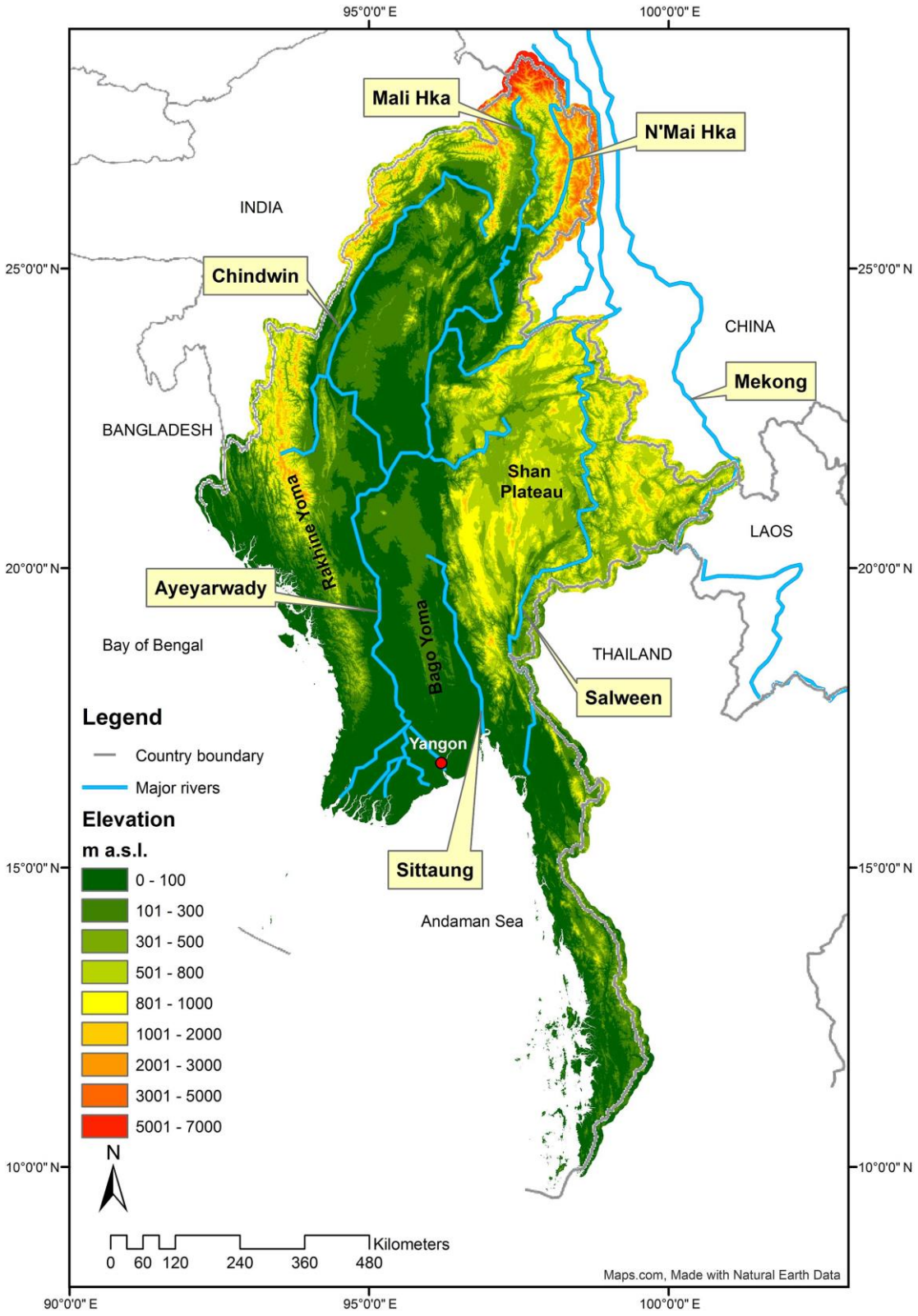

Figure 1: Physical overview map of Myanmar including state border lines, major rivers and mountain ranges.

2. MYANMAR ENERGY OVERVIEW

2.1 Known Energy Resources

Myanmar has both non-renewable and renewable energy resources within its borders. Apart from coal, natural gas, and crude oil, the nation produces biomass and generates electricity from hydroelectric power plants and PV systems. The 2017 nonrenewable resource distribution is as follows:

- Coal reserve: 543.75 million metric tons
- Oil reserve: 105.78 million barrels
- Natural gas reserve: 6.6 trillion cubic feet

PV (photovoltaic) systems accounted for approximately 10.94 GWh of generation in 2016. Wind turbine systems are present, although they produce a relatively small amount of electricity (0.0016 GWh) compared to other forms of renewable energy production and have very few incentives for funding. Water resources, however, are the prevailing choice for both grid and off-grid renewable energy solutions with almost all of renewable capacity being hydropower as seen in Figure 2. Table 1 lists the current hydropower installations in Myanmar and their capacity in MW.

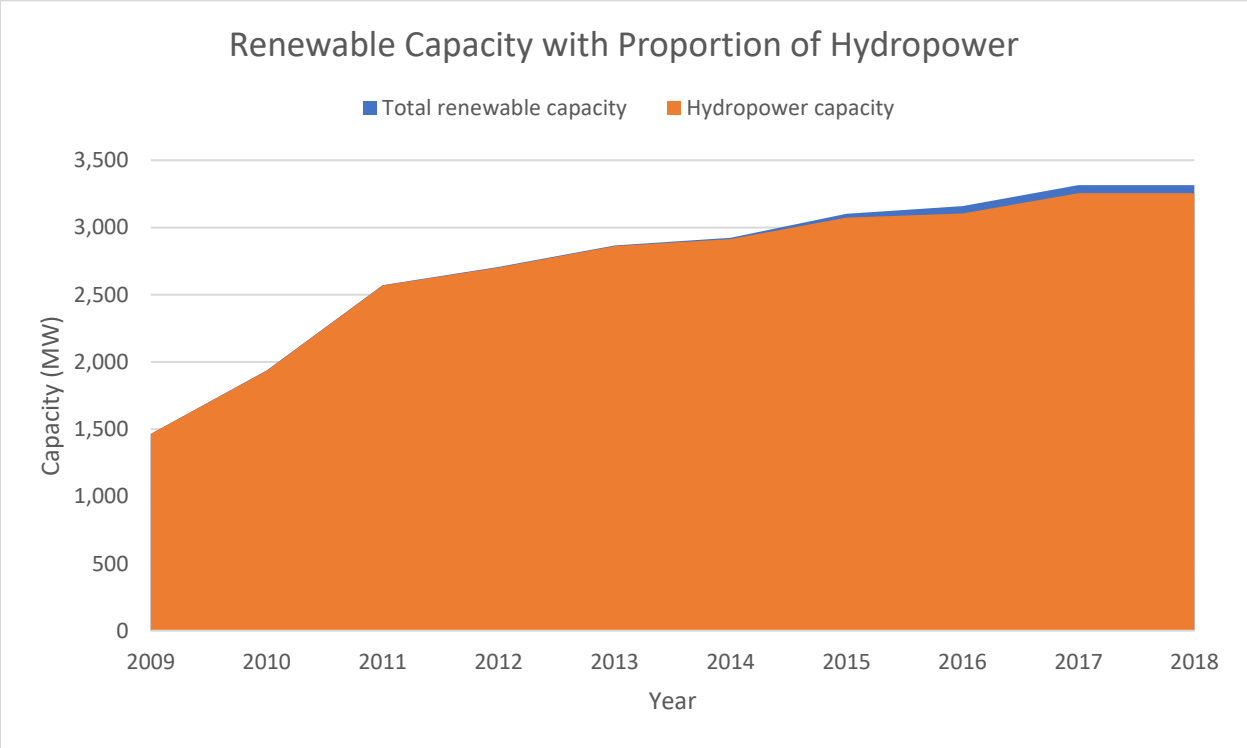

Figure 2: Renewable capacity in Myanmar with proportion of hydropower.

Nos.	Name of stations	Number of machine	Type of machine	Installed capacity	Name of river	Type of hydropower plant
1	Zawgyi no (1)	3	Francis	18	Zawgyi	Runoff river
2	Keng Tawng	3	Francis	54	Nantein	Runoff river
3	Kinda	2	Francis	56	Panlaung	Rock fill
4	Sedawgyi	2	Kaplan	25	Chaungmagyi	Rock fill
5	Zawgyi no (2)	2	Francis	12	Zawgyi	Arch
6	Thaphanseik	3	Kaplan	30	Mue	Earth fill
7	Mone Chaung	3	Francis	75	Mone	Rock fill
8	Kyeeohn Kyeewa	2	Kaplan	74	Mone	Earth fill
9	Baluchaung no (1)	2	Francis	28	Baluchaung	Runoff river + dam
10	Baluchaung no (2)	6	Pelton	168	Baluchaung	Runoff river + dam
11	Zaungtu	2	Kaplan	20	Bago	Earth fill
12	Paung Laung	4	Francis	280	Paung Laung	Rock fill
13	Yenwe	2	Francis	25	Yenwe	Earth fill
14	Kabaung	2	Francis	30	Kabaung	Earth fill
15	Yeywa	4	Francis	790	Myitnge	Roller compacted concrete
16	Shwe Gyin	4	Francis	75	Shwegyin	Rock fill
17	Kun Chaung	3	Francis	60	Kun	Rock fill
18	Shweli no (1)	6	Francis	600	Shweli	Runoff river
19	Dapein no (1)	4	Francis	240	Dapein	Runoff river
20	Thaukyekhat no (2)	3	Francis	120	Thaukyekhat	Concrete faced rock fill
21	Nancho	2	Francis	40	Nan Cho	Runoff river
22	Phyu Chaung	2	Francis	40	Phyu Chaung	Rock fill
23	Upper Paung Laung	2	Francis	140	Paung Laung	Roller Compacted Concrete
24	Myo Gyi	2	Francis	30	Zaw Gyi	Earth fill
25	Myittha	2	Kaplan	40	Myitta	Earth fill
26	Baluchaung (3)	2	Francis	52	Baluchaung	Runoff River + Dam
27	Chipwe Nge	3	Pelton	99	Chipwe	Runoff river

Table 1: Currently operational hydropower stations in Myanmar.

2.2 Electric Capacity, Generation, and Share of Hydroelectricity

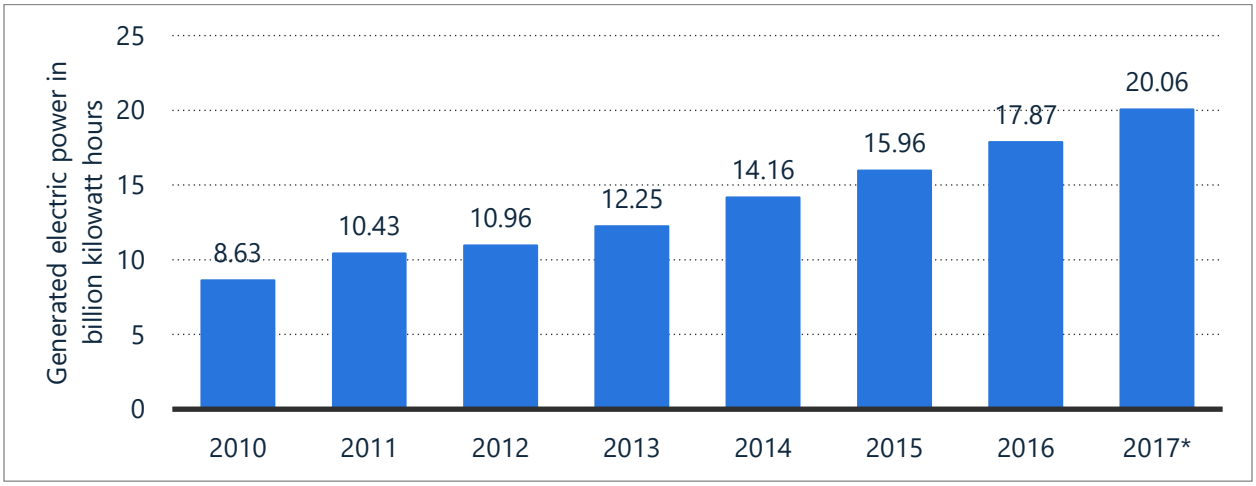

Figure 3: Annual electricity generation in Myanmar from 2010-2017.

Figure 3 shows the trend in electricity generation for Myanmar from 2010 to 2017. Installed capacity follows a similar upward trend.

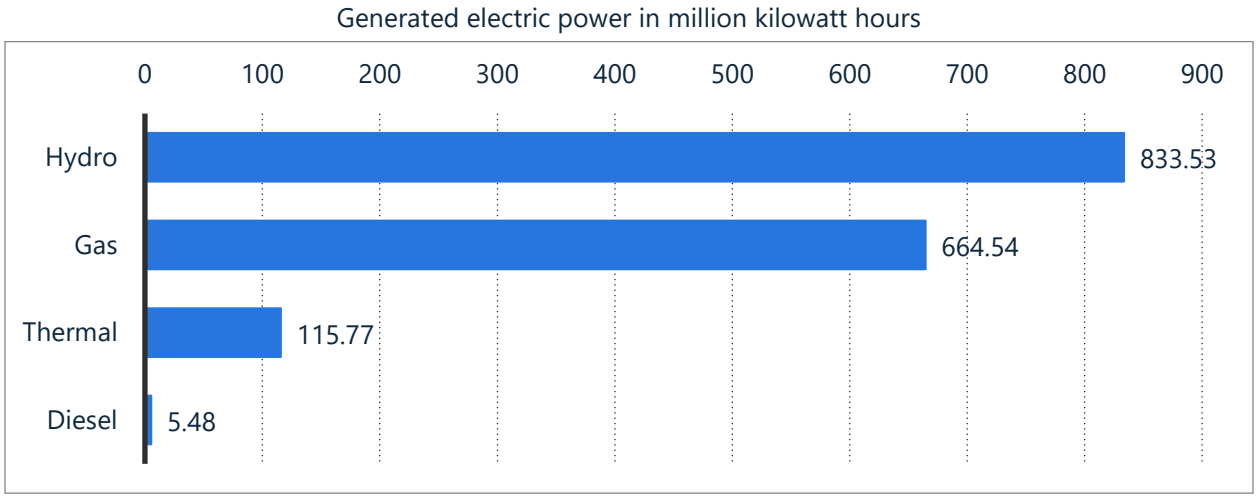

Figure 4: A breakdown by source of electricity generation in December 2017.

As seen in Figure 4 for December 2017 (the only year for which generation data was available), hydroelectric power is the primary means of electricity generation in Myanmar, accounting for approximately 41.55% of all generated electricity. Figure 5 further reinforces the prominence of hydropower by illustrating the proportion of hydropower in total installed electric capacity.

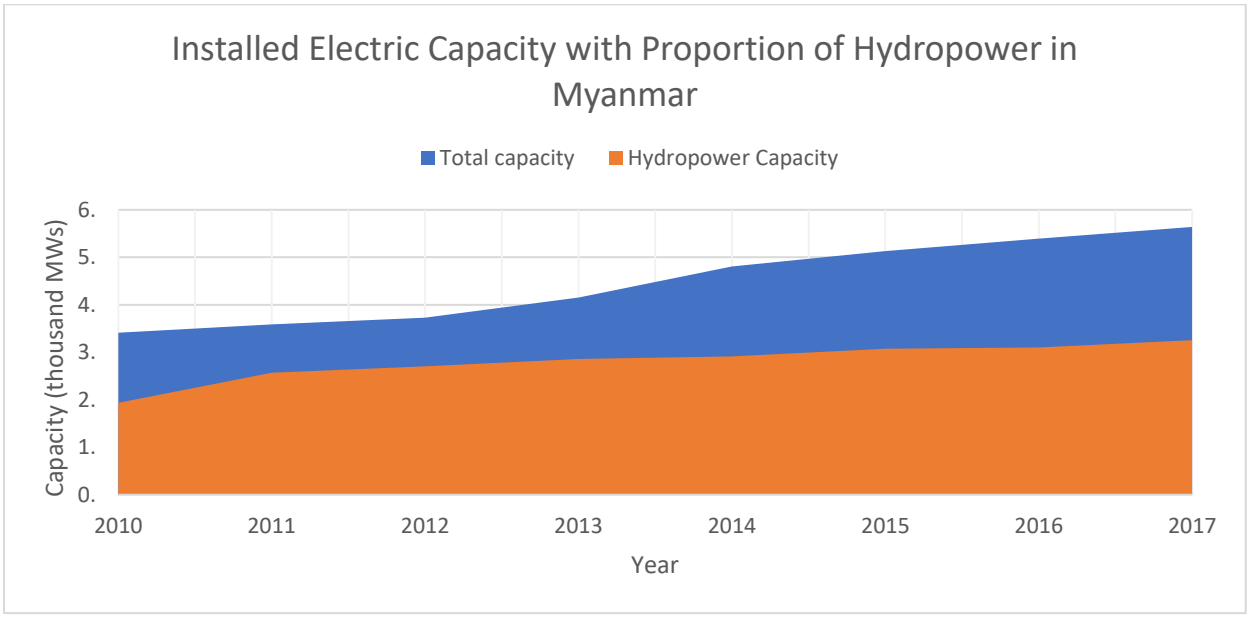

Figure 5: Share of hydropower capacity in Myanmar from 2010 to 2017.

In Figure 6, it can be seen that the total installed electric capacity in Myanmar has been steadily rising as more facilities for both hydropower and other forms of power generation continue to develop. These figures imply that a larger proportion of Myanmar's population may gain access to grid electricity in the near future.

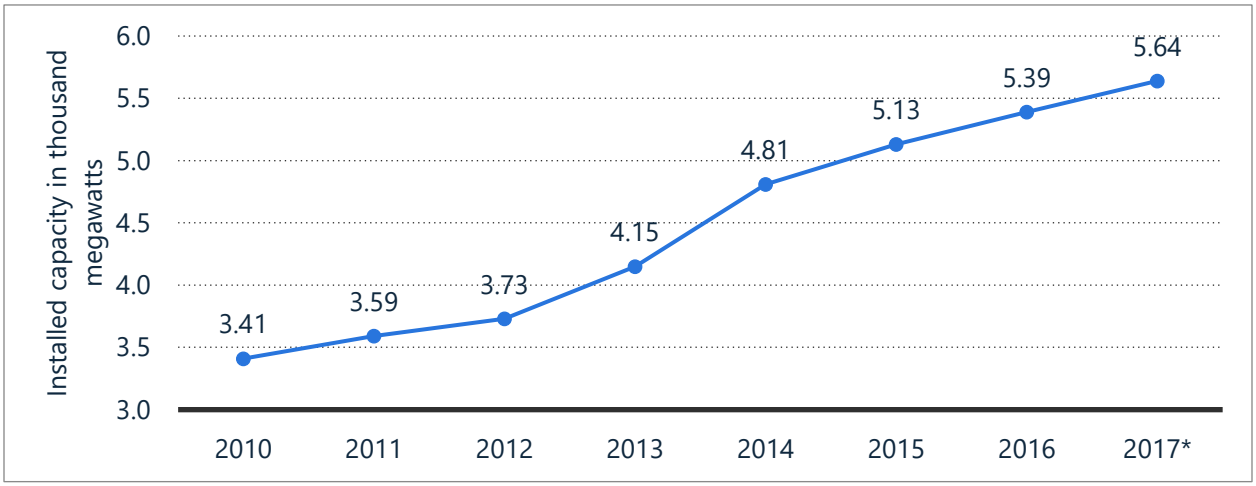

Figure 6: Total installed capacity (all types) in Myanmar from 2010 to 2017.

Hydropower plant factor could not be calculated due to a lack of data on annual generation, and no statistics on annual fossil fuel plant capacity and generation were available for fossil fuel plant factor calculation.

3. INTERNATIONAL COMPARISONS

As seen in Figure 7, Myanmar has one of the lowest electricity consumption rates per capita in southeast Asia due to grid electricity not being available to much of its population.

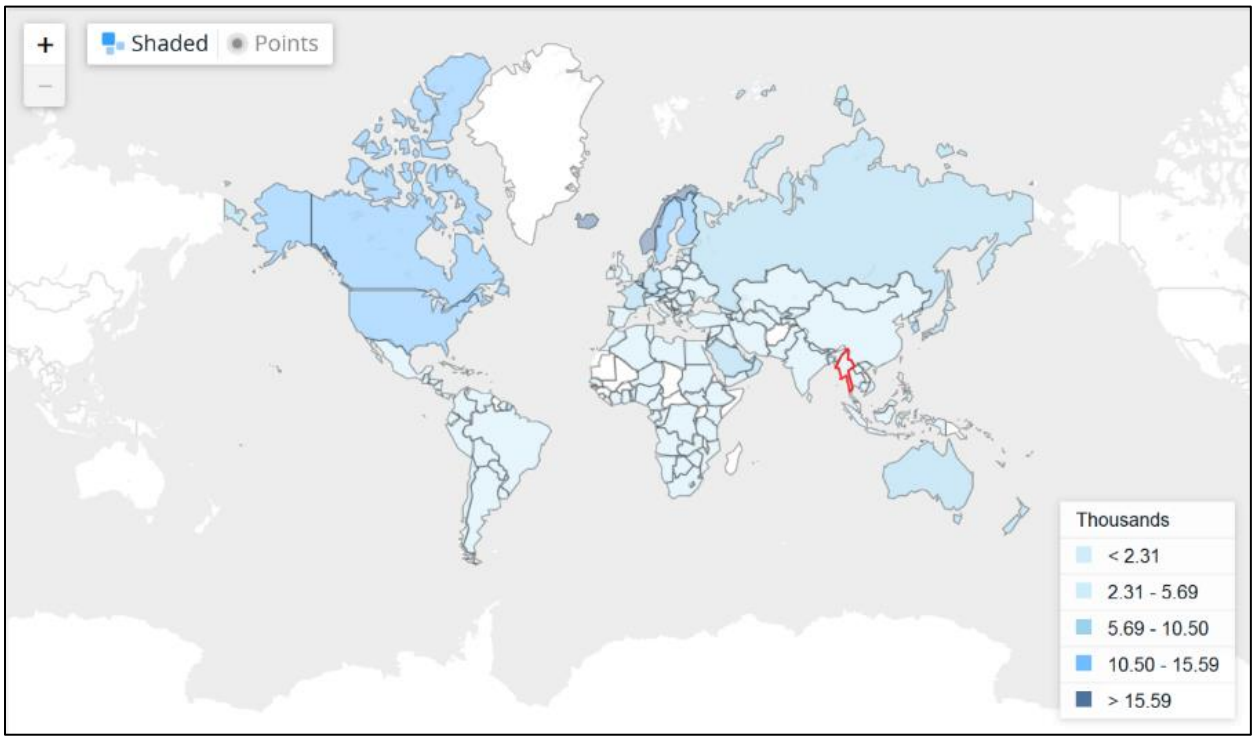

Figure 7: Electric power consumption (kWh per capita) of Myanmar compared to the rest of the world.

Compared to other nations in the Asia-Pacific region, Myanmar produces most of its electricity via hydroelectric sources second only to Nepal as seen in Figure 8. This implies a relatively developed hydroelectricity infrastructure from currently exploited water resources. As new waterways are surveyed and new plants are built, this percentage is likely to increase over time.

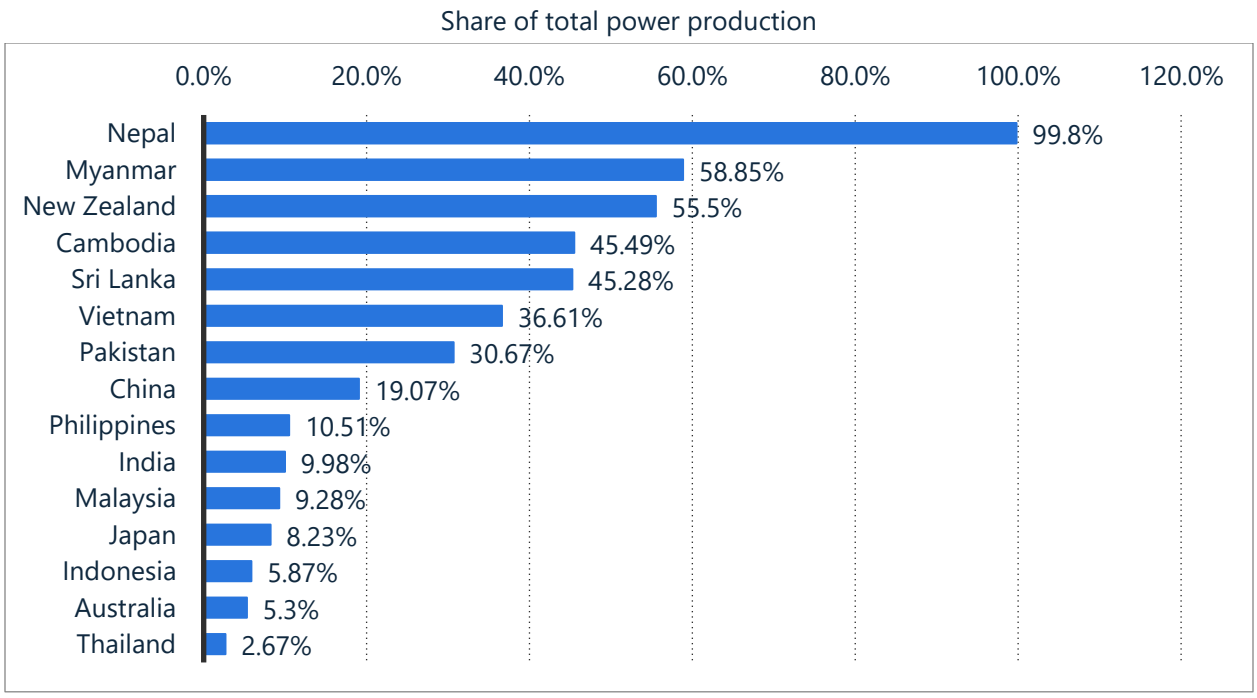

Figure 8: Electricity production from hydroelectric sources in the Asia-Pacific region in 2015 by country.

4. BENEFICIAL TECHNICAL AND ECONOMIC PARAMETERS FOR HYDRPOWER

There are several technical and economic factors in play that are beneficial for hydropower in Myanmar. Most notable among them are the presence of many high head and high flow water resources and the geographical elevation gradient generally sloping downward from north to south in the path of many rivers—by the maximum potential power formula

$$P = Q \times H$$

where P = theoretical power, Q = water flow, and H = head, it follows that a high amount of power is available from the waterways that are yet to be utilized. If hydroelectric power is fully implemented in Myanmar to its maximum potential, it is possible that the overriding majority of electric capacity and generation will be from hydroelectricity.

Furthermore, foreign development investment and joint ventures in recent years between Myanmar and the wider global community have promoted technical collaboration on hydropower projects. This brings in an influx of international expertise and investment cash flow.

Finally, high GDP growth for Myanmar in recent years is a positive indicator of the government's capacity for funding new hydroelectricity projects. As the national budget expands,

many more areas can be surveyed with new feasibility studies that may uncover new water resources which are suitable for hydroelectric power plants. Planned projects may also be able to move to the construction phase with secure financing.

5. MAJOR OBSTACLES IN HYDROPOWER DEVELOPMENT

A number of factors may negatively affect the continued development of hydropower infrastructure in Myanmar. These include (but are not limited to) a number of technical, economic, political, and environmental parameters.

One of the most visible constraints on hydropower development in the modern era is a lack of project financing and related budgetary concerns. Decades of economic stagnation, in addition to corruption (Myanmar ranked 29/100 in the Transparency International Corruption Index in 2018) may reduce project funding while disincentivizing key stakeholders from investing in regional hydropower.

Disputes over land ownership around a planned hydropower site is another obstacle that can significantly delay projects in a country with a largely dysfunctional judicial system. The litigation process is highly uncertain, creating additional barriers to development.

Furthermore, the lack of a highly skilled technical workforce that is properly trained in modern workplace technologies along with a relatively small manufacturing sector that is not focused on heavy machinery such as turbines may also significantly hinder hydropower project progress.

Other factors include civil war with armed ethnic groups, which create conflict zones where it becomes impossible to properly survey and perform feasibility studies of significant water resources. The budgetary drain due to continued conflict also reduces available funding for other endeavors such as hydropower projects. Finally, concerns over habitat destruction, environmental impact (such as effects on biodiversity and preservation of endangered species), population displacement, the protection of archeological sites, and the effects of climate change are all considerations that may sway public opinion against the implementation of many hydropower projects.

Figure 9: Locally fabricated private sector turbines for micro hydropower projects in Myanmar.

6. FUTURE PLANNED DEVELOPMENTS

By the end of 2021, the Ministry of Electricity and Energy plans to expand hydropower, gas, coal, and other renewable energy power plant capacities 4721 MW, 1969 MW, 1925 MW, and 200 MW respectively. By 2031, further infrastructure expansions are predicted to yield 8896 MW, 7940 MW, 4758 MW, and 2000 MW for hydro, coal, gas power plants, and other renewable energy solutions (respectively). These infrastructure upgrades are intended to make grid electricity available to 50% of the nation's population by 2020, 75% of the population by 2025, and 100% of the population by 2030.

There are currently 34 hydropower projects in Ayeyarwaddy River, 8 hydropower projects in Chindwin River, 11 hydropower projects in Sittaung River, 21 hydropower projects in Thanlwin River, 4 hydropower projects in Mekong River, and 14 hydropower projects in other rivers planned for future development. At present, eight hydropower projects are under construction, as listed below:

- 30.4 MW plant at upper Baluchaung in southern Shan state
- 51 MW plant at Upper Kengtawn in southern Shan state
- 280 MW plant at Upper Yeywa in northern Shan state
- 1050 MW plant at Shweli-3 in northern Shan state
- 111 MW plant at Thahtay in Rakhine state
- 3.2 MW plant at Upper Nattrum in Kachin state
- 66 MW plant at Deedoke in Mandalay region
- 100 MW plant at Middle Paunglaung in Naypyitaw.

All the hydropower projects mentioned above are constructed by Ministry of Electricity and Energy except for the upper Baluchaung project, which is being implemented by local companies in build–operate-transfer (BOT) schemes.

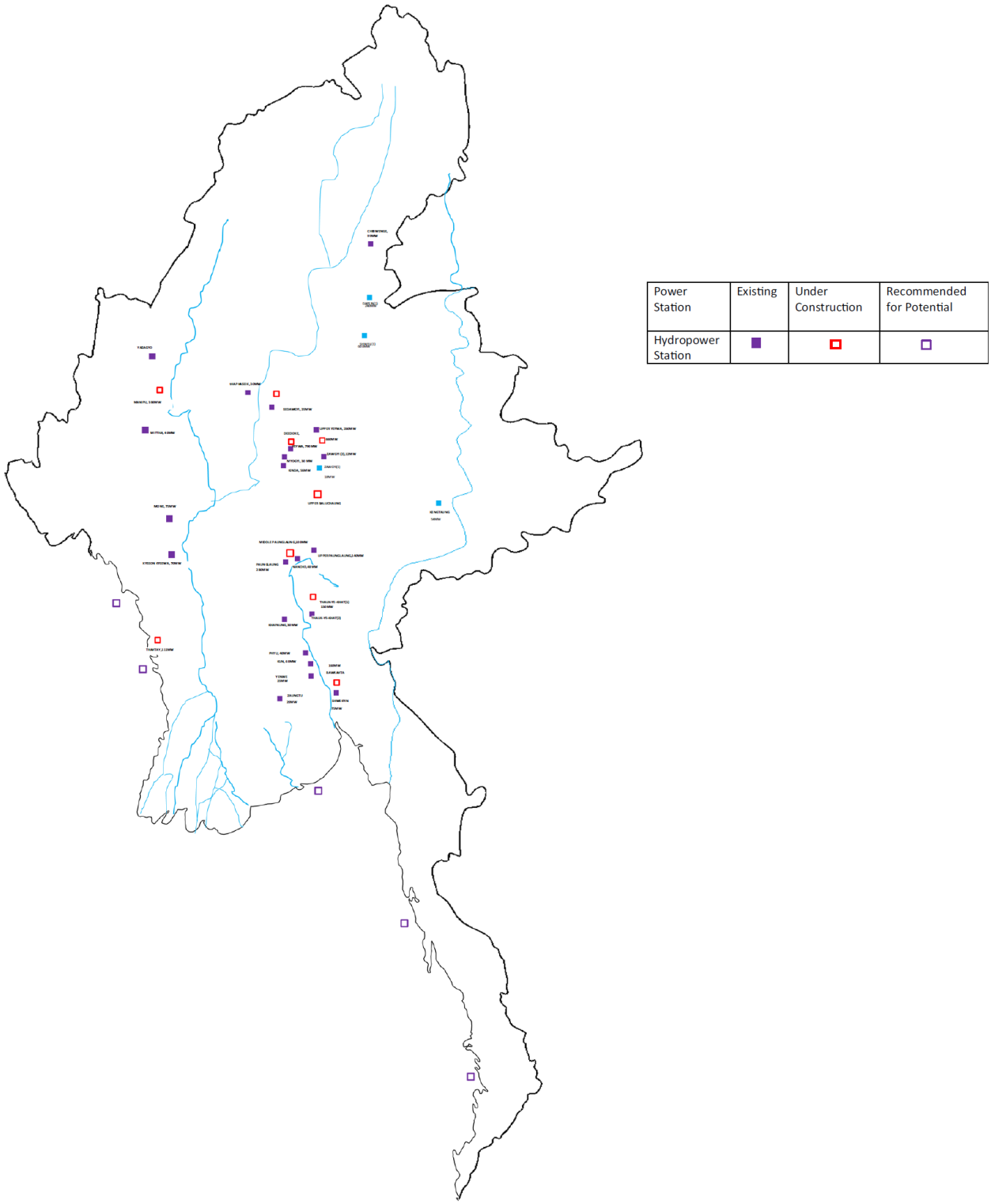

Figure 10: A map of Myanmar showing currently existing hydropower stations along with stations under construction and future planned development locations.

7. CONCLUSIONS

Myanmar is a nation with extensive renewable and non-renewable energy resources. Among these, one of the most significant renewable resources is hydropower. Continued expansion of the hydroelectric power infrastructure in Myanmar is crucial to ensuring energy security as a nation. There is much potential for development, as can be seen in comparisons between Myanmar and the rest of the world.

There are several technical and economic factors in play that are beneficial for hydropower in Myanmar. Most notable among them are the presence of high head and high flow water resources and the geographical elevation gradient generally sloping downward from north to south in the path of many rivers. Furthermore, foreign development investment and joint ventures between Myanmar and the wider global community have promoted technical collaboration on hydropower projects, while high GDP growth in recent years is a positive indicator of the government's capacity for funding new hydroelectricity projects.

Despite these factors, however, there are several major obstacles to hydropower development in the nation. Budgetary concerns are still a significant issue, disputes over land ownership around a planned hydropower site can significantly delay projects in a country with a largely dysfunctional judicial system, and corruption may reduce project funding while disincentivizing key stakeholders from investing in regional hydropower. The lack of a highly skilled technical workforce and a small manufacturing sector that is not focused on heavy machinery may also significantly hinder hydropower project progress. Civil war creates conflict zones where it becomes impossible to perform feasibility studies of water resources and drains the national budget, reducing funding for hydropower. Issues regarding potential habitat destruction, environmental impact, population displacement, archeological heritage site protection, and the effects of climate change are all considerations that may sway public sentiment against the implementation of many hydropower projects. However, as Myanmar continues to develop as a nation, many of these obstacles may be feasibly tackled.

Currently, there are eight new hydropower projects under construction with several more planned for future development. With the growing number of grid electricity consumers, hydropower is sure to remain an integral part of energy infrastructure in Myanmar.

REFERENCES

H. Aung, "Current Status Of Myanmar’s Energy Statistics", Kuala Lumpur, Malaysia, 2017.

L. Taft and M. Evers, "A review of current and possible future human-water dynamics in Myanmar's river basins", *Hydrology and Earth System Sciences*, vol. 20, no. 12, pp. 4913-4928, 2016. Available: 10.5194/hess-20-4913-2016.

M. Saw and L. Qing, *Review on hydropower in Myanmar*. Springer Nature, 2019.

M. Bak, Overview of Corruption and Anti-Corruption in Myanmar. Transparency International, 2019.

S. Hla, "Sai Htun Hla & Brothers Company", Renewable Energy Association Myanmar, 2018.

"Myanmar: electric power generation 2017 | Statista", *Statista*, 2020. [Online]. Available: https://www.statista.com/statistics/1059896/myanmar-electric-power-generation-by-type-of-energy/. [Accessed: 23- Jan- 2020].

"Total hydropower capacity in Myanmar from 2009 to 2018 | Statista", *Statista*, 2020. [Online]. Available: https://www.statista.com/statistics/1006099/myanmar-total-hydropower-capacity/. [Accessed: 23- Jan- 2020].

"Total renewable power generation capacity in Myanmar from 2009 to 2018 | Statista", *Statista*, 2020. [Online]. Available: https://www.statista.com/statistics/872583/total-renewable-power-generation-capacity-in-myanmar/. [Accessed: 25- Jan- 2020].

"Amount of generated electric power in Myanmar from 2010 to 2017 | Statista", *Statista*, 2020. [Online]. Available: https://www.statista.com/statistics/1059861/myanmar-electric-power-generation/. [Accessed: 26- Jan- 2020].

"Electric power consumption (kWh per capita) - Myanmar", The World Bank, 2014. [Online]. Available: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?end=2014&locations=MM&start=1971&type=shaded&view=map&year=2014. [Accessed: 04- Feb- 2020].